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彙編
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A Compilation of Soil and Water Conservation Important Reports from 2002 to 2007 (II)



行政院農業委員會
水土保持局
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行政院農業委員會水土保持局



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行政院農業委員會水土保持局
Soil and Water Conservation Bureau, COA

中華民國九十七年十二月
December 2008

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編者 黃宏斌

行政院農業委員會水土保持局
Soil and Water Conservation Bureau, COA

中華民國九十七年十二月
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序

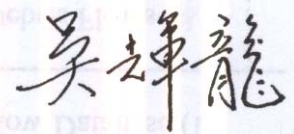
水土保持局為求突破與創新，近 6 年來持續不斷投入經費，辦理水土保持及農村建設之研究計畫，至目前為止，所獲得之資料與研究成果相當豐碩，為能將水土保持及農村建設之研究成果廣泛分享給各界，本局篩選出近 6 年來各項委託辦理計畫之重要成果，並以能詮釋研究精髓之中、英文摘要編撰成冊，將冊本分送各水土保持相關機關、團體、學術單位、法人團體、技師公會及各大圖書館等參考，期能廣為宣導應用，並喚起大眾對水土資源保育之重視，俾利後續推動各項水土保持工作。

本計畫蒐集所有 91—96 年度之水土保持及農村建設研究計畫，邀請長期投入水土保持與農村建設研究發展領域之專家學者篩選出 200 篇以上，水土保持篇分為：土石流防災與宣導、工程技術、工程管理、生態工法、坡地管理、集水區規劃共六項，另農村建設一大篇，共將本彙編分成水土保持領域上冊、水土保持領域下冊及農村建設領域乙冊等共 3 冊。

本計畫「水土保持及農村建設研究發展成果彙編」在收集資料過程中，因資料取得不易，因難重重，能如期編輯完成付梓，感謝各計畫執行人之配合、編審委員的專業審閱，以及本局同仁之策劃與協調，方得以如期出版，謹此深致謝忱。

行政院農業委員會水土保持局

局長



謹識

中華民國九十七年十二月

目 次

CONTENTS

序

第四篇：生態工法 Part IV : Ecological technology

生態工程推行成果評估與研究(94-96年)-----	曾晴賢	---1
The Soil and Water Conservation Bureau (SWCB) Council of Agriculture(COA) Assessment and Research on the achievements of Ecological Engineering Methods(III)		
坡地植生工程暨植生調查應用手冊-----	林信輝	---17
Manual of Slopeland Vegetation Engineering and Investigation Method		
緩衝綠帶帶寬與適用植物之研究(第三年)-----	吳嘉俊	---21
Research of Strip Width and Suitable Grass Species for Grass Buffer Strips (III)		
環都市周邊山坡地防災與生態工程之研究(第二年)-----	朱子偉、林鎮洋、 鄭光炎、陳偉堯	---25
Disaster Mitigation and Ecological Study of Hillside Areas Surrounding Major Cities (2nd year)		
邊坡穩定生態工程圖冊查詢系統建置及穩定性分析之研究-----	范正成	---27
Establishing and Development of the Graphic Displays Information Systems of Ecological Engineering on Slope Stability and Stability Analytical Method		
九份二山紀念園區植物手冊-----	鄭雅芳、林信輝	---29
Handbook of Plants in Jioufenershan Memorial Park		
坡地植生草類與綠肥植物-----	林信輝	---31
Grasses and Green Manures Used on the Slopeland		
土石流及崩場地源頭水土保持處理工作手冊-----	林信輝	---35
Handbook of Debris Flow and Landslide Source Treatments for Soil and Water Conservation		
緩衝綠帶帶寬與適用植物之研究(第二年)-----	吳嘉俊	---38
Research of Strip Width and Suitable Grass Species for Grass Buffer Strips (II)		
坡地保育多元化經營之研究-----	歐聖榮	---42
The Study of Multiple Management in the Preservation on Slope Areas		

坡地植生與保育功能之調查研究 -----	林俐玲、張舒婷、蔡義誌	---44
Investigations on Slopeland Vegetation and Its Conservation Functions		
推動生態綠化策略及苗木培育分析方法 -----	張焜標	---46
Promoting the Strategies of Ecological Greening and Analysis of Nursery Stock Growing Method		
緩衝綠帶帶寬與適用植物之研究 -----	吳嘉俊	---50
Determination of the Width of Buffer Strip and Suitable Grass Species		
應用生態指數探討九份二山、華山及草嶺地區植生復育之空間分布與調查分析 -----	林昭遠	---52
The Spatial Distribution and Investigation Analysis of Vegetation Recovery for Chufenursan, Huasan, and Tsaolin Areas Using Ecological Indices		
草帶法應用植物及土壤保育之效益評估 -----	吳嘉俊	---56
Assessment of Effectiveness of Grass Strip in Soil Conservation		
野溪生態調查及棲地改善模式之建置(第二年) -----	林信輝、蔡志偉	---58
Establishment of Ecological Investigation and Habitat Enhancement Model for Creeks (2nd Year)		
集水區生態工法規劃設計參考模式之建立(第二年) -----	王傳益	---61
Integrated Watershed-level Planning and Design Model of the Natural Ecological Engineering Methods (Second Year)		
集水區生態資源調查手冊 -----	林信輝、蔡志偉	---90
Handbook of Watershed Ecological Resources Survey		
不同植被水土保持功能之調查規劃 -----	林俐玲	---92
Investigation and Planning on the Function of Plant Cover for Soil and Water Conservation		
埤仔溝溪集水區自然生態工法博覽會規劃及設計 -----	吳嘉俊	---94
Ecological Engineering Expo – Pi-Tsia-Ko Creek Watershed		
培地茅於崩塌裸露地之應用與規劃設計 -----	吳嘉俊	---96
Application and Design of Staking-and-Wattling and Vetiver Grass on Bare Slopes		
集水區自然生態工法規劃設計參考模式之建立 -----	王傳益	---99
Integrated Watershed-level Planning and Design Model of the Natural Ecological Engineering Methods		

第五篇：坡地管理

Part V : Slope land use management

利用遙控無人載具進行易淹水地區上游環境資訊蒐集建置與分析 -----	---101
----- 周天穎、葉美伶	
Using Remotely Piloted Vehicle to Collect and Analyze Environment Information in Flood-prone Area	
整合衛星影像輔助山坡地變異點判釋及石門水庫集水區現況監測 -----	---104
----- 陳錕山、梁隆鑫、朱昶任、吳沛儒、江陽聖、高郡汝	
Identification of Land Use Changes in the Slope Lands and Landslides in the Shihmen Reservoir by Using Satellite Imagery	
山坡地可利用限度分類標準檢討 ----- 林俐玲、陳克強、何國謙、張光宗	---107
Review of Classification Standard for Slope Land Utilizable Limitation	
山坡地管理作業參考手冊 ----- 林昭遠	---109
Reference Handbook for Slope Land Management Practices	
石門水庫集水區水土保持管理及土石流防災教育宣導計畫 ----- 巫仲明	---111
Soil and Water Conservation Management and Debris Flow Disaster Prevention Education and Publicity Plan for SHIH-MEN Reservoir Watershed	
坡地集水區分析整合系統研發 ----- 林昭遠	---113
Integration of the Slope Land Watershed Analysis System	
研修山坡地管理作業參考手冊及研編查詢網頁計畫 ----- 林昭遠	---115
Slope Land Management Reference Handbook Modification and Inquiry Website Improvement Project	
農路調查與環境修復衝擊評估 ----- 連惠邦	---119
The Inquisition of Agricultural Roads and The Valuation of Repair Environment Impact	
運用衛星影像輔助山坡地變異點判釋 ----- 陳錕山、梁隆鑫、	---126
----- 朱昶任、吳沛儒、劉岫雲、江陽聖	
Identification of Land Use Changes in the Slope Lands Using Satellite Imagery	
衛星影像變異點查證網際網路管理系統開發(2/3) - 蔡明璋、張英暉、周天穎	---129
Changed Point Areas Inspection and Management System (2/3)	
山坡地查報取締實務研討會及執行成效研究 ----- 林昭遠	---131
Research for Slope Land Violation Investigation and Enforcement Practice Conference and Implementation Benefits	
衛星影像輔助山坡地監測與管理教育訓練 ----- 蔡明璋、張英暉、周天穎	---133
Educational Training on Slope Land Management and Monitoring Via Satellite Images	

衛星影像變異點查證網際網路管理系統開發(1/3) - 蔡明璋、張英暉、周天穎	---	135
Changed Point Areas Inspection and Management System (1/3)		
水土保持相關法規解釋函彙編專家系統 ----- 林昭遠	---	137
Establishment of Expert System for Compiling the Declaratory Statutes of Soil and Water Conservation		
網際網路地理資訊系統、土石流資訊系統、工程管考系統維護提昇 -周天穎	---	139
The Maintenance and Upgrade of Internet Geographic Information System, The Debris flow Information System, The Engineering Management System		
遙測技術在崩場地、土石流量化分析及坡地管理監測之應用(二)-- 周天穎、	---	141
----- 袁嵐焜、郭靜怡		
The Project of Application of the Technology of Remote Sensing on collapse, Debris-Flow Quantification Analysis and Slope Management (2)		

第六篇：集水區規劃

Part VI : Watershed planning

上坪溪集水區整體治理調查規劃 ----- 童文麟	---	143
The Sun-Pie River Watershed Investigation And Planning		
東港溪等上游集水區整體調查規劃 -----王佩兮	---	145
Integrated Assessment and Planning for Upper Watersheds of DongGang River		
後龍溪及中港溪等上游集水區整體調查規劃 ----- 林俐玲、馮正一	---	153
Investigation and Planning of the Watersheds of Hou-Long Stream and Zhong-Gang Stream		
梨山地區地層滑動基準檢核及監測系統維護資料分析 ----- 蘇苗彬	---	158
Reevaluation of Criteria for Safety Management and Maintenance of Monitoring Systems of Li-Shan Landslide Area		
通霄溪集水區上游坡地水土保持整體治理調查規劃 ----- 連惠邦	---	160
The Integrated Regulation Planning of Soil and Water Conservation on Tong-Siao Watershed		
集水區研發技術應用暨多元化發展 ----- 周天穎	---	164
The Application and Diverse Development with Watershed RD Technology		
塘下橋集水區上游坡地水土保持整體治理調查規劃 ----- 鄭魁香	---	166
Integrated Investigation and Planning of Water-Soil Reservation at Upper Stream Land Slope on Tongha Bridge Watershed		
濁水溪上游集水區整體調查規劃 -----蘇苗彬、陳毅輝、曾國維	---	170
Watershed Management Planning for Jhuoshueisi		
濁水溪上游集水區整體調查規劃圖表與解說彙編 ----- 蘇苗彬	---	172
A Pictorial Guide of Watershed Management Planning for Jhuoshueisi		

大坑溪上游集水區整體治理調查規劃 -----	連惠邦	--174
Integral Investigation and Management Project of Da-Ken Creak Upstream Watershed		
大村及三家春集水區上游坡地水土保持規劃 -----	連惠邦	---177
The Upstream Management of Soil and Water Conservation on Da-Tsuen and San-Jia-Tsuen Watersheds		
山腳村七鄰崩場地整體治理調查規劃 -----	吳正義、黃貞凱	---180
The Renovation Planning for the Landslide in the 7th Neighborhood, Shan-Jiao Village		
北區土石流防災專員培訓 -----	巫仲明	---184
North Debris Flow Disaster Prevention Education, Publicity and Training Observer		
石門水庫白石—秀巒子集水區整體治理調查規劃 -----	魏迺雄	---186
Integrated Shihmen Reservoir Watershed Management Plan-A Case Study of Baishih- Shiouluan Sub-Watershed		
花蓮地區治理成效風貌展現規劃 -----	穆青雲、周天穎	---190
The Promotion Plan of the New Rural Village's Appearance with Hualien Region		
南勢溪上游集水區整體治理調查規劃 -----	周明坤	---192
Investigation and Planning for the Integral Control on the Watershed in the Upstream of Nan Shih Chi		
美濃集水區整體治理調查規劃 -----	鄭麗瓊、蔡文鎗	---204
The Minon Watershed Management Planning		
烏山頭水庫集水區山坡地整體治理調查規劃 -----	鄭麗瓊、蔡文鎗	---206
The Wu-Shan-Tou Reservoir Watershed Management Planning		
梨山地區地層滑動管理基準檢核及監測系統維護資料分析 -----	蘇苗彬	---208
Reevaluation of Criteria for Safety Management and Maintenance of Monitoring Systems of Li-Shan Landslide Area		
雙溪集水區上游坡地水土保持整體治理調查規劃 -----	周明坤、黃偉倫	---210
The Integrated Regulation Planning of Shuang-Si River		
小北坑野溪集水區整體治理調查規劃 -----	周明坤、黃偉倫	---217
The Integrated Regulation Planning of Siao-Bei-Keng River		
抽藤坑溪集水區調查規劃 -----	鄭麗瓊、蔡文鎗	---222
Chou-Teng-Keng Creek Watershed Management Assessment		
屏東縣牡丹鄉旭海溪集水區整體治理調查規劃 -----	尹念秦	---226
Project of Xuhai Stream Watershed Management, Mudan Shiang, Pingtung County		
梨山地區上游集水區整體調查與治理規劃 -----	蘇苗彬	---228
Investigation and Remedial Plan for Upstream Catchment of Li-Shan Area		

通霄沿海集水區整體治理調查規劃 -----	連惠邦	---230
The Integrated Regulation Planning of Tong-Siao Circumlittoral Watershed		
萬里磺溪集水區整體治理調查規劃 -----	鄭麗瓊、蔡文鎗	---234
The Wan-LI Watershed Management Planning		
潭子內集水區整體治理調查規劃 -----	陳智誠	---236
Managing and Investigative Plan of Whole Tan-tsu-nei Watershed		
安通溪及磯崎集水區生態資源調查及規劃 -----	林昭遠	---241
Ecological Resources Investigation and Planning for the Anton Stream and Geechi Watershed		
基隆河圓山子分洪(瑞芳地區)野溪集水區整體治理調查規劃 -----	鄭麗瓊、蔡文鎗	---246
The Soil and Water Conservation Management Assessment at Wild Creek Watersheds at Ruei-Fang Township Region in the Upstream of 「Keelung River Yuanshantzi Flood Diversion Project」		
新樂水田野溪集水區整體治理調查規劃 -----	周明坤	---249
Investigation and Planning for the Integral Control on the Watershed of Hsin Le Shui Tien Wild Creek		
南勢溪集水區整體治理調查規劃 -----	連惠邦	---259
The Integrated Regulation Planning of the Watershed of Nan-Shih River		
梨山地區地層滑動整治計畫成效評估 -----	蘇苗彬	---261
Performance Evaluation on the Renovation Work for Li-Shan Landslide		
梨山地區地層滑動整治計畫成效評估 -----	蘇苗彬	---263
Performance Evaluation on the Renovation Work for Li-Shan Landslide		
清水溪集水區土砂災害重點區段整體治理調查規劃 -----	鄭麗瓊、蔡文鎗	---265
Control Planning in Debris Flow Disaster Zone at the Chin-Sui Creek		
蘭陽溪繼光橋上游治理規劃工程 -----	莊聿今	---268
Project of Lan-Yang River Management (Ji-Guang Bridge) at Upstream		

第四篇：生態工法
Part IV : Ecological Technology

計畫名稱	生態工程推行成果評估與研究（94—96 年） The Soil and Water Conservation Bureau (SWCB) Council of Agriculture(COA) Assessment and Research on the achievements of Ecological Engineering Methods(III)
主持人	曾晴賢 Tzeng, Chyng-Shyan
計畫年度	96 年
<p style="text-align: center;">摘 要</p> <p>本研究於民國 94—96 年，陸續針對包含花蓮縣壽豐鄉荖溪和白鮑溪、台北縣雙溪鄉丁子蘭溪、苗栗縣獅潭鄉新店溪（以上 94 年度進行）、南投縣中寮鄉樟平溪、台南縣白河鎮六重溪、台東縣東河鄉羊橋溪（以上 95 年度進行）、台北縣雙溪鄉后番子坑溪、新竹縣尖石鄉那羅溪及屏東縣牡丹鄉旭海溪（以上 96 年度進行）等共九個水土保持局生態工法示範集水區的生物廊道現況進行評估研究。研究方法採用森下等（2000）所提出的「河川生息環境評估法」(Habitat Index Method, HIM) 內十個簡易指標進行評估（表 1），透過調查該河段棲地環境、生物廊道現況，以及當地溪流生物組成與數量，以瞭解其縱向或橫向構造物是否對生物造成通行上的阻礙。</p> <p>HIM 的各項評估指標主要著重在生物廊道的暢通與否，棲地多樣化的程度，以及河床恢復穩定的時程。和一般評估方法不同的是，HIM 希望以比較簡易且快速的方式進行，透過對當地環境的一些觀察，就可以直觀的進行評估與比較。HIM 的方法由於可以快速進行河川生態工法設施的評估，加上其項目同時考量物種多樣化與棲地豐富，因此越來越受到大家的重視。</p> <p>HIM 中的各項因子，雖然看起來十分簡單，但其實都內含相當豐富的生態意義，以下為各項因子的簡介。</p>	

表 1 河川生息環境評估法各項指標與說明

項目	棲息環境的指標性條件	分數	評價標準
HIM1	河川上下游是否貫通	5	魚可自由移動
		3	可稍微移動
		1	不可移動
HIM2	支流是否有效相連	5	可經常移動
		3	不容易往支流移動
		1	無法移動
HIM3	有無被水淹沒率高的水邊(濕地)或伏流水源	5	經常出現的濕地
		3	一年 2、3 次的覆水濕地
		1	數年覆水一次
HIM4	河床上有無大小石頭	5	河床材料多樣性
		3	大都是同樣大小的石粒
		1	只有石頭或泥土、砂石
HIM5	有無大小不同的水深	5	富變化
		3	在一定範圍內的水深變化
		1	水深沒有變化
HIM6	有無大小不同的流速	5	流速變化大
		3	有一點變化
		1	流速平穩
HIM7	有無水生植物	5	有各種的水生植物
		3	有少許同種類的水生植物
		1	沒有水生植物
HIM8	水邊林有無連續	5	水邊林連續，突出水面
		3	水邊林稀疏
		1	沒有水邊林
HIM9	水面上有日照嗎	5	水面上的日照時間短於每天六小時以下
		3	有陰暗、有明亮
		1	全部都日照
HIM10	擾亂的程度	5	改變後經過一點時間會安定
		3	改變不明顯
		1	返復改變

HIM1：河川上下游是否貫通

由於溪流中許多生物，包含魚蝦蟹類都有洄游的行為，即使是純淡水魚，也會因繁殖或覓食需求，而在河川上下游間成群移動。對於河川流量變動非常劇烈的野溪而言，魚類在高水時期經常會被沖往下游，而水退之後就會想辦法回到原本棲息的中上游河段，因此溪流的上下游間是否可以維持暢通，就十分

重要了！由於橋樑、水利或農業的用途，溪流中會有許多大小不同的橫斷構造，這些構造都會影響到溪流間的廊道，進而阻礙生物的洄游行動。為了減低影響程度，往往需要考慮橫斷構造物的規模或是應該有魚道等輔助廊道的興建，本項指標即是評估這些構造物或是生態廊道設施等是否可以減少生物廊道的阻礙或是完全發揮連接的功能。譬如河川橫斷構造物如果不影響生物的洄游，基本上不需要特別加設其他輔助設施，但是如果該構造物會影響生物的洄游，則必須增設如魚道等可供生物洄游的輔助設施。這些設施的功能是否發揮，還是只能發揮部份的功能，都是我們想要了解的地方。

由於每種魚洄游的時間與方式都不同，同一條河上下游所利用的物種也大不相同，因此本項指標在不同魚種以及不同河段中也不有不同的參考標準。「5分」表示魚類可以完全自由移動，「3分」表示可以稍微移動。「1分」則表示完全無法移動。

HIM2：支流是否有效相連

一條河川通常有許多支流組成，各個支流由於集水區環境不同，而呈現不同的特性，通常支流會具有較主流來得低些的水溫，可以避免主流的水溫升高，有些支流則帶來豐富的食物來源，也可以吸引許多魚群。此外一些小支流雖然平常可能不會有太多生物分佈，但在洪水來臨的時候，由於水位高漲，主流變得湍急，支流反而成爲良好的避難所。待水退之後，魚群才又回到主流。此外，小支流由於水流較爲緩慢，且底質通常均質，而成爲螺貝類或是一些底棲生物如水蟲的產卵場所。而這些都是許多魚類重要的食物來源。在此項標準中，「5分」表示魚類可以完全自由來往主支流間，「3分」表示不太容易往支流移動。「1分」則表示完全無法前往支流。

HIM3：有無被水淹沒率高的水邊濕地或伏流水源

河岸邊有時會有一些地方經常是水池或濕地的環境，大部分是爲地下伏流或是經常遭遇淹水所形成的，這樣不穩定的環境很容易被人類認爲是沒有辦法利用的環境。但實際上這環境的存在，提供許多生物的躲藏空間，也創造出河岸草生環境的多樣性，對自然河川來說相當的重要。「5分」表示河岸邊有經常出現（淹水）的濕地環境，「3分」表示一年可能出現2~3次短期的濕地環境。「1分」則表示可能要好幾年才出現一次。

HIM4：河床上有無大小石頭

河床底質的多樣性與河床棲地有密切的關係，例如：有巨石的存在，才可能有深潭的出現。加上，許多魚類在其生活史的各時期，往往會利用到不同的底質環境，譬如一般的鮎魚或是石賓等溪流魚類會啃食石頭上附著的藻類和水生昆蟲，如果石頭太小就不容易穩定生長藻類和水生昆蟲。但是有一些魚類必須在小石頭或是砂礫間躲藏，譬如小鰻魚、砂鰍、鰍鮓或是許多的蟹類。有一些魚類必須在中型石頭下方築巢產卵，譬如日本禿頭鯊等蝦虎魚類。因此其河床石礫的分佈，也可以視為河川環境健康與否的指標之一。「5分」表示河床底質組成十分多樣化，「3分」表示都多是同樣大小的石礫。「1分」則表示只有石頭、泥土或砂石。

HIM5：有無大小不同的水深

此項指標可以視為所謂棲地型態(Meso-habitat)的多樣性，一般河川中都應該可以見到潭、瀨、流等各種不同棲地的變化，才可以創出不同的環境給魚類生存。深潭是魚類休息或是躲藏的地方，但是過深的深潭因為食物量通常會比較少，反而不一定是有很好的生產力。一般在水深兩公尺以內的河川中，因為陽光照射得到，所以石頭的表面會長藻類。如果水太淺了，陽光的照射過於強烈，加上水流太緩的話，就容易滋長綠藻等魚類不是非常喜歡的藻類。同時，如果水流太淺，魚類無法躲過水鳥的攻擊，通常很難長到較大的體型。這也是許多人工整治後的河川，因為棲地環境過於均質化，因此生物數量和體型整個降低。深潭水域因為陽光較無法到達，基本上生產力較弱，無法提供較充足的食物來源。急流與深潭基本上有如夫婦般的關係，在河川中缺一不可，同時也要相互的平衡。對此項指標來說，「5分」表示具有深淺不同的水深變化，「3分」表示在一定範圍內具有變化。「1分」則表示水深沒有變化。

HIM6：有無大小不同的流速

HIM4 不同底質石頭大小、HIM5 不同水深與本項 HIM6 不同流速三項，其實是互有相關的因子。急流地區通常是河川中非常重要的生產區，因為陽光曝曬強烈，同時水較淺而且氧氣充沛，藻類和水生昆蟲的生長極為快速，因此可以提供非常多的食物來源。流水性的魚類雖然平常棲息在水流較湍急的水域覓食，但在夜間或休息時，仍會集中在較緩的深潭水域環境。在許多人工整治的

灌溉渠道中，水流的速度都非常快，這樣的環境基本上無法提供魚類的棲息之用，因此環境的條件會相當惡劣。可是，如果一些水流非常緩慢的河段，因為缺少落差的天然曝氣機制，水中的溶氧量將會明顯的降低，對於一些需要高溶氧的魚類而言極為不利。再加上前面所敘述的流速較高的時候比較不會滋生魚類不喜歡啃食的綠藻，以及石頭表面比較不會沈積泥沙等關係，都是我們必須了解一條健康河川需要有不同的流速的原因。流速 1m/sec 以上可以視為「大」流速，而流速 0.05m/sec 以下可以視為「小」流速。「5 分」表示流速變化大，「3 分」表示流速有一些變化。「1 分」則表示流速相當平穩，完全沒有變化。

HIM7：有無水生植物

河岸邊的植物可以幫助減緩洪水速度，也可以提供底棲生物或魚類的躲藏空間，許多水生植物亦且有淨化水質的功能，因此水生植物的多樣性，對溪流來說也是重要的指標。「5 分」表示河中有各式各樣的水生植物，「3 分」表示有一些同種類的水生植物。「1 分」則表示沒有水生植物。

HIM8：水邊林有無連續

連續的水邊林可以形成生物廊道，讓陸域生物在其中活動無礙，並且提供昆蟲良好的躲藏空間，這些陸生昆蟲或是水生成蟲，都提供了魚類及鳥類的食物來源。河川的樹蔭可以提供魚類棲息的場所。對河川的下游來說，由於河岸通常較遠，因此連續性的河岸林顯得更為可貴。這些溪畔林在洪水來臨時，並且可以提供護岸基腳的緩衝保護空間。此外，河岸林亦提供了緩衝帶，讓兩岸匯入的水流（伏流）可以經過濾作用而減輕可能的污染。對該項指標來說，「5 分」表示岸邊有連續的樹林，且突出於水面，「3 分」表示河邊可見稀疏的。「1 分」則表示完全沒有河岸樹林。

HIM9：水面上有日照嗎

本項指標屬於物理性指標，主要是考量水溫的高低，因為日照時間越久，溪流的水溫將會越高，可能將造成溶氧過低，以及藻類增生，使得魚類不適合棲息其中。而且兩岸沒有覆蓋的情況下，水溫的溫差也會變大，也不利於魚類繁殖或生存。譬如台灣的櫻花鉤吻鮭所需要的生長水溫要低於 17°C，繁殖水溫要低於 12°C，但是水溫的變化如果超過 3°C 以上的話，對於繁殖時期卵的孵化

會有很大的影響。台灣山區의 鮎魚平常生活在水溫低於 20°C 以下的河段，但是如果河川受到日照的影響，有時水溫會徒昇超過 7~8°C，對於該種魚類的生長或是繁殖都極為不利。根據對魚類生息地偏好的研究指出，同一河段，日照時間超過 8 小時，就可以視為「陽性」河段，日照時間低於 6 小時，則可以視為「陰性」河段，陰性河段由於日照時間相對較短，對於溪流水溫以及魚類來說通常是更為好些的。在水保局管轄範圍之內的山區溪流大都是一些嗜流水性的冷水性或是狹溫性魚類，如果水溫的變化過大，很容易就有一些廣溫性的外來種侵入。「5 分」表示水面日照時間低於 6 小時，「3 分」表示有陰暗有明亮的部分。「1 分」則表示完全受到日照影響，沒有任何遮蔽。

HIM10：擾亂的程度

如同「滾石不生苔」一般，不斷擾動的河床也無法形成穩定的附著藻類，這些藻類可以是魚類或水棲昆蟲的食物來源，也可以提供躲避的場所。因此河床經過擾動後，恢復時間越短，對河內的生物會越好。河床的安定程度因為底質和周遭環境的條件而有所不同，以及整個地區是否經常性的施工或是自然擾動也有關係。有的地區幾乎是長年在施工，河川幾乎沒有休息的機會，這樣的地區對於河川的生態極為不利。「5 分」表示改變後經過一些時間後會形成安定，「3 分」表示雖然有改變但並不顯著。「1 分」則表示往復改變，沒有穩定的時候。

本研究綜合 3 年來針對九個不同地點集水區 HIM 的評估結果如表 2，並簡述內容如下：

1. 花蓮荖溪與白鮑溪：雖然荖溪與白鮑溪有許多人工構造物，不過後來針對一些構造物設置魚道等生物廊道設施，加上其他棲地條件保持十分優良，因此 HIM 平均分數還算不錯，評等屬於「佳」。
2. 台北丁子蘭溪：雖然有河中有不少固床工形成阻隔，但是有些河段的自然與棲地環境較佳，因此仍有不錯的 HIM 評分。評等屬於「尚可」。
3. 苗栗新店溪：流域內的生物種類相當豐富，不過因為有人工構造物的阻隔，加上底床亦有潛壩與固床工等人工設施，因此 HIM 評分僅略高於丁子蘭溪。評等列為「尚可」。
4. 南投樟平溪：由於有不少固床工形成阻隔，且兩岸開發密集，因此自然環

- 境狀況也未盡理想，因此 HIM 評比的分數不高。評等屬於「尚可」。
5. 台南六重溪：原本該流域有一些防砂壩設施，不過許多都已設置魚道等廊道，不過有些廊道並未完全發揮效果，加上自然環境不夠好，因此 HIM 分數相對在各集水區中是比較低的。因此評等屬於「差」。
 6. 台東羊橋溪：該流域的兩岸自然環境維持的還不錯，不過有些河段仍然受到固床工阻礙，加上河道底質狀況不夠多樣，因此 HIM 的分數不高，屬於「尚可」等級。
 7. 台北后番子坑溪：本流域集水區中各個河段因為施工強度不高，因此復原很快，在 2003 並選拔成爲「台灣生態工程博覽會」的示範集水區會場。在 HIM 評比各河段分數相似，總體評價等第屬於「佳」層級。
 8. 新竹那羅溪：流域內的生物種類相當豐富，不過因爲人工構造物仍然形成阻隔，以及缺乏河岸林，因此某些項目評分不佳，不過因爲流速較快，因此水溫並未如想像中提高，只有在一些較爲緩慢的區域影響較大。因此 HIM 總分仍高，等級評價在「佳」的程度。
 9. 屏東旭海溪：旭海溪各河段因爲沒有明顯的構造物，加上河岸兩側的自然程度也還維持得不錯，生物調查狀況也都顯示相當豐富，因此 HIM 評估表現相當優秀，屬於「佳」層級。

表 2 本研究中各流域以「河川生息環境評估法」結果比較表

河段	花蓮壽豐港溪 與白鮑溪	台北雙溪丁子 蘭溪	苗栗獅潭新店 溪	南投中寮樟平 溪	台南白河六重 溪	台東東河羊橋 溪	台北雙溪后番 子坑溪	新竹尖石那羅 溪	屏東牡丹旭海 溪
項目	平均	平均	平均	平均	平均	平均	平均	平均	平均
HIM1 上下游是否貫通	2.2	3.0	2.3	2.0	1.7	2.3	3.0	2.3	4.3
HIM2 支流是否有效相連	1.0	2.3	2.3	2.0	3.0	1.0	4.3	2.8	4.3
HIM3 有無穩定濕地伏流	4.2	3.0	3.0	2.0	1.0	1.7	5.0	3.7	4.3
HIM4 河床上有無大小石頭	4.6	3.7	2.3	1.0	3.0	3.0	3.0	3.7	3.0
HIM5 有無大小不同的水深	3.0	1.7	2.3	3.0	3.0	1.7	3.7	2.6	3.7
HIM6 有無大小不同的流速	3.0	1.7	1.7	3.0	1.7	1.7	3.7	3.9	3.7
HIM7 有無水生植物	2.6	1.7	3.0	1.0	1.0	1.0	4.3	2.8	3.7
HIM8 水邊林有無連續	3.8	2.3	3.0	3.0	1.0	3.0	3.0	3.0	3.0
HIM9 水面上有日照嗎	3.4	2.3	3.0	1.0	1.0	2.3	2.3	2.1	3.0
HIM10 擾亂回復的程度	4.2	3.0	2.3	3.0	3.0	3.0	4.3	4.8	3.7
總分	32.0	24.7	25.3	21.0	19.3	20.7	36.7	31.6	36.7
等第	佳	尚可	尚可	尚可	差	尚可	佳	佳	佳

多樣性的棲地除了意味著可以提供給不同需求的生物所需的物化條件之外，也意味著會有比較多樣的生態組成。舉例而言，如果我們把一個河段都營造成連續的湍湍流水，看起來好像可以讓河川水中的溶氧量提高，一些附著性藻類和水生昆蟲等生產量也會提高，應該會有更多的魚類生產量才對。其實不

然，因為光是這樣的基礎生產區還不夠，也要有魚類的休息區或是繁殖區。如果不能搭配急流和深潭交互的環境條件，基本上對於河川生態是相當不利的。因此，在河川中有不同的大小石頭、水深和流速，都意味著棲地的多樣性的高低。

由於以往生態工法的概念是希望能夠以人的方法，去塑造一個生物可以棲息的空間。但近來年如日本等先進國家，其觀念已經逐漸轉變，開始有所謂以自然的力量復原魚類本來就應該擁有的棲息空間的概念。此兩種概念在原理與觀念上有許多不同，對魚類來說，以前的概念是只要「可棲息」即可，而現在則進步至「適合棲息」。過去經常運用的生態工法規劃方式，通常不容易營造出多樣性的河川棲地。譬如我們大都以一維的水理計算公式，求得河川的平均流速，將河川整體的斷面都均質化，或是缺乏河相學的概念，把蜿蜒的河川給直線化，都會使河川的棲地單純化。如果要讓河川環境有更多樣的棲息地，則在規畫的時候，所要運用的工程技術和思考的深度，就必須比目前大家所常用的模式還要提高和用心。

基本上，我們目前所評估的幾個示範集水區，其基本生態條件和生物資源都算是相當良好，遠比一些缺乏適當規畫的野溪有更豐富的生態環境。但是，我們所提供的十項評估項目之評分，可以讓主辦的工程師了解，如果想要更確實的營造好的河川環境之時，有哪些可以思考和探討的項目。雖然這些檢討的項目未必能夠和大家所常常看到的許多硬梆梆的科學分析模式一樣嚴謹，但是每一個項目的內涵都非常重要，同時也可以讓一般的民眾藉由五感法，就可以清楚的體會我們所營造的河川環境是否良好，這可是其他科學分析模式不容易做到的地方。

本研究並舉辦「生物廊道改善研習會」，召集包含水保相關學者、政府單位以及顧問公司等數十位人員參與研習，研習課程內容為台灣魚道現況，並針對新竹縣關西鎮牛欄河中的攔砂壩進行簡易式魚道的搭設與練習。

根據以上結果，我們提供幾項建議如下：

1. 逐年分區檢討與改善既有的生物廊道：在後續的年度中，按照不同示範集水區，分別檢討各集水區內應該改善的生物廊道工程，並且實地的調查各工程所需要改善的項目。

- 2.研發創造多樣性河道的工法：過去許多溪流整治工程，往往在設計階段沒有考慮到保留河道的多樣性，因此大都藉由整平河道的方式收尾。也因此，許多河道在整治後都被夷為平地，缺乏深潭和急流交互的多樣性環境。由於深潭是溪流生態中最重要，也是最不容易保留和創造的棲地，如果在規劃設計階段就知道怎樣考慮進去這樣的需求，往往對溪流生態的傷害非常大。
- 3.建立生物廊道改善示範區：今年研習地點的關西鎮牛欄河，河川生態非常豐富，第一工程所在過去也陸續建設了超過十餘座的防砂壩，有部分的防砂壩附設有魚道的設施。雖然有不少因為設計上的缺失，或是天然災害的問題而失去功能，但是都有陸續在改善當中。該處地點不僅是台灣地區防砂壩附設魚道數量最多，同時也是密度最高的區域，加上交通非常方便，過去又是以親水環境觀念整建的河段，因此可以考慮在此地進行較長期的生物廊道規劃和設計研究，同時陸續編列經費改善現有的設施，以期能夠讓該地成為另一個具有示範功能的水土保持工程區段。
- 4.分區舉辦生物廊道規劃與設計講習：建議按照今年在生物廊道改善技術研習會所做的模式，在各區選擇一～二座需要改善的工程構造物，邀請專家學者親自的參與，和各負責的工程師，一同進行實際的改善研究與施做，並辦理現場研習，才能夠將本項技術落實到各工程所當中。
- 5.加強培訓本身的種子教師：由於生態工程的規劃設計能力，光靠講習訓練還是不夠，最好能夠多方觀摩才能夠吸取較多的經驗。建議水保局應該選訓種子教師，有計畫的送至各先進國家做短期的培訓。這樣的工作才不至於閉門造車，同時經由實地的觀摩，可以快速的培養實力，以及收集最新的資訊，對於水土保持局的生態工程業務推動將會有莫大的助益。

(關鍵詞：生態工程、生態廊道、魚道、河川生息環境評估法)

Abstract

This Project carried out the assessment of the biological corridors in the Lao and Bai-bao stream in Hualien county, Ding-zi-lan stream in Taipei county, Xin-dian stream in Miaolin county, Jhung-pin stream in Nanto county, Liou-chong stream in Tainan county, Yang-ciao stream in Taitung county, Hou-fan-zi-keng stream in Taipei county, Na-luo stream in Hsinchu county, and Xu-hai stream in Pintung county between 2004 to 2006. This project used 10 simple indicators of the Habitat Index Method (HIM) (Morishita *et al.* , 2000) to know the longitudinal and lateral artificial construction whether they would obstruct the passage via surveying the habitat , the present of the biological corridor and population size and composition of each stream.

Each item of the HIM indicators emphasized on the passage of the biological corridor, the degree of the habitat diversity, and the recovery time of the riverbed after disturbing. HIM hope through more simpler and faster way than other evaluation method to evaluate and compare directly by observed the environment locality. HIM becomes more and more important recently because it can evaluate the ecological engineering construction quickly and it also considers the species diversity and the richness of the habitat.

Table 1 HIM Score Table and Description

Item	Assessment indicators (Condition of the habitat)	Score	Criterion of the assessment
HIM1	Passages between upstream and downstream	5	Fish move freely
		3	Fish move difficultly
		1	Fish move forbidden
HIM2	The joint of the branch	5	Move to the branch freely
		3	Move to the branch difficultly
		1	Cannot move to the branch
HIM3	The existence of the watershore(wetlands) or subterranean	5	Flooded always
		3	Flooded repeatedly in the year
		1	Flooded once several years
HIM4	The existence of the variable size rock on riverbed	5	Size variant
		3	The same size rock
		1	Only sand, silt or fine gravel
HIM5	The existence of the variable water depth	5	Depth variant
		3	Depth variant slightly
		1	Depth no variety
HIM6	The existence of the variable velocity	5	Velocity variant
		3	Velocity variant slightly
		1	Velocity no variety
6HIM7	The existence of the aquatic plant	5	Many different plants
		3	Some the same plants
		1	No any aquatic plant
HIM8	The continuity of the riverside forest	5	Continuous forest
		3	Few and scattered forest
		1	No riverside forest
HIM9	The existence of the sun over the river	5	The sunshine time lower than 6 hrs
		3	Somewhere sheltered
		1	All day sunshine
HIM10	The degree of the disturbance	5	Stabilize fastly after disturb
		3	Variety no evident
		1	Variety go and return

The result of the evaluation for the six tributaries via HIM is shown as Table2, and described in the content as follows :

1.Lao and Bai-bao stream : Although the whole stream had many lateral artificial construction, some had setup the biological corridor as fishway and the nature circumstances of the stream were very well, so the HIM score was up about 30, and class to 「Good」 rank.

2.Ding-zi-lan stream : Although the passage of the site was disconnected by the

concrete dam, the natural environment was still better than other site. Therefore, the HIM score was quite high here and class to 「Marginal」 rank.

3.Xin-dian stream : This tributary had abundant stream organisms among all SWCB model tributaries, however, the passage were disconnected due to the artificial construction and many hidden dams and concrete dams were setup on the riverbed. Therefore, the HIM score was slightly higher than the Ding-zi-lan stream and class to the same 「Marginal」 rank.

4.Jhung-pin stream : Because many high riverbed blocked the upstream of fish and the natural circumstance not better, the score of the HIM is not too high and only class to 「Marginal」 rank.

5.Liou-chong stream : Some high checkdams were setup in the river, but most of them were built fishway recently, however the fishway really not develop because of the bad design, as well as the poor natural circumstance, the HIM score is lower than others and class to 「Poor」 rank.

6.Yang-ciao stream : The natural circumstance of the riverside is good but some section blocked by the riverbed structure, and more, the substrate of river not various, so the score of HIM is not high and rank only to 「Marginal」 rank.

7.Hou-fan-zi-keng stream : No high checkdams or heavily constructions inside the river, and held to the model watershed of Taiwan Ecological Engineering Exhibition in 2003, so the score of HIM is high and similar among sections, and rank to 「Good」 rank.

8.Na-luo stream : This tributary had abundant stream organisms, , however, the passage were disconnected due to the some artificial construction, and lack riverside forest, some score of HIM items lower, but in average the totally score still high and class to 「Good」 rank.

9.Xu-hai stream : Because of no artificial constructions in the river, nature riverside and abundant aqua biota, the HIM score is high and class to 「Good」 rank.

**Table 2 The comparison table of the HIM average score and rank
(2005~2007)**

Tributary	Lao and Bai-bao Stream	Ding-zi-lan Stream	Xin-dian Stream	Jhung-pin stream	Liou-chong stream	Yang-ciao stream	Hou-fan-zi-keng stream	Na-luo stream	Xu-hai stream	
HIM Item	Condition of the habitat /Average Score									
HIM1	2.2	3.0	2.3	2.0	1.7	2.3	3.0	2.3	4.3	
HIM2	1.0	2.3	2.3	2.0	3.0	1.0	4.3	2.8	4.3	
HIM3	4.2	3.0	3.0	2.0	1.0	1.7	5.0	3.7	4.3	
HIM4	4.6	3.7	2.3	1.0	3.0	3.0	3.0	3.7	3.0	
HIM5	3.0	1.7	2.3	3.0	3.0	1.7	3.7	2.6	3.7	
HIM6	3.0	1.7	1.7	3.0	1.7	1.7	3.7	3.9	3.7	
HIM7	2.6	1.7	3.0	1.0	1.0	1.0	4.3	2.8	3.7	
HIM8	3.8	2.3	3.0	3.0	1.0	3.0	3.0	3.0	3.0	
HIM9	3.4	2.3	3.0	1.0	1.0	2.3	2.3	2.1	3.0	
HIM10	4.2	3.0	2.3	3.0	3.0	3.0	4.3	4.8	3.7	
SUM	Total=50	32.0	24.7	25.3	21.0	19.3	20.7	36.7	31.6	36.7
	Rank	Good	Marginal	Marginal	Marginal	Poor	Marginal	Good	Good	Good

From the evaluation result of HIM, it revealed that the better or worse of the stream ecological environment was major in if the consistence was well between different river habitat, the same as that whether the passage of the biological corridor through or not, and if the habitat was variable. If the biological corridor did not flow without obstruction, then river habitat divide into several fragments and could not integrate into a whole larger environments. Small fragments habitat itself can only supply fragile ecological environment, and supply less organism and construct more unstable ecosystem. For the river environment, the well condition of the entire ecological environment depended upon the good and bad gradient of the biological corridor. Although some small creeks of our sample site were not easy to joint with the main steam, the organism can not move freely even if in the nature condition. This criterion can help us to be aware of if the ecosystem is belonging to more fragile primarily. If the answer was yes, then you must be more careful to consider the need of the biological shelter before carried out the ecological habitat by ecological engineering method or maintained the nature world itself. For example, the SWCB did many concrete structure or hidden dam to stabilize the riverbed at some model watershed, however, it caused long upstream section of the

concrete structure becoming shallow and flat current after fully silt formed, then the mainstream varied frequently. The ecosystem will shift to bad because of unstable habitat at this kind region.

Various habitat means that it can supply not only the need of the physical and chemical condition for different organism, but also the diversity of species composition. For example, if we build a continuous riffle habitat in a section, then we expect the dissolved oxygen should upward and the yield of the adhesion algae and aquatic insects would upward at the same time, then the number of fish increases. In fact, beside the need of the basic production region, there must have the rest and breed region for fish. It is very unfavorable for the river ecology if it does not have the criterion that fast riffle and pool habitat appear by turns. Therefore, various size rock, water depth and current velocity, all indicate the level of the diversity.

The concept of the ecological engineering method was to build the space for organism to stay in the past, but in recent day, the concept in some developed countries such as Japan has gradually changed the idea to restore the space for fish by nature force. These two concepts are very different in their principles and notions. The concept in the past primarily focus on「fish can rest in the habitat」, and now on 「suitable for fish to rest in the habitat」. The former ecological engineering plan was not easy to construct the diversity of river habitat, for example, the engineer always computed the 1D formula to request the mean stream velocity, that would homogenize the whole cross-section of the river, or lack of the concept of the river pattern topography, then linearize the meandered river, both way as above will normalize the river habitat. If we want to have more diversity habitat in river environment, we should think over more attentive and exercise more high-tech engineering technology than usual mode when we plan the project.

Basically, the several SWCB model watersheds we assess to have better

ecological condition and more abundant biological resource than other wild stream that lack of appropriate planning. However, the ten criteria of HIM of this study can supply sponsored engineer to understand which item should be considered and conferred if they want to make up well river circumstance. Although these criteria could not conscientious as the hard scientific analysis we frequently read, each intension of the HIM criteria is still very important, the public can clearly realize the well of the river circumstance or not via five-sense method directly, that is not easy done by other scientific method.

We also assembled tens of people that the soil and water conservation related scholar, governmental organization and adviser company to hold the 「Biological Corridor Improvement Programme」, the course that including the introduction of the current fishway in Taiwan, and to setup the simple and convenient fishway to the checkdam at the Niu-lan-he Stream at Guan-xi town, Hsinchu..

According to the review as above paragraph, we provide some suggestions as follows :

1. To review and examine each biological corridor and structure in the basin to check the item should be improved in the follow-up years.
2. Research and develop technical methods to creative (maintain) diverse channel and habitat, as pools and riffles.
3. Suggest to setup the model watersheds of the biological corridor, some places as Niu-lan-he stream have natural habitats and abundant biological assemblages but with many checkdams and fishways, and built many water-familiar structure in the past, could be as good and worse fishway design examples and materials.
- 4.Suggest to held the local workshop in the way of 「Biological Corridor Improvement Programme」 this year in Miaolin, to choose some ought-to-improve structures as example to invite experts, scholars and responsible engineers to do the real improvement and research together, then the

technology of the local engineering can move up quickly.

5. Suggest choosing and training the seed engineering to advanced country every period to cultivate the up-to-date information and technology to enhance the actual strength. Then it will benefit to move up the ecological engineering work.

(Keywords : Ecological Engineering Method, Ecological Corridor, Fishway, HIM, Habitat Index Method)

計畫名稱	坡地植生工程暨植生調查應用手冊 Manual of Slopeland Vegetation Engineering and Investigation Method
主持人	林信輝 Lin, Shin-Hwei
計畫年度	96

摘 要

臺灣因地形陡峻、河川短促等因素，每年逢颱風、豪雨季節及地震等，易發生山坡地崩塌裸露，為免除二次災害及減少土砂沖蝕流失，及維持生態環境之恆久性與保育物種延續生存等為目標，利用植生工程加速植被復育，以達控制沖蝕、減少土地災害及涵養水源之目的乃為必要之措施。

植生工程係以人為處理方法，營造適生生活環境，迅速有效地導入植物材料，促使其恢復原有之植被功能，及達到生態保育生態之效果。本手冊蒐集彙整國內外相關坡地工程、植生工法、植栽作業以及植生覆蓋調查方法，及參考水土保持局近年編印之水土保持手冊--植生篇、植生資材應用手冊、集水區植生群落調查手冊等資料，針對植生工程之各項基礎工與植生導入工法之規劃設計理念、設計施工實務、養護驗收以及植生調查等問題進行解析，最終彙編成冊，以提供從事坡地植生工程、綠化復育之現場工程師、技師等技術人員之參考。

第壹章緒論中，介紹坡地植生工程之內容與範圍，及蒐集彙整植生工程調查之相關法規。第貳章植生前期作業（基礎工）規劃設計，說明植生基礎工規劃設計原則，並針對整地與坡面處理、排水工程、坡腳基礎及坡面保護工程，分節敘述相關施作方式與原則。第叁章植生工程材料之特性與應用，針對種子材料、客土材料、植生被覆材料、植生木樁（萌芽樁）材料、一般木樁（疏伐材、雜木樁等）材料分節說明其特性與應用。第肆章植生導入工法之規劃要項，

乃將植生導入依方法區分為播種法與栽植法，並分節說明此二法間差異及施作原則等。第五章植生導入工法之施工方法，乃針對不同植生導入方法之特性差異、設計施作、應注意事項等。第陸章植生工程成果調查與驗收，說明植生工程施作後成果調查與失敗與否之判定標準及植生工程成果驗收相關條例。

本手冊旨在供從事坡地植生工程規劃設計或現場施作之使用，除參考本手冊外，相關技術人員仍需依據水土保持技術規範、水土保持手冊、相關工程施工規範等相關規定，因地制宜規劃設計合宜之植生工程，以臻符合植生目標之設計，達植生工程最大效益。

(關鍵詞：坡地、植生工程、植生調查)

Abstract

Due to the steep topography and extremely short distance of flow channel, landslide events on slope land are very common during the typhoon season in Taiwan. To prevent the sequential disaster caused by landslide, reduce the erosive sediments, sustain the eternity of ecological environment and reserve the sustainable propagation of species, it is necessary to adopt the vegetation engineering method to expedite the restoration of vegetation, control the soil erosion and mitigate the sediment disaster and store the water resources.

The vegetation engineering can be defined as a man-made working method which was used to create a comfortable living environment, effectively introduce a proper plant material, expedite the restoration of original coverage and achieve a goal of ecological conservation. This manual has collected most of the relevant data from various aspects such as slope engineering, vegetation working method, plantation operation and investigation method of vegetation coverage. Based on the soil and water conservation manual of recent version published by Soil and Water Conservation Bureau, namely, the Vegetation Chapter(in soil and water conservation handbook), the Vegetation Material Handbook, the Investigation Handbook for Vegetation Community in Watershed, this manual is edited and compiled. The foundation work for vegetation engineering, the concept of vegetation initiation, design and construction practices, detection and analyses on vegetation are also analyzed and edited as a handbook. This handbook manual can offer most of the information for the engineers who are engaging in slope land vegetation and restoration of green plant

In *Chapter 1 Introduction*, the content and scope of vegetation engineering at slope land are introduced. Meanwhile, the relevant laws or acts for vegetation survey are also collected. In *Chapter 2 The principles of the pre-operation for*

foundation work, the foundation work includes ground leveling and slope treatment, drainage, foundation at slope toe and protection engineering works on slope surface. The relevant construction method is discussed in various paragraphs. In *Chapter 3 The characteristics and application of vegetation materials*, seed materials, imported soil, vegetation coverage materials, vegetation staking materials, general pile materials are depicted and discussed. In Chapter 4 Initiation of vegetation, the initiation method which initiates the vegetation can be classified into seeding method and plantation method. The difference between these methods is discussed in various paragraphs. Chapter 5 The construction of initiation method for vegetation, discusses the characteristic difference of various initiation methods and design method. Chapter 6 Detection and evaluation of vegetation efficiencies presents the criteria for evaluating the effectiveness of vegetation work.

The manual is aimed to offer a ready-for-use handbook for the engineers who are engaging in the slope vegetation works. In addition to using this manual as a design handbook, the engineers are also suggested to refer the Soil and Water Conservation Technical Code, Soil and Water Conservation Handbook and relevant engineering handbooks in their design and construction practices. Conclusively, the design and construction in vegetation engineering are greatly dependent on the field condition of jobsite and the engineers are advised to perform the vegetation work with caution.

(**Keywords : Slopeland, Vegetation Engineering, Vegetation Investigation Method**)

計畫名稱	緩衝綠帶帶寬與適用植物之研究（第三年） Research of Strip Width and Suitable Grass Species for Grass Buffer Strips (III)
主持人	吳嘉俊 Wu, Chia-Chun
計畫年度	96

摘 要

當山坡地上從事農業及非農業利用時，不慎的經營管理常常使得山麓、河溪易受土砂災害及化學污染的威脅。本計畫乃針對緩衝綠帶的土砂攔阻與過濾進行研究；其中包含：田間土壤沖蝕試驗、室內水工試驗、植物之水淹與土掩逆境試驗等，並結合國內外相關研究成果的搜集與彙整，提出緩衝綠帶的帶寬及適用喬、灌木及地被植物之建議，以做為國內緩衝綠帶設計的參考。

田間試驗及水工試驗的主要目的，是瞭解緩衝綠帶之地被植被帶寬對沖蝕土砂攔阻的影響，而水淹與土掩逆境的試驗，主要是瞭解七種受試草類對於水淹逆境與土掩逆境的反應，藉以自這七種受試草類中挑選適用於緩衝綠帶之地被植被帶草種。由於完整的緩衝綠帶是由複層植被的喬灌木帶及地被植被帶所組成，基於試驗研究的期程限制，本研究以搜尋國外相關研究的成果及本研究田間試驗與水工試驗的結果，擬訂出適用做為緩衝綠帶植物種類。

連續 3 年的試驗研究成果結論摘要如下：

- 1.完整的緩衝綠帶應包含複層林帶與地被植被帶，複層林帶可由喬、灌木所組成，而地被植被帶則主要由草類所組成。緩衝綠帶的寬度應依設計者所設定擬緩衝之標的而改變，倘若用地取得容易，則最理想的完整緩衝綠帶全寬可設計 300m，但倘若用地取得有困難，則完整緩衝綠帶的全寬最好能保持在緩衝綠帶內最高樹種之平均樹高的一倍或至少 10m 寬。
- 2.緩衝綠帶內的地被植被帶寬應設計至少 4.5m，以達有效攔阻沖蝕土砂的功

能。倘若用地取得容易而可以加寬寬度時，則地被植被帶的帶寬應小於7.5m，以免於地被植被帶內發生集中逕流沖蝕(concentrated-flow erosion)，反而增加額外土砂來源。

3. 緩衝綠帶之地被植被的選擇，應選擇抗逆境能力高的植物種類，其中所面臨的逆境包含：與喬、灌木或同物種間的水份與養份競爭、遮蔭逆境、水淹逆境、土掩逆境等。

4. 百慕達草、馬尼拉芝草、南美蟛蜞菊等植物在土掩逆境上有不錯的表現，而水淹逆境表現最佳的是奧古斯丁草，均可列入緩衝綠帶地被植物之參考。

(關鍵詞：緩衝綠帶、帶寬、適用植物、土砂控制)

Abstract

Sediment disaster and non-point source pollution are common problems associated with slopeland activities regardless the types of utilization and development. Therefore, the objective of this research is to provide strip width and suitable vegetation species guidelines of vegetation buffer strips.

Field erosion plot studies and indoor flume studies were conducted to identify the width of grass strip. Experiments of environmental stresses; especially the submerge and overtopping stresses caused by flooding and sediment deposit; respectively, that may exert on vegetations were performed at seven selected grasses to isolate the high stress-resistance species. Through references collection and compilation, along with the field and laboratory flume studies, strip widths for various functions of vegetation buffer strip were therefore formulated. Similarly, through references collection and compilation, along with the field stress-resistance studies, suitable vegetations including trees, shrubs, and grasses for vegetation buffer strip were also suggested.

The research outcomes for three consecutive years are summarized as follows:

1. Vegetation buffer strip should consist of three zones that include trees, shrubs, and ground vegetation. The width of the vegetation buffer strip depends on its designed function. The width of an ideal vegetation buffer can reach 300m; whereas, 10m or width equivalent to the mean height of the selected trees of the designed buffer should set as the minimum width provided that land acquisition become the issue.
2. The width of ground vegetation; especially the grasses, should set at the minimum of 4.5m to maintain the sediment trapping capability. The width of the grass strip should not exceed 7.5m to prevent concentrated -flow erosion from occurring, which may in turns cause additional soil loss.

3. The ideal grass species for vegetation buffer strip should possess high stress-resistance ability. The environmental stresses that grass species may encounter involve that from water and nutrient competition, shading, submerge and overtopping cause by flooding and sediment deposit; respectively.

4. Bermuda grass (*Cynodon dactylon*), Tou-Liu grass (*Zoysia matrella* Tou Liu Tsao (TL)), Wedelia (*Wedelia triloba* L.) illustrated their high stress resistance during the sediment overtopping test; whereas, St. Augustine grass (*Stenotaphrum secundatum* (Walt.) Kuntze) ranked first in flooding submerge test. They can be considered as suitable ground vegetation candidates for vegetation buffer strip.

(Keywords : Grass Buffer Strip, Strip Width, Suitable Grass Species, Sediment Control)

計畫名稱	<p>環都市周邊山坡地防災與生態工程之研究 (第二年)</p> <p>Disaster Mitigation and Ecological Study of Hillside Areas Surrounding Major Cities (2nd year)</p>
主持人	<p>朱子偉 Chu, Tzyy-Woei 林鎮洋 Lin, Jen-Yang 鄭光炎 Cheng, Kuang-Yen 陳偉堯 Chen, Walter W.</p>
計畫年度	96

摘 要

台灣因先天地理條件不佳，再加上人為不當開發，造成水土保持的破壞，使得山坡地災害頻繁。而環都市周邊山坡地因緊鄰人口稠密地區保全對象較偏遠山區多，若發生災害時影響也嚴重許多。本研究延續第 1 年計畫的成果，檢討修正「山坡地生態及災害潛勢綜合指標」模式，並應用於高雄市周邊山坡地之生態及災害潛勢分析。模式共包含 12 項評估指標，並應用層級分析法(AHP)賦予各指標相對權重，再利用地理資訊系統(GIS)疊圖和空間分析功能進行整合運算，求得該區域綜合指標總分，總分越高表示發生災害之潛勢越高。模式分析結果顯示，高雄市環都市山坡地綜合指標總分，以壽山西南側中山大學後方為最高（53 分），此處恰有土石流潛勢溪流通過，歷年也發生過山崩等災害；模式因此得以驗證能有效的標定較危險區域或易損區域，以達成事先規劃和降低災害的目標。此外，依據模式分析結果，挑選綜合指標總分較高 3 處進行現地調查，並整理出適用山坡地防災生態工程的範圍。

（關鍵詞：層級分析法，災害潛勢，生態，地理資訊系統，山坡地）

Abstract

The frequent disasters around hillside areas in Taiwan usually result from the fragile geological conditions and improper developments which create serious soil and water conservation problems. The disasters on hillsides surrounding urban areas have especially caused more damages due to their adjacency to dense residency. This study aims to modify a GIS-based combined index model and apply it to evaluating the ecological impairment and disaster potential on hillsides around Kaohsiung city. The Analytic Hierarchy Process (AHP) is employed to determine the relative significance of 12 indexes adopted in this model. Given its capacity of spatial analysis and calculation, the GIS-based model produces the combined-index score. The higher model score indicates the higher ecological impairment and disaster potential. Accordingly, the highest-scored part in Kaohsiung metropolitan area turns out to be the southwest to Shou Shan and the backside of National Sun Yat-Sen University, where two debris-flow-prone streams stay nearby and landslides have broken out in the past decades. The model is hereby validated to effectively identify the critical areas with high disaster potential, which will warn the agencies of precaution and remind them of further investigation on those sites by establishing effective engineering measures. In addition, site investigation is to be carried out in the three locations, based on the modeling result with higher combined-index scores, and their proper use of eco-technology to the constructions is to be examined. Finally, the applicable guidelines of various ecological engineering constructions for specific conditions will be delineated.

(**Keywords : Analytic Hierarchy Process, Disaster Potential, Ecology, Geographic Information System, hillside**)

計畫名稱	邊坡穩定生態工程圖冊查詢系統建置及穩定性分析之研究 Establishing and Development of the Graphic Displays Information Systems of Ecological Engineering on Slope Stability and Stability Analytical Method
主持人	范正成 Fan, Jen-Chen
計畫年度	96

摘 要

本研究計畫蒐集分析國內外各種邊坡穩定生態工程方法，和適用於台灣本土地區邊坡穩定植生之物種予以分析及分類。並針對所彙編之邊坡穩定生態工程方法和植生物種，建置成網路版邊坡穩定生態工程查詢系統和辦理相關教育訓練。

穩定性分析部份，以國內外邊坡穩定常用之 STABL 程式，進行各種邊坡穩定生態工程方法穩定性分析。並以石門水庫-蘇樂集水區邊坡生態工程案例，評估其整治完成工程之穩定性。

收集美國、中國及日本三個地區四個邊坡穩定生態工程案例，分類整理編譯成中文，以提供相關單位規劃設計之參考。

(關鍵詞：生態工程、邊坡穩定、穩定性分析)

Abstract

In this project, various ecological engineering methods for slope stabilization were collected from various countries, compared and suggested to be used in Taiwan. Vegetation species appropriate to be used for slope stabilization in Taiwan were also studied, analyzed and classified. These results were used to establish an on-line system, and education and training for this were conducted.

As for the analysis of stability, STABL, widely used computer software, was used for analyzing the stability of several ecological engineering methods for slope stabilization. Some ecological engineering projects in Su-Le watershed of the Shihmen Reservoir were used for case studies, in which the stabilities of the completed projects were evaluated.

In addition, in this project, four cases of ecological engineering methods for slope stabilization in the United States, China and Japan were collected, classified and translated into Chinese language, so that they may be used as references for engineering plan and design.

(Keywords : Ecological Engineering Method, Slope Stabilization, Stability Analytical Method)

計畫名稱	九份二山紀念園區植物手冊 Handbook of Plants in Jioufenershan Memorial Park
主持人	鄭雅芳 Cheng, Yea-Fang 林信輝 Lin, Shin-Hwei
計畫年度	95

摘 要

在民國 89 年 921 大地震後，行政院農業委員會水土保持局針對南投縣九份二山地區進行調查規劃，設置 921 紀念公園，該公園於民國 93 年開始建設工作，並完成土地徵收及撥用約 262 公頃，並以七里香、茄冬、山櫻花、九芎等適生於當地之原生植物為園區內主要種植樹種。重建完成後期許本地區能迅速恢復成一個完整的生態系，並提供民眾一個地震災害整治成果體驗與生態旅遊的好去處。

為配合九份二山紀念公園的設置，本手冊以九份二山紀念公園為主要的調查區域，並將其區分為觀景台區、植物栽植區、次生林區、紀念碑區、原生植物展示區等五個區域分別進行現地植物調查，彙整相關資料並篩選其中常見或特殊植物種類共 142 種，編印此「九份二山紀念園區植物手冊」。希望藉由本書的介紹，讓民眾除能認識台灣地區原生的植物種類外，並增加民眾對於坡地崩塌後植生復育成效及生態保育的認識。

（關鍵詞：921 紀念公園、原生植物、植生調查）

Abstract

The soil and water conservation bureau dedicated their efforts in the investigation and planning on 921 Earthquakes Memorial Park in Jioufenershan area Nantou county after 921 earthquake in 1999. The construction of this park started from 1994, land levied and the appropriation of public land were about 262 hectares, and planted proper protophyte to correspondent with local environment as main tree species such as common jasmine orange 、 autumn maple tree 、 Taiwan cherry tree 、 sub costae crape myrtle etc. Ideally expect the area could be restoring rapidly as an integrated ecological system after reconstruction, and provide locals a good place to experience the renovation from earthquake disaster and ecological tourism.

In order to accordance with the establish purposes of Jioufenershan Memorial Park, the field survey range cover Jioufenershan and its adjacent areas , and further divided into five regions as the district of scenic viewing terrace 、 vegetation area 、 secondary forest area 、 memorial monument area 、 protophyte demonstration area to proceed vegetation survey separately. Where 142 species of the most common or special species were sieved from the survey outcomes, and then compiled as 「 Jioufenershan Memorial Park vegetation manual 」 . This manual may hopefully make people more familiar with the protophyte in Taiwan, and promote the horizon in vegetation rehabilitation as well as ecological conservation in landslide area.

(Keywords : 921 Memorial Park, Native Plants, Vegetation Investigation)

計畫名稱	土石流及崩塌地源頭水土保持處理工作手冊 Handbook of Debris Flow and Landslide Source Treatments for Soil and Water Conservation
主持人	林信輝 Lin, Shin-Hwei
計畫年度	95

摘 要

民國 88 年 921 地震所造成許多山坡地土石鬆動，導致甚多之崩塌地與土石流災害。為加強坡地保育、國土保安、防治土壤沖蝕、崩塌與土石流等，針對危及下游之地區安全與環境生態維護等工作，特編列本手冊，提供各相關機關之應用參考。

本手冊處理之作業適用對象包括：

- 1.一般山坡地或林班地崩塌地、易發生災害地區、環境較敏感地區及需辦理適當復育及保育地區。
- 2.水土保持局所屬工程所、各縣市政府、各鄉鎮公所，依據國土復育策略暨行動計畫辦理水庫集水區及土石流高潛勢流之國土復育地區之坡地保育案件。
- 3.其他颱風豪雨引發土石災害之緊急水土保持處理。

本手冊源頭處理之策略與原則包括：

- 1.從崩塌源頭開始處理並延續至下游土石流堆積區，針對崩塌地整治與水土保持防治並行，以徹底防止崩塌、減少土石來源。
- 2.僱用在地人，辦理山坡地水土保持處理工作。
- 3.聘用學者及專業技師，協助鄉、鎮公所規劃及提供技術指導。
- 4.相關工程應用之資材，以生態考量、適地適用、就地取材為原則。
- 5.較大規模坡地保育處理工作應依其發生機制與規模，選用適當處理工法，

進行最有效之處理方式。

(**關鍵詞：崩塌地、土石流、源頭處理、水土保持**)

Abstract

The earthquake in September 21st, 1999 has caused of loosing earth in hillside areas, and lead to tremendous disasters such as landslide and debris flow in extensive areas. In order to enhance the conservation of hillside field and national territory security, as well as soil erosion prevention to mitigate the damage from landslide and debris flow, this manual is prepared for related authorities as a reference handbook which focusing on the protection of endanger downstream communities or areas and the preservation of ecological environmental.

The operation processes of this manual are used for the following situations:

- 1.General hillside or forest landslide areas 、vulnerable disaster areas 、 environmental sensitive areas and those which needs proper restoration and conservation areas.
- 2.The projects which based on the national conservation strategy and action plan to process cases of hillside protection in country rehabilitation areas of reservoir watershed and highly potential mud and debris flow areas, while carry out by soil and water conservation bureau and its related engineering offices, county and city government, village and township office.
- 3.Others emergency disaster mitigation and rescue projects caused by typhoon or torrential rain.

The strategies and principles of sources treatments in this manual include:

- 1.The treatments start from landslide source areas and extend to downstream debris deposit areas, and focus both on the prevention of landslide and soil and water conservation aspects, to avoid collapse and minimize the sources of earth volume thoroughly.
- 2.Hiring locals to participate in treatment works.
- 3.Invite scholars and professions to assist village and township authorities to

provide suggestions and technical advice.

4.The introduced materials should be based on ecological concerned, correspondent with local environment and expect functions and to obtain materials from local resources.

5.In large scale hillside conservation projects, the major concern should be in accordance with its occurrence mechanism and scale, and to choose proper treatment measures to achieve maximum efficiency.

(Keywords : Landslide Area, Debris Flow, Landslide Treatment, Soil and Water Conservation)

計畫名稱	坡地植生草類與綠肥植物 Grasses and Green Manures Used on the Slopeland
主持人	林信輝 Lin, Shin-Hwei
計畫年度	95

摘 要

植生工程於植物材料使用上，草類因種子發芽快速、立地適應能力強，適於山坡地復育初期之大面積植生覆蓋使用，快速發揮坡面保護、沖蝕控制、防風定砂、荒地復舊等功能，其中禾本科草類之應用最為廣泛。水土保持局於民國 78 年編印水土保持植物簡介—禾草篇供各界參考，由於水土保持植物應用漸趨於多樣化，為配合坡地保育處理植生技術發展乃將原編印之手冊進行修正與增補。

綠肥植物具根瘤菌改善土壤物理性質化學性質，促進土壤中微生物活動等功能。目前台灣地區綠肥植物之培育、技術研究與推廣，行政院農業委員會種苗改良繁殖場深具經驗，為期資料完整性與廣用性，因此有關綠肥植物篇章，洽請種苗改良繁殖場協助撰寫。

本書蒐集坡地應用禾本科草類 26 種及綠肥植物 10 種，每種植物均包括學名、英名、習性、根莖葉花果種等性狀特性、生長區域分布、繁殖與栽植方法、坡地用途等說明，並附圖說、照片，可供從事水土保持工作人員參考應用，對國土保育工作的推廣應可發揮輔助功效。

(關鍵詞：坡地、植物材料、禾本科草類、綠肥植物)

Abstract

Because of its rapid germinating capability and strong accommodate ability in different environment conditions, grass is suitable for large area coverage on hillside region at the beginning of rehabilitation works, with functions of fast protection of landform surface 、 erosion control 、 check winds and control sand 、 wasteland restoration etc., while the Gramineae grass species are especially the most popular that been used. The Soil and Water Conservation Bureau has published the introduction of vegetation on soil and water conservation- Gramineae grass species in 1989 for all reference. Due to the diversity development of vegetation in soil and water conservation, the original published manual should be correct and augmented in accordance with the pace of vegetation engineering development on slope conservation.

The green manure plants possess root nodule which can improve both in physical and chemical properties of soil, and arouse function of microorganism's activities in the soil. The Taiwan seed improvement and propagation station, COA has dedicate their efforts and accumulated lot of experience in breeding 、 technological research and promotion of manure plants , its appropriate to invite these professions to participate in this program to enhance the referential materials more in integrity and wildly usage. Thanks to Taiwan seed improvement and propagation station, COA for their generous help.

There are 26 species of Gramineae grass and 10 species of manure plants which are suitable for hillside been collected in this handbook. The description of each species include scientific name, English name, habitual behavior, and the characters of root 、 stem 、 leaf 、 flower and fruit, distribution of range, propagation and planting ways, description of usage on slope land etc., the attached drawings and pictures provide useful reference for those who work on the soil and water conservation, and

it may also be helpful in popularization of nation territory conservation efforts.

(**Keywords : Slopeland, Vegetation Materials, Gramineae Grasses, Green Manures**)

計畫名稱	緩衝綠帶帶寬與適用植物之研究（第二年） Research of Strip Width and Suitable Grass Species for Grass Buffer Strips (II)
主持人	吳嘉俊 Wu, Chia-Chun
計畫年度	95

摘 要

當山坡地上從事農業及非農業利用時，不慎的經營管理常常使得山麓、河溪易造成土砂災害及化學污染之威脅。為減輕坡地利用不當所衍生對環境的負面衝擊，本計畫針對狹義定義之緩衝綠帶的草帶進行研究，以瞭解土砂攔阻功能與帶寬之間的關係。同時藉由國外相關文獻的收集與整理，歸納出國外研究的成果與應用案例，提供國內未來應用上的參考。

緩衝綠帶除用於隔離污染源外，更可以應用於濱水生態棲地的營造。因此，國外研究成果大多建議將緩衝綠帶依功能分為三區，最接近溪流的為喬木林區，居中的為灌木區，最上游的為草帶區。最接近溪流的喬木林區樹種，應選擇生長快速深根性的樹種，以穩固溪岸。濱水緩衝帶的先驅樹種，可採用白楊、接骨木、椴木、山茱萸、篠懸木、槭樹。灌木區的主要功能在於提供棲地的多樣性。至於草帶區，其最窄寬度以 6~7m 為宜。

經由本年度水工試驗及國外研究文獻收集的結果，本研究更加確定上一年度田間試驗的結論；亦即，以大葉百喜草或類地毯草所形成的緩衝綠帶之寬度不宜設置過長，以 4.5~6m 為宜。若寬度比 4.5m 短，無論設置之坡度為何，均無法有效攔阻沖蝕土砂；若寬度超過 6m，則將於緩衝帶之植株間發生蝕溝，反而影響其攔阻土砂的功效。

國外的研究文獻中曾對於「較寬的緩衝帶設置，具有較佳的功能」觀念提出質疑，因而建議改採非固定寬度設計，其理由是認為非固定寬度的緩衝綠帶

設計不會出現對地表逕流水不可能發生匯集地區的過度保護，及對地表逕流確定匯集地區的保護不足現象。

本年度亦對選定的四種匍匐性草類及三種直立性草類進行環境逆境的室內試驗；其中包含土掩試驗及水淹試驗。逆境試驗的目的，在瞭解模擬受試草類倘若用於緩衝綠帶內時，其對於上游來砂的掩埋及地表水蓄積的反應，以做為未來適用草類挑選的先期試驗參考。

由於受試草類初期生長不良，嚴重影響逆境試驗的成果；尤其是土掩試驗最差。水淹試驗表現最佳的是奧古斯丁草，經過為期近 3 個月的浸泡仍能持續生長並於水面下長出不定根。類地毯次之，雖然經過 3 個月的浸泡植株死亡，但一旦脫離水淹逆境仍發生復活現象。百喜草初期扦插時就已顯現生長劣勢，所以導致不到兩個月就全數死亡。針對於植物逆境的研究仍有待未來加強。

(關鍵詞：緩衝綠帶、帶寬、適用植物、土砂控制)

Abstract

Sediment disaster and non-point source pollution are common problems associated with hillslope development regardless the types of utilization and development. Therefore, the objective of this research was to investigate the sediment trapping efficiency of grass strips which often serves as the front-end control of a vegetative buffer strip. Information mining on the subject of vegetative buffer strip or related disciplines were conducted through literature review.

Vegetative buffer strip not only serves as a buffer along agricultural upland, but also creates riparian habits. Most of the reviewed literatures recommended a vegetative buffer strip; especially a riparian buffer strip should consist of three zones. Any fast-growing trees; for instance, cottonwood, elder, dogwood, and maple are suitable to use next to the stream banks to protect stream banks from erosion. The middle zone situated between streambank zone and inner zone serves as a habitat zone or corridor so that slow-growing trees or shrubs should be selected with greater diversity. The inner zone mainly consists of grass and minimum width of 6~7m is recommended.

Through laboratory experiments and literature review, the results of this study provide further support to last year's field study. The results suggest that grass strip formed by either Bahia grass or carpet grass with the width along the slope of 4.5~6m is sufficient for trapping sediment. Grass strip with the width exceeding 6m may encourage rills to occur within the strip.

The concept of fix-width design for buffer strip may need to re-adjust to varied-width design. Varied-width buffer has given a promising trend in sediment trapping efficiency based on literature review, which provides sufficient protection to places where surface runoff converges yet not overprotecting places where surface runoff hardly concentrates.

Four creep grasses and three erect-stem grasses were selected for indoor environmental-stress tests that included both water and sediment submergence tests. The purpose of the environmental-stress tests is to simulate the environment stresses that grasses may be subjected to once become part of the grass strip, and to understand how grasses respond to stresses.

The sediment submergence tests were not successful due to growth failure in the beginning of the test, nor did water submergence tests. However, St. Augustine grass (*Stenotaphrum secundatum* (Walt.) Kuntze) survived for close to three-month water submergence test with gradual growth, followed by carpet grass (*Axonopus affinis* Chase), and Bahia grass (*Paspalum notatum* Flügge) failed the water submergence test within two months. Carpet grass revived from withered after released from water submergence stress. Further research related to environmental stress is needed.

(Keywords : Grass Buffer Strip, Strip Width, Suitable Grass Species, Sediment Control)

計畫名稱	坡地保育多元化經營之研究 The Study of Multiple Management in the Preservation on Slope Areas
主持人	歐聖榮 Ou, Sheng-Jung
計畫年度	94

摘 要

本計畫係針對台灣地區之山坡地作一通盤檢視與分析，同時對國內外山坡之經營型式進行調查與評估，並藉由坡地使用程度序列之建立，將山坡地經營類型分類，並藉由研擬評估指標因子及評分標準，訂定一套坡地多元化經營評估方法，再擬定山坡地保育永續之多元化經營策略，以期營造一個「優質、安全、休閒、環保」之永續生態環境。研究最後利用此模式進行 21 個重點地區之調查與評估，針對其調查結果提出未來經營發展之策略，希冀對坡地現行之經營方式，有實質參考之價值。

（**關鍵詞：多元化經營、坡地保育、坡地使用程度序列**）

Abstract

This project tries to comprehensively inspect and analyze the multiple uses of slope areas in Taiwan. By reviewing successful management approaches in slope areas from both foreign countries and Taiwan, establishing use level spectrum of slope area, and creating evaluative indicators and criteria, this project will propose different management models and detailed strategies to make sustainable environments with the functions of superior quality, safety, leisure, and environmental protection. Also 21 case studies have been investigated and evaluated by using these management models in the end of this project. Hopefully those strategies produced from models shown above can be useful in management development of slope areas in Taiwan.

(Keywords : Multiple Management, Conservation of Slope Area, Use Level Spectrum of Slope Area)

計畫名稱	坡地植生與保育功能之調查研究 Investigations on Slopeland Vegetation and Its Conservation Functions
主持人	林俐玲 Lin, Li-Ling 張舒婷 Chang, Shu-Ting 蔡義誌 Tsai, Yi-Zhih
計畫年度	94

摘 要

本研究以坡度、土壤流失深度、有機質含量、粗孔隙百分比、土壤 pH 值和土壤硬度做為植生立地條件之評估因子，完成調查地區土壤理化性質分析、植被種類、覆蓋度紀錄及土壤保育模式訂定。影響土壤沖蝕之主要因子包括降雨、土壤性質、地形、地表狀況和水土保持措施等。土壤與地表植生有相輔相成之效果，兩者並非獨立因子，在植生初期土壤性質對沖蝕的影響較大，在有良好的植生立地條件下，植生能迅速覆蓋地表，形成良好的被覆，在有完整垂直結構（冠層、灌木層、草層、枯枝落葉層）時，能有效的控制土壤流失量，在評估植生功效時應考慮冠層覆蓋、地表覆蓋、地表粗糙度與土壤水分含量。

（關鍵詞：植生立地條件、土壤流失量）

Abstract

Soil properties analysis, vegetation species, and vegetation cover rate have been investigated for experimental areas. Soil conservation model was also modified. Land slope, soil loss depth, organic matter content, coarse pore size percentage, soil pH value and soil hardness has been used as evaluation index for plant growth conditions. The main factors affect soil erosion is rainfall, soil property, topography, land surface condition and conservation practices. Soil and plant have closed relationship and would affect each other. Soil and plant are not independent. During the early vegetative stage, the soil properties will affect plant growth tremendously. If the land is in good soil condition, where will be covered by plant rapidly. However, it will take longer time to complete the vegetation cover if the land is in poor condition. The vegetation with complete vertical structure, namely, canopy, under canopy, shrub layer, grass layer, and surface residual cover would control soil erosion effectively. To evaluate the vegetation function should consider canopy cover, surface cover, land surface roughness, and moisture content.

(Keywords : Plant Growth Habitat Condition, Soil Erosion)

計畫名稱	推動生態綠化策略及苗木培育分析方法 Promoting the Strategies of Ecological Greening and Analysis of Nursery Stock Growing Method
主持人	張焜標 Chang, Kun-Piao
計畫年度	94

摘 要

本研究利用生態綠化工法的理念，做為山坡崩場地植生復舊的策略。生態綠化之實施策略包括以下幾個步驟:1.生態環境及潛在植被之調查，2.應用植物的選擇，3.潛在植被之復育，4.復育基地土壤穩定之措施及改良，5.複層林植栽配植並從小苗種起，6.人工補助與管理誘導演替進行。本年度計畫初步以培育11種台灣原生樹種苗木為目標，主要利用不同構型與容積大小之容器培育熱帶樹種苗木，分析苗木之形質生長與形態指標，以供選擇適當的育苗容器。樟葉槭(*Acer albopurpurascens* Hayata)、樟樹(*Cinnamomum camphora* (L.) Presl)、青剛櫟(*Cyclobalanopsis globosa* Lin & Liu)、黃心柿(*Diospyros maritime* Blume)、台灣山枇杷(*Eriobotrya deflexa* (Hemsl.) Nakai)、香楠(*Machilus zuihoensis* Hayata var. *zuihoensis*)、大葉山欖(*Palaquium formosanum* Hayata)、菜豆樹(*Radermachia sinica* (Hance) Hemsl)、台灣梭欖木(*Reevesia formosana* Sprague)、台灣赤楠(*Syzygium formosanum* (Hayata) Mori)、珊瑚樹(*Viburnum odoratissimum* Ker. & Maxim)等種子發芽後2-3個月小苗分別移植於3種穴植管(A、B、C型)、2種軟盆(D、E)及1種長型樹鉢(F型)容器。培育6個月後各樹種苗木形質生長受到構型及容積大小之影響，以苗高及生物量而言，F型樹鉢的苗木生長最佳，D與E型軟盆苗木生長次之，而穴植管A型及B型苗木之生長則略遜於軟盆者，C型穴植管因容積最小生長也最差。但綜合評估T/R率、健壯商數、Dickson品質商數等形質生長，除了C型(太小)與F型

(太大) 苗木外，其餘類型苗木均極適合出栽種植。檢視根系是否盤根、容易脫盆與否、大小是否適中、種植困難與否等條件，穴植管 A 型及 B 型所培育之苗木具有最佳的條件。

(關鍵詞：生態綠化、穴植管、容器育苗、苗木分級、苗木品質評估)

Abstract

This research presented a strategy for landslide recovery on the hillside by the concept of ecological greening technique. The practice of ecological greening strategy includes the following steps: 1.the survey of ecological environment and potential vegetation. 2.The selection of applied plant species. 3.The cultivation of nursery stock of the potential vegetation. 4.The measurement and improvement of the soil stable on recovery base. 5.The establishment of a multiple forest from seedling. 6.inducing of ecological succession by artificial subside and management. The goal of first year was to cultivate 11 native species in Taiwan, using the containers of different configuration and volume size for cultivating the nursery stocks of tropical species. For selection of an appropriate container the seedling's quality and morphologic indices were analyzed. Seedlings of *Acer albopurpurascens* Hayata, *Cinnamomum camphora* (L.) Presl, *Cyclobalanopsis globosa* Lin & Liu, *Diospyros maritime* Blume, *Eriobotrya deflexa* (Hemsl.) Nakai, *Machilus zuihoensis* Hayata var. *Zuihoensis*, *Palaquium formosanum* Hayata, *Radermachia sinica* (Hance) Hemsl, *Reevesia formosana* Sprague, *Syzygium formosanum* (Hayata) Mori. and *Viburnum odoratissimum* Ker. & Maxim aged about 2-3 months were transplanted into 3 kinds of dibbling tube (A,B,C- type), 2 kinds of soft pots(D,E- type) and one kind of long tree-pot (F-type) respectively. The seedling's quality of every species after growing 6 months by the effects of container configuration and volume size, plant height and dry biomass were measured and showed best by F-type, and D- and E-type were next, then A- and B-type were slight smaller than former, and the bad one was C-type. However, general assessment on a morphological index of T/R ratio, sturdiness quotient, Dickson quality index, the seedlings, except C- (too small) and F-type (too large), the rest were suitable for planting. After inspecting the conditions of seedlings have

root circulation or not, the easiness of container to take off and the seedlings has proper size for planting or not, dibbling tubes of A and B-type were showed best criteria for growing seedlings.

(Keywords : Ecological Greening, Dibbling Tube, Containerization, Seedling Grading, Assessment of Seedling quality)

計畫名稱	緩衝綠帶帶寬與適用植物之研究 Determination of the Width of Buffer Strip and Suitable Grass Species
主持人	吳嘉俊 Wu, Chia-Chun
計畫年度	94

摘 要

國人在山坡地上從事農業及非農業之利用密度高，相對易對山麓、河溪產生土砂災害及化學污染，為防止及減輕坡地因開發行為所造成之災害及污染，與配合生態工法之觀念，擬對運用植物，構築濱水區域及山麓之緩衝綠帶做一研究，以探討適當之寬度及適生植物。本年度的重點工作包含：1.田間試驗的推動、2.國內外相關研究文獻的收集與整理。其中，田間試驗包含兩種匍匐性草類、三種緩衝帶寬度、三種坡地坡度。

田間試驗的結果顯示緩衝綠帶土砂平均攔截率的極限，換句話說，緩衝綠帶的帶寬似乎不需要無限度的延伸，若以土砂攔截功能而言，本年度的研究成果似乎暗示，以類地毯草或以與類地毯草具備相似性狀的草類所形成的緩衝綠帶，帶寬採 6m 設計，應該足夠攔阻 90%來自於帶寬 1.67 倍裸露區及緩衝綠帶內所生產的沖蝕土砂。

(關鍵詞：緩衝綠帶、帶寬、適用植物、土砂控制)

Abstract

Ecologic technique has gained attention in recent years. The rationale of ecologic technique is to utilize natural resources to not only prevent the occurrence of disaster, but also conserve ecologic system. Agricultural and non-agricultural development on sloping land produces sediment as well as chemical pollution which greatly affect the water quality and ecologic environment at the downstream water bodies. Therefore, the objectives of this research are two folds. One objective is to quantify the proper width of the vegetative buffer strip within which eroded soil can be effectively trapped by vegetation. The other objective is to identify the suitable grass species with which the filtering function of the strip can be maximized.

The main functions of this year's research include: 1. conducting field experiment and 2. Review related research results. As far as the field experiment is concerned, two grass species were tested at three buffer strip's width on three slope gradients. This year's field study indicated that a limit in the width of buffer strip seemed exist. Taking Carpet Grass as an example, 6m-width of Carpet grass buffer strip can trap 90% of the sediment that generated from 1.67 times widthwise bare slope and that from the strip.

(Keywords : Grass Buffer Strip, Strip Width, Suitable Grass Species, Sediment Control)

計畫名稱	<p>應用生態指數探討九份二山、華山及草嶺地區植生復育之空間分布與調查分析</p> <p>The Spatial Distribution and Investigation Analysis of Vegetation Recovery for Chufenursan, Huasan, and Tsaolin Areas Using Ecological Indices</p>
主持人	<p>林昭遠</p> <p>Lin, Chao-Yuan</p>
計畫年度	<p>94</p>

摘 要

本計畫利用生態嵌塊體理論，以嵌塊體、廊道與基質的變異及能量信息之流動，量化評估九份二山、華山及草嶺地區在區域及地景尺度下，集水區生態指數之變化；建置集水區生態分析系統，有系統地建立本土化生態知識庫，使集水區之生態環境能有妥善之維護管理。建置之崩場地植生復育變遷系統，分為崩場地萃取、植生復育率評估、生態指數計算、坡面泥砂產量推估及多變量統計分析等五項。

崩塌區位九份二山約為 234.02ha，華山地區約為 9.61ha，草嶺地區則約為 1255.08ha。其 kappa 值分別為 0.87、0.79 及 0.78。九份二山、華山及草嶺地區植生復育率平均值分別約達 68.9%、42.9%及 37%。而植生復育差之區位，九份二山及草嶺地區主要分布於崩落區位，所佔比例各為 35.55%及 30.94%；華山地區則主要分布於陡峭區位，佔 33.47%。

由嵌塊體數目、面積及邊緣分析，探討 921 崩塌至 72 水災後復育情形，顯示九份二山及草嶺地區兩區，崩場地面積減少且形狀較為破碎，崩塌區位經生物作用（物種、物質及能量流動）有復原之現象。經 USLE 公式配合遞移率估算泥砂產量，其中，九份二山約為 18718.20tons/yr；華山地區為 109569.72tons/yr；草嶺地區為 2633726.52tons/yr。平均沖刷深度分別為：九份

二山 0.04cm/yr，華山地區 1.76cm/yr，草嶺地區 0.80cm/yr。

以多變量典型判別分析九份二山植生復育率之影響因子，顯示第一函數及第二函數可解釋 90.9% 的變異。其中，第一函數主要為泥砂遞移、土壤及凹凸岸等，影響逕流流量及運動型式之因子；第二函數為順向坡、土地利用、坡向及坡度等地型因子；華山地區典型判別分析顯示，第一函數及第二函數可解釋 99.3% 的變異。其中，第一函數主要為土地利用、泥砂遞移及坡向；第二函數為坡度及高程；草嶺地區典型判別分析顯示，第一函數及第二函數可解釋 95.5% 的變異。第一函數為坡向、順向坡、地質、土地利用及泥砂遞移，第二函數為凹凸岸，第三函數為土壤、坡度及高程。

(關鍵詞：植生復育率、崩塌地、生態指標)

Abstract

The ecological patch theories are used in this study. The quantitative evaluation for the Chufenursan, Huasan, and Tsaolin areas can be reached under local and landscape scales using patch, corridor, and matrix variations and energy flow analysis. Moreover, a watershed ecological analysis system has been established to build a domestic ecological knowledge base and maintain a better ecological condition. There are five models in this system including landslide extraction, vegetation restoration ratio evaluation, ecological index calculation, slopeland sediment yield estimation, and multi-variant statistical analysis.

The landslide area for the Chufenursan, Huasan, and Tsaolin is 234.02ha, 9.61ha, and 1255.08ha, the kappa value for the Chufenursan, Huasan, and Tsaolin is 0.87, 0.79, and 0.78, the vegetation recovery ratio for the Chufenursan, Huasan, and Tsaolin is 68.9%, 42.9%, and 37%, respectively. The poor vegetation recovery areas for Chufenursan and Tsaolin are located at collapse cliffs and occupied 35.55% and 30.94%, respectively. The poor vegetation recovery area for Huasan is located at steep slopes and occupied 33.47%.

The vegetation recovery condition was analyzed for the 921 earthquake and 72 flood events by patch numbers, areas, and edge analysis. The results show the landslide areas are decreased and the shape become fragile through biological reactions including species, substances, and energy flow for Chufenursan and Tsaolin study sites. The estimated sediment yield by USLE and sediment delivery ratio for Chufenursan, Huasan, and Tsaolin is 18718.20tons/yr, 109569.72tons/yr, and 2633726.52tons/yr, respectively. The average eroded depth is 0.04cm/yr, 1.76cm/yr, and 0.80cm/yr, respectively.

The analyzes factors for vegetation recovery of Chufenursan area using multi-variant discrimination reveal the first function and the second function

containing 90.9% variation. Among them, the first function is composite with sediment delivery, soil, concave or convex bank, runoff influenced factors, and flow dynamic factors. The second function is composite with dip slope, landuse, aspect, and slope. From the Huasan case study, the first and the second function can explain 99.3% variance. Among them, the first function is composite with landuse, sediment delivery, and aspect. The second function is composite with slope and elevation. From the Tsaolin case study, the first and the second function can explain 95.5% variance. Among them, the first function is composite with slope, dip slope, geology, landuse, and sediment delivery. The second function is composite with concave or convex bank. The third function is composite with soil, slope, and elevation.

(Keywords : Vegetation recovery Ratio, Landslide, Ecological Index)

計畫名稱	草帶法應用植物及土壤保育之效益評估 Assessment of Effectiveness of Grass Strip in Soil Conservation
主持人	吳嘉俊 Wu, Chia-Chun
計畫年度	93

摘 要

本研究所謂的草帶法與水土保持手冊農地篇中所提之草帶有所差異，主要在於其未來的應用範圍，期望能將研究成果應用於緩衝綠帶或過濾帶中。根據本研究第一年度田間試驗的觀測發現，草帶法的土砂攔截率隨時間的進程而逐漸提昇。除此之外，草帶法的土砂攔截率隨草帶寬度的增加而增加。

本年度田間試驗反應兩項發現，其一為：以百喜草草帶而言，土砂攔截率似乎有一極限；換句話說，當草帶寬度超過某一特定寬度之後，土砂攔截效率提昇的幅度有漸趨平緩的趨勢。本研究第一年度的研究發現之二為，類地毯草於本年度較差的地表覆蓋率前提下仍能提供較百喜草草帶為佳的土砂攔截率，似乎說明類地毯草的地上莖於相同的發育期程內，較百喜草有較佳的土砂攔截效果。

至於水質的部份，各項水質在各處理間雖有明顯差異，但其變動趨勢並無明顯規律。

(關鍵詞：草帶法、植生過濾帶、土砂攔截率、逕流水質)

Abstract

The grass strip has different definition as that addressed in Soil and Water Conservation Handbook. The grass strip that continuously referred in this study has similar definition as that of vegetative buffer strip. According to the first year field experiment, we found that grass strip's sediment trapping efficiency increased as time proceeded. The sediment trapping efficiency also increased as strip width increased.

Two findings were obtained from this first-year field experiment. 1. Field results indicated an existence of sediment trapping limit as strip width reached to a certain width. 2. Creeping characteristics that possessed by Carpet Grass helped improve the sediment trapping efficiency that even outran Bahia Grass.

As far as surface runoff water quality was concerned, apparent difference was found between experiment treatments. However, no regulation controlling the experiment outcomes was found.

(**Keywords : Grass Strip, Vegetative Buffer Strip, Sediment Trapping Efficiency, Runoff Water Quality**)

計畫名稱	野溪生態調查及棲地改善模式之建置(第二年) Establishment of Ecological Investigation and Habitat Enhancement Model for Creeks (2nd Year)
主持人	林信輝 Lin, Shin-Hwei 蔡志偉 Tsai, Chih-Wei
計畫年度	93

摘 要

本計畫延續第 1 年度計畫之內涵，持續選取台中縣頭汴坑溪、台北縣牡丹溪及台南縣六重溪集水區為主要研究範圍，進行生態資源調查與分析工作，完成六重溪與牡丹溪棲地改善細部規劃設計、生態工程推廣解說摺頁編印、集水區生態資源調查手冊、棲地改善設計參考圖冊及棲地改善模擬應用等工作。

計畫重點工作項目說明如下：

1.野溪水陸域物化環境河段持續生態調查監測

完成包含河溪水理調查、河溪水質調查、生物資源調查及調查成果與分析。

2.建立集水區生態資源調查手冊

本手冊主要搜集生態環境調查資料，包含物理因子、化學因子、植生、動物等生態資源項目，進行調查項目、調查工具、分析方法以及調查頻率等項目之說明。

3.棲地改善細部規劃設計與設計參考圖冊編印

完成六重溪水理計算、河道沖淤分析及四處防砂壩之棲地改善細部設計、牡丹溪則完成護岸與固床工改善之細部設計。

4.棲地改善工法設計成果模擬與動態模擬應用

完成 2 張動態景觀模擬與 30 張靜態景觀模擬圖片。

5.生態工法之教育訓練

辦理台日生態工法研討會及赴國外進行生態工法案例考察。

(**關鍵詞：野溪、生態資源、集水區、設計參考圖冊、景觀模擬**)

Abstract

The major items of this project including:

1. Ecological investigations and continuous monitoring on the Physical and chemical environments of aquatic and terrestrial areas of creek.

Included the investigation of hydraulic and hydrological, water quality, creature Resources etc.

2. Compilation of the Watershed Ecological Resources Survey Handbook.

The ecological environment, including physical, chemical, vegetation and animal factors were collected in this handbook. In addition, the investigation items, used tools and measures, analytic methods and investigation frequency were also discussed in detail.

3. Detail design of habitat enhancement and compilation of design reference book.

Hydraulic calculation, erosion and deposition analysis of stream channel, detail design of habitat enhancement for 4 check dams have been completed in this project. While the detail design of revetment and sill works in Mu-dan Creek was also completed and the length of stream channel is about 300m.

4. Image simulation of habitat enhancement concepts.

Photoshop and 3D max were adopted to produce 2 sets of dynamic landscape image simulations and 30 sets of static landscape photo simulation for actual planning and design cases.

5. Education and Training courses of Ecological Engineering.

A Taiwan-Japan Conference on Ecological Engineering has been held in July 2004 and a field trip abroad for site investigation on ecological engineering aspects was also taken in 2004.

(**Keywords : Creek, Ecological Resource, Watershed, Referential Design Drawings, Landscape Simulation**)

計畫名稱	集水區生態工法規劃設計參考模式之建立 (第二年) Integrated Watershed-level Planning and Design Model of the Natural Ecological Engineering Methods (Second Year)
主持人	王傳益 Wang, Chuan-Yi
計畫年度	93

摘 要

壹、緒論

1.1 計畫目的

國內河溪生態工程模式近兩年以後在政府明確政策引導之下、集國內產官學科以及國外學人專家能力、頗有快速推展 進步因為之勢實可以非常的喜之事。而水土保持局自 90 年度起即全力推動生態工法，為使工法專業技術能有所突破創新，先後辦理「北部地區治山防災構造物運用生態工法之調查評估及新工法之研發計畫」、「921 重建區治山防災構造物運用生態工法之調查評估及新工法之研發計畫」及「野溪生態工法評估指標及設計參考圖冊之建立」等計畫，分別完成研究成果報告及設計參考圖冊。

而有感於該等圖冊僅為各工法之設計參考斷面圖，為增加其整合能力及現場人員之參考應用價值，遂成立本研究計畫，期以選定之集水區規劃個案，以整體宏觀考量，整合防災安全、休閒遊憩、生態保育與體驗面向做規劃設計，期能建立集水區規劃設計之模式，供工程人員實務之參採應用，以提升生態工法規劃設計之專業素養與理念。

1.2 工作範圍

南投縣國姓鄉南港村北坑溪(又名木屐欄溪)主流，自南港二號橋上游 100m 起溯至永元橋，全長 4.26km，集水區面積約 1412.5ha。

1.3 工作項目及內容

一、集水區生態工法規劃作業實用模式

- 1.集水區環境調查與分析作業，
- 2.集水區生態工法空間配置作業，
- 3.集水區生態工法安全評估作業，
- 4.集水區生態工法環境監測作業。

二、北坑溪集水區生態工法規劃模式補遺與應用

- 1.規劃區域環境調查與分析補遺，
- 2.規劃區域生態工法空間配置檢討，
- 3.規劃區域生態工法安全評估模式應用，
- 4.規劃區域生態工法環境監測補遺，
- 5.建立規劃區域環境資料庫，
- 6.建立規劃區域河川生態資料庫。

三、集水區生態工法之推廣

- 1.生態工法國內外相關文獻蒐集，
- 2.生態工法國外書籍翻譯彙編（日本或歐美國家），
- 3.生態工法技術交流研習，
- 4.生態工法規劃作業參考手冊彙編。

四、北坑溪示範河段工程設計（第二期工程）

（一）規劃區域補充測量：

- 1.規劃區河段地形測量；
- 2.河道中心線及縱、橫斷面測量。

（二）工程構造物規劃設計：

- 應繪製 1.工程配置圖；2.設計平面圖；3.縱橫斷面圖；4.構造物各剖面圖。

五、規劃成果多媒體展示

六、後續年度計畫建議

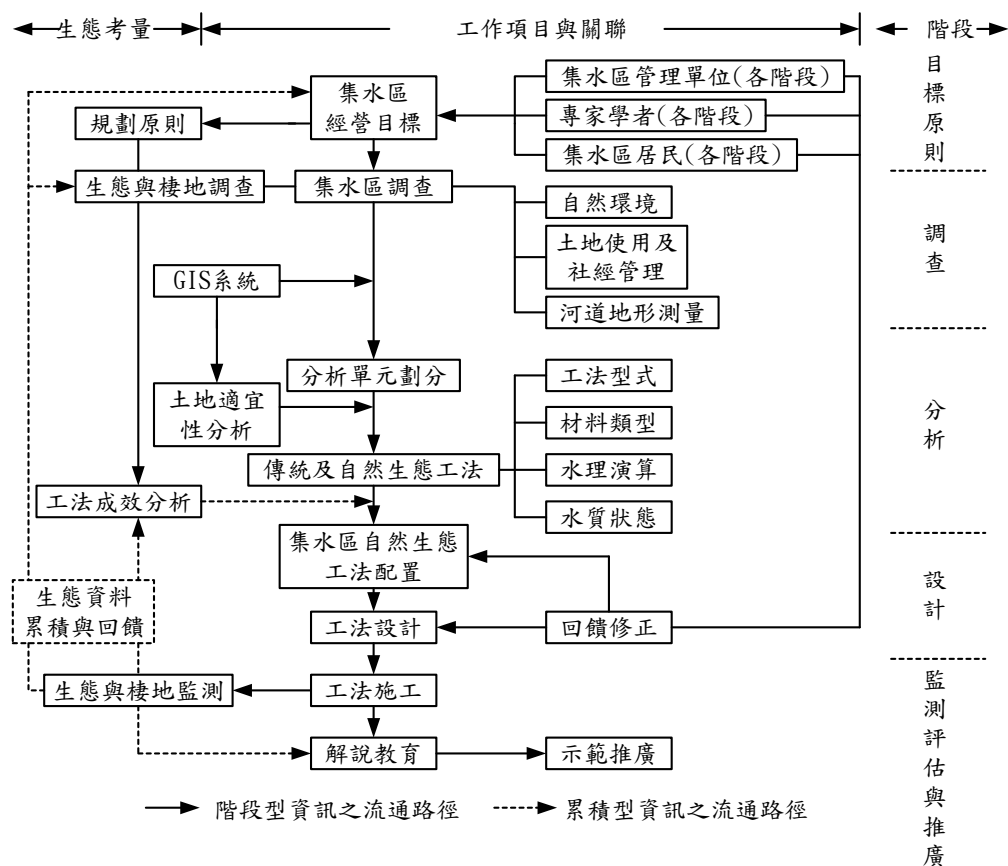
1.4 本年度工作流程

本計畫工作流程，如圖 1.4 所示。經由第 1 年計畫針對十五處候選集水區進

表 2.1 「集水區生態工法規劃設計流程」與「水土保持技術規範」第 144 條「河川集水區整體治理計畫」擬定原則之關聯分析

	集水區經營 目標確定	特性調查	規劃單元劃分 與工法分析	工法配置 與設計	生態評估與 教育推廣
集水區概況		●	○		○
集水區問題分析	○	○	○	○	○
處理維護之需要性	●		●		○
治理內容	○		○	●	
配合措施	○				○
治理順序及實施			●		
經費及來源				○	
整體治理規劃配置			○	●	

●表示兩者之概念與內涵相近；○表示兩者之部分概念或內涵相近



由表 2.1 可知，「集水區生態工法規劃設計流程」不僅滿足現行法規所要求之擬定原則，而且更強調生態環境之特性瞭解與價值提昇。因此，本研究認為其過程或需透過跨領域合作方能實施，但其規劃設計流程不宜予以簡化，以免

因爲求便利而遺漏關鍵資訊。

2.1 集水區環境調查與分析作業

在確定規劃設計模式之計畫工作流程後，本研究將延續第一年之工作，建立生態工法規劃作業實用模式，以供集水區整體治理計畫實際規劃工作之應用。以下就規劃區域環境調查與分析作業說明操作方式及未來作業執行重點（詳如集水區生態工法規劃作業手冊）。

2.2 集水區生態工法空間配置作業

根據 92 年度研究成果，生態工法空間配置之實施主要在建立土地適宜性分析及分區工法規劃等兩項操作過程。前者係以地理資訊系統爲工具對各分區進行發展潛力之分析，後者則配合崩場地與土石流潛勢溪流現有 GIS 圖層、水理分析模式之淹水潛勢以及水質與生態現場調查結果等資訊，最後將各分區依其特性而分爲自然保育分區、土砂災害防治分區及生態工法改善分區（含景觀遊憩設施分區）等三類。

綜合上述分區型態，並以生態環境、自然災害潛勢以及社會人文遊憩價值等條件加以界定，則可得表 2.2.1 之經營分區分類表。

表 2.2.1 集水區經營分區分類原則

集水區經營分區	判斷條件		
	生態環境	自然災害潛勢	社會人文遊憩價值
自然保育分區	良好、完整	無嚴重泥砂災害或保全對象	—
土砂災害防治分區	—	土砂災害嚴重、溪流坡度較陡、河道較窄或河岸保全對象分佈較密	—
生態工法改善分區	尚可	無明顯災害威脅	具有適當土地開發潛力

然而，欲完成此空間配置之操作程序，必須同時具備前一階段環境調查與分析作業之部分成果方能順利進行。因此空間配置作業所需資料，依其來源可分爲現場調查及電腦分析兩種；前一類資訊包含集水區環境、生態及河川水質（化學性棲地環境），後一類資訊則包含土地發展潛力、崩場地分佈、土石流潛勢溪流及淹水潛勢等。將這兩類資料與前一階段環境調查與分析作業之成果加

以結合則可得表 2.2.2。

表 2.2.2 集水區生態工法空間配置作業所需資訊及條件

空間配置操作程序	所需資訊		與「環境調查與分析作業」之關聯									
	類別	獲得方式	一	二	三	四	五	六	七	八	九	十
分析單元劃分	地形圖	室內分析、現場確認	√									
土地適宜性分析	發展潛力	GIS 疊圖分析	√	√					√	√	√	
分區工法規劃	生態環境	環境調查	√		√	√	√					
	自然災害潛勢	環境調查、電腦分析	√		√			√	√	√	√	√
	社會人文遊憩價值	環境調查	√	√	√	√		√				

註：一、集水區人文、水文及地文資料調查作業
 二、道路交通系統調查作業
 三、流量與水位調查作業
 四、水質(化學性棲地環境)調查
 五、溪流棲地流況調查
 六、應用資材調查
 七、水際域或洪氾區區位調查
 八、集水區歷年整治概況
 九、集水區災害調查
 十、集水區河溪水理演算

2.3 集水區生態工法安全評估作業

生態工法除了考量當地水文及地文條件外，保全對象的考量為施作背景條件，因此需「因地制宜」，在安全無虞之前提下，兼顧對生態之保障。因此在集水區進行生態工法的施作前後，工程的安全評估列為首要重點。

一、結構穩定安全性

生態工法種類繁多，依照保護對象及順應地形坡向而有不同的設計，但是所有工法的最基本原則在於結構物需符合安全穩定要求。結構物可分剛性與柔性兩種工法，在進行應力分析時，則視為一個剛體來分析，其中結構的安全可就兩方面探討，一為外應力所造成的結構物傾倒、滑動與沉陷，另一種則為內應力所造成的結構物崩解或損壞。

二、土砂生產安全性

土砂生產的安全性控制除需瞭解土砂生產的原因、類型與致災特性，另一方面須針對問題提出生態化治理對策，使土砂的生產控制在適當且安全的範圍內。生態工法的設置，必須考量兩種土砂生產的區位，一種為該區域曾經或目前已發生土砂災害的坡面或河道進行緊急搶修或長久治理，另一種則根據學理找出區域內具有潛勢災害特性之地方，以工法消除或減少危險之疑慮。

三、河道穩定安全性

工程構造物施設於河道中主要目的在控制流心，並且保護岸坡與溪床避免無限制橫向沖蝕與縱向沖刷。另一方面，河道設置縱橫向之人工構造物亦可透過水流與泥砂的作用，創造不同的棲地環境，如深潭、淺灘等。設置生態工法後，該構造物必須肩負水流與河道安全之責任，亦即，除了創造不同類型之流況以利生物生存外，河道本身的穩定，亦是生物長久生存的必要條件。

四、生態保育與復育功能

生態工法的施設，其中一個主要目的在於營造更多適合生物棲息之場所，並且利用工程的方法予以穩定，使棲地能永續發展。棲地環境的穩定、物種之穩定與空間之連續性皆為考量之因素，而棲地與物種的數量必須做詳細考量，避免出現所謂優勢物種或型態的產生，以避免整體環境之單調化與物種趨向滅亡的傾向。

五、植生功能安全性

植生工法在生態工法內佔有相當重要的角色，除了景觀綠美化的功能外，植生工法亦有穩定邊坡、提供棲息遮蔭以及防風定沙的效果。植生工法的應用需考量植物的立地條件，亦即其生活環境是否適宜，且在移栽過程對植物生命之影響，以及與其周遭植物間的互動，是否產生優勢族群的現象等，皆是植生環境的應用安全考量。

六、親水遊憩安全性

水環境的必備條件可分為兩種，一為親水路途的安全性，包含是否容易親近與阻隔程度的關係說明，另一種則為當可以近水，水域環境是否適合戲水為使人類能接近河川與大自然，工程不致太僵化，且不因工程的設置，而阻隔生物接近水源的能力。因此避免坡度過於陡峻，且提供更多且更安全的人與水接

觸的機會。

2.4 集水區生態工法環境監測作業

集水區治理是否達到原先設定之經營目標，有賴於治理設施實施後之調查分析，方能依據調查相關資料加以評估。對於生態工法實施成效之確認，則需以環境調查作業呈現工法在生態環境之成果或影響。因此，實用模式之第四階段即為以水質（化學性棲地環境）及生態系（含陸域生態及水域生態）為主要調查作業項目，調查結果亦可回饋至前三階段以為調適式管理(adaptive management)的基礎資訊來源，其關聯性示如表 2.4.1。

表 2.4.1 環境調查項目與模式前三階段比較之操作內容

實用模式		環境調查項目		
階段	操作內容	水質	陸域生態	水域生態
環境調查與分析	一、集水區人文、水文及地文資料調查作業（人口、農產經濟、土地利用、歷史文化、氣象水文、地形、地質及土壤及溪流現況）		√	√
	四、水質簡易調查	√		
	五、溪流棲地流況調查			√
空間配置（分區工法規劃）	生態環境		√	√
	自然災害潛勢		√	√
	社會人文遊憩價值	√	√	√
工法安全評估	生態保育安全性	√	√	√
	植生綠化安全性		√	
	親水安全性	√		√

參、示範集水區生態工法規劃模式補遺與應用

3.1 規劃區域環境調查與分析補遺

以 92 年規劃成果建立集水區環境調查與分析作業、空間配置作業、工法安全評估作業及環境監測作業等集水區生態工法規劃作業實用模式，並將該模式實際操作應用於北坑溪集水區，進行回饋修正與補遺。

3.2 規劃區域生態工法空間配置

藉由「土地適宜性分析」及地理資訊系統對規劃區之土地資源容受力進行瞭解，由分析單元為 40m×40m 之土地適宜性分析成果（圖 3.2.1）可知，北坑溪較適合發展遊憩景觀活動之區域多位於中下河道附近，而崩塌地較多之左岸五

條支流亦為土石流潛勢溪流，經分析研判分為限制發展區或適宜性最低區域。而後利用前述之土地適宜性分析結果（中等以上發展潛力區），並彙整與「社會人文遊憩價值」有關之環境調查項目而成表 3.2.1。

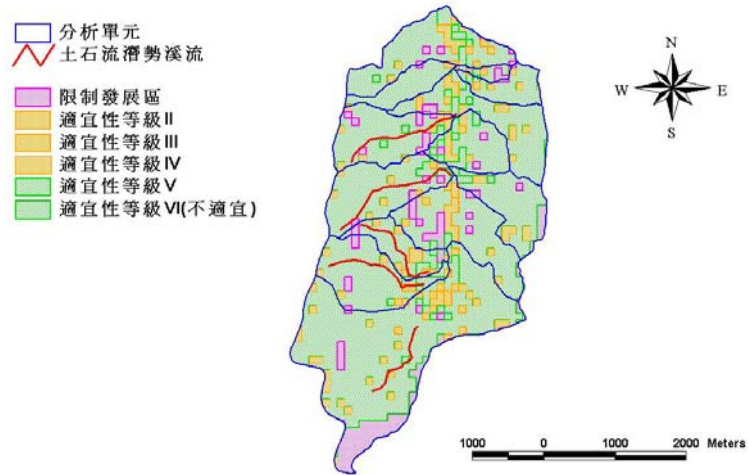


圖 3.2.1 規劃區域土地適宜性分析結果

表 3.2.1 北坑溪各子集水區之「社會人文遊憩價值」分析

編號	名稱	中等以上發展潛力區 (面積百分比)	人口及社區經濟	河岸發展空間	人文遊憩資源
1	奄江岸坑	12.95%	散戶	-	-
2	蓮生坑	15.55%	散戶	-	港源國小
3		32.77%	涵蓋部分盧厝 (53 戶)	-	港源一號橋附近 河道因岩盤地形 形成特殊流況
4	紅仙水坑	18.40%	散戶	右岸具平坦野溪 出口堆積地	廢棄陶土廠房
5		21.13%	散戶	-	港源國小
6	三合溪	16.97%	散戶	-	-
7		32.02%	散戶	-	-
8	富山坑	16.73%	散戶	-	-
9		8.68%	涵蓋部分林厝 (38 戶)	-	-
10		16.03%	涵蓋部分林厝 (38 戶)	-	-
11		31.47%	涵蓋部分南港社 區(179 戶)	鹿源橋附近溪幅 寬廣，河岸植生 茂密	林家養鹿場
12		37.58%	涵蓋部分林厝 (38 戶)	-	-
13		22.23%	涵蓋部分盧厝 (53 戶)	協興橋附近河道 較寬約 40m，護 岸保持良好	-

而利用環境調查成果之土砂災害(崩塌地、土石流潛勢溪流、水災潛勢)分佈狀況及水質調查結果，彙整成表 3.2.2。

表 3.2.2 北坑溪各子集水區之「生態環境及自然災害潛勢」分析

編號	名稱	崩塌地 (面積百分比)	土石流潛 勢溪流	淹水潛勢	生態調查 (保育類數)	水質 (河川水質指數)			
						1	2	3	4
1	奄江岸坑	9.86%	●	●	陸域生態 (一)植物：無 (二)鳥類：7 (三)哺乳類：1 (四)爬蟲類：2 (五)兩生類：3 (六)蝶類：無 水域生態 (一)魚類：2 (二)蝦蟹類：0 (三)底棲生物：各 樣點差異不大	-			
2	蓮生坑	12.60%	●	-		丙	丁	乙	丙
3		0.83%	-	●		-			
4	紅仙水坑	1.75%	-	-		丙	丁	乙	丙
5		0.81%	-	-		丙	丁	乙	丙
6	三合溪	7.04%	●	-		丙	丁	丙	丙
7		3.54%	●	-		丙	丁	丙	丙
8	富山坑	15.01%	●	-		丙	丁	丙	丙
9		3.47%	-	-		-			
10		1.36%	-	-		-			
11		1.04%	-	-		丙	丁	乙	丙
12		2.32%	-	-		-			
13		1.15%	-	●		-			

最後，依據第二章所建議之集水區經營分區分類原則，並利用前述規劃及現場調查之資料類別而對北坑溪各子集水區之經營型態進行研判。此外，針對生態工法改善分區中，具有適當土地開發潛力者設定為景觀遊憩區，其結果如表 3.2.3 與表 3.2.4 所示。

表 3.2.3 集水區經營分區分類原則

集水區經營分區	判斷條件		
	生態環境	自然災害潛勢	社會人文遊憩價值
自然保育分區	良好、完整	無嚴重泥砂災害或保全對象	-
土砂災害防治分區	-	土砂災害嚴重、溪流坡度較陡、河道較窄或河岸保全對象分佈較密	-
生態工法改善分區	尚可	無明顯災害威脅	具有適當土地開發潛力

表 3.2.4 北坑溪各子集水區之經營類型綜合分析

編號	名稱	生態環境	自然災害潛勢	社會人文遊憩價值	經營分區
1	奄江岸坑	全區無明顯差異，但區內發現13種保育類陸域生物及2種保育類魚類	高崩塌率、土石流及淹水潛勢	低（散戶）	土砂災害防治
2	蓮生坑		高崩塌率、土石流潛勢	中（散戶）	土砂災害防治
3			淹水潛勢	高	生態工法
4	紅仙水坑		無嚴重災害潛勢	中（散戶）	生態工法
5			無嚴重災害潛勢	高（散戶）	遊憩景觀
6	三合溪		土石流潛勢	低（散戶）	自然保育
7			土石流潛勢	中（散戶）	土砂災害防治
8	富山坑		高崩塌率、土石流潛勢	低（散戶）	—
9			無嚴重災害潛勢	低	自然保育
10			無嚴重災害潛勢	低	自然保育
11			無嚴重災害潛勢	極高	遊憩景觀
12			無嚴重災害潛勢	中	生態工法
13			淹水潛勢	高	生態工法

3.3 規劃區域生態工法安全評估模式應用

根據 2.3 節之國內外常見生態工法安全評估作業，依序針對結構物穩定、土砂生產、河道穩定、生態保育及復育、植生功能與親水遊憩安全性於北坑溪內之應用加以說明。

一、北坑溪集水區結構穩定之安全性

根據現場調查與分析，發現該區域 50 年頻率洪峰流量條件下，全河段之河寬約為 15—48 m，最大流速位於火龍果園旁及無名橋附近約可達 5.2 m/sec，惟依 3.1 節水理分析，當火龍果園段退縮 1.5 m，最大流速可降至 5.0 m/sec 以下。配合當地土砂調查之河道粒徑特徵發現為使岸坡穩定，建議拋石粒徑大小需達 100cm。本研究區段位處北坑溪中游段 D50 粒徑約為 69 cm，因此若單以乾砌石工法施設護岸，無法達到穩定要求，因此建議採用漿砌石工法，以符安全需求。

二、北坑溪集水區土砂生產之安全性

本區在土砂生產方面主要來源有二，其一為來自上游坡面的崩塌與逕流，另一部分則來自於溪床面的輸砂。本集水區之土砂生產主要來自於北坑溪四處支流之土石流危險溪流（奄江岸坑、蓮生坑、富山坑與三合坑）以及紅仙水坑集水區內之崩塌坡面與溪床冲刷。

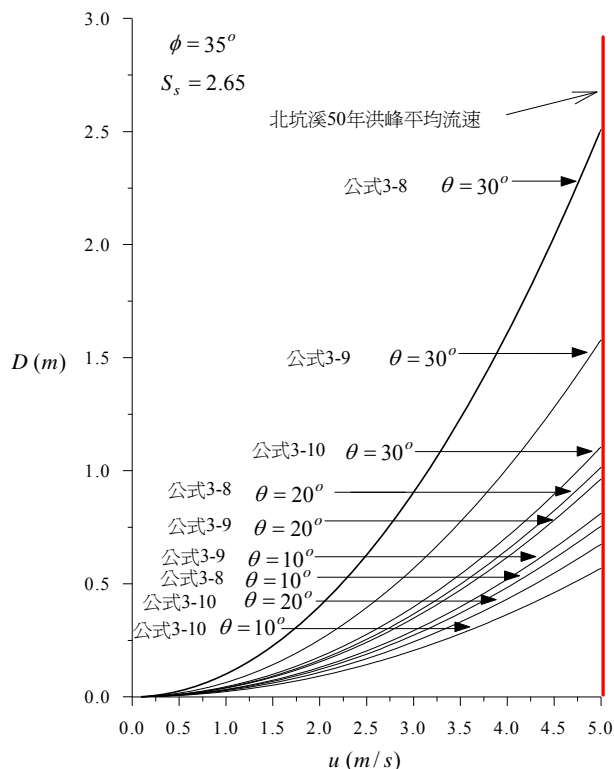


圖 3.3.2 不同水流流速及邊坡傾角下之塊石最小粒徑

三、北坑溪集水區河道穩定之安全性

根據集水區植被特性，配合幾何變化，本研究利用 WinGrid 集水區資訊系統，分析此五區之集水區特性與水流狀況，並計算在不同降雨特性條件下洪峰流量之推估值，做為溪流結構物安全設計與河道穩定之依據。此外，根據河床質與床面幾何的調查，可由錢寧河道穩定性指標 $Ks=D/hs$ 來研判各河段之相對穩定性，以瞭解河川水流橫向與縱向闊床與沖刷行為。分析結果顯示，北坑溪上游河道均稱穩定。

四、北坑溪集水區生態保育與復育之安全性

在河道內，棲地保育措施構造物的設置相當重要，可區分為：1.卵石組串堆；2.壩堤或橫向固床工法；3.魚道；4.防遷移障礙物；5.河道坡降控制措施；6.多孔性混凝土。

五、北坑溪集水區植生功能之安全性

根據調查結果發現本區雖然植生條件良好，但是針對規劃區域動線周遭的植生與河岸改善之植生設計進行規劃考量。

3.4 規劃區域生態工法環境調查補遺

一、集水區化學棲地環境調查(水質調查)

93 年度規劃區域生態工法化學棲地環境調查補遺將進行水質採樣調查工作，對河川水質於計畫區域生態工法施作區段施工前、施工中及施工後水質之差異做比較及評估；綜合 93 年度水質資料評估，在天氣狀況良好條件下，北坑溪水質屬於未受污染的乙類水質，可作為公共用水及灌溉用水之水源，而河川水質清澈，親水性佳，且流量不大較不容易發生危險，可以規劃為適合娛樂、親水及遊憩活動使用。

二、生態調查補遺

93 年度是以鹿源橋與港源二號橋(港源國小旁)作為生態工法施作點，比較施作前後在生態上的差異，以作為生態工法成效的依據。同時利用高度依賴溪流的水生昆蟲來建立 Hilsenhoff 科級生物指標值(Family-lever Biotic Index, FBI)，以評估方式進行水質的初步檢定。調查結果鹿源橋第一季 FBI 值為 4.09，屬於 very good 等級；港源二號橋（港源國小旁）第一季 FBI 值為 4.38，屬於 good 等級。由於北山坑溪魚類去年與今年調查僅 9 種，如果以生物整合指標評分標準需建立最大物種豐度標準線(Maximum Species Richness lines, MSR lines)，則無法達到優良等級；因此若欲以生物整合指標來評估北山坑溪在工程前後的環境變化，在工程前則需建立本河川或相似河川的基礎資料庫，才能作為評分的標準。

3.5 規劃區域環境與生態資料庫之建立原則

一、集水區環境資料庫之概念模式

(1)空間與時間之本體論、架構及呈現方式；(2)時空資料庫管理系統之模式及程式語言問題；(3)時空資訊之繪圖使用者介面問題；(4)時空資料庫之查詢處理；(5)時空資料庫之儲存架構及索引技術；及(6)時空資料庫管理系統之架構。

二、集水區環境資料庫之設計考量

- 1.分析資料庫(analytic database)的使用者多為小眾、均質且具專業知識的團體，他們的資料庫問題也事先被瞭解。
- 2.地球科學通常分析時間順序性的多維度表格(time sequenced, multidimensional table)，生物種群研究需要線性資料比對，空間科學則運用

多頻譜分析於大量的二或三維向量資料。

3. 資料庫之設計應著重批次儲存而非頻繁轉換。

三、集水區環境資料庫之尺度建議

由於本資料庫不是以特定生物進行復育或監測為目的，因此建議以「集水區」的監測尺度來建立環境資料庫。

四、集水區環境資料庫資料收集方法、流程

肆、集水區生態工法之推廣

4.1 生態工法國內外相關文獻蒐集

由於日本之水文地文條件與台灣相仿，因此 92 年赴日收集資料。奧地利為生態工法之濫觴，93 年則參訪奧地利，由奧地利中部薩爾斯堡(Salzburg)之泰卡集水區整體治理計畫(Integrated Watershed Management Project THALGAU)、晉肯(GILGEN)野溪系統整治前後現勘，向西至提洛地區(Tyrol)之合德河集水區(Holderbach catchment)治理，以迄於因斯布魯克(Innsbruck)地區之渥格河集水區(Woerglerbach catchment)整治前後差異比較，瞭解當地政府先將土砂災害治理後，劃定危險區(hazard map)，明訂緩衝帶，而後針對不同野溪問題「因地制宜」採用不同的工法，為仍以「安全」為首要考量，其次儘量兼顧生態。對於治理後之濕地或生態池區，並未以觀光休閒為導向，以減低人類介入當地後造成生態之影響與衝擊。

4.2 生態工法國外書籍翻譯彙編(日本或歐美國家)

國外書籍的選取首先以地勢起伏條件較接近台灣的日本以及奧地利為主要考量。日文書籍擬針對河岸構造的穩定性考量，則選取河川條件較相近的日本國土技術研究中心所編纂的「護岸之力學設計法」來參考借鏡。而計畫以集水區整體治理為先，且顧及護岸工程的穩定性考量，本研究群經由多方蒐尋之後，考量了台灣本土的需求以及引進最先進的觀念而挑選了生態工法的兩位開山大師, Willian J. Mitsch 以及 Sven Erik Jorgensen, 2004 年所新著作的「Ecological Engineering and Ecosystem Restoration」一書，作為節錄河川部分來摘譯的範本，詳細翻譯內容如「生態工法國外書籍翻譯彙編」一書。

4.3 生態工法技術交流研習

原訂辦理集水區生態工法之推廣之「生態工法技術交流研習」，因 93.07.02 敏督莉颱風、93.08.24 艾利颱風及多次超大豪雨造成水土保持局轄區溪流各地災情，需積極參與災修及復建工程，局內工程人員工作量驟增，無暇參加相關技術研討會；且本計畫原欲調訓各縣市政府相關單位工程人員參與生態工法技術交流研習，亦因各地災情亟需投入眾多人力及物力，無法在短期內調撥人員參訓；復因本計畫之「北坑溪集水區」經 2 次颱風侵襲其地形地貌已改變，且因原列第三期工程中之紅仙水坑溪匯流口至港源一號橋間急需進行規劃治理，因此奉水土保持局 93 年 10 月 29 日水保治字第 0931824728 號函核准辦理計畫契約變更，取消技術交流研習，增加工程測量設計區段。

4.4 生態工法規劃作業參考手冊彙編

本計畫以集水區生態工法規劃設計模式為基礎，蒐集整合相關資訊，進而編撰生態工法規劃作業參考手冊，做為相關工程人員規劃設計時之指引。

伍、北坑溪示範河段工程設計（第二期工程）

5.1 示範河段補充測量

一、測量地點及範圍

針對北坑溪示範河段第二期工程（鹿源橋區段、港源國小區段）進行地形、河道中心線及縱橫斷面相關補充測量。

二、控制系統

以 GPS 接收儀量測定位座標假設為之，高程數值以公尺為單位，計至公厘止。

三、測量作業內容程序、方法及成果展繪：

(1)控制點佈設(含位置及高程)；(2)地形測量；(3)河道中心線測量；(4)縱橫斷面測量。

四、人員組織及設備

5.2 示範河段工程規劃

北坑溪集水區在 93 年初施工之鹿源橋上游護岸整治工程已經完成，93 年度

即將於鹿源橋上游與港源國小區塊進行規劃，先進行點的發展，而後再進行線的串連。主要規劃原則如下：

1. 尊重基地地形條件，區塊之開發與建設應加以融合。
2. 展現當地資源特色，適當的保留區塊內以存在之農田景觀（如牧草）及養鹿文化等，做為此區域之解說展示內容。
3. 呼應地方風格與整體意象，展現屬於北坑溪獨特的農業文化與人文意涵。
4. 規劃戶外生物多樣性教育園區（如生態池），營造生態多樣性棲地環境，提供中小學戶外教學場所。
5. 整備完善之遊園路線及步道系統，同時搭配戶外展示與體驗教育解說環境，達到休閒富麗農村之目標。
6. 結合溪流岸邊特色與親水設施，營造多樣化棲地型態及親水空間。
7. 以安全為基礎，對於已遭破壞工程結構物妥善處理，並融入生態及景觀概念，在最低之衝擊影響條件下，進行棲地改善。

一、鹿源橋區段整體規劃配置（圖 5.2.1）

此區段之護岸整治工程已於 92 年發包，並於 93 年 5 月完工，歷經 7 月 2 日敏督利颱風百年大水災後，其安全無虞，顯見工程設計適當。93 年度此區段規劃之項目如下：

1. 親水河岸改善：A. 深潭淺瀨營造；B. 親水空間營造；C. 護岸植生改善；D. 左岸之護岸規劃。
2. 河濱空間規劃：A. 服務中心；B. 停車場；C. 苗圃區；D. 觀景區；E. 牧草區；F. 堤頂步道；G. 解說站。

二、港源國小區段整體規劃配置（圖 5.2.2）

93 年主要是以港源國小為中心向外延伸，同時配合生態池、生態植物體驗區、棲地改善、解說亭等設施，此外並結合國小之教育系統與既有資源，發展港源社區客家文化特色。主要規劃如下：



圖 5.2.1 鹿源橋區段規劃配置圖

1. 親水河岸改善：A. 生態池；B. 港源國小旁無名橋改善工程；C. 無名橋至永元橋行水區棲地改善；D. 永元橋下游左岸以複式護岸營造親水

遊憩空間。

2.河濱空間規劃：A.生態植物體驗區；B.生態解說規劃；C.湧泉體驗區。



圖 5.2.2 港源國小區段規劃配置圖

5.3 示範河段工程細部設計

一、規劃理念

為有效實施集水區之治理計畫，維護原有流域及週邊生態及符合多數民

眾需求等目標，視溪流天然條件適當引入親水設施提供遊客親水空間，結合現有人為設施及溪溝自然環境立地條件，提供完善之規劃以滿足人們親近自然生態環境之渴望。考量生態永續設計理念，以低維護、低遊客量的設施規劃設計方式，營造小而美、深度生態體驗的教育園區，使集水區在較小成本需求與符合當地生態人文特色條件下達成永續經營與發展。

工程營造除考慮安全排洪要求及維護原有野溪之生態環境外，並兼顧鄰近聚落休閒遊憩環境之需求為目標，整治時依現有野溪環境研判，並儘量以就地取材為原則，期能符合生態工法之目標。

二、設計原則

- (1)創造環境多樣性及營造自然生態空間；
- (2)綠帶與藍帶之結合與環境景觀之調和；
- (3)生物廊道維持及水域生態環境之維護；
- (4)因地制宜的規劃及提高民眾參與。

三、工程構造物設計圖

規劃設計原則將工程配置圖、縱橫斷面圖、標準斷面圖及構造物各剖面圖等繪製如成果報告書。

5.4 規劃成果多媒體展示

藉由模擬飛行動畫之展示，對於各項規劃成果可獲致通盤性之認識。針對規劃區域內之地形、地貌及重要地物，作整體性之導覽，動畫製作主要利用 Discreet 所開發之 3ds max 軟體完成，並於預設飛行路徑，介紹各項工程構造物之配置、生態工法及棲地營造構想之應用。

陸、後續年度計畫建議

一、集水區河川生態工法效能評估體系及其指標之建構

- 1.生態工法安全性指標
- 2.生態工法生態性指標
- 3.生態工法水質變異指標

二、集水區生態工法規劃觀摩研習與技術移轉

- 1.生態工法規劃實務研習會

2.生態工法規劃觀摩研習圖說資料之製作

3.生態工法教學活動手冊之製作

4.舉辦現地觀摩研習

三、生態工法教學園區及解說系統之建立

1.分區構想與全區配置規劃

2.生態工法教學園區之規劃設計

3.生態工法應用手冊之製作

四、規劃成果多媒體展示

五、示範河段工程設計(第三期工程)

1.示範河段補充測量

2.示範河段工程構造物規劃設計

(關鍵詞：集水區、生態工法、環境資料庫、生態資料庫)

Abstract

1. Background Information

1.1 Project Goals

As the second-year project, this year project expands and modifies the research outcomes from previous year project, i.e., an integrated watershed-level planning and design model of the natural ecological engineering methods, in order to achieve the purposes of disaster prevention and treatment, natural resources conservation, and protection of watershed resident and their properties within a single watershed management project. Besides, the application procedures of the model for the study watershed had also been operated at two reaches.

1.2 Study Watershed

From the 100 meters upstream section of Nan-Kang No. 2 Bridge to Yung-Yuan Bridge, the study watershed of this project includes the main channel of Pei-Keng Creek of 4.26 kilometers with total area of about 1412.5 square kilometers.

1.3 Operation Items and Contents

- A. Practical model for the integrated watershed-level planning of the natural ecological engineering methods.
- B. Modification and application of the watershed-level planning and design model for the study watershed.
- C. Extension of watershed ecological engineering methods.
- D. Engineering design of study watershed.
- E. Multi-media demonstration of the planning outcomes.
- F. Recommendations on the follow-up yearly plans.

2. Practical Model for the Integrated Watershed-Level Planning Of the Natural Ecological Engineering Methods.

To verify the viability of this model, the five major stages (Figure 1) of the model are examined by the scoping principles of watershed management project

suggested in the “Technical Guidelines of Soil and Water Conservation”. Shown in Table 1, comparison result indicates that this model not only satisfies the principles but also impresses the appreciation and promotion of ecological environment. Even these complex procedures can not be completed without interdisciplinary collaboration, the planning and design process of a practical model should not be over-modified such that some important factors or information will be ignored or uncovered.

Table 1 Comparison between the scoping principles of watershed management project and the five major stages of the mode I

	Objectives & Principles	Investigation	Analysis	Design	Monitoring, Evaluation, & Extension
Watershed Condition		●	○		○
Problem Analysis	○	○	○	○	○
Treatment Necessity	●		●		○
Treatment Content	○		○	●	
Supplemental Measures	○				○
Priority and Implementation			●		
Budget				○	
Planning & Allocation			○	●	

● : highly consistent; ○ : somehow related.

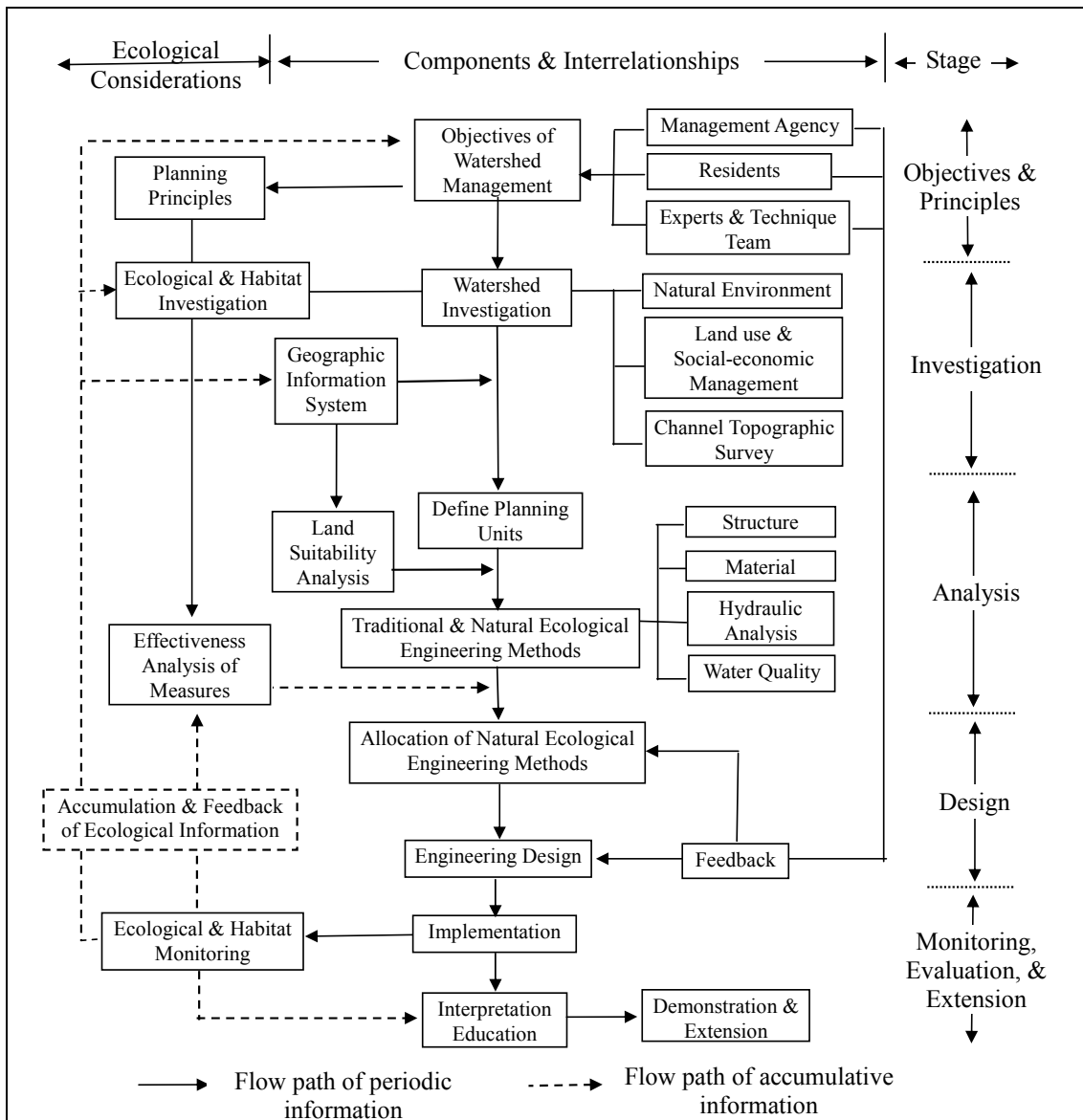


Figure 1 Integrated Watershed-Level Planning and Design Model of Natural Ecological Engineering Methods

2.1 Watershed Environmental Investigation and Analysis Procedures

Based on the outcomes of last year project, a handbook titled as “Planning Handbook of Watershed-Level Ecological Engineering Methods” was edited as part of this year project and will provide key procedures for on-site engineers.

2.2 Watershed Spatial Allocation of Ecological Engineering Practices

With three criteria on ecological environment, natural hazard potential, and social-human-tourism value, sub-basins are categorized into natural conservation area, sediment hazard prevent area, and ecological-engineering enhanced area based

on their characteristics. The principles of sub-basin zoning and their categories are tabulated as Table 2.

Table 2 Categories and the Zoning Principles for Sub-basins

Management Sub-basin	Criteria		
	Ecological Environment	Natural Hazard potential	Social, Human, & Tourism value
Natural Conservation Area	Natural & Healthy	No serious hazard or protection objects	-
Sediment Hazard Prevent Area	-	Serious sediment hazard, steep stream channel, narrow channel, or populated protection area	-
Ecological-Engineering Enhanced Area	Fair	No apparent sediment hazard	With fair land development potential

- : Criterion not applicable.

2.3 Safety Evaluation on Ecological Engineering Practices

Appropriate ecological engineering practices for ecological-engineering enhanced area should be identified based on their safety features as well as their fitness to the natural environment. In this year project, six safety features of an ecological engineering practice are included and applied as follows:

- (1) structural stabilization,
- (2) sediment control,
- (3) channel stability,
- (4) ecological conservation and restoration function,
- (5) plantation function, and
- (6) water-front accessibility.

2.4 Environmental Monitoring Procedures of Watershed Level Ecological Engineering Methods

To evaluate the performance of a watershed management project on its objectives, monitoring data gathered after the completion of the project are essential

to this procedure. Two main investigation and monitoring subjects in this model are water quality and ecosystem and they will be the key information sources for adaptive management.

3.Modification and Application of the Watershed-Level Planning and Design Model for Pei-Kung Creek Watershed

Investigation and Analysis of Environment and Ecosystem Data

Spatial Allocation of Ecological Engineering Practices in Study Watershed

Safety Evaluation on Ecological Engineering Practices

Environmental Investigation of Watershed Level Ecological Engineering Methods

Guidelines and Principles of Environmental and Ecological Databank

- (1) Conceptual model of watershed environmental databank
- (2) Design considerations of watershed environmental databank
- (3) Scale considerations of watershed environmental databank
- (4) Data collection methods and procedures

4.Extension of Watershed Ecological Engineering Methods

4.1 Collection of Related Research Reports

With similar hydrological and geological conditions to Taiwan, Japan was the visiting country for 2003 project. For this year visiting country, Australia was chosen for its early development in ecological engineering methods. Several famous watersheds were visited during the trip, including Integrated Watershed Management Project THALGAU at Salzburg, Holderbach Catchment at Tyrol, and Woerglerbach Catchment at Innsbruck.

4.2 Translation of Selected Sections of Related Publications

4.3 Communication and Exchange on the Techniques of Ecological Engineering Methods

4.4 Edition of Reference Handbook of Ecological Engineering Methods Planning Procedures

5. Integrated Treatment Planning for Study Watershed (the Second Year)

5.1 Supplementary Survey of Demonstration Reaches

5.2 Engineering Planning of Demonstration Reaches





Figure 3 Demonstration Reach #2

(Keywords : Watershed, Ecological Engineering Methods, Environment)

計畫名稱	集水區生態資源調查手冊 Handbook of Watershed Ecological Resources Survey
主持人	林信輝 Lin, Shin-Hwei 蔡志偉 Tsai, Chih-Wei
計畫年度	93

摘 要

爲探討、評估或監測集水區生態環境，必須藉由生態調查來取得集水區環境與生物資料。生態調查除了必須考量集水區內之河溪本體及濱水地區外，更可擴大至周邊的土地利用狀態，才能蒐集到完整集水區生態資源。本手冊著手進行集水區生態環境調查資料之蒐集，包含物理因子、化學因子、植生、動物等生態資源項目，進行調查項目、調查工具、分析方法以及調查頻率等項目之說明，並藉由實際案例說明生態調查資料之分析應用方法。手冊重點章節包括如下：

第一章 集水區生態調查概說

第二章 集水區物理因子

第三章 集水區化學因子

第四章 植生調查

第五章 動物相調查

第六章 集水區生態資源調查之應用

第七章 集水生態資源調查實例解說

(**關鍵詞：集水區、生態調查、環境調查**)

Abstract

In order to explore, evaluate and monitoring ecological environment of watershed, it is essential to conducting ecological survey to obtain the environmental and biological data. Not only the field survey works on water body itself and its riparian areas are necessary, but also the land-use pattern of the adjacent areas are also critical to assure the integrity of the survey outcomes. The handbook contents ecological environment materials which including physical, chemical factors, vegetation condition, animal community and distribution. The interpretation and operating descriptions about survey items, survey tools, analytic methods and survey frequency were also been discussed in detail. The handbook contents:

Chapter 1. Introduction of watershed ecological survey

Chapter 2. Physical factors of watershed environment

Chapter 3. Chemical factors of watershed environment

Chapter 4. Vegetation survey

Chapter 5. Animal survey in species amount and distribution

Chapter 6. Application of watershed ecological survey

Chapter 7. Interpretation of watershed ecological survey cases

(Keywords : Watershed, Ecological Survey, Environmental Survey)

計畫名稱	不同植被水土保持功能之調查規劃 Investigation and Planning on the Function of Plant Cover for Soil and Water Conservation
主持人	林俐玲 Lin, Li-Ling
計畫年度	92

摘 要

植被乃影響土壤化育的重要因子之一，不同植被下雖有相同的母質，卻可形成不同的土壤，又不同的植被因根系生長及分佈型態的不同，亦會影響土壤之理化性質，基本性質將會影響土壤之穩定性、水分入滲能力、保水能力和土壤養分含量等，進而影響植被的生長和對水土資源保育之功效。因而好的植被覆蓋能保護水與土，而土壤立地條件的好壞，則決定了水土保持植生工作之成敗，以往植生工作的進行，對於立地條件不佳之環境，多以客土等方式解決，而未考慮該地之主、客觀條件及植生後不同時期土壤、氣候等立地條件之變化，致使植生不良而導致事倍功半。

本計畫調查不同土壤植生復育前後之土壤理化性質變化，並針對不同植被對水土保持之效益進行評估，以作為綠資源重建及保育之指標參據。

(關鍵詞：植生立地條件、土壤沖蝕)

Abstract

Vegetation is one of important factors that affect soil development. Although different vegetation has the same parent material but could weather into different soil. Different vegetation has different root system and distribution, also effect soil property. Soil properties affect soil stability, water infiltration ability, water retention capacity and soil nutrient. Therefore effective vegetation growing will conserve soil and water. Soil property and vegetation growing are related each other on soil and water conservation.

This project investigated the soil properties variation before and after vegetation. The benefit of soil and water conservation in different vegetation was evaluated also, which could regard as an index for green resource reconstruction and preservation.

(Keywords : Plant Growth Habitat Condition, Soil Erosion)

計畫名稱	埤仔溝溪集水區自然生態工法博覽會規劃及設計 Ecological Engineering Expo — Pi-Tsia-Ko Creek Watershed
主持人	吳嘉俊 Wu, Chia-Chun
計畫年度	92

摘 要

本委託案之目的，在藉由自然生態工法博覽會活動的執行，讓參訪民眾瞭解委辦機關過去投入泥岩惡地集水區整治的績效、自然生態工法的設計理念，及對周邊環境保存、維護與永續利用的重要；而地方政府推動地方產業的活動想，有助於本次自然生態工法博覽會的宣傳造勢，亦可以達到生態、生產、生活「三生共榮」的目標。

(關鍵詞：生態工法博覽會、泥岩惡地、集水區經營)

Abstract

The objective of this project is to promote the concept of ecological engineering through Ecological Engineering Expo. Main themes included in the Expo consisted of watershed management implemented in Pi-Tsia-Ko Creek, design concept of ecological engineering, and the significance of environment conservation, maintenance, and sustainable usage of natural resources. In addition, promotion of local agricultural industry by local government helped rally the Expo as well as address the core concept of unifying ecology, production, and living.

(Keywords : Ecological Engineering Expo, Mudstone Badland, Watershed Management)

計畫名稱	培地茅於崩塌裸露地之應用與規劃設計 Application and Design of Staking-and-Wattling and Vetiver Grass on Bare Slopes
主持人	吳嘉俊 Wu, Chia-Chun
計畫年度	92

摘 要

連續兩年度打樁編柵現場調查，刪除已損毀及已改變裸坡植生工法的樣區之後，共計調查 64 個樣區。由現場調查成果得知：

1. 25.00%的調查樣區地表植生覆蓋率下降、7.81%的調查樣區其地表植生覆蓋率持平、67.19%的調查樣區地表植生覆蓋率增加。此結果顯示各樣區打樁編柵間距間地表因植生入侵或人工撒播草種的萌芽，已逐漸趨向自然復育。

2. 經顯著水準及雙向表預期計數分析，就本研究所選定的樣區特性而言，「坡向」對於打樁編柵間裸地植生復育的影響呈現 $\alpha=0.01$ 顯著水準，其影響遠超過「坡度」、「土壤」、「間距」、「地質」等因子。

3. 本研究現場調查的統計分析結果不建議於未風化的「砂岩、砂頁岩互層」及「泥質砂岩」地區施作打樁編柵。就立地之土壤而言，本研究統計分析結果不建議於「坩質壤土、坩土」地區施作打樁編柵。至於立地之坡度，本研究建議若需要在裸露邊坡進行打樁編柵之植生復育工作時，立地坡度範圍應以 55%~119% (29°~ 50°)之間為宜。若以打樁編柵的間距，本研究建議仍同上年度之結論，採用 2~4m 間距施作打樁編柵。

至於培地茅的田間沖蝕試驗，可獲得以下結論：

1. 培地茅對於沖蝕土砂攔阻的效益不及打樁編柵，其主要的理由：植株間之間隙自然形成地表逕流通過的通路，直到培地茅分蘗後，植株間空隙逐漸

填滿，其對於沖蝕土砂的攔阻效益才逐漸顯現。

- 2.以培地茅草帶及打樁編柵之成本（包含材料與工資）紀錄而言，單位長度之培地茅草帶成本為打樁編柵的 1.57 倍。打樁編柵於施作的第一年有其對於土砂攔阻、地表逕流截留、較高經濟效益成本之優點；而培地茅草帶因逐漸成長，預期其土砂攔阻效益將逐漸趕上打樁編柵。

（關鍵詞：打樁編柵、培地茅、適地條件）

Abstract

The following conclusions were drawn from two consecutive years' field survey on the success of staking-and-wattling excluding those sites that did not survive for two years:

1. Vegetation coverage rate was found decreased in 25% of the survey sites, 7.81% of the sites remained the same vegetation coverage; whereas, 67.19% of the sites showed increase in vegetation coverage.
2. Two-way Table analysis indicated that slope aspect had significant effect on rejuvenation of vegetation cover. Its effect reached 0.01 significant level, which outran that from slope, soil, staking-and-wattling spacing, and geology.
3. Installing staking-and-wattling on sand stone, slate, and mudstone was found to be less successful; neither on clay loam and clay soil. As far as slope gradient was concerned, 55% ~ 119% (29° ~ 50°) is the proper range for staking-and-wattling. Same conclusion as that from last year of setting 2~4m as taking-and wattling spacing was confirmed.

Field experiments provided the following conclusions for vetiver grass:

1. Sediment trapping efficiency of vetiver grass during the early growing stage did not exceed that provided by staking-and-wattling simply because gaps between grass stems provided passages for runoff to flow through.
2. Using vetiver grass for the purpose of erosion control required high capital that was 1.57 times higher than that of staking-and-wattling. Staking-and-wattling had higher benefit-capital ratio in the first year of implementation for sediment trapping and runoff detention; whereas, installing vetiver grass gradually gained its benefit-capital ratio as time proceeded.

(**Keywords : Staking-and-Wattling, Vetiver Grass, Suitable Site Conditions**)

計畫名稱	集水區自然生態工法規劃設計參考模式之建立 Integrated Watershed-level Planning and Design Model of the Natural Ecological Engineering Methods
主持人	王傳益 Wang, Chuan-Yi
計畫年度	92

摘 要

水土保持局自 2001 年起即全力推動生態工法，並分別辦理各項治山防災生態工法，惟該等計畫僅為各工法之設計參考斷面圖，蓋侷限於「點」或「線」的工作範疇，未能完全考量集水區地文、水文及土砂災害等條件之整體因子，做整合性之治理規劃。為了將過去之研究成果推廣至「面」之層次，提升其參考應用價值，因此本研究以集水區整體考量進行生態工法之規劃設計。換言之，以集水區為單元進行生態工法規劃，同時建立集水區整體規劃設計之模式，以達到災害防治、自然資源保育與保護人民生命財產安全之目的。藉由此次研究探討出完整的生態工法規劃設計參考模式，期能提供國內相關集水區治理工法之參採。

(關鍵詞：生態工法、土砂災害、集水區治理)

Abstract

Since 2001, the Soil and Water Conservation Bureau (SWCB) has promoted the plans of ecological engineering methods for precaution against natural calamities. However, these plans only provided sectional design drawings for different working methods, which were localized upon the view of point or line. It has not considered the conditions of geography, hydrology and soil calamities to integrate into the planning. In order to apply the past research findings to the entire watershed, an integral planning and design using ecological engineering methods are needed. In other words, one needs to use the entire watershed as a unit for ecological engineering methods planning, and sets up a model at the same time to achieve the objectives of taking precautions against disasters and protecting the natural resources and human lives and properties. It is hoped that the integral planning of watershed using ecological engineering methods as proposed in this study can be served as a reference for similar watersheds regulation in Taiwan.

(Keywords : Ecological Engineering Methods, Soil Calamities, Watersheds Regulation)

第五篇：坡地管理
Part V : Slopeland Use Management

計畫名稱	利用遙控無人載具進行易淹水地區上游環境 資訊蒐集建置與分析 Using Remotely Piloted Vehicle to Collect and Analyze Environment Information in Flood-prone Area
主持人	周天穎 Chou, Tien-Yin 葉美伶 Yeh, Meilin
計畫年度	96

摘 要

遙控無人載具技術(Remotely Piloted Vehicle ; RPV)具有機動力強、即時迅速、時效性快及較寬鬆天氣條件即可操作之優勢，因此本計畫根據水土保持局之需求，利用遙控無人載具技術完成 20 處地點之空拍與加值處理作業。此等空拍資訊可有效提供水土保持局即時、廣域之環境輔助資訊，並進行基礎坡地環境資訊蒐集與整體變遷監測分析。並將空拍成果運用多項式法與橡皮伸張法進行影像校正，將二種法則之校正成果進行比較，提供水土保持局應用上之建議。

另一方面，為有效宣導無人載具技術之特性與成效，本計畫以主體性呈現方式製作多元視效動畫，模擬地區以台北縣雙溪鄉后番仔坑地區為範圍，藉由 3D 視效模擬技術，融合多元的知識領域與多類型的媒體元素（如靜態照片、動態影片等資訊），進行動畫製作，此等動畫未來可有效成為水土保持局應用與宣導之參考資訊。

最後，鑑於水土保持局應用遙控無人載具之技術行之有年，95 年度為提供遙控無人載具空拍影像資訊流通之機制，已建置「遙控無人載具技術成果網頁」，此網站資訊除呈現豐富之遙控無人載具技術之應用介紹外，另可提供水土保持局與各工程所人員便利之影像查詢與下載機制，進而達到資訊共享、流通之效益。本計畫根據 95 年度所建置之網站成果進行影像資訊更新與網站維

護，務使該成果網站保持良好之運作。

(**關鍵詞：遙感探測、無人載具、易淹水地區**)

Abstract

Remotely Piloted Vehicle (RPV) technology possesses advantages of mobilization, instant response and non-limitation by strict weather condition. In this project, we used RPV technology to collect the environmental information of 20 hillside areas managing by the Soil and Water Conservation Bureau. These RPV images could provide SWCB with Instant and wide environmental information, such as, the foundation information collection of the sloping fields and the whole analyses of change and monitor. Then we using Polynomial and Rubber Sheeting rules to do the geometric correction, and analyze the correction results, providing the suggestion to SWCB for the image application.

On the other hand, to promote the characteristics and achievements of the RPV technology effectively, we made 3D animation which simulated the area called HOU-FAN-ZI-KENG. We used 3D simulation technique and many media elements to make topic 3D animation. The 3D animation can become the reference of the application and disaster prevention effectively.

Finally, SWCB implements RPV technology to build environment information for many years. This project collected the RPV images to establish the “Remotely Piloted Vehicle information system” in 2006. The system could show the introduction of RPV technologies and applications. It also provides convenient functions about RPV images query and download for SWCB officers to reach benefits of information sharing and distribution. In 2007, this project according the result of 2006, renewing the image data and maintaining the web system, let it be a good operating.

(Keywords : Remote Sensing, RPV, Flood-Prone Areas)

計畫名稱	<p>整合衛星影像輔助山坡地變異點判釋及石門水庫集水區現況監測</p> <p>Identification of Land Use Changes in the Slope Lands and Landslides in the Shihmen Reservoir by Using Satellite Imagery</p>
主持人	<p>陳錕山 Chen, Kun-Shan</p> <p>梁隆鑫 Liang, Long-Shin</p> <p>朱昶任 Chu, Chang-Renn</p> <p>吳沛儒 Wu, Pei-Ru</p> <p>江陽聖 Chiang, Yang-Sheng</p> <p>高郡汝 Kao, Jyun-Ru</p>
計畫年度	96

摘 要

由於台灣本島的特殊地質與地理環境，在山坡地開發初期，水土保持設施若未設置完善，當暴雨或夾帶大量降雨的颱風來襲時，表土因含水量飽和而容易流失，甚至發生土石崩塌。因此有效掌握現有山坡地變異情形、遏止非法或不當的開發利用，實為當務之急的工作。

本計畫係延續水土保持局以衛星影像進行山坡地變異點監測的一貫政策，本年度（96年）以光學及雷達兩種不同的衛星影像，監測台灣地區山坡地及石門水庫集水區，有效輔助山坡地管理。

本年度（96年）山坡地及石門水庫集水區變異點判釋部分，共使用六期光學影像，石門水庫集水區部分另加三期雷達影像。山坡地及石門水庫集水區變異點判釋成果方面，第一期判釋出 503 處、第二期 615 處、第三期 332 處、第四期 439 處、第五期 342 處及第六期 438 處；本年度試辦變異點即時查報機制，六期共即時查報 8 處，對於偶發變異案件發生或持續進行監測，具有相當成效；變異點現況調查亦按需求規劃、期程完成 251 處；在石門水庫集水區現況監測

方面，除變異點判釋外，亦完成六期崩塌地判釋，並就崩塌地坡度、坡向、高程及六大優先治理區域植生等屬性資料，配合現況調查加以分析驗證。

(關鍵詞：山坡地監測、衛星影像、坡地管理)

Abstract

Taiwan Island is of complex geological and geo-environmental settings and is prone to landslide and soil erosion triggered by torrent storms and typhoons if soil and water conservation are not well cared. Hence, effective and efficient monitoring of the slopeland-use changes is essential for reducing or even preventing illegal and over developments on the slopeland.

This project continues the efforts of satellite slopeland-use monitoring, a long-term project managed by Soil & Water Conservation Bureau (SWCB). Slopeland-use changes were analyzed from SPOT series satellites and FORMOSAT-2 images aided with ground truth work and GIS data provided by SWCB. Reports are then issued every two months to city government for in-situ checks. Results from this year are summarized below. Total of 6 periods of satellite images covering the slopeland regions were analyzed, with additional 3 periods of SAR images for Shihmen Dam catchment basin. Among the total changes, 503 spots occurred in period 1, 615 in period 2, 332 in period 3, 439 in period 4, 342 in period 5, and 438 in period 6. All changes analysis is finished. Attempts of check-and-report in timely fashion was made and tested. Total of 8 trials were carried out so far. Preliminary results demonstrate that such campaign is quite convincing as far as contingent monitoring is concerned. Finally, the landslide was identified for a total of 6 periods over Shihmen Dam catchment basin. The occurrence associated with slope, direction, and terrain height, vegetation covers of 6 top-priority remediation areas has been analyzed and verified by ground truth work.

(**Keywords : Mountainside Monitoring, Satellite Images, Mountainside Management**)

計畫名稱	山坡地可利用限度分類標準檢討 Review of Classification Standard for Slopeland Utilizable Limitation
主持人	林俐玲 Lin, Li-Ling 陳克強 Chen, Ke Chiang 何國謙 Kuo, Chien He 張光宗 Zhang, Guang Zong
計畫年度	95

摘 要

現行山坡地土地可利用限度之分級查定因子為坡度、土壤有效深度、沖蝕指數和土壤母岩特性。經檢討坡度和地質狀況應該可以當做獨立因子。土壤沖蝕程度與地形、地質和地表排水狀況有關聯，而土壤有效深度又與地形、地質和沖蝕程度有關。分類考慮的因素應該以獨立的因素為原則。

本計畫探討以地形、地質和土壤沖蝕程度做為分類依據，並將地質狀況和土壤沖蝕程度量化，以建立合理可利用的分類標準。另研擬山坡地土地可利用限度查定工作標準作業程序草案，以利現場執行。

(關鍵詞：坡度、土壤有效深度、土壤沖蝕程度、母岩性質)

Abstract

Four factors were applied as classification standards for slopeland utilization limitation. There are land slope, soil effective depth, erosion degree, and property of parent material. In this project, the rationality of criteria for four factors was reviewed. The slope and parent material criteria are reasonable, however, the degree of soil erosion and soil effective depth are not independent, which will affect by slope. Actually, the criteria should be independent for land use classification.

We suggest that, slope and soil effective depth can still use as classification standards, and degree of soil erosion and parent material can just apply as a reference. Furthermore, we are trying to quantify the soil erosion amount by applying USLE, and classify the degree of soil erosion.

(Keywords : Slopeland Slope, Soil Effective Depth, Degree of Soil Erosion, Parent Material)

計畫名稱	山坡地管理作業參考手冊 Reference Handbook for Slopeland Management Practices
主持人	林昭遠 Lin, Chao-Yuan
計畫年度	95

摘 要

國土保安環境保育是政府施政的重點工作，尤其山坡地約占台灣地區土地總面積的四分之三，如何有效利用、保育、管理及維護山坡地資源變成非常重要的一件事。惟山坡地管理工作涉及層面非常廣泛，是隨著社會經濟發展的需要、水土資源客觀環境的限制及土地利用思潮而持續不繼的演變。山坡地管理政策亦隨著時代演進在調整，主政者為解決問題，主導整體政策研擬及制定相關法規加以規範，期以法治的手段，限制山坡地開發、增加水土保持義務人實施水土保持處理與維護工作義務、防治或減少水土災害發生以增進國土保安，並引導國人合理利用土地資源，以維護水土資源基礎環境安全，達到永續發展的目標。

山坡地管理業務主要分為「違規查報取締」及合法申請開發案之「水土保持計畫審核及監督管理」二部分，因涉及法令頗多，基層人員異動頻繁，而在職訓練工作常無法滿足工作同仁執行業務所需知識及技能，為利於管理工作順利推展，爰編製「山坡地管理作業參考手冊」，本手冊分「查報取締」與「審核監督」二篇，供負責各該項業務人員參考之用。

（**關鍵詞：山坡地管理、土地利用、查報取締、審核監督**）

Abstract

Land preservation and environmental conservation are critical viewpoints for policy-making; especially three quarters of Taiwan's territory belong to slopeland. Utilization, conservation, management, and maintenance for slopeland resources become important works. However, the practices for slopeland management correlate to variety of aspects. Also, slopeland polices are modified according to social economics development, soil and water natural resources restriction, and land-use patterns variations. In order to solve problems encountered, the administrators need organize related policies and regulations to restrict slopeland development and push soil and water obligors to implement maintenance works and duties. Prevention and mitigation for soil and water hazardous can enhance land security, improve natural resources utilization, and achieve sustainable development goals.

The major slopeland management tasks can be separated as 1.enforcement for against regulations and 2.soil and water conservation plan investigation and supervision for legally developing cases. For too many relating regulations and basic staff transferring frequently, the on-the-job training cannot satisfy the fundamental knowledge and techniques for implementing occupational activities. In order to increase managing practices smoothly, the Reference Handbook for Slopeland Management Practices was published to accomplish this target. In this handbook, these two parts as mentioned above are providing references to staff.

(Keywords : Slopeland Management, Land-Use Patterns, Enforcement for Against Regulations, Investigation and Supervision)

計畫名稱	<p>石門水庫集水區水土保持管理及土石流防災教育宣導計畫</p> <p>Soil and Water Conservation Management and Debris Flow Disaster Prevention Education and Publicity Plan for SHIH-MEN Reservoir Watershed</p>
主持人	<p>巫仲明</p> <p>Wu, Chung-Ming</p>
計畫年度	<p>95</p>

摘 要

93 年 8 月的艾利颱風及 94 年馬莎颱風，導致石門水庫集水範圍多處崩塌及水質濁度提高。為積極處理石門水庫問題，必需從水土保持管理與土石流防災教育宣導開始紮根，並結合教會、部落、學校及地方政府等四個資訊管道，使當地原住民同胞獲得水土保持、山坡地管理，以及土石流防災疏散避難的正確觀念與積極作法。工作項目包括：研編教會水土保持宣導教材、辦理教會水土保持教育宣導協調座談會、辦理 40 場教會水土保持與土石流防災教育宣導、研編泰雅語版水土保持及土石流防災教育摺頁、辦理 17 場村里水土保持管理及土石流防災等教育宣導以及辦理 10 場學校水土保持管理及土石流防災等教育宣導。本計畫所產生的正面成效包括，防災知識之提升、了解水土保持局之用心以及化解以前誤解、加強民眾對山坡地的認同感、使民眾支持教育宣導活動並認同應持續辦理。民眾認為未來應持續辦理宣導活動，並針對民眾需求舉辦座談會、專家學者水土保持經驗分享、影片講述等宣導，以吸引對多民眾前往參與，達到傳達相關水土保持知識，進而延伸到水土保持管理及土石流防災工作與政策支持，由公私部門合作開始落實水土保持工作在地化的目標。

(關鍵詞：教育宣導、水土保持管理、土石流防災、石門水庫)

Abstract

The team has accepted SWCB' s commission to launch the 「Water and soil conservation management and debris flow disaster prevention instruction program of Shih-men reservoir」. Program content includes: 1.design a debris flow disaster prevention instructions Manual for the communion, 2.hold a discussions forum on debris flow disaster prevention for the communion, 3.hold 40 instruction sessions on water and soil conservation and debris flow disaster prevention within the communion, 4.edit Tayal version of water and soil conservation and debris flow disaster prevention pamphlet, 5.hold 17 instruction sessions on water and soil conservation and debris flow disaster prevention for the community, 6.hold 10 instruction sessions on water and soil conservation and debris flow disaster prevention within schools.

This instructional program undergone by the team is showing positive results by increasing the residents' awareness on disaster prevention, deeper understanding of SWCB, fortifying residents' understanding of the slopes, and encouraging residents to understand and support the continuity of this program.

The public acknowledges that further instructional programs should be carried out. Due to public demand, more forums will be held 、experts and scholars will be invited to share their precious knowledge and experience 、documentaries and films to be shown to encourage active public involvement, as well as to spread the water and soil conservation awareness. In future, water and soil conservation issue such as disaster mitigation, preparation, response and reconstruction issues and decision will be practiced by the local residents and organizations at the assistance of central governments.

(**Keywords : Educational Program, Water and Soil Management, Debris Flow Disaster Prevention, SHIH-MEN Reservoir**)

計畫名稱	坡地集水區分析整合系統研發 Integration of the Slopeland Watershed Analysis System
主持人	林昭遠 Lin, Chao-Yuan
計畫年度	95

摘 要

921 大地震、90 年桃芝颱風、93 年敏督利及艾利颱風、94 年馬沙颱風天然風災襲擊影響，造成台灣坡地土砂災害事件的發生，影響坡地產業經濟發展，因此以集水區為單元之整體規劃治理，為水土保持業務推動重點工作之一。

本計畫包含四大工作項目：一、研發坡地集水區分析系統，用以分析繁雜的集水區水文地文資訊，迅速量化各分析集水區水文、地文特性，二、研發坡地集水區資訊整合系統，以彙整工程所歷年整治資訊，整合已有之報告與圖資，經由地理資訊系統架構，可提供相關規劃、決策者參考，三、製作山坡地集水區圖冊，劃分第一及第四工程所轄區內小於 1000ha 之野溪集水區，建置野溪集水區之地文及水文資訊，供工程所人員規劃或現勘之用，四、辦理「坡地集水區分析系統」及「坡地集水區資訊整合系統」教育訓練。

本計畫開發之兩套系統，能提高集水區規劃及執行成果彙整效率，除本次教育訓練外建議各工程所於適當時機辦理教育推廣，使系統充分運用於工程所，俾有利工程所業務推展。此外，山坡地集水區圖冊本年度已劃分第一及第四工程所轄區，待未來劃分其他工程所轄區之野溪集水區，業務單位將能更系統性的規劃台灣集水區治理業務。

(關鍵詞：野溪集水區、資訊整合、集水區圖冊)

Abstract

The slopeland sediment hazards caused by 921 earthquake, typhoon Toraji in 2001, typhoon Mindulle and Aere in 2004, and typhoon Matsa in 2005 may decrease the slopeland economic development. Therefore, the watershed scale planning and treatment as a unit becomes an important soil and water conservation activity.

This project includes four main topics as follows. 1. Developing slopeland watershed analysis system, it can be used to evaluate the complicate watershed hydrological and geomorphologic information and calculate the watershed hydrological and geomorphologic characteristics. 2. Developing slopeland watershed information integration system, it can be integrated with historical treatment data, reports, and illustrations to provide policy-making assistance. 3. Preparing slopeland watershed illustration volume, the delineated torrent watershed with area under 1,000ha in the First and the Fourth Engineering Office jurisdiction can be provided to staff as a handy reference. 4. Holding slopeland watershed analysis system and slopeland watershed information integration system educational training.

There are two developed computer systems can increase the watershed planning and implementing efficiency. Besides the education training included in this project, it is also recommended for other engineering offices to fully rollout the system benefits and promote the works. The delineated watershed information illustrations are covered the First and the Fourth Engineering Office, in the future, the watersheds in the other engineering offices can be systematically delineated through the developed systems.

(**Keywords : Torrent Watershed, Information Integration, Watershed Illustration Volume**)

計畫名稱	研修山坡地管理作業參考手冊及研編查詢網頁計畫 Slopeland Management Reference Handbook Modification and Inquiry Website Improvement Project
主持人	林昭遠 Lin, Chao-Yuan
計畫年度	95

摘 要

為提升山坡地管理效能及配合山坡地管理資訊化發展，水土保持局開發「水土保持相關法規解釋函彙編專家（查詢）系統」，配合水土保持相關法規隨時空變遷修正，需即時維護並加強資料分析與相關法規蒐集查詢管理效能，且涉及水土保持技術規範應用之資訊系統在實務上亦需推廣應用，使水土保持工作同仁在執行上更能提升水土保持計畫審查品質、效率。本計畫主要分為「研修山坡地管理作業參考手冊」、「英譯水土保持計畫審核監督辦法」、「中譯日本砂防五法」及「研編查詢網頁計畫與水土保持相關法規解釋函彙編專家（查詢）系統整合及資料更新、功能擴充」等。在修訂山坡地管理作業參考手冊乃為因應 95 年 2 月 5 日行政罰法實施以及針對第二版之不完善處進行修正，以期對日後水土保持工作同仁有所助益；英譯水土保持計畫審核監督辦法部分乃為順應全球化的發展趨勢，加上前已翻譯法規成效極佳，故本計畫依水土保持局需求再增譯水土保持計畫審核監督辦法，俾利推動國際化之目的；在中譯日本砂防五法部分，因台灣與日本於先天條件及土砂災害雷同，可供日後研擬水土保持相關法規時可參閱；在研編查詢網頁計畫與水土保持相關法規解釋函彙編專家（查詢）系統整合及資料更新、功能擴充部分，主要針對本計畫所完成之相關文件進行彙整研編成查詢網頁，並對前已開發之水土保持相關法規解釋函彙編專家（查詢）系統進行資料更新及功能擴充，並彙整至本計畫之研編查詢網

頁，以增進工作同仁於山坡地管理之成效，讓從事山坡地管理作業人員能有效性、迅速性擷取新知，俾達合理之土地利用與管理以及永續經營之理念。

(關鍵詞：山坡地管理、水土保持相關法規、行政函釋)

Abstract

In order to develop the slopeland management efficiency and slopeland information enquiry capability, the expert system for compiling the declaratory statutes of soil and water conservation has been established by Soil and Water conservation Bureau. Since the related soil and water conservation regulations may be changed from time to time, the developed system need be maintained and enhanced the data analysis, collection, inquiry, and management capability. It is necessary for promoting this system for practical uses and improving the soil and water conservation project evaluation ability for staff. This project includes the Slopeland Management Reference Handbook, English version for the Soil and Water Conservation Evaluation and Supervision Regulation, Chinese version for Japanese Sabo Five Rules, and integration, data renewal, and function enhancement for the inquiry website system and expert system for compiling the declaratory statutes of soil and water conservation. The Slopeland Management Reference Handbook modification is based on the new civilian penalty and the incomplete in the second edition to increase the capability of staff. English version for the Soil and Water Conservation Evaluation and Supervision Regulation is following the global tendency. The former English translation reached a good reputation; therefore, the project includes this regulation. Because of the similar natural hazards, the Chinese version for Japanese Sabo Five Rules may provide a reference. For the integration, data renewal, and function enhancement for the inquiry website system and expert system for compiling the declaratory statutes of soil and water conservation, they can provide slopeland management efficiency. Staff may benefit from this system and inquiring update knowledge to reach a reasonable landuse and sustainable

management.

(Keywords : Slopeland Management, Soil and Water Conservation Related Regulations, Declaratory Statutes of Soil and Water Conservation)

計畫名稱	農路調查與環境修復衝擊評估 The Inquisition of Agricultural Roads and The Valuation of Repair Environment Impact
主持人	連惠邦 Lien, Hui-Pang
計畫年度	95

摘 要

本計畫在國土復育策略方案暨行動計畫、國土復育條例（草案）及公共設施災後復建工程經費審議作業要點等攸關農路問題之相關規定下，針對農路進行資料蒐集與補充調查，並研擬各項指標參數進行農路修復環境衝擊之評估、評分及其重要性分級，同時就具有修復需求之農路，研提妥適之災後修復工程經費審議要點（草案），以提供主管機關管理維護決策之依據。

為此，本計畫從國土保育觀念出發，由農路正面和負面因子之分級與權重，建立「農路修復環境衝擊評估模式」，以評估分級農路之重要性程度，作為其修復工程優先順序或必要性之決策依據。而農路重要性可由其：1.效益指標；2.環境衝擊面指標和 3.管理指標之評估指標予以分級，其中效益指標包括單位長度農業受益面積、單位長度林業受益面積、富麗農村效益、受益住戶數、公共設施數、替代道路功能及唯一聯外道路等七項參數，而環境衝擊面指標包括非農業土地使用比、生態敏感度、地質災害敏感度、崩塌面積比及土石流潛勢溪流數等五項參數，由上述兩大指標（12 項參數）給予「重要性評定（分）」，再加上「管理指標」（依據本計畫所提供農路現況資料及照片），以作為災後受損農路報審之時，由中央主管機關成立「審議小組」決議農路受損修復與否決策之參採依據。

以彰化縣及雲林縣作為本期計畫調查範圍，根據既有「網際網路農路地理資訊系統」裡二個縣市共 851 條農路著手進行現地調查。此外，由於彰化縣以及雲林縣境內多屬平地區域，故特分為平地區域與山坡地區域進行修復環境衝

擊評估分析，且針對既定之農路地理資訊系統進行建置，以提供農路災後修復工程對策之決策支援。

根據本次調查結果得知，已完成彰化縣以及雲林縣共 851 條農路之現場調查資料中，現已併入公路系統者或圖資有異應修正農路資料之情形如下表所示：

縣市別	農路條數	併入公路系統條數	圖資有異，應修正農路資料之條數	完成實際條數
彰化縣	445	14	10	421
雲林縣	406	2	20	384
小計	851	16	30	805

全省 21 縣市屬於農業委員會所曾輔建之農路數量共 5,942 條（本期計畫調查後更正為 5,785 條），而前期計畫已完成調查台中縣市及南投縣之 819 條農路，再加上本年度所完成之農路調查包括彰化縣及雲林縣 851 條農路，合計完成調查之農路數量共 1,670 條，則估計約再二年即可完成全省 21 縣市全數農路之調查分析與地理資訊系統資料庫增補。

	原始資料庫	前期計畫	本期計畫
調查條數	—	819	851
應修正之農路條數	—	111	46
修正後全省農路條數	5,942	5,831	5,785

本計畫實際進行農路現地調查後，發現有無法辨識農路名稱、農路長度差異大、農路長度修正、現已併入公路系統者或圖資有異應修正農路資料之情形等問題，這都顯示農路資料庫系統現有保存的資料實有必要加以更新。且目前國土復育策略方案已對於農路存廢及其修建工程之必要性廣泛討論和質疑，實有必要進行全面性的調查和評估，以提供管理決策之參採。再者邊坡災害（崩塌、土石流等）與農路系統息息相關，若有完整之農路資料庫系統則對於坡地

防救災工作有相當程度的貢獻，故應加速進行農路調查與建構更完整之農路資料庫系統，以提高防救災系統之效率。

(關鍵詞：農路修復環境衝擊評估模式、彰化縣、雲林縣)

Abstract

This project is according to the related provision concerning agriculture road problem of "national territory rehabilitation strategy project", " act project", "the regulation (drafted plan) of the national territory rehabilitation" and" public facilities after-calamity budget of the reconstruction engineering review operation point". Aim at Roads of Agricultural to carry on a data collection and add inquisition. Also draw up various index sign parameters to carry on The Investigation of Agricultural Roads and The Valuation of Repair Environment Impact, grade point and its importance ratings. Have the agriculture road of repair need in the meantime, the after-calamity budget of the repair engineering ground to lift adequacy review the important point(drafted plan) manage by providing the supervisor with the organization maintenance decision of basis.

For this, this project sets out from the idea of the national territory conservation, through ratings and proportion of agriculture road anode and anode factor, build up "The model of The Valuation of Agricultural Roads Repair Environment Impact ". Can use to importance of evaluating the ratings agriculture road, is the decision basis of sequence and necessity that repairs engineering. The importance of the agriculture road can basis: 1.Benefit index sign, 2.The environment impact faces index sign, 3.Manage the valuation index sign of index sign. Among them, the benefit index sign includes: The benefit of the being subjected to of forestry benefit area, abundance village of the being subjected to of agriculture benefit area, unit length of unit length, be subjected to the amount of the benefit inhabitant's amount, public facilities and act for function and the only connective road etc. of road. The environment impact index sign includes: The comparison, ecosystem sensitive comparison, geology disaster sensitive comparison of the non- agriculture land usage, collapse area comparison and the amount of the

debris flow etc... The two greatest index signs(12 parameters) provide "importance grade point" and "management index sign".(according to originally plan provide the agriculture road current conditions data and photograph). When the after-calamity agriculture road damages of time, Central supervisor's organization establishes "review group" and decides the decision basis of the agriculture road damaged repair.

Use Chang-hua County and Yunlin County as this period plans inquisition scope, according to current "Internet agriculture road geography information system", totally have 851 agriculture roads in two counties begin to carry on inquisition now. In addition, inshore because of Chang-hua County and Yunlin County greatly part of belong to flat ground district. So, be divided into flat ground district and hillside region area to carry on repairing the valuation of the environment impact analysis. Build decided agriculture road geography information system, provide the decision support of agriculture road after-calamity counterplan of the repair engineering.

Investigate a result to know according to this time, in Chang-hua County and Yunlin County, have already completed the scene of 851 agriculture roads inquisition data in, have already merged into of the highway system or picture data to arise problem, should revise the situation of agriculture road data to is shown as form below:

County City	Agriculture road amount	The agriculture road merges into the amount of highway system	The picture data contains problem, should revise the amount of agriculture road data	The amount physically completed
Chang-hua County	445	14	10	421
Yunlin County	406	2	20	384
Total	851	16	30	805

In whole Taiwan of 21 counties, agriculture committee the guidance once built up of the agriculture amount of method is total 5,942.(corrected to 5,785, this project investigated after) In the front the period the project, Taichung County and Nantou County have already completed 819 inquisitions of agriculture roads. Plus the agriculture road that this year completes to investigate, include Chang-hua County and Yunlin County, 851 total agriculture roads, add up the agriculture amount of method of completion inquisition total 1,670. The estimate invites again can immediately complete the increment that the inquisition of 21 total amount agriculture roads in county City in whole Taiwan analysis and geography information system database for two years.

	Original database	Previous of project	The origin plans
Inquisition amount	—	819	851
The agriculture road should be revised amount	—	111	46
After revising whole Taiwanese agriculture road amount	5,942	5,831	5,785

The origin plans physically carry on agriculture road now after investigating,

find the problem with the following, Can't recognize agriculture road name, The agriculture road length difference is big, The agriculture road length revises, Have already merged into an of the highway system, The picture data has problem that should revise the agriculture road the data etc. This all shows that the data of the agriculture road database system has a necessity to take in to renew. The national territory rehabilitation strategy project has already built the necessity of engineering to extensively discuss and query to existence and abrogation of agriculture road and it currently. There is a necessity carrying on comprehensive inquisition and valuation to provide the reference of management decision. Besides, the side ascent disaster (collapse, mudslide etc.) and agriculture road system is vitally related. If the agriculture road database system been complete then defends the contribution that the relief work has equal degree to the sloping fields. So should accelerate to carry on the agriculture road inquisition and the construction more complete agriculture road database system, defend the efficiency of relief system by exaltation.

(Keywords : The Model of The Valuation of Agricultural Roads Repair Environment Impact, Chang-hua County, Yunlin County)

計畫名稱	<p>運用衛星影像輔助山坡地變異點判釋</p> <p>Identification of Land Use Changes in the Slope Lands Using Satellite Imagery</p>
主持人	<p>陳錕山 Chen, Kun-Shan</p> <p>梁隆鑫 Liang, Long-Shin</p> <p>朱昶任 Chu, Chang-Renn</p> <p>吳沛儒 Wu, Pei-Ru</p> <p>劉岫雲 Liu, Shiou-Yun</p> <p>江陽聖 Chiang, Yang-Sheng</p>
計畫年度	95
<p style="text-align: center;">摘 要</p> <p>台灣地狹人稠，在平地開發漸趨飽和後，已往山坡地區發展；如開發新社區、拓墾農業用地、設立高爾夫球場及開設新道路...等，均已改變原有較穩定的地貌。由於台灣本島的特殊地質與陡峻的地形條件，在山坡地開發初期，若水土保持設施未完善，當暴雨或夾帶大量降雨的颱風來襲，表土容易因土壤的含水量超過負荷而產生表土沖蝕，甚至發生土石崩塌；因此掌握現有山坡地之變異情形，以遏止非法或不當的開發利用為當務之急的工作。</p> <p>本計畫係為延續水土保持局利用衛星影像比對變異點政策，有效監測山坡地變異情形，以 2 個月為一期，利用無雲的 SPOT-5 及 FORMOSAT-2 衛星影像，輔以 SPOT-2、-4 影像，即時監測山坡地開發利用狀況，並配合輔助圖資及定期更新的合法工程點位等資訊，以植生指數(NDVI)技術進行變異點判釋、分析，將判釋結果輔助縣市政府進行查核，以了解山坡地違規使用情形，有效減少非法或不當的開發利用，達到坡地永續利用之願景。</p> <p>本(95)年度工作，共使用六期影像，資料獲取與判釋圖幅數皆符合計畫規格要求；第一期判釋 440 處、第二期判釋 429 處、第三期判釋 385 處、第四期</p>	

判釋 448 處、第五期判釋 229 處及第六期判釋 322 處，六期共判釋 2,253 處。

(**關鍵詞：山坡地監測、衛星影像、土地管理**)

Abstract

Taiwan Island is of mountainous with high density of population concentrated on a narrow belt of western plain. Human activities are forced to move toward slopland and even mountains after an overdeveloping of flat plain. These include establishment and construction of local community, agricultural zone, golf course, and road network, among others. The competition of land use with nature leads to landscape changes to a substantially dramatic degree. The complex geological setting is prone to landslide and soil erosion triggered by torrent storms if soil and water conversation are not well cared. These Typhoons adversely raged against some counties. Hence, monitoring of land-use change to reduce or prevent illegal and over developments becomes critical for effective and efficient land management.

This project continues the efforts of satellite land-use monitoring carried out by Soil & Water Conservation Bureau (SWCB). Land-use changes were analyzed from SPOT series satellites and FORMOSAT-2 images aided with ground truth work and GIS data provided by SWCB. Reports are then issued every two months to city government for in-situ checks. It is proved that the use of satellite imagery through the current Project substantially enhances the efficiency of monitoring of land-use change and improves the detection rate.

(Keywords : Mountainside Monitoring, Satellite Images, Land Management)

計畫名稱	衛星影像變異點查證網際網路管理系統開發 (2/3) Changed Point Areas Inspection and Management System (2/3)
主持人	蔡明璋 Tsai, Ming-Chang 張英暉 Chang, Ying-Hui 周天穎 Chou, Tien-Yin
計畫年度	93

摘 要

水土保持局為有效監測山坡地地表現況，遏止山坡地違規開發行為之發生，導入現代化的遙測技術、衛星定位系統及地理資訊系統技術，輔助監測山坡地之開發使用行為，歷年來已獲致良好之成效。

本計畫之主要執行方向在於彙整歷年建立之衛星變異點查證結果資訊，並據以進行決策支援分析，透過各項進階統計分析研究，提供山坡地政策擬定及執行山坡地開發行為管制相關作業之參考，另一方面進行「衛星影像變異點網際網路資訊系統」之系統功能提升計畫，同時將系統推展至鄉鎮單位，務使衛星本系統能擴展到山坡地監督管理體系之基層單位，全面提升查證業務效率，達到行政作業電子化及遏止山坡地違規開發行為之目的。

(關鍵詞：衛星影像、地理資訊系統、網際網路)

Abstract

During the past few years, multiple disciplines including RS, GPS, GIS and MIS data survey are used for data collection, retrieval, and analysis in order to efficiently monitor and manage slope land by the Soil and Water Conservation Bureau.

The main goal of this project is to integrate the data of changed point areas over the years for decision-making analysis. The result of the statistics and analysis can be used as the references for policy-making on slope land management. Mean while, the functions of Changed Point Areas Inspection and Management System are upgraded and released to every local government units. The inspection efficiency man be increased by the generally participation of every members on slope land management system. All these efforts are used to reach the goal of e-government and to hold back the illegal behaviors in slope land areas.

(**Keywords : Remote Sensing, GIS, WWW**)

計畫名稱	山坡地查報取締實務研討會及執行成效研究 Research for Slope Land Violation Investigation and Enforcement Practice Conference and Implementation Benefits
主持人	林昭遠 Lin, Chao-Yuan
計畫年度	92

摘 要

台灣地區之高山及丘陵地約佔全島面積的四分之三，且該地形具有地質構造複雜、地勢陡峻、河短流急等不良特性，再加以台灣位於亞熱帶，降雨量多，且強度大而集中，因此土壤沖蝕及山崩、地滑現象時常發生。然而除了自然沖蝕所造成之災害以外，更嚴重者為開發山坡地所造成之破壞，由於土地資源有限，在產業發展及人口壓力下，使得山坡地開發規模愈趨向大型化，一旦開發利用不當，極易造成自然生態環境嚴重破壞及水土保持問題。

台灣地區近年來由於人口增加，經濟快速發展結果，平地土地利用趨近飽和，開發行為逐漸向山坡地發展，若干民眾或因不諳法令，或因蓄意投機，在未經申請情況下，違規使用山坡地結果，常造成自然生態之破壞及水土流失，影響國土保安，導致嚴重後果，因此，如何落實山坡地查報取締及管理工作，減少不當的開發利用行為，為政府重要施政課題。

為此，本計畫除檢討現行山坡地管理查報取締執行成效，編製山坡地查報取締實務教材，並辦理山坡地查報取締實務研討會，藉由本計畫之推展、研討會之推廣，將可強化直轄市、縣(市)政府各級機關及基層工作同仁對相關法規之認識及提昇執法能力，以達到山坡地管理績效。透過法規之約束、取締工作之持續進行，加強民眾對山坡地保育利用及守法之觀念，並可減少違規訴願案件。

(關鍵詞：水土保持法、山坡地管理、查報取締)

Abstract

The slopeland and hills occupy almost three quarters of Taiwan area. Soil erosion, avalanche, or landslide occurs frequently for vulnerable geological, steep slope, torrential streams, and high precipitation for its subtropical location. Besides the natural erosion damages, the further destruction are caused by slopeland development. Based on the limited land resources, the slopeland development becomes larger scale under business and population stress. It may result in severe ecological deterioration and soil and water conservation problem by inappropriate development.

Recently, the land development is focusing on slopeland for population growth, economic development, and limited plain area. The ecological deterioration, soil and water losses, and influence on land resources conservation may occur by violating slopeland utilization without application under unfamiliar with regulations or violating purposely. Therefore, it is an important policy-making topic for slopeland investigation and enforcement and management to prevent inappropriate development.

This project reviewed the current slopeland management and enforcement results, published a practical teaching material, and held a conference. Hopefully, it may increase the concepts, communicate between the basic staff in municipal governments, and improve enforcement capability. It may also increase conservation concepts and law-abiding behaviors and reduce violation cases through investigation and enforcement continually.

(**Keywords : The Law of Soil and Water Conservation, Slopeland Management, Investigation and Enforcement**)

計畫名稱	衛星影像輔助山坡地監測與管理教育訓練 Educational Training on Slopeland Management and Monitoring Via Satellite Images
主持人	蔡明璋 Tsai, Ming-Chang 張英暉 Chang, Ying-Hui 周天穎 Chou, Tien-Yin
計畫年度	92

摘 要

行政院農委會水土保持局（以下簡稱水土保持局）有鑒於傳統以人工方式之山坡地違規使用查報工作，因面臨人手不足、工作量繁重、地方查報之人情壓力等問題，相當程度影響山坡地違規查報取締業務推展成效，對於國土保安、水土保持，乃致於人民生命財產安全都造成嚴重之威脅。為防範山坡地違規開發之情事於未然，水土保持局先知灼見地導入現代化的衛星遙測技術、衛星定位系統及地理資訊系統技術輔助監測山坡地之開發使用行爲。

由於利用衛星影像變異點比對輔助山坡地違規使用查報管理之工作甚爲專業，亦需時間經驗的累積，但卻常因各縣市政府及地方單位工作人員職務之異動，致使原負責山坡地變異點查核、管理人員之經驗無法順利、完整地傳承及交接。爲此，本計畫進行衛星影像輔助山坡地違規使用查報之宣傳文宣製作、教育訓練教材編印、教學及多媒體展示光碟之製作，並辦理專業教育訓練及技術交流等工作。同時，透過文宣及多媒體光碟可對一般民眾宣導水土保持之重要觀念，對於日後水土保持局對內之業務教育及對外之保育觀念推廣，可收事半功倍之效果。

（關鍵詞：衛星影像、地理資訊系統、網際網路）

Abstract

Due to the lack of human resource, overload works and politics matters lead to the low performance in slopeland management, the Soil and Water Conservation Bureau (SWCB) use remote sensing, GPS and GIS technologies to assist to monitor the development in slopeland.

Specialties and experiences are required to investigate, report and ban illegal usage of slopelands. However, fast turnover causes the gaps in the knowledge and experiences of slopeland management and monitoring business via satellite. This project products advertisement and multimedia disc to propagate some important views of soil and water conservation to the populace. Instruction disk, courses, field trips are provided for public officials to promote their ability.

(Keywords : Remote Sensing, GIS, WWW)

計畫名稱	衛星影像變異點查證網際網路管理系統開發 (1/3) Changed Point Areas Inspection and Management System (1/3)
主持人	蔡明璋 Tsai, Ming-Chang 張英暉 Chang, Ying-Hui 周天穎 Chou, Tien-Yin
計畫年度	92

摘 要

本計畫以開發衛星影像變異點查證網際網路管理系統為主軸，加速衛星影像變異點查證時程，以達到「違規行為立即舉發，危害情勢立即排除」的目標。同時利用地理資訊系統之特性，將全局衛星影像變異點歷史資料製成 GIS 格式，藉由地理資訊系統空間分析的特性，增加衛星影像的利用層面，強化山坡地監測之成效。在資料庫方面，依據專業資料庫管理模式，建立 SPOT 衛星影像及像片基本圖影像圖資管理模式，改善原有以唯讀光碟分片個別儲存資料的種種不便，並可藉由網際網路查證系統提供各相關單位同時應用，大幅提升衛星影像與相片基本圖資料查詢與使用的效益。

藉由建置衛星影像變異點查證網際網路管理系統，可提供使用單位透過網際網路快速獲得相關資訊，迅速引導山坡地巡查人員赴變異點現場查證與處理，以有效提高坡地管理績效。

(關鍵詞：衛星影像、地理資訊系統、網際網路)

Abstract

The SWCB takes charge of planning and developing the Web GIS for Changed Point Areas Inspection and Management System, and the local governments retrieve the data, inspect on-site information register case information, and manage the follow-up case tracking through the system, it costs less time on administrative procedure, and enhances the management efficiency on slope land monitoring management assisted by satellite images.

Web GIS for Changed Point Areas Inspection and Management System is planned and developed to provide an integrated and web operation system, meanwhile, the database is built with normalized database structure and integrated spatial and attribute data.

The slope land predominates the territory in Taiwan, and the complicated slope land management business can't be coped with by the traditionally artificial methods. To maintain the whole environment resource. The SWCB uses GPS, GIS, RS and MIS technologies to assist the business on slope land monitoring and management in recent years. Those actions are expected to manage the slope land monitoring business effectively.

(Keywords : Remote Sensing, GIS, WWW)

計畫名稱	水土保持相關法規解釋函彙編專家系統 Establishment of Expert System for Compiling the Declaratory Statutes of Soil and Water Conservation
主持人	林昭遠 Lin, Chao-Yuan
計畫年度	91

摘 要

近年來由於有關水土保持之相關案件不斷增多，種類與個案性質之不同無法規適用上之差異與疑慮，要滿足山坡地管理專業人員及民眾以最便捷之方式，得到最新最正確之水土保持法相關法規行政函釋資訊，必須朝向現代高科技化與網路化發展，因此本計畫建置水土保持法相關法規解釋函彙編專家系統，建立資訊化之專家系統透過網路化發行，提供大眾及山坡地管理專業人員工作參考，增進作業效率。以透過本系統之檢索功能，進而了解水土保持法相關行政函釋的資訊。尤其，多重關鍵字詞之查詢功能提供使用者及山坡地管理專業人員經由關鍵字詞等線索來逐步查詢與獲得水土保持法相關法規之行政函釋資料。

(關鍵詞：水土保持法、山坡地管理、行政函釋)

Abstract

As a result of soil and water conservation cases increasing recently and to adopt the suitable law and regulations explanation for the use in a variety of slopeland exploitation, an expert system with network oriented developed in this study for compiling the declaratory statutes of soil and water conservation issued before. The system provides users effectively through keywords query to get the information of declaratory statutes in slopeland exploitation.

(**Keywords : The Law of Soil and Water Conservation, Slopeland Management, Declaratory Statutes**)

計畫名稱	網際網路地理資訊系統、土石流資訊系統、工程管考系統維護提昇 The Maintenance and Upgrade of Internet Geographic Information System, The Debris flow Information System, The Engineering Management System
主持人	周天穎 Chou, Tien-Yin
計畫年度	91

摘 要

為達資訊共享之目標，水保局近年內已完成多項網際網路版資訊系統，使各界能獲得即時資訊，並於災害發生時增加應變時間，各項資訊系統仍需進行功能提昇，並增加備援機制，以防止各種可預期因素造成運作不順暢，包括「土石流資訊中心系統」9項功能提昇、「網際網路地理資訊系統」14項功能提昇、「工程管考系統」14項功能提昇與中央氣象局雨量連線系統維護作業3項。

(關鍵詞：土石流資訊、工程管考、備援機制)

Abstract

To reach the information sharing goal, Soil and Water Conservation Bureau (SWCB) have set up much internet information management systems to provide the all circles with the real time information and to strive more time as the disaster happen. All the internet information systems still have to keep upgrade their functions and to set up the backup system, which can improve the system operation more smooth. There are 9 functions upgraded for “ The Debris flow information Center System” ,14 functions upgraded for ” Internet Geographic Information System” ,14 functions upgrade for “The Engineering Management System” and 3 items maintained and upgraded for “ the Central Weather Bureau Rainfall Connect System” .

(Keywords : Debris flow information, Engineering Management, Back Up System)

計畫名稱	遙測技術在崩塌地、土石流量化分析及坡地管理監測之應用（二） The Project of Application of the Technology of Remote Sensing on collapse, Debris-Flow Quantification Analysis and Slope Management (2)
主持人	周天穎 Chou, Tien-Yin 衷嵐焜 Chung, Lan-Kun 郭靜怡 Kuo, Ching-Yi
計畫年度	91
<p style="text-align: center;">摘 要</p> <p>台灣山坡地分佈極廣，加上地勢險惡、交通不便且具危險性，無法利用有限的人員詳實地監測土地資源不當使用情形及深入查看了解災區受災程度，故為執行山坡地保育利用管理之責，實需建立一套妥善的土地資源運用及管理機制，除了平時能實際掌握山坡地資源利用現況，災害發生時能爭取時效，快速、有系統地取得一致的災區量化資訊，還可評估災後復建工程之成效，以提供未來相關單位對該區規劃與管理之參考依據，達土地永續使用及研擬有效救災對策之目的。</p> <p>本年度計畫根據「遙測技術在崩塌地、土石流量化分析及坡地管理監測之應用計畫」成果，建立一套土地資源運用及管理作業程序，提出現行山坡地土地利用觀測流程改善建議，並整合水土保持局地理資料庫、土石流觀測站觀測資料以及遙測影像，進行相關土砂量化分析，配合現場查核分析結果，以作為治山防災之管理參考依據。</p> <p>（關鍵詞：遙測、土石流、坡地）</p>	

Abstract

The lands in Taiwan are very widespread. The landforms are dangerous and inconvenient, so it's difficult to monitor the use condition of lands and realize the degree of damages. In order to protect and manage the lands, it's necessary to set up a management system for lands use well. It can not only knowing well the use of lands but also evaluating the process of disasters recovering to the related units in the future as the reference.

This project is based on "The Application of the Technology of Remote Sensing on collapse, Debris-Flow Quantification Analysis and Slope Management" and set up a process of land management, including the suggestions of process well in land use, intergrading the data in SWCB and the information in Debris-Flow Monitoring station and Remote Sensing images to precede soils and gravel quantification analysis, and as a reference for land management.

(Keywords : Remote Sensing, Debris-Flow, land)

第六篇：集水區規劃
Part VI：Watershed Planning

計畫名稱	上坪溪集水區整體治理調查規劃 The Sun-Pie River Watershed Investigation And Planning
主持人	童文麟 Tung, Wung-Lin
計畫年度	96

摘 要

「上坪溪集水區整體治理調查規劃」為「易淹水地區水患治理計畫」之一部分，未來經本計畫之實施，將可達到保護原住民地區，降低土砂災害發生程度及洪患規模、加速山坡地水土資源復育、增加地下水補注及提升居民品質，達到「易淹水地區水患治理計畫」之預期效益及目標。

本案就計畫集水區範圍內之現況、水文水理資料、水土保持問題、泥砂生產量、相關人文及產業活動，進行廣泛蒐集背景資料，並依水土保持技術規範，進行溪床泥砂粒徑採樣分析、坡面水土保持問題調查分析、產業道路水土保持問題問題調查分析、土石流潛勢溪跳查分析等及上坪溪主流調查分析及水文水理檢等等，並針對集水區內可能肇生之水土保持問題進行剖析並提出整體治理計畫，結論則依其問題嚴重性、保護對象及交通便利性，建議將本集水區治理計畫分為八期進行治理，其所需工程總工程經費為 865,500,000 元。

（**關鍵詞：集水區，水土保持，洪患**）

Abstract

「The sun-pie river watershed investigation and planning」is a part of 「Easy to be flooded the local flood to govern the plan」. This project implementation will protect the indigenous people area and reduce the earth granulated substance disaster and the flood scale. Acceleration hilly land water and soil resources cicada chrysalis. This plan implementation will increase the groundwater to make up the note and promotes the resident to live quality, It will achieves easily to be flooded the local flood to govern plan.

This plan will collected the watershed present situation material, hydrological data, conservation of water and soil question, silt productivity, humanities material and industry activity. This plan will make the location survey and field work. This plan will make silt sampling analysis and the brook field work. This plan will depend on the question gravity protection object and the transportation convenience by stages. This plan will divide into for 8 year to carry on the goverment. This plan always governs the funds is 865,500,000N.T..

(Keywords : Watershed, Soil and Water Conservation, Flood Hazard)

計畫名稱	東港溪等上游集水區整體調查規劃 Integrated Assessment and Planning for Upper Watersheds of DongGang River
主持人	王佩兮 Wang, Pei-Hsi
計畫年度	96

摘 要

計畫集水區涵蓋：東港河流域（編號 22）、林邊河流域（編號 41）、南屏東沿海河系（編號 42）及四重河流域（編號 23）等上游集水區，均位屬屏東縣境內。近年颱風豪雨來襲常造成本區重創，導至邊坡及溪岸崩塌、道路及上下邊坡崩塌、土石流暴發及溪流洪氾災害，致使下游堤防潰決、房屋被淹沒、農田流失及橋樑中斷交通受阻，對居民生命財產及經濟建設造成莫大損失，亦影響到當地生活品質及環境生態。

根據本計畫區崩場地調查成果顯示，計畫區有崩場地 1,729 處，合計崩塌面積 395.75 公頃，其中，山坡地保育區有崩場地 772 處，合計崩塌面積 124.60 公頃，佔總崩塌地面積之 31.5%；國有林班地有崩場地 957 處，合計崩塌面積 271.16 公頃，佔總崩塌地面積之 68.5%。計畫區崩場地分布統計成果顯示，林邊溪(2201)崩塌面積 138.03 公頃，佔計畫區總崩塌面積之 34.9% 為最多；枋山溪(4204)崩塌面積 89.01 公頃，佔計畫區總崩塌面積之 22.5% 及率芒溪(4203) 崩塌面積 66.68 公頃，佔計畫區總崩塌面積之 16.8% 次之。

計畫區上游經水土保持局公告有 49 條土石流潛勢溪流，依危險等級進行統計，高危險等級有 13 條，中危險等級有 23 條，屬低潛勢度者有 13 條。已劃定公告為「土石流特定水土保持區」者，包括林邊河流域來義社區之屏東 008 土石流潛勢溪流；位於楓港溪次集水區丹路社區之屏東 019 土石流潛勢溪流、屏東 021 土石流潛勢溪流；南屏東沿海河系竹坑溪次集水區之屏東 025 土石流潛勢溪流、屏東 026 土石流潛勢溪流，均具相當顯著的保全對象。

東港溪上游佳平排水系統近年來，由於上游坡地開發日益密集，導致逕流係數增高及逕流量增加，使現有排洪通水斷面日漸緊迫；再者平原區與坡地交界地帶地形地勢突變平緩，加上農業及非農業開發日益密集，未有滯洪沉砂機制緩衝空間設置的情況下，更讓區域排水問題雪上加霜。每逢颱風豪大雨期間，坡地洪水匯流迅速，屢有土砂淤積及洪水溢流災情，造成野溪與道路交會處橋涵通水斷面阻塞、土砂泥水漫溢，急流挾帶泥砂沖入下游市街及低窪地區，造成野溪下游赤山、萬金、四溝及五溝等村落淹水情形。除此之外，淹水災情亦常出現在林邊溪下游、枋寮沿海及保力溪下游恆春車城地區。

有鑑於此，本計畫依行政院「易淹水地區水患治理計畫」及「第五期治山防災計畫」需求。針對本區災害特性研提治理計畫。計畫經費之編列依優先順序權重，以直接影響生命安全為首要考量，影響如橋樑、道路等交通設施次之，影響農作物等為第三考量要點，並依據現況勘查結果提出治理計畫成果。治理項目包含土石災害防治、土石流防治、野溪治理、崩場地治理、道路水土保持、坡地保育及調查規劃等，因地制宜提出適當之整治內容。針對工程規劃配置情形，整治工程總工程費用概估約為 1,524,200 仟元。

治理工程包括於易淹水地區研提設置滯洪沉砂機制緩衝空間計 36 處，有效延遲洪峰，降低下游區域排水或排水瓶頸區段之負荷，減少淹水區域及降低洪氾頻率。配合野溪治理設置整流工程 38,366 公尺，保護溪岸免於水流直接衝擊，以控制泥砂生產及向源侵蝕，進而保全兩岸之既有設施及道路，減少下游河道淤積所造成通洪斷面減少之問題。設置防砂設施合計 328 座，控制縱橫向沖刷及兩岸崩塌，達到減輕下游區域土石災害之目的。另進行崩場地處理及緩衝綠帶設置，包含坡腳保護工計 3,866 公尺、坡面植生保護 19.8 公頃、苗木栽植 14,690 株及打樁編柵 19,550 公尺，截排水設施計 13,236 公尺等，除為控制現有崩塌及裸露地繼續擴展，並可恢復坡面植生減低坡面沖蝕能力，消滅本計畫區土石料源之供應，減少下游土石災害之發生。計畫實施間接效益則可保育水土，維護國土資源、涵養水源、減少洪水災害損失、進而營造優質自然生態環境、提高經營效率，帶動當地休閒觀光產業之目標。

預期本計畫針對易淹水地區所研擬水患治理方案及第五期治山防災計畫之實施，當 8 年整治工作完成後，整治率可達 45.61%，符合計畫預期目標。計

畫執行後，評估可控制土砂量達 151.3 萬立方公尺；為瞭解淹水治理工作實施成效，計畫期間取得東港溪上游 2006 年地形高程數值資料，採 FLO-2D 數值模式進行該區淹水動態模擬，分析成果顯示治理工作實施後可有效減少該區域淹水面積約 59.8 公頃；除此之外，未來配合下游公路橋樑及水利管理單位針對排水瓶頸段之整體治理計畫實施後，將更有效順暢水流，減降淹水範圍及水患發生頻率。

針對本區淹水及土砂災害之防治相關單位有必要針對本區坡地土砂控制、排洪斷面檢討及若需改善原排洪斷面或滯洪沉砂機制緩衝空間設置方案之用地取得問題，進行上中下游整體性方案探討，得使本區易淹水計畫後續之實施成效得以彰顯。計畫區內瓦魯斯溪、大後溪、七佳溪及枋山溪上游之崩塌嚴重，導致平緩溪段溪床大量砂石持續堆積，除規劃於交通可及溪段進行清淤及配合上游野溪之防砂工程及崩場地處理外，並建請林務單位持續加強上游林班地崩塌裸露地造林工作。

計畫區內包括泰武、佳興、義林、來義、力里歸崇及望嘉等人口相當密集的村落，居民沿陡峭山勢構築屋舍形成聚落，未預留緩衝空間，對坡地住宅安全形成極大威脅，建請建管單位進行坡地危險聚落的全面調查工作及落實違建之查報、制止與取締，確保坡地居住安全。由於坡地的密集使用，保全對象與洪氾路徑間常無法確保出安全的緩衝帶，因此一但洪氾發生，災難即難避免。因此除坡地土砂及洪氾災害來臨前之疏散作業外，較有系統的坡地防災知識宣導及坡地緩衝地帶的留設，將是未來幾年水土保持權責機關推動要務之一。

本計畫之實施需根據生態調查結果，後續在工程配置時，考量各溪流之生態基流量，並以不破壞野溪物理棲地為原則，進行設計施工。施設以生態工程為考量，在安全無虞之下減用混凝土構造，取代以塊石、木樁、透水混凝土、魚槽塊、人工魚礁或場鑄塊石等設計，利用現場石材穩定河床，設置複式排洪斷面及低水流路，於安全之餘更兼顧親水性與綠美化環境，保持與周遭環境之和諧性，提供動植物棲息、生長空間，尊重各種生命及保護生態環境，並減緩護岸之坡度避免阻絕橫向生物廊道。

本計畫之實施，區域之環境將有效改善，降低災害發生機率，人民安全及

社會發展獲得保障。分析計畫年計效益約 178,261 仟元，年計成本約 160,871 仟元，益本比為 1.11，極具投資價值。

(關鍵詞：集水區整體治理規劃、東港溪流域、集水區整備率)

Abstract

This project covers four major watersheds situated in Pingtung Township, which include upper watersheds of DongGang (No. 22), LinBian (No. 41), Southern Pingtung Coastal Region (No. 42), and Sihchongsi Basins(No. 23). Recently typhoons and torrential storms often strike this region and cause slides on hill slopes, stream banks, and road sideslopes, which result in disasters of debris-flow and flooding, collapse of stream embankments, inundation of houses and farm lands, as well as bridges break off. All these have greatly affected the economic development, lives and properties, living quality, and local ecology.

Based on landslide survey results, total of 1,729 landslide sites were sighted that covered area of 395.75 hectares; in which, 772 sites covering total area of 124.60 hectares and constituting 31.5% of the total landslide areas were situated in slope lands conservation regions, and 957 sites covering total area of 271.16 hectares and constituting 68.5% of the total landslide areas were situated in state-owned forest area. The spatial distribution analysis indicated that 138.03 hectares of landslide constituting 34.9% of the total landslide areas were located in LinBian River Basin, 89.01 hectares constituting 22.5% were located in FangShan River Basin, and 66.68 hectares constituting 16.8% were located in SuaiMon River Basin.

There were total of 49 potential debris flow torrents officially announced by Soil and Water Conservation Bureau; in which, 13 of them with high threaten level, 23 with medium threaten level, and 13 with low threaten level. To protect lives and both public and private properties, there were several 'Designated Soil and Water Conservation Area' officially delimited by the government, which included Pingtung 008 in LinBian River Basin, Pingtung 019 and Pingtung 021 in FenGang River Basin, Pingtung 025 and Pingtung 026 in Southern Pingtung Coastal Region.

Increases in runoff volume and less infiltration due to slopeland development has put direct threats to lowland drainage system; especially in ChiaPin drainage network located at upper DongGang River Basin. In addition, the sudden slope gradient changes at the boundary of slopelands and plains as well as heavily packed agricultural and non-agricultural development has greatly occupied the land that left no room for flood retention, sediment settlement, and disaster buffering. Therefore, flooding and sedimentation problems often cause disasters at villages situated at plains. Similar problems can be easily found in LinBian, FangLiou, and HengChun areas.

Master plan was therefore drawn through this project under the guidelines of 'Flood Control Project' and '5th Watershed Management and Erosion Control Project' outlined by Executive Yuan. Funding required for both flood control and watershed management was prioritized so that those may directly affect lives were ranked first, followed by civil facilities, and farmlands. Countermeasures considered in the Master Plan include those for sedimentation, debris-flow, torrent control, landslide control, soil and water conservation for roads, slopeland conservation etc. The total funding was estimated to reach NT\$1,524,200,000.

To overcome the flooding problems, total of 36 locations was proposed for the implementation of flood retention and sediment settlement so that loading as well as flooding frequency at the bottle-neck regions at plains can be released. Total of 28,266-m river training structures and 328 erosion control structures were also proposed to protect rivers from scouring at both river banks and channel beds. In addition, 3,866-m of slope-toe protection structures, 19.8 hectare of slopeland vegetation, 14,690 nursery-grown plants, 19,550-m of staking-and-wattling, and 13,236-m of drainage ditches were included in the Master Plan not only to control landslide from development, to reduce soil loss, but also to reduce debris disaster downstream. The indirect benefit that this Master Plan can produce includes

conserving soil and water resources, reducing damages caused by flooding, restoring high quality ecological environment, and prompting local tourism.

The watershed readiness rate is foreseen to reach 45.61% after 8-year implementation provided that this Master Plan is carefully executed, and total volume of 1.513 million cubic meter of sediment can be regulated. In order to foresee the result of flood control, digital elevation model was constructed for upper DongGang River Basin and was used in FLO-2D model for simulation. The numerical simulation indicated that the installation of flood retention basin can reduce flood areas by 59.8 hectare. With the interagency support from Water Resources Agency and Directorate General of Highways to release bottleneck at bridges and roadways, the effect of flooding control can be expected to further improve.

Land acquisition for flood retention, sediment settlement, and vegetation buffer zones is the key to ensure the success of this Master Plan. Therefore, inter-agency communication is required to fully implement the integrated watershed management project. Support of forestation from Forestry Service is required to control the landslide as well as dragging and torrent control to maintain the conveyance of rivers; especially for WaLuSe River, DaHo River, CheeChia River and FonShan River.

Stability of hill slopes is an important issue; however, buffer zone along the edge of hill slopes is required to secure the safety of lives and properties. Therefore, census of dangerous as well as illegal buildings is required. Installation of vegetation buffer zone and promotion of slopeland disaster prevention drill and education are essential for flood and debris disaster control. They shall be considered and carried out in the future action plan.

Eco-engineering techniques are encouraged to use under the basic requirement of safety so that disrupt of riparian habit can be minimized. Corridor for wildlife

shall receive higher attention than recreation usage; especially along the riparian zones. Amount of concrete structures shall be reduced and replaced by suitable materials that can be gathered at the construction sites to maintain the harmonious atmosphere.

This Master Plan is expected to generate NT\$178,261,000 of benefit annually as compared with annual capital of 160,871,000 that makes benefit-capital ratio of 1.11.

(Keywords : Integrated Watershed Management, DongGang River Basin, Watershed Readiness Ratio)

計畫名稱	後龍溪及中港溪等上游集水區整體調查規劃 Investigation and Planning of the Watersheds of Hou-Long Stream and Zhong-Gang Stream
主持人	林俐玲 Lin, Li-Ling 馮正一 Feng, Zheng-yi
計畫年度	96

摘 要

為有效減少後龍溪與中港溪上游等集水區之水患問題及土石災害，本計畫以整體性、安全性、生態性和人文性之治理考量，在調查範圍內，針對集水區重點問題研提對策，做為短、中、長期治理計畫之依據。透過分年分期治理規劃，以減低災害的發生規模，營造生態環境，帶動地方發展，期使後龍溪及中港溪上游等集水區能達到經濟發展及水土保持雙贏的目標。因此本計畫著手針對崩場地、土石流潛勢溪流、野溪、道路及治山防災構造物進行現地調查，以瞭解計畫區之現況。

根據現勘調查結果，本計畫區內有幾處較大規模之崩塌、地滑，如雞隆河集水區八燕坑地滑、大湖溪集水區出火坑地滑、明德水庫集水區仁隆地滑及出水坑地滑，另外在大東河集水區苗21線蘿拉段有大型崩塌，南河溪集水區鱸鰻窟崩塌等，這些較大規模崩塌成為區內主要土砂來源。而由現地勘查結果顯示，區內之土石流潛勢溪流大部分呈現穩定狀態，僅有部分呈現河床土石堆積，但不易引發土石災害。野溪之狀況良好，僅有部分構造物輕微淘刷與河道旁坡面沖蝕、崩塌。道路水土保持問題大致為排水不良導致道路邊坡崩塌、道路路基流失。針對規劃區內治山防災構造物，由調查結果發現規劃區內之治山防災構造物狀況良好，能有效發揮功能，僅有部分輕微淘刷。

為求更瞭解計畫範圍內集水區之特性，利用數值高程模型(DEM)資料進行分析，以瞭解集水區溪流特性，藉此進行地文、水文、水理及泥砂產量分析，瞭解計畫區溪流的情勢。並以區內氣候、地文、水文資料以及水規所公告流量

為依據，分析各重現期距各斷面水位及土砂生產遞移。水理分析結果為南湖溪、沙河溪、大湖溪及雞隆河集水區內有溢流情形。由產砂量分析可得本計畫區主要以溪流河道堆積為主，河道沖刷之情況僅為局部，且只有少量出現。為能更確實掌握保全對象問題癥結所在，將保全對象分為土砂災害及淹水影響保全對象，針對分析結果有問題之區位進行現地調查，以瞭解災害區位附近保全對象的分佈情形及其可能受影響之範圍，再列出該區所面臨災害問題較嚴重之保全對象，供後續編列工程之參考。

本計畫利用地理資訊系統進行權重計算，進行集水區治理優先順序之排定依據，以SPOT衛星影像所判釋之崩場地、土石流潛勢溪流流路、土石流潛勢溪流影響範圍、水理計算所得溢流點位、保全對象（包含建物、道路及橋樑）等因素進行「影響範圍劃定」，再以所劃定出影響範圍進行分析，加上考量現勘結果之後，選定本計畫內之「重點規劃區段」為大湖溪集水區、沙河溪集水區、汶水溪集水區及雞隆河集水區等四個集水區。其中，選定雞隆河集水區及沙河溪集水區內部分區位作為航拍區位，並進行3D數位之動態模擬及靜態展示。

本計畫注重治理與保育結合，以泥砂收支平衡、安全排水、保護保全對象、保育環境生態、發展富麗農村、積極管理與維護等為規劃原則。本計畫並提出包含造林、崩場地處理、野溪整治、土石流整治、道路水土保持、農村營造等各方面的治理對策。主要針對集水區內具有淹水潛勢、土砂災害影響區域、保全對象之保護，探討災害發生之原因，並進行集水區特性分析，檢討目前水土保持處理實施情況，以集水區整體治理之觀念等，作為擬定治理內容之參考。

為了解本計畫規劃所能帶來之效益，採直接效益與間接效益兩部分進行估算，直接效益係指直接設施財產損失的降低、直接經濟中斷損失的降低與傷亡賠償的降低等。間接效益則包含社會效益、生態環境效益及風險管理效益。集水區整治效益估算以本計畫之治理工程、現地調查資料與分析資料，進行量化評估。

建議應透過分年分期治理，分階段執行與隨時回饋修訂之滾動式管理，使後龍溪及中港溪上游等集水區之整體治理能達到經濟發展及水土保持雙贏的目標。

（關鍵詞：集水區、水土保持、後龍溪、中港溪、調查規劃）

Abstract

In order to reduce the problems of flood and sedimentation hazards in the watersheds of Hou-long Stream and Zhong-gang Stream effectively, the comprehensive, safety, ecological and humane treatments are considered. In the scope of investigation, the mitigation strategies for the key problems in the watersheds are proposed for short-term, mid-term, and long-term plans. The plans are divided into stages to be performed year by year in order to reduce the scale of hazards, build the ecological environment, and drive local development. It is expected the project can make the economical growth and functions of soil and water conservation to a win-win situation in the watersheds of Hou-long Stream and Zhong-gang Stream. Therefore, the project performed investigation on landslides, debris flow potential streams, torrent, roads and mitigation structures in order to find out the present situation of the area.

From the investigation results, there are several large collapses and landslides, such as Ba-yen Keng landslide in Kee-lung river sub-watershed, Chu-huo-keng landslide in Da-Hu Creek sub-watershed, Ren-long landslide in Ming-der reservoir sub-watershed. In addition, there are a large scale collapse of Road Miao-21 Lo-La section in Da-dong River sub-watershed, and a Lu-man-ku collapse at Nan-ho Creek sub-watershed. These large scale landslides become the main source of sedimentation in the project area. According to the investigation results, the debris flow potential streams in the project area are mostly stable, only some streambeds are accumulated with sediments. However, it is not likely to cause sedimentation hazards. The state of the torrent creek is normal, only some structures were slightly scoured and riverside slope eroded locally by the streams. For conservation work of roads, the most problems come from poor drainage system causing up-slope and/or down-slope collapse, or losing of road base. For the mitigation structures, the

investigation results indicate that the mitigation structures are mostly in good situation and being effective. There are only a few structures shows local scour by the streams.

To understand the characteristics of the two watersheds, the digital elevation model (DEM) is utilized for analysis of topographical, hydrological, hydraulic routing and sediment yield characteristics. According to climate, topography, hydrology conditions and discharge data published by Water Resources Planning Institute, WRA, the water level and sedimentations are calculated at many sections for different recurrence periods. The results of the hydraulic routing analysis show that there are some overflow situations in Nan-hu Creek, Sha-ho Creek, Da-hu Creek, and Kee-lung River watersheds. From sediment yield analysis, the condition of streambeds mainly shows sediment accumulation rather than scouring. Only a few locations show local scours and it occurs only occasionally. To better handle the key problems of protection targets, the targets are separated into two parts of sedimentation hazard and flood hazard. Where there are problems indicated by the analysis, in-situ inspections were performed to understand the distribution of protection targets and influenced zones for listing the critical protection targets and zones for further engineering treatments.

This project utilized the geographical information system with the factor-weighted method to carry out the calculation for priority order of watershed mitigations. With the landslides recognized from SPOT satellite images, routes of debris flow potential streams, affected regions by debris flow potential streams, overflow zones calculated by hydraulic routing, protection targets (including buildings, roads and bridges), and the “influence zones” are delineated. According to influence zones, in-situ investigations and further analysis, the four “Key Planning Sectors” in this project are determined as the Da-hu Creek watershed, Sha-ho Creek watershed, Wen-shui Creek watershed and Kee-lung River watershed.

Among them, part of Kee-lung River watershed and Sha-ho Creek watershed are chosen to acquire aerial photographs, and 3D digital flythrough simulations and future vision posters are made.

This project focus on combining mitigation and conservation, considering sediment budget balance and safe drainage, safeguarding protection targets, protecting environment and ecology, developing prosperous rural village, concentrating positive management and maintenance, etc. This project proposes all aspect mitigation strategies, including afforestations, landslide treatments, creek and debris flow mitigations, soil and water conservation for roads, village constructions. The treatments focus on areas of high flood and sedimentation potential for protection targets. The causes of the hazards are discussed; characteristics of the watersheds are analyzed; and current soil and water conservation treatments are reviewed. With integrated mitigation concepts, contents of the mitigation treatments are finally planed.

To estimate the benefit of the mitigation plan, the benefit assessment is divided into a direct benefit and an indirect benefit. The direct benefit is reduction of direct property damage, direct business interruption loss and casualty/life loss. The indirect benefit includes social benefit, ecological environment benefit and risk management benefit. Watershed mitigation benefit is assessed quantitatively based on the proposed engineering projects, field investigation data, and analysis data.

It is recommended that the integrated plan shall be carried out stage-by-stage and year-by-year; using process management to feedback, control and improve the performance of the integration plan to a win-win situation in the watersheds of Hou-long Stream and Zhong-gang Stream on the economical growth and functions of soil and water conservation.

(Keywords : Watershed, Soil and Water Conservation, Hou-Long Stream, Zhong-Gang Stream, Investigation and Planning)

計畫名稱	梨山地區地層滑動基準檢核及監測系統維護資料分析 Reevaluation of Criteria for Safety Management and Maintenance of Monitoring Systems of Li-Shan Landslide Area
主持人	蘇苗彬 Su, Miao-Bin
計畫年度	96

摘 要

本年度考量敏督利颱風過後，原治理區外圍，包括台七甲線上的松茂部落、梨山老部落及台八線上的新舊佳陽部落等地，都有新的地滑地產生，危及居民居家及耕作的安全，雖經緊急處理，仍有長期治理的需求及安全監測預警的必要，因此擴大工作的範圍，包括了松茂地區原住民部落安全的監測，並可加強保護德基水庫上游集水區的安定。

年度計畫進行中，遭遇多次颱風侵襲，通往梨山地區之台七甲線及台八線道路因路基流失、邊坡崩坍等因素，造成道路數度中斷。但梨山地區在監測系統與防災體系運作下，除局部地區小規模土砂災害外，並未發生嚴重地滑災害，各項監測數據綜合評定亦未達到危險等級，顯示梨山地區在排水廊道、集水井等各項整治工程完工並發揮成效之下，安全獲得良好保障。

今年度監測系統維護工作維持了各自動監測站即時監測正常運作，並更換了超過使用年限或故障的監測設備，提供平日及颱風警報期間即時之各項監測數據，供主辦單位參考依據。松茂自動監測站裝設地下水水位計長期觀測地下水變化及 TDR 地層滑動面監測，配合地表傾斜計及雨量計，將梨山地滑自動監測系統範圍擴大至松茂部落，對整體大梨山地區之安全掌控更形完備。

(關鍵詞：梨山地滑、松茂地滑、管理基準值、監測系統、預警)

Abstract

In this year, concerning about after typhoon Mindulle, more sliding occurred around original sliding zone of Li-Shan village. New sliding area included Song-Mou tribe, old tribe and Ga-Yang tribe. More effort should be applied in regards to remedial work for safety of tribe area. Extension of the monitoring work can help to prevent debris crises for Teh-Ke reservoirs catchment land.

A few typhoons hit the project area this year, communication was disconnected. But, with the help of battery system, the monitoring system and prewarning function were able to implement well. No major disaster occurred within renovated area. Safety of this area was ensured.

Some of the monitoring items were replaced in order to keep the whole system functionable. In Song-Mou, New station were set and connected together with the original. Groundwater level change together with TDR cable for sliding zone monitoring can help to the safety for a larger area.

(Keywords : Li-Shan Landslide, Song-Mou Landslide, Criterion for Safety Management, Monitoring System, Prewarning)

計畫名稱	通霄溪集水區上游坡地水土保持整體治理調查規劃 The Integrated Regulation Planning of Soil and Water Conservation on Tong-Siao Watershed
主持人	連惠邦 Lien, Hui-Pang
計畫年度	96

摘 要

通霄集水區涵括房裡溪、苑裡溪、南勢溪、通霄溪、圳頭溪及北勢窩溪等六個次集水區，總面積約達 29,000 公頃，統稱為通霄沿海集水區。

本研究除了依據水土保持技術規範第 144 條河川集水區整體治理計畫內容作為基本架構外，亦擬透過一系列資料蒐集和現地調查工作，首先針對工作範圍內之潛在土砂問題、水患問題、區域農村開發、道路水土保持及以往災害和治理情形等進行檢討分析，選取適當評估因子及其權重設定和分配，以決定集水區評估優先順序以作為後續相關單位在治理與檢討上之參考依據。

經過兩階段之評估分析，於計畫範圍內取得 3 處集水分區作為重點規劃區，針對三大治理區段提出其治理對策及措施建議，以作為後續相關工程之應用，其平面測量、規劃設計圖與單價分析，針對本計畫區之上游集水區作如下之規劃改善：

大坑野溪上游部分、大坑野溪中游福興橋上下游與車輪坑上游野溪，

坡面：

- 1.頭料山層的存在建議設置防落石欄柵。並設置適當之擋土與植生措施一起改善與保護保全對象；
- 2.利吉層部分則建議改以透水效果良好之石籠一方面防砂一方面排水以達坡面穩定與避免過多土砂堵塞河道之效果。

河道：

- 1.河床堆積甚多礫石，雖不會造成大規模之立即性災害，但仍須定期做清淤，上游避免過多土砂進入河道，以免影響通水斷面；
- 2.水量缺乏，棲地單調，建議透過就地取材方式，創造多樣化之生態溪流棲地，並有效蓄積更多水，使土壤涵養更多水源。

(關鍵詞：評估因子、權重、重點規劃區、生態溪流棲地)

Abstract

Tong-siao watershed includes six time watersheds such as the river of Fang-li, the river of Yuan-li, the river of Nan-shih, the river of Tong-siao, the river of Zun-tou and Bei-shi-wo river etc. and the total area reaches to 29,000 hectares around. Know together as circumlittoral Tong-siao coast watershed.

This project in addition to is whole to manage project content according to water and soil conservation technical specification the 144th river watershed conduct and actions is basic to configure. Also collect and investigate a work through a series of data. Aim at project soil sand problem, floods problem, district village in the area to develop first, road water and soil conservation and former disaster and manage situation's etc. to carry on examining analysis. Select by examinations the factor of the adequacy valuation and its power heavy enactment and allotment with decide that the watershed valuation has the initiative sequence to is the reference that the follow-up parties concerned is in managing with examining basis.

After two stages of the valuation is analytical, in project inside the scope, obtain 3 watersheds as to particularly program area. Aim at three greatly manage a block to put forth it to manage counterplan and measure suggestion to is the application of follow-up related engineering. Its flat surface measure, program design diagram and unit price to analyze. Aim at origin to plan area on swim the programming that the watershed is made as follows.

The upstream and midstream of Da-keng river, the upstream and midstream of Fu-sing bridge and The upstream of Che-lun river :

1. In the geologic strata of Tou-ke-shan, the suggestion constitution can prevent the column grid of rockslide from. And constitution adequacy it blocks soil and plants to get measure to keep intact object by its improvement and the

protection.

2. In the Li-ji the geologic strata, the suggestion establishes the catchment good stone cage. On the other hand obstruct soil sand and then can drain on the other hand, then can reach a ground stability in hillside and avoid excessive soil sand jaming river bed thus.

In the river bed part:

1. The river bed piles up a lot of gravels, although will not immediately cause large-scale disaster, still must the periodical clearance silt up of ground. Avoid excessive soil sand into river in the upper stream course of river, the water cross section of of the in order to prevent influence.

2. The amount of water lacks of and stay ground monotonous. Suggest through acquire necessary material locally a way, create the ecosystem rivulet of diversification to stay ground. Also effectively store more water, make soil self-restraint more headwaterses.

(Keywords : Evaluate Factor, Comparison, Particularly Program Area, The Ecosystem Rivulet Stays Ground)

計畫名稱	集水區研發技術應用暨多元化發展 The Application and Diverse Development with Watershed RD Technology
主持人	周天穎 Chou, Tien-Yin
計畫年度	96

摘 要

本計畫以多元化之方式，將水土保持局台中分局歷年來之「集水區研發技術」成果，結合當地民眾同心協力及積極熱心參與經營之理念，予以彙整並有效推廣，期能讓大眾能更加了解「水土保持加值農村發展」之效益。

水土保持局台中分局近年致力於農村發展工作，於轄區內之重點規劃區投入相當多的建設與心力，本計畫規劃製作之宣傳文宣、影帶等，未來除了可作為遊客至當地旅遊的導覽工具外，對於所內或局內安排參訪行程時，也是最好的宣傳工具。

本計畫以多元化之整合行銷手法，包含「水土保持局第二工程所志」、「農村行銷推廣活動」、「形象文宣」、「攝影比賽」及「解說宣導動畫及影片」等方式，將水土保持局台中分局所歷年來之成果，以多元方式推廣出去，有效帶動當地產業經濟發展，展現水土保持建設推動之實質效益。

（**關鍵詞：行銷推廣、永續發展、農村**）

Abstract

Soil and Water Conservation Bureau Taichung Branch made great effort and construction in the key areas of Taichung County, Taichung City and Miaoli County. The project collected the achievements and promoted to the general public.

Taichung Branch pays attention to rural development in these years. The promotion of the project includes paper propaganda and video. They' re not only the tourism guide for traveler in the future also the best promotion tools for the visitor of Soil and Water Conservation Bureau.

In order to promote the achievements and the realistic beneficial results of Soil and Water Conservation Bureau Taichung Branch, the project has multiple marketing plans including “History of 2nd Engineering Office” , “Rural promotion activity” , “paper propaganda” and “Photography Competitions and video” . They benefit the local economic development.

(Keywords : Marketing and Promotion, Rural Development, Village)

計畫名稱	塘下橋集水區上游坡地水土保持整體治理調查規劃 Integrated Investigation and Planning of Water-Soil Reservation at Upper Stream Land Slope on Tongha Bridge Watershed
主持人	鄭魁香 Cheng, Kuei-Hsiang
計畫年度	96

摘 要

塘下橋集水區位於嘉義縣竹崎鄉，範圍涵蓋灣橋、鹿滿、紫雲、義隆、內埔、白杞、塘興及龍山八村，計畫集水區面積範圍達 1,156.7 公頃，周長達 21.4 公里。重要道路有台三線、縣道 159、縣道 166、縣道 169 號及嘉 118、嘉 120 等多條鄉道。

氣候溫和，年平均溫度在 20~23℃，最高 33.7℃，最低 10.1℃，早晚溫差變化較大，屬山區特殊型氣候。雨量集中於 4~9 月間，雨量分布隨海拔增高而遞增。

人口方面，依據竹崎鄉公所統計 95 年 8 月為止，集水區內八村共計約 8,933 人，4,633 戶，每戶平均人口數約 3.686 人，其中以灣橋村及龍山村人口較多。

地形與地勢方面，由東部丘陵向西漸變為平原，最高處 595 公尺，最低處 63 公尺，平均 205 公尺，多為一級坡與二級坡，平均坡度 53.5%，坡向分布則以東向及東南向分佈最多。

地質方面，卓蘭層及其相當地層約占 50%，屬於泥岩層，分布於計畫區西側丘陵地，其特性遇水容易軟化崩解，為區內多達 30 處崩塌之主因，因此造成本區溪水呈灰白色，其他地層包含錦水頁岩層及其相當地層、桂竹林層、頭料山層及局部沖積層等。此外，在計畫區西側尚有九穹坑存疑性活動斷層通過

鹿滿村與紫雲村，呈東北－西南向通過，評估活動可能造成規模 6.5 強震。

在流域方面，本集水區位於中央管河川濁水溪上游地區，屬於朴子溪流域。集水區河系主要由樟樹坪溪（即嘉義 A023 土石流潛勢溪流）、鹽田溪，以及濁水溪所組成。集水區於塘興橋處與家州厝集水區相連接，坡地為樟樹坪溪及鹽田溪流域。

在土砂災害方面，在本區以土石流潛勢溪流及崩塌地為主。土石流潛勢溪流位於塘興村嘉義 A023，即本計畫所稱樟樹坪溪，保全戶數為 4 戶，居住人數約 27 人。在崩塌地方面，以樟樹坪溪上游中心崙崩塌地最為嚴重，為土石流潛勢溪流嘉義 A023 之源頭，過去雖無造成傷害情事，但該崩塌地目前持續滑移，顯示過去針對該崩塌地之治理收效不彰，除影響白杞村樟樹坪路之行車外，對下游塘興村更是一大威脅。

（關鍵詞：集水區整體治理調查與規劃、塘下橋集水區）

Abstract

The watershed of Tongha Bridge is located in the areas of Chuchi township in Chiayi County, covers the Bay Bridge, Lumun, Ziyun, Elan, Neipo, Baiqi, Tonghing and Longshan eight Villages. Planning area of watershed is near 1156.7 hectares, around up to 21.4km. Important roads have the third province road, county road 159, county road 166, county road 169, Chia 118, Chia120 and so on a number of village roads.

Mild climate, the average annual temperature is between of 20~23°C, the highest 33.7°C, the lowest 10.1°C. Sooner or later, a larger temperature changes, it is a special type of climate of mountain area. Rainfall concentrated from April to September, rainfall distribution increased with increasing elevation.

Population, according to the Chuchi township offices statistics to 95 years in August, the total watershed of eight villages around 8933 people, the average population of about 3.686 people, Longshan Village and Bay Bridge are more of the population.

Topography and terrain, from the eastern hills to the west is gradually plain, top 595 meters, the lowest 63 meters, 205 meters on average, for more than a second slope and the first slope, with an average gradient of 53.5 percent, while the distribution aspect from the east to the south-east distribution is the most.

Geology, Layer Zhuolan is the very formation accounts about 50% of the soil, belonging to the siltstone. It located in the west side of the hilly district, which features water to soften easily collapse in the region for as many as 30 main causes of the collapse, resulting in the area was off-white stream. The other strata contain Kamshu shale formation and its very, Kuishalin formation, Tokeshan formation and local alluvial and so on. In addition, the project area in the west side, there are doubts about the Jouthukan active fault through the village Lumun and Ziyun

village, was the northeast to the southwest through to assess the activities of the potential magnitude of the 6.5 earthquake.

In the basin, located in the watershed area of the central Choshui river upper reaches of the river area, Puzai river belong to the basin. The main river watershed areas by the Cheungshuping river (that is, Chiayi A023 debris potential flow), Yimtin river, as well as the composition of the Choshui river. Tongxing bridge in the watershed area with the Chachuzhe watershed connected to the areas, Cheungshuping river for the slope and Yim- tin river basin

Sediment of the disaster, it is the areas of potential landslides and collapsed in the main stream. Potential debris flow at Tonghing village, Chiayi A023, that the alleged plan to Cheungshuping creek, for the preservation of four buildings, the number of people is about 27 people. Landslide in the area of Changshulun is the most serious potential for landslides at source Chiayi A023. Further more no harm occurred in the past, but the failure is continuing slide shows to present. It is seemed lack of effective governance, in addition to the impact of Baiqi village of road traffic, the lower stream reaches of the Tong- hing village is a major threat.

(Keywords : Investigation Watershed Investigation and Planning, Tongha Bridge Watershed)

計畫名稱	濁水溪上游集水區整體調查規劃 Watershed Management Planning for Jhuoshueisi
主持人	蘇苗彬 Su, Miao-Bin 陳毅輝 Chen, I-Hui 曾國維 Tseng, Kuo-Wei
計畫年度	96

摘 要

本濁水溪上游集水區整體治理計畫依現地現況完成檢討後，針對問題首先擬定治理方案，並交由各主管單位，配合「易淹水地區水患治理綜合規劃管理」內容辦理。最主要研擬分年分期計畫及規劃整體治理需求。

濁水溪流域之上游集水區歷經過去的開發利用，隱藏了許多的危機，尤其 921 地震後，更加速與擴大危險，幾次颱風豪雨進入本區域造成了很大的傷亡，上游坡地水土保持與治山防洪兩項應著眼於彌平 921 造成的影響，而整體長期土地利用的問題則應歸屬治山防災的五期工作。

本治理計畫實質內容包括兩部分，一為依現地現況調查評估所得上游集水區內後續應治理的工作，依其複雜程度編列調查規劃計畫或直接可工程緊急處理項目，另一為區域內民眾反應有緊急治理需求者，仍依整體治理之概念，經檢討若符合上游坡地水土保持及治山防洪需要者，直接以治理工程之方式編入。

(關鍵詞：濁水溪、集水區經營管理、調查、規劃)

Abstract

Watershed management planning for Jhuoshueisi was conducted based on field conditions. After finishing discussion of field problem, remedial strategies were set. This planning was part of flood prevention work plan for local drainage system.

Upstream watershed for Jhuoshueisi has been through extensive developing stage. Some forms of disaster existed. Especially after Chi-Chi earthquake, potential of danger was expanded. Typhoon season in the past few years induced very large amount of damage and casualty. Watershed management planning is urged to be implemented.

In this planning, works are divided into two parts. First is the work required to have the watershed back into equilibrium in regards to debris transport and local drainage system. The second is the work called for help to prevent damage to people and property.

(Keywords : Jhuoshueisi, Watershed Management, Investigation, Planning)

計畫名稱	濁水溪上游集水區整體調查規劃圖表與解說彙編 A Pictorial Guide of Watershed Management Planning for Jhuoshueisi
主持人	蘇苗彬 Su, Miao-Bin
計畫年度	96

摘 要

上游集水區整體調查規劃是整個國土保安、生態保育、環境保護非常重要的一環，透過影像判釋、地理資訊系統建檔與分析、現地調查與分析，依地貌學及河相學的理论，評定各個集水區現況的問題，後續可據以擬定治理及管理的對策，再依此編定治理工程及管理事項，則上游集水區可得到良善經營管理。由目前彙整之結果可以看出，濁水溪上游集水區存在有許多水土環境之問題，有待解決，相信在台灣地區的其他集水區也會有類似問題，待調查與評估。

透過彙集整體調查規劃所運用與製作之相關圖表及現地調查的照片紀錄可以清楚呈現上游集水區的現況與問題所在，再經由深入檢討及解說編撰，對後續治理的策略可以正確有效的訂出，應是可行的方法。

(關鍵詞：濁水溪，集水區經營管理，規劃，解說)

Abstract

Upstream watershed management work is very important from the point of view of land safety, ecological preservation and environmental protection. It is conducted through image certification, GIS data base collection, field investigation and analysis based on geomorphology and river engineering. Current endangerous factors for each watershed are evaluated and remedial strategy are set. Final plan for the total problem are set including management and engineering work.

In this pictorial guide, methodologies applied in proceeding the watershed management planning for Jhuoshueisi are described mostly in tables, graphs and photos. Background informations are collected and presented in sequence. And, at the end, a few important topics in relation to this specific watershed are presented to provide a forum for future discussion.

(Keywords : Jhuoshueisi, Watershed Management, Planning, Guide)

計畫名稱	大坑溪上游集水區整體治理調查規劃 Integral Investigation and Management Project of Da-Ken Creak Upstream Watershed
主持人	連惠邦 Lien, Hui-Pang
計畫年度	95

摘 要

本計畫集水區位於台中市北屯區逢甲橋上游之三處集水區，分別為大坑橋上游集水區、清水橋上游集水區與廣盛橋上游集水區，合計 1779.1 公頃。本區多為頭料山層（約 28%）與卓蘭層（約 56%）地質所組成，因此每逢豪雨沖刷，泥砂輸送明顯，上游崩塌堆積卵石甚多，對於此種特殊地質，加上中下游保全對象甚多，因此土砂的控制實屬重要。

經調查，本區土地利用以林業佔居多(53%)，其次為農業使用，建地在下流也相當多，主要產業為竹子與觀光果園。區內上游集水區存在四條主要觀光登山步道，因此假日與平時早晨遊客甚多，相對的區內道路使用率相當高。本區道路共計 26 條農路，經調查多半為經濟作物與觀光農業用途居多，但多半道路目前狀況良好，僅有幾處道路上邊坡之坡面小規模崩塌需注意。

本區土石流潛勢溪流共計三條，崩場地歷經 921、桃芝與海棠颱風的肆虐，以廣盛橋上游之崩塌數量最多達 347 筆，總面積當時高達 214 公頃之多，全區後續新增部分僅 15 處，總面積僅 33 公頃，表示該區崩塌已達控制，僅有零星分布。

本區年平均降雨量約 1823.6mm，經檢算，本區河道設計當時以洪水迴規頻率 25 年之設計規模予以施設，僅有番子城溪上游、清水坑溪上游以及橫坑溪上游之頭料山層堆積物阻塞河道影響通水外，多半橋涵無溢岸之虞。

除此之外，本案亦透過水質與生態的調查，對於本規劃集水區內之河道

棲地生物與水質環境作兩季之調查，本區生態豐富，物種甚多，保育類動植物也不少，至於水質之調查成果，多半水質良好，僅有下游部分地區受家庭污水排放及上游果園有機肥的排放影響。

根據現場調查結果，針對區內水土保持消關問題如野溪治理、土石流問題、崩場地治理、道路水土保持等作如下支建議工程，其分布點位如圖所示，總計三期經費中，第一期約 2,667 萬，第二期約 2130 萬而最後一期約 1494 萬之多。

(關鍵詞：頭嵙山層、卓蘭層、集水區整體治理)

Abstract

This research watershed including Da-Ken-Chao, Chin-Swe-Chao and Kwan-Shen-Chao watershed is in the upstream part of Feng-Chia Bridge in Taichung City, and the total area is 1779.1 ha. The major geologic layer is Tokershan Formation and Tzolan Formation , therefore, this kind of layer is fragile and often cause large amount of sediment scour and boulder deposit. Due to the special geological layer and also too many protection target at the downstream section, it is important to make integral watershed mitigations.

Through field investigation, forest land is 53% of land use, then is agriculture and building site at the downstream section, and industrial product is bamboo and orchard farms. There is also many hiking route in this area for recreation and 26 farm roads for farming usage, and most of the road environment is good, only a small part has minor magnitude up hill landslides in which needed to be notice.

This research area also have 3 debris flow potential rivers, and after the 921 earthquake, there are many landslides, including 347 spot in Kwan-Shen-Chao watershed, total landslide area is 214 ha, but after 5 year, only 15 new site is spotted and total landslide area is 33 ha. Besides the above mentioned, this research also did some work on habitat investigation, and this area has many valuable animals and plants, and the water quality and quantity is good here.

From result, for soil and water conservation management, including creak mitigation, debris flow problem and landslide disaster, for construction recommendation, the first period need 26,670,000\$ the second period need 21,300,000\$ and the last period need 14,940,000\$ for future management planning and construction.

(Keywords : Tokershan Formation, Tzolan Formation, Integral Watershed Mitigations)

計畫名稱	大村及三家春集水區上游坡地水土保持規劃 The Upstream Management of Soil and Water Conservation on Da-Tsuen and San-Jia-Tsuen Watersheds
主持人	連惠邦 Lien, Hui-Pang
計畫年度	95

摘 要

本計畫區為彰化縣境內大村及三家春集水區上游坡地，總面積 1,750 公頃，屬八卦山集水區之子集水區，位處八卦山台地，西接平原區，屬於都市邊緣淺層山坡地帶，計畫集水區內之主要野溪包含有應公坑及其支流姜子寮坑、苦瓜寮坑、八股坑、秀水坑、番仔田坑、古井坑及中坑、三家春坑、南方寮坑、炭坑及五里坑等 12 條坑溝野溪。

本計畫區年平均降雨量為 1292.6mm，經河道瓶頸斷面檢算後僅有應公坑上游二處為斷面不足，其餘皆可通過 50 年重現期距之洪峰流量，惟本計畫區野溪兩岸常有崩塌石礫及掉落植物阻塞河道影響通水，故定期河道整理為本計畫區重要辦理事項。另外本區道路總長度達 31.1 公里（道路密度為 1.78），多數道路狀況良好，幾處道路上邊坡之小型崩塌需注意。

本計畫區多為頭料山層(89.2%)地質，每逢豪雨沖刷，上游河道泥砂輸送明顯，下游河道（137 縣道附近）產生淤積，且本計畫區位於坡地平地交界處（排水路銜接問題），十幾年來各相關單位戮力整治下，以減低許多淹水災情，但近幾年來豪大雨發生機率突增，加上中下游保全對象甚多，因此上游坡地土砂的控制與滯洪機制並配合下游水利單位整體規劃治理實屬重要。

（**關鍵詞：瓶頸斷面、土砂控制**）

Abstract

This plan area lies within the boundaries of Changhua county, Da-Tsuen and San-Jia-Tsuen watershed upstream slopeland, the whole area is 1,750 hectares, belong to sub-watershed of Ba-Gua mountain watershed, it is Ba-Gua mountain tableland, the west of it is plain, it is Shallow Slopeland, plan to collect the main wild small stream in water district and include You ying gong river , Jiang zih liao river, Ku gua liao river, Ba gu river, Siou shuei river, Fan zai tian river, Gu jing river, Zhong river, San jia chun river, Nan fang liao river, Tan river, Wu li river ,etc..

The annual average rainfall in the plan area is 1292.6mm, there are only two too small for section places of You ying gong river upstream after river chocking spot calculation, and other can pass peak discharge of 50year frequency. In the plan district, the river two sides often collapse the stone drops, it influences the open water that the plant blocks the river, so manage the plan area for a fixed period of time and is based on river and work importantly. In addition, the total length of road in the plan area is up to 31.1 kilometers (the density of the road is 1.78), most road states are good, and the small-scale collapse of the slopeland needs to pay attention to on several roads.

In this plan district, geology is mostly Tou-ke-shan strata (89.2%). The local form is eroded by the torrential rain, upstream river silt particle sends strongly, downstream river (near 137 County Road) is produced and deposited. This plan area lies in the intersection peacefully of hillside fields (the question that river links up). For over ten years, every relevant unit makes great efforts to manage, has already lowered a lot of and flooded the floods feeling. But in recent years, bold heavy rain take place probability increase, very more target that midstream and downstream must protect. So, the sediment control and postponement peak discharge of upstream slopeland, and cooperate with the downstream water conservancy unit to seem very

important to manage wholly.

(Keywords : Chocking Spot Chocking Spot Calculation, Sediment Control)

計畫名稱	山腳村七鄰崩塌地整體治理調查規劃 The Renovation Planning for the Landslide in the 7th Neighborhood, Shan-Jiao Village
主持人	吳正義 Wu, Chen-Yi 黃貞凱 Huang, Jen-Kai
計畫年度	95

摘 要

一、計畫緣起及目的

民國 95 年 6 月間的連續豪雨，造成桃園縣蘆竹鄉山腳村附近「桃北 4」鄉道下側邊坡崩塌、路基流失，嚴重影響居民出入；而崩塌範圍更可能危及周邊房舍之安全。水土保持局第一工程所為保護該地區居民身家財產安全及鄉道之通暢，乃辦理「山腳村七鄰崩塌地整體治理調查規劃」。

二、工作內容

本計畫辦理崩塌地現況調查、資料蒐集及崩塌地特性與災害原因分析，且根據各項調查成果研擬治理對策，作為崩塌地之治理依據，並提出整治工程細部設計，以達整體治理防災工作成效。

三、崩塌範圍及規模

計畫區主要崩塌地位於大古山三角點附近沿桃北4鄉道北側邊坡，向林口鄉境內東華高爾夫球場崩落，崩塌面積約2,400平方公尺，推估崩塌土方量約為14,000立方公尺。

四、崩塌原因判釋

計畫區地層以大南灣層超覆林口層為主，層面大致水平，具不透水層面，當大量且持續之降雨時，其地下水位受不透水層影響而不及排出，造成孔隙水壓積蓄，並使得上覆之紅土層浸水膨脹軟化與細料易於流失，為典型紅土台地邊緣坍塌現象。

另因「桃北4」主要道路施築於稜線上，降雨時地表逕流快速匯集沖刷，更加速台地邊緣土壤沖蝕情形。

五、治理對策

本區主要災害為「桃北4」道路路基流失，在考量安全、經濟及快速復舊並恢復交通等原則及條件下，選擇採用加勁邊坡工法配合截水及排水系統進行復建，以得到最佳效益。

六、工程規劃及細部設計

本加勁邊坡設計採用容許抗張強度100及80KN/m之兩種地工格網作為加勁材，並分三階回填。由於地質調查成果顯示工址岩盤較為軟弱，設計時以加勁基礎版及微型樁提高基礎承載力，以維持整體之穩定性。

本工程排水系統以道路側溝、新設各階加勁擋土牆下方設置之拍漿溝及縱向噴漿溝組成，經水理分析，新設之排水系統斷面均可有效宣洩50年洪峰頻率之地表逕流。

七、效益分析

本計畫治理之效益包含直接效益及間接效益兩類，直接效益包含避免該地區崩塌之情形持續惡化、恢復道路交通功能及促進觀光產業發展等方面，其益本比約1.47；而間接效益則包含維持民生交通安全、改善農業經營環境、保育自然生態、促進土地永續利用等。

(關鍵詞：崩塌地、治理)

Abstract

1. Project Origin and Purpose

The persistent torrential rain in June 2006 caused the landslide of the downside slope and the roadbed sinking on Tao-Bei Township Road No. 4 in Luchu Township, Taoyuan County. The range of the landslide not only affected the traffic, but also endangered property safety of the buildings nearby. In order to protect life and property for the area and ensure the unobstructed traffic, 1st Engineering Office, Soil and Water Conservation Bureau specifically transacted “The Renovation Planning for the Landslide in the 7th Neighborhood, Shan-Jiao Village” project.

2. Work Contents

Various works were performed in this project such as the field investigation in the landslide area, information collection, landslide characteristics and disaster analysis, etc. Accordingly, renovating strategies are proposed based on the above works and the design layout of the renovation is presented to achieve integral renovation and hazard mitigation.

3. The Range and Scale of the Landslide

The landslide area in this project, falling from the northern slopes of Tao-Bei Township Road No. 4 to Dong-Hua Golf Course in Lin-Kou Township, was mainly located on the vicinity of the Bench Mark at Mount Da-Gu. The estimated landslide area was around 2,400m² and the volume was around 14,000m³.

4. Causes of Landslides

The stratum in the project area, with almost horizontal and impermeable layer, is mainly Da-Nan-Wan Formation covered with Lin-Kou Formation. When the persistent rain caused the groundwater to accumulate in the impermeable layer, the laterite covering on it soaked in the water and became softened and easy to wash away. The above-mentioned was the typical landslide phenomenon along the edge of

Laterite Tableland.

Since Tao-Bei Township Road No. 4 was mostly constructed on the crest line, the washout along the tableland edge was hastened because of the rapid surface runoff from the heavy rain.

5. Renovating Strategies

After considering various factors including safety, economy, efficiency and unobstructed traffic, a “Reinforce Slope” is suggested to be the optimal solution for the slope erosion renovation of Tao-Bei Township Road No. 4.

6. Project Planning and Design Layout

The standard design profile for “Reinforce Slope” adopted two kinds of geotextiles with tensile strength of 100 and 80 KN. The slope was designed to be backfilled in three steps. Since the rock foundation was relatively weak according to the geological investigations, “Reinforce Foundation Plate” and “Micro Pile” were designed to enhance the bearing capacity and integral stability.

The storm drain in the project was composed of gutters, new ditches on each step of the retaining wall and lengthwise ditches. According to the hydrological analysis, it showed that the new draining system would be able to accommodate 50-year-flood surface runoff.

7. Benefit Analysis

The anticipated benefit of the renovation contains direct and indirect benefits. The former, with Price Earnings Ratio 1.47, includes keeping the landslide from deteriorating, recovering the traffic and improving the tourism etc.; the latter comprises providing safe traffic, promoting agricultural operation, preserving the natural ecology and maintaining the sustainability for land use.

(Keywords : Landslide, Renovation Planning)

計畫名稱	北區土石流防災專員培訓 North Debris Flow Disaster Prevention Education, Publicity and Training Observer
主持人	巫仲明 Wu, Chung-Ming
計畫年度	95

摘 要

本團隊接受水土保持局第一工程所委託辦理「北區土石流防災專員培訓」。工作項目包括 5 大項目：1.培訓土石流防災專員 94 名、2.土石流防災專員裝備製作 252 套、3.土石流防災專員身分證明 ID 卡設計、4.辦理土石流防災專員演練觀摩活動與回訓課程、5.提供水土保持局第一工程所辦理轄區災害緊急聯絡人教育訓練課程安排及師資，以上工作均已辦理完成。

95 年培訓 94 名土石流防災專員透過專業課程訓練，使與訓人員具備自主觀測雨量、環境設施檢查、協助災情通報與疏散撤離等專業能力，以達成落實土石流防災自主管理，並降低土石流災害之目標。

完訓者授予「結訓證書」及高級防災裝備，並聘任為「土石流防災專員」，任期 2 年，實際投入未來土石流防災工作。

(關鍵詞：土石流防災專員、第一工程所)

Abstract

The team has accepted SWCB First Engineering Office's commission to launch the "Northern Region Debris flow disaster observers Training Program." The program consists of five major schemes: 1.to train 94 volunteers as Debris flow disaster observer, 2.purchase 252 sets of equipments for trainees, 3.Identity Card designing, 4.annual observation and training sessions, and 5.provide region supervised by SWCB First Engineering Office training program and qualified teachers for the education of Disaster Emergency Contact Persons. The above has been processed.

Through professional training, 94 volunteers in 2006 shall be equipped with the ability to independently observe rainfall conditions, inspect environmental facilities, assist with disaster announcements and evacuation, thus implementing self-management of Debris Flow Disaster Prevention, and thereby reaching the target to decrease the disaster scale caused by Debris Flow.

Upon completion of training, trainees shall receive a certificate and quality prevention equipment, and appointed as an official Debris flow disaster observer for a two year period, with practical involvement with Debris Flow Disaster Prevention.

(Keywords : Debris Flow Disaster Observer, First Engineering Office)

計畫名稱	<p>石門水庫白石－秀巒子集水區整體治理調查 規劃</p> <p>Integrated Shihmen Reservoir Watershed Management Plan-A Case Study of Baishih- Shiouluan Sub-Watershed</p>
主持人	<p>魏迺雄</p> <p>Wei, Nai-hsiung</p>
計畫年度	<p>95</p>

摘 要

本計畫針對白石－秀巒子集水區各項調查資料進行規劃及問題分析，並依據保全對象擬定治理工程設計原則及訂定初步治理計畫，以利相關權責機關在未來訂定治理計畫時有所參考及依據。

有關計畫區之地理位置、地形、地勢、人口、交通、氣象水文、地質與土壤、土地權屬、崩塌地、土石流潛勢溪流、野溪、道路水土保持、危險聚落等基本資料均加以蒐集整理及研判分析，作為整治工作之依據。

本計畫治理工程在具體之直接效益上，擬定 6 年治理（95～100 年）計畫，預計處理崩塌地處理工程 61 處、野溪治理 15 件、坡地保育工程 6 件及土石流潛勢溪流治理一件，應可控制 833,363m³ 之泥砂土石量，達 28.67% 之整治率，社會及經濟效益將提供當地居民 145 戶之就業機會、保護公共設施、居民生活安全、道路行車安全等。並達到裸露崩塌地植生復育使區域微氣候改善，並使區域水土資源涵養效能提昇等生態環境效益。

為達成集水區整體治理效益，相關單位應配合辦理之事項建議如下：

集水區內需整治區位可能涉及林班地或道路養護單位，未來需林務局與新竹縣政府配合執行。

由於觀光業日益蓬勃，絡繹不絕之觀光人潮容易造成集水區內水質與環境之污染及破壞，進而影響生態棲息地與物種之變化，建議相關單位在本計畫區

完成各項治理後（由於目前路況甚差，路面適合高底盤車輛通行），應於秀巒之入山管制哨控制入山人數。

（關鍵詞：整治率）

Abstract

This project focused on developing preliminary management plan of Baishih-Shiouluan sub-watershed which is a part of Shihmen reservoir watershed through analyzing historical data and on-site survey information. In order to facilitate the authority to formulate detail management plan, design principles are suggested according to different secured objects.

The background database such as region geography and topography, population and traffics condition, climate, hydrology, geology, territory belonging, landslide distribution information, potential debris flow torrent, soil and water conservation construction and potential hazard zone, were studied as the watershed remediation foundation.

A 6-year remediation project which concludes to rehabilitate 61 landslide areas, restore 6 slopeland zones, and manage 15 torrents and 1 potential debris flow torrent were proposed, which is planned to control 833363 cubic meters of sediment yield , or 28.67% in completion ratio as the direct benefit. Through the result will reduce the chance of disaster occurrence and provide living protection and infrastructure and traffic safety. The more secured environment will thus bring more job opportunities for the 145 local families. Ultimately, the vegetation rehabilitation of landslides will also indirectly benefits the region climate through water conserving in the soil, and turns the ecological environment to a better way.

To achieve the best integrated management effect, the suggested authorities and co-operation items are as follows:

1. Due to some construction would be taken in forest compartment or on the road, administrations, such as Forestry Bureau and Hsinchu County Government, should cooperate in the remediation plan.
2. As the tourism industry flourishes day by day in this area, the increasing

population of tourists brings more pollution and lowers the water quality. It influences animal habitat and causes changes of species. Relative authorities should take ecological factors into account when people apply entry permits at Shiouluan mountain permit station after all remediation.

(Keywords : Completion Ratio)

計畫名稱	花蓮地區治理成效風貌展現規劃 The Promotion Plan of the New Rural Village's Appearance with Hualien Region
主持人	穆青雲 Mu, Cing-Yun 周天穎 Chou, Tien-Yin
計畫年度	95

摘 要

行政院農業委員會水土保持局花蓮分局秉持水土保持與農村發展緊密結合，使其產生「加值效果」的原則下，推動多元化山坡地資源保育，建構社區安全之土石流防災機制，營造健康活力的農村新風貌，以達鄉村未來永續發展之目標。

花蓮分局自民國 77 年以來，於花蓮縣轄內各農村規劃重點區投入相當多的建設與努力，並獲得初步的成果及多方的肯定；為能積極推動農村整建工作，以綜合性的發展規劃，針對各個農村地區實際需要，分年分項推動有計畫的建設，以期形塑優質的農村特色，達成農村新風貌的新境界，實為重要課題。

本計畫重點在於建置花蓮分局中英文網頁及中英文形象文宣，並輔以形象識別標章及創意紀念品，期以花蓮分局之重點區—「壽豐鄉米棧村」、「鳳林鎮鳳義里」、「瑞穗鄉舞鶴村、鶴岡村」、「玉里鎮東豐里」、「富里鄉羅山村、東里村」五鄉鎮為範疇，希冀將長期以來當地民眾攜手努力及積極營造的理念，結合花蓮分局於各地區推動農村發展之心力，以多元風貌展現方式，呈現出社區總體營造的特色與生命力，將各農村特色推廣至國內外各地。

（關鍵詞：農村發展、行銷推廣、永續發展）

Abstract

Soil and Water Conservation Bureau Hualien Branch promotes the conservation of soil and water and the rural industries development positively. To combine soil and water conservation and rural village development tightly yield the value-added effect. Base on the principle, pushing the multiple slope land conservation and constructing the mechanism of the mudflows and the landslides control of community security promotes the new rural village style and features to achieve the goal of everlasting development.

The Hualien Branch puts great constructions and efforts in Hualien county key areas since 1988 and acquires an initial result and affirmation in many ways; In order to use the methods of comprehensive development planning and community construction to aim at the realistic requirements of each rural village planning area to satisfy them, divide into a year's item promotion to have a plan, and construct a high-quality village special feature, to reach the new rural village style and features is become a really important topic.

The project is particularly in building the Hualien Branch's Chinese-English web page and promoting through paper propaganda of the Chinese-English image, and secondarily in identify system and creativity trophy by image in Hualien Branch's 5 key areas that including "Mi-Jan village in Shou-Feng", "Feng-Yi Lane in Feng-Lin", "Wu-He Village & He-Gang Village in Ruei-Suei", "Dung-Feng Lane in Yu-Li", "Lo-Shan Village & Dung-Li Village in Fu-Li", in order to present the great efforts and the principle constructed aggressively by Hualien Branch and local people. To promote the community empowerment in multiple ways and the new rural village style and features to everyplace of Taiwan and overseas.

(**Keywords : Rural Industries Development, Marketing and Promotion, Everlasting Development**)

計畫名稱	南勢溪上游集水區整體治理調查規劃 Investigation and Planning for the Integral Control on the Watershed in the Upstream of Nan Shih Chi
主持人	周明坤 Chou, Ming Kun
計畫年度	95

摘 要

南勢溪主流長約45km，溪流平均坡降約1/28，全流域面積33,160ha，本計畫區位於台北縣烏來鄉南勢溪攬勝大橋以上之集水區，屬於台北水源特定區範圍內，其集水區面積約22,712ha，近年來受颱風豪雨等天候變化侵襲影響，加以地形地貌之改變，區內山坡地水土保持需求日殷，因此為確保大臺北地區自來水之水源、水質、水量不受破壞與污染，需針對上游集水區作一整體規劃。本計畫之治理工程能防止及減低上游土砂下移，避免下游攬勝大橋及烏來溫泉區之土砂淤積造成淹水災害，達到水患治理之成效。

本溪流上游集水區並無工業區及高污染產業，原水質清澈環境自然幽靜，惟90~94年間因受龍王、海馬等颱風帶來豐沛豪雨，山坡地多處崩塌，河道沿線嚴重受創，造成人民生命財產之損失，另於各重要部落人口密集，民房緊鄰溪畔，基於關懷當地居民及保護下游村落居家安全，以及確保台9甲線道路交通安全，故規劃辦理區內集水區現況調查、野溪整治、水文資料、治理效益評估及建議、斷面分析及針對災害嚴重處，進行生態工程規劃設計並予以配合綠美化等相關設施，為沿線原住民部落之未來發展轉型奠定新契機，遂成立本計畫。

本計畫工作重點與內容可概分為兩大要項，一為集水區現地調查，二為治理方案研擬，茲將報告中提出之成果及資料內容分述如下：

一、基本資料調查

(一) 集水區基本資料調查、蒐集及建立，包括氣候、水文、地質、土壤、

集水區水系等，彙整以上基本資料供集水區地文水文分析，以作為瞭解及評估集水區概況之依據。調查結果本集水區年平均氣溫約 22.6°C，年平均降雨量約 3,385mm。

- (二) 於信賢國小及福山一號橋進行 2 組河床質調查分析，並依據粒徑分析成果推求河床粗糙係數，分析結果南勢溪河床粗糙係數約界於 0.035~0.037 之間。另針對德拉楠橋、斯其野溪、大羅蘭溪等三處溪流進行河床表面粒徑調查分析，其 D_{max} 介於 130cm~180cm 間。
- (三) 對集水區內土地利用現況及河道沿岸歷年水土保持工程包括整流與防洪工程、防砂工程進行現況調查，並計算集水區洪峰流量以作為未來評估集水區整治規劃設計之參考。
- (四) 根據歷年雨量資料統計，推估各河段各控制點不同重現期距之洪峰流量，並以 50 年重現期距之洪峰流量為設計流量，做為河川水位演算之依據。本計畫集水區水文分析結果攬勝大橋控制點 50 年重現期距之洪峰流量為 2,451cms。

二、現地調查結果及問題

- (一) 溪流：依據地形及溪流特性可劃分為 15 個子集水區，現地調查及分析結果發現，現況溪流多呈卵礫石或大塊石堆積，大雨時仍有明顯土石下移，部份既設橫向構造物已成為水域生物棲息環境的阻礙為主要問題。另分析本計畫集水區年土壤沖蝕量約為 481,581m³/年、平均沖蝕深度為 2.12mm/年，土壤沖蝕多集中於上游子集水區，其中以大羅蘭溪子集水區土壤沖蝕量約 55,300m³/年最多。
- (二) 崩場地：本計畫依據既有資料、現地調查結果及最新購買之衛星影像，針對區內崩場地進行重新判釋，調查結果本集水區內現存崩場地共 387 處(SPOT5(2.5m))，桃芝後判釋共有 28 處(SPOT3(20m))，敏都利後判釋共有 34 處(SPOT4(10m))，因本計畫之衛星影像解析度較高，故判釋之崩場地較多，其破壞類型多屬淺層岩盤崩解破壞及平面型破壞，比較以往與現況判釋崩場地資料可知，大規模崩塌已逐漸植生復育，現況多為小規模的崩塌。調查分析結果崩塌總面積約 66.71ha、總崩塌量約 109 萬 m³，其中以茶墾子集水區崩塌量約

24 萬 m³ 最多。

(三) 集水區內土石流潛勢溪流計有 3 條，其中 2 條屬於中潛勢溪流、1 條屬於持續觀察溪流，推估其土石流潛能流出量共約 17.92 萬 m³，其中以屯鹿溪土石流潛勢溪流潛能量最多。

(四) 道路水土保持：本集水區道路水土保持尚稱良好，主要道路有北 107、北 107-1 縣道及西羅岸、信賢、馬岸、哈盆、內洞等農路、林道。受計畫區地形陡峭、立地條件不佳等因素影響，尤其颱風豪雨過後，常造成許多坑溝與道路交會處路基沖刷或落石坍方阻斷交通等災情，其中又以北 107 線沿線最為嚴重，其他農路系統，部分路段因未施設排水系統，如遇大雨，道路無法收集坡面逕流，逕流沿路面順流而下，一旦累積足夠的量或流速過快，易造成路面塌陷，或在坡面形成蝕溝，加速土壤沖蝕。

三、改善對策及效益

為達到控制上游土砂下移，必須先計算各子集水區土砂流出量，進而緩和河床坡度以降低輸砂至下游能力並減低河道縱向淘刷等。

(一) 土石流潛勢溪流、野溪及蝕溝整治

野溪整治工程之目的，乃在於減低土砂生產、輸送、淤積，避免造成下游地區災害，因此本計畫針對土砂災害嚴重河段進行整治，目的為緩和河床坡度以降低輸送土砂至下游之能力並減低河道縱橫向淘刷，預計施設護岸約 5.9km、固床工 61 支、防砂壩及梳子壩 6 座、護岸基礎保護工 2,530m 及蝕溝控制 825m，施設護岸及蝕溝控制後，將可減少兩岸崩塌之土砂體積約為 125,169m³。另依據 Takahashi 平衡濃度公式推估本集水區整治後每年可防止 121,069m³ 泥砂下移。

(二) 崩場地處理

崩場地處理目的係安定坡面，保護坡腳穩定，以減少坡面之沖蝕及泥砂來源。依據調查分析結果，本計畫崩場地需處理面積約 2.46ha，除崩場地處理外，包含崩場地間接處理（防砂壩、梳子壩）、河岸及河道不安定土砂處理等，實施後總防砂量預估可達 397,490m³，年平均整治成效約 56,784m³。

(三) 道路水土保持

道路水土保持不僅能穩定邊坡及改善路況，以減少坡面及路面沖刷，且可防止水流到處竄流而安全排除，本計畫調查道路水土保持需保護面積約 1,105m²，沖蝕深度以 5mm 計算，則每年可減少泥砂流失量 5.53m³。

四、治理規劃內容

(一) 分年分期實施計畫

本計畫針對集水區整體調查分析後研擬治理工程，總工程費約 22,568 萬元，以「維護重於治理」的原則建議分年分期實施計畫如下：

項次	分年實施計畫	經費概估(萬元)	備註
1	96 年度治理工程	5,321	
2	97 年度治理工程	7,657	
3	98 年度治理工程	2,395	
4	99 年度治理工程	2,693	
5	100 年度治理工程	1,526	
6	101 年度治理工程	1,519	
7	102 年度治理工程	1,457	
總計		22,568	

(二) 計畫實施成效

本計畫預計在民國 96—102 年間投資約 2 億 2,568 萬元，預期 7 年整治工作完成後，計畫區域之環境將有效改善，災害發生機率降低，人民生命安全、社會發展獲得保障。經計算，本計畫之年計成本為 2,160 萬元，年計效益含直接及間接效益為 4,001 萬元，益本比為 1.85，由此可知本計畫實施符合經濟效益，應屬經濟可行。

而整治率部分，本計畫參照「水庫集水區土砂整治成效評估(2/2)」(陳樹群，2003.12)以土砂整治觀點，藉由集水區土砂整治率評估模式之應用，有效評估水土保持措施之土砂整治成效，在往年長期之整治工程投入及本計畫之規劃整治下，在未來 7 年內預計可達到整治率 42.38%，符合台灣地區治山防

災計畫第四期之目標。

(關鍵詞：南勢溪、烏來溫泉區、治理規劃、整治率)

Abstract

The main length, average slope and total basin area are about 45km, 1/28 and 33,160ha in the Nan Shih Chi, respectively. This project scope with 22,712ha or so basin area is located in the watershed above the Lan Sheng Bridge (LSB), Wu Lai Township, Taipei County, belonging to the range of specific area of Taipei Water Source. Recently, under the influence of strike on climate change of typhoon and storm, etc. and in addition to variance in topography and terrain features, the water and soil conservation on the slope land is eagerly to be required day by day; thus, an integral planning for the upstream watershed needs to be made in order that no encounter with damage and pollution on the water source, quality and quantity of water supply in Taipei Metropolitan Area (TMA) is assured. The control engineering in this project can not only prevent and reduce the downward shift of the upstream debris but also avoid the flood damage resulting from the downstream debris deposit of the LSB and Wu Lai Spring Area (WLSA). After all, the effect on the flood control is available after its completion.

Although clear raw water quality and nature and quiet surroundings result from no industry park and high pollution enterprise in the watershed of this upstream tributary, during the period from 2,001 to 2,005, abundant storms under the strike of Longwang and Haima Typhoon, etc. give rise to many sites of slope land collapse, serious damage along the channel and a great loss of resident's life and property. Moreover, judging from caring for the local resident, protecting the downstream village and dwelling safely and guaranteeing the traffic safety on the 1st branch of the 9th Taiwan Provincial Highway in every tribe with dense population and residence close to the nearby channel, planning for watershed current situation survey, wild creek control, hydrological data collection and analysis, control benefit assessment and suggestion and sectional analysis is to be carried out in this project

scope. Meanwhile, as for the serious damage site, planning and design for the ecological engineering in match with the relevant facility on afforestation, beautification and so on is also to be performed in order to establish the new moment on the aboriginal's tribe development and reform along this tributary in the future.

Work keynotes and relevant contents can be divided into 2 main items, i.e. 1.watershed site survey; 2.control plan study and proposal. The proposed results and data contents in this report are to be indicated, individually as follows:

I. Basic Data Survey

- (I) Watershed basic data survey, collection and establishment include climate, hydrology, geology, soil and watershed tributary, etc. and are collected to provide the catchment geologic and hydrological analysis on the basis of realizing and assessing the catchment common situation. Survey results indicate that annual average temperature and rainfall are about 22.6 °C and 3,385 mm in this basin, separately.
- (II) There are 2 sets of bed load survey and analysis, according to the result of grain size analysis, bed roughness coefficient (BRC) is to be estimated; the analysis outcome indicates that the BRC in the Nan Shih Chi is roughly between 0.035 and 0.037. Moreover, the bed surface grain size survey and analysis for 3 tributaries, i.e. De La Nan Bridge, Si Chi Ye Chi and Ta Lo Lan Chi, is to be accomplished and the relevant value of Dmax is between 130 and 180 cm.
- (III) It's been performed for the current survey on the existing land use within the watershed and statistical water and soil conservation engineering along the channel bank over the years including flow control, deflood and sediment control engineering; the watershed peak flood is analyzed as the reference of assessment on planning and design for the watershed control in

the future.

(IV) According to the statistical records of rainfall data over the years, it's been estimated at each control point in every channel section for the peak flood in various recurrence, the peak flood in 50 years recurrence is used for the design discharge on the basis of the stage calculation; the result of the watershed hydrological analysis in this project shows the peak flood in 50 years recurrence is about 2,451cms at the control point of the LSB.

II. Site Survey Results and problem

(I) Tributary: The project scope can be divided into 15 subwatersheds via the topography and tributary features, it's found out that according to the results of site survey and relevant analysis, main problems include heaps of gravel and cobble or big boulder mostly existing in the current tributary, debris still moving downward significantly during heavy storm and some existing transverse structure having become the obstruction of habitat surroundings of the aqueous species. Moreover, the analyzed yearly soil erosion amount and average erosion depth are about 481,581 m³/yr and 2.12 mm/yr, respectively; the soil scour mainly focuses the upstream subwatershed where the maximum soil erosion amount is about 55,300 m³/yr in the subwatershed of Ta Lo Lan Chi.

(II) Landslide: According to the existing data, site survey result and newest bought satellite image in this project, landslide in this project scope is reanalyzed and the survey result shows that total landslide sites in quite recent or after Toraji and Mindulle Typhoon are 387 (SPOT5(2.5m)), 28 (SPOT3(20m)) and 34 (SPOT4(10m)) locations, respectively. There're more analyzed landslide sites, resulting from the higher resolution of satellite image in this project, their relevant damage types mostly belong to the rupture of shallow bedrock collapse and planar type; it can be known via

comparison between the past and the current landslide data that the relevant site in large scale has been vegetated and restored and the landslide site in present mostly exists in small scale. Furthermore, the survey analysis result indicates that total landslide area and volume are about 66.71 ha and 1.09 millions m³, individually; among the project scope, the maximum landslide volume in the Cha Ken subwatershed is about 0.24 millions m³.

(III) There're up to 3 debris flow potential creeks within the watershed, 2 of these creeks and the rest belong to medium potential and continuous monitoring creeks, respectively; the estimated potential outflow of such relevant debris flow is totally about 0.1792 million m³ among which the maximum potential amount belongs to the Tun Lu Chi debris flow potential creeks.

(IV) Water and Soil Conservation on Road: Water and soil conservation on Road within this catchment can be considered to be in good condition; main roads include Taipei County Road (TCR) 107 and 107-1, farmway for Si Luo An, Sin Sian, Ma An, Ha Pen and Nei Tong, etc. and wood lane. Under the influence of factors on steep landform and bad basic ground condition, etc., damage to traffic interruption and so on resulting from roadbed scour at the intersection of many pits and ditches and roads or stone fallen and collapse has often happened, especially after the strike of typhoon and storm; among these relevant damages, the most serious case exists along the TCR 107. Meanwhile, as for the other farmway system if without drainage installation, then road surface collapse or slope scour ditch to increase the soil scour in part of section is easily to occur during heavy storm in that the slope runoff can't be collected by the road; the runoff smoothly flows downward along the road surface if enough accumulated discharge and too high velocity.

III. Improvement Strategy and Benefit

To attain the control on the upstream debris moving downward, debris yield needs estimate first in every subwatershed

(I) Debris Flow Potential Creek, Wild Creek and Scour Ditch Control

The goal of tributary control is to reduce debris yield, transport, and deposit and avoid damage in the downstream area Comb type dam sabo/check dam. Moreover, the channel section with serious debris damage is focused on this project in order to milden the bed slope for decreasing the capacity of debris transport into the downstream and lessening the longitudinal and transverse channel scour. Preliminary facility includes about 5.9km slope protection and 2,530m its foundation protection engineering , 61 sets of bed engineering, 6 sets of sabo and slit dams and 825 m gully erosion control; after installation of slope protection and gully erosion control, annual reducible debris volume of both bank collapse is about 125,169m³/yr. In addition, the annual estimated debris volume via Takahashi equilibrium concentration formula is about 121,069m³/yr to be avoided moving downward after this watershed control.

(II) Landslide Control: These goals for landslide control are slope stabilization and toe-stability protection to reduce the slope erosion and grit source; judging from the survey analysis result, landslide control area in this project is about 2.46ha, total annual estimated control sediment volume, besides the landslide control also including landslide indirect control (sabo and slit dams) and bank and channel unstable debris control etc., amounts to 397,490m³/yr; annual average control effect is about 56,784m³/yr after the project execution.

(III) Soil and Water Conservation on Road: This is not only used for slope stabilization and road condition improvement in reducing the erosion of

slope and road surface but also the prevention of random flow all over excluding the safety. If the estimate protection area under survey and erosion depth in this project are 1,105m² and 5mm, respectively, then the annual reducible debris volume is about 5.53m³/yr.

IV. Control Planning Contents

(I) Project Execution in Phase and Year by Year

After the completion of the focused watershed integral survey and analysis, control engineering is to be suggested in this project, total engineering cost is about 22.568 millions NTD; according to the principle of 「Maintenance is more important than control」, the project execution is to be proposed in diverse phase year by year and shown as follows:

Item No.	Project Execution in Phase and Year by Year	Estimated Cost (10 ⁴ NTD)	Notes
1	Control Engineering in 2,007	5,321	
2	Control Engineering in 2,008	7,657	
3	Control Engineering in 2,009	2,395	
4	Control Engineering in 2,010	2,693	
5	Control Engineering in 2,011	1,526	
6	Control Engineering in 2,012	1,519	
7	Control Engineering in 2,013	1,457	
	Total	22,568	

(II) Project Execution Result

Total expected investment cost between 2,007 and 2,013 is about 0.22568 billion NTD, after the accomplishment of the relevant control work in 7 years as expected, the project scope surrounding is effectively to be improved, damage occurrence probability is lessened; the protection on local resident's life safety and social development is available. Furthermore, annual cost and benefit with direct and indirect benefit and the ratio of benefit to cost (B/C) in this project are 21.60 and

40.01 millions NTD and 1.85, respectively. Thus, as a result of the above-mentioned data, this project execution meets the economical benefit and should belong to the feasible economy.

As for the part of control rate, according to 「Evaluation on the Effect of Sediment Control for Reservoir Watershed (2/2)」 (Chen, Shu Chun, 2003.12) in this project, the sediment control effect on the method of water and soil conservation can be validly assessed via the sediment control viewpoint as well as the application of the assessment model for watershed sediment control rate. In summary, under the past and long term investment on control engineering and planning for control in this project, the control rate is supposed to be up to 42.38 % within 7 years in the future and meets the objective in the 4th phase for the project— 「Mountain Control and Damage Prevention in Taiwan」 .

(Keywords : Nan Shih Chi, Wu Lai Spring Area, Planning for Control; Control Rate)

計畫名稱	美濃集水區整體治理調查規劃 The Minon Watershed Management Planning
主持人	鄭麗瓊 Weng, Debbie L. C. 蔡文鎗 Tsai, Wen-Chiang
計畫年度	95

摘 要

本集水區位於高雄縣境內，集水面積 2071.58 公頃。除美濃溪主流流經集水區中央外，另包含雙溪、橫溝、竹子門溝及其他野溪支流；土石流潛勢溪經劃定共計四條，分別為高雄A038、A039、A040 及A041 土石流潛勢溪，大部份中、上游的溪床兩側仍有土石淤積情形且護岸尚未施作保護。崩塌地共計八處，面積約 1.2 公頃，大部分集中於東光寮左近野溪上游區域之道路旁邊坡，由於集水區內地質為桂竹林層，其岩層易碎且易剝落的地質與自然侵蝕現象的崩塌，加上道路水土保持不良等問題，導致泥砂、土石大量產生，因雨水逕流帶往蝕溝再由野溪之沖刷下移至集水區內各溪流。最後於溪流河道堆積河水沖下形成土石災害。經檢討分析本集水區問題依需求及時程，擬定本集水區之中、長期治理計劃，分為野溪整治、崩塌地處理、道路改善、坡地改善與坡地水土保持及鄉村新風貌規畫。彙總整體集水區整治構想，各整治工程設施的配置建議與其分期施工經費總計為 693,596,070 元，整體集水區整治率推估可達 36.99%。

(關鍵詞：土石流潛勢溪、崩塌地、蝕溝、整治率)

Abstract

The Minon watershed area is situated in Kaohsiung County. It has a collection area of 2071.58 hectares. Besides the Minon River, this watershed also collects runoff from the Sungai, Han-Go, Shiu-Zi-man-Go, and other creeks. Four of these creeks (A038, A039, A040, and A041) have been designated as high potential debris flow creeks. Most of the riverbed and bank areas upstream of these four creeks have not been properly treated to prevent debris flow. The eight landslide sites, having an area of 1.2 hectare, are mostly situated in road side slope in the upstream area of the Dong-Guang-Liu creek. Due to fragile geological composite of the watershed area, natural decay, inadequate road soil and water conservation, large volume of debris will be washed down stream resulting in debris flow damage. This plan, being divided into intermediate and long term plans, comprises of creek control, landslide treatment, road improvement, slopeland stabilization, soil and water conservation plan for slopeland, and greenization of the slopes. The total cost of the plan is estimated to be NT\$693,596,070. The watershed control ratio is estimated to be 36.99%.

(Keywords : Potential Debris Flow, Landslide, Gully, Control Ratio)

計畫名稱	烏山頭水庫集水區山坡地整體治理調查規劃 The Wu-Shan-Tou Reservoir Watershed Management Planning
主持人	鄭麗瓊 Weng, Debbie L. C. 蔡文鎗 Tsai, Wen-Chiang
計畫年度	95

摘 要

整個烏山頭水庫集水區面積約有 4,539 公頃。本集水區可分為三子集水區包含烏山頭水庫、麻亞坪及部份冷水坑。其行政區橫跨台南縣六甲鄉、官田鄉、大內及東山鄉。烏山頭水庫係匯集官田溪各支流如南勢坑溪、北勢坑溪、土埋坑溪及馬欄坑、番仔厝坑溪等野溪支流之溪水。其中，崩塌地屬道路或農路下邊坡部份，主因為道路處理不當，遇雨逕流直衝下邊坡或滲漏淘空路基導致道路坍塌。崩塌地屬溪岸部份，主因為受水流長時沖刷導致護岸基腳淘空而坍塌。另計有台南 A022、A023、A024、A027 等四條土石流潛勢溪流，各溪流上游土石(巨礫相當多)淤積嚴重，下游與 174 縣道相交，颱風豪雨時 174 縣道常遭土石災害而阻斷。集水區整治理原則應以防止土砂下移為主要標的，俾能有效降低水庫泥砂淤積，增加烏山頭水庫之壽命。整治內容包含野溪治理及土石流防治、崩塌地處理、道路水土保持及農地水土保持等，實施後可直接減少土石災害、穩定河床及維持道路暢通、保護農園、房舍及人民生命財產安全，並提昇土地利用之價值及達到保土蓄水之功能。提具分年分期實施計畫之總治理工程經費達 255,199 仟元。預期效益評估可控制下移年平均土砂量約為 108.1 萬立方公尺。

(**關鍵詞：土石流潛勢溪、崩塌地**)

Abstract

The Wu-Shan-Tou Reservoir Watershed encompasses an area which crosses township of Lioujia, Danei, Guantian, Daongshan in Tainan County. The watershed contains 5839 hectares of slopeland and forest. The Wu-Shan-Tou Reservoir Watershed can be divided into 3 sub-watersheds, Wu-Shan-To Reservoir, Ma-Ya-Ping, and partial of Lan-Uei-Keng comprise this watershed area. The watershed area is fed by the branches of the Guantian river such as Nan-Shin-Keng creek, Bei-Shin-Keng creek, Tou-My-Keng creek, Ma-Lan-Keng Creek, and Fun-Keng creeks. In the watershed area rainfall and seepage erosion often leads to the collapse on the downhill side of a road. This stems from improper road management.

Landslides also occur on banks of the creeks of the watershed area. This is due river flow which erodes the river bank over time. Also, #174 county road is crossed by four (Tainan A022, A023, A024, A027) potential debris flow creeks. Whenever there is a typhoon, this will bring huge volume of debris to downstream and cut off #174 county roads.

The main purpose of this study is to prevent landslides and the resulting debris from being washed downstream. It can also reduce the sedimentation in the reservoir areas leading to the increase lifespan of the Wu-Shan-Tou Reservoir. This plan will include creek control, torrent control, debris flow prevention, landslide treatment, road and farmland soil and water conservation plan. After enactment of this plan it will decrease debris flow, stabilize the riverbed, keep the roads open, and protect farmland, house and property of local residents. It will also increase the yield of the land and water storage. The total cost of the projects spread over several years and phases will be NT\$ 255,199,000. The estimated amount of sand that will be controlled will be 1081000 m³.

(**Keywords : Potential Debris Flow 、 Landslide**)

計畫名稱	梨山地區地層滑動管理基準檢核及監測系統 維護資料分析 Reevaluation of Criteria for Safety Management and Maintenance of Monitoring Systems of Li-Shan Landslide Area
主持人	蘇苗彬 Su, Miao-Bin
計畫年度	95

摘 要

梨山地區地層滑動範圍涵蓋遼闊，主要包括中橫公路台8線與宜蘭支線（台7甲）交會處的梨山村一帶，本區域在民國79年4月間發生大規模的地層滑動，水土保持局自84年度起實施梨山地區的「坡地災害整治」計畫。於民國91年度完成原計畫編定之工作，並依現地需要擬定了梨山地區地層滑動整治第二期4年的計畫。

本年度為梨山地區地層滑動整治計畫第二期4年之最後1年度，在第二期計畫中除了持續評估與維護原工程外，並加強了監測系統的功能。在二期的4年當中，梨山地區經歷了幾次較大的風災侵襲，包括93年度的敏督利與94年度的海棠，對本區域造成不少的災情，尤其公路沿線、松茂部落。本二期計畫第4年的實施，應針對整體大梨山地區做全面的檢討與後續德基水庫上游集水區整體的建議，以配合重要水庫集水區治理工作的進行。

本年度計畫執行中雖遭遇數次颱風侵襲與69水災之長時間降雨，道路數度中斷，但在監測系統正常作業與防災體系運作下，梨山地區安全無虞。

梨山地滑地區的觀測成果與預警系統的運作，是提供相關單位防災工作進行的依據，目前已建立即時觀測的結果與災害預估研判，以網頁的方式，即時上網供相關單位應用。

（關鍵詞：梨山地滑、管理基準值、監測系統、預警）

Abstract

Landslide area in Li-Shan village occurred a major sliding in April 1990. Soil & Water conservation Bureau proceeded a contingent project renovating the landslide. The project named “Investigation and renovation planning for landslides in Li-Shan area,” was accomplished at the end of 2002. As required by field conditions, the second stage renovation plan was set for a four years term. This year is the end of the second stage. The function of monitoring system was expanded in this stage.

In this stage, a few typhoon hit Li-Shan area, especially Mindulle 2004 and Haiton 2005. Both typhoons caused some damage especially for slopes along the route and Song-Mou tribe. It is suggested by evaluation of this project that a total investigation and remedial plan should be proceeded for the upstream catchment area of Li-Shan landslide zone.

In this years executed of the field work be broken by long term strong rainfall caused route disconnected. The monitoring system and disaster prevention work were continued. An internet embedded prewarning system was built to provide real-time warning information to people incharged for safety management.

(Keywords : Li-Shan Landslide, Criterion for Safety Management, Monitoring System, Prewarning)

計畫名稱	雙溪集水區上游坡地水土保持整體治理調查 規劃 The Integrated Regulation Planning of Shuang-Si River
主持人	周明坤 Chou, Ming-Kun 黃偉倫 Huang, Woei-Luen
計畫年度	95

摘 要

雙溪集水區位於台北縣雙溪鄉及貢寮鄉，為北海岸河系之一部分，其集水區面積約14,395公頃，溪流全長約28.6公里，平均坡降約2.36%。

本野溪上游未經開發污染，水流清澈，環境自然清幽，惟其支流坡陡流急，未經整治之河道，常挾帶大量土砂，至雙溪下游因坡度和緩而淤積，致洪水溢流成災，造成人民生命財產損失；另本計畫區內有21條土石流潛勢溪流，過去在納莉、納坦颱風都曾造成土石災害，嚴重威脅鄰近民宅安全。

此外，本集水區生態資源豐富，區內有后番子坑溪生態工法教學園區及福隆海水浴場等著名景點；為維護生態環境及配合該集水區未來發展，特辦理「雙溪集水區上游坡地水土保持整體治理調查規劃」（以下簡稱本計畫）。

本計畫工作重點與內容可概分為兩大要項，一為集水區現地調查，二為治理方案研擬，茲將報告中提出之成果及資料內容分述如下：

一、基本資料調查

(一) 集水區基本資料調查、蒐集及建立，包括氣候、水文、地質、土壤、集水區水系等，彙整以上基本資料供集水區地文水文分析，以作為瞭解及評估集水區概況之依據。調查結果本集水區年平均氣溫約22.5°C，年平均降雨量約3,812mm。

(二) 河道測量成果共八處，包括導線測量座標成果、地形測量成果、水準測量成果及測量成果圖面，詳請另見測量成果報告書。

(三) 河道泥砂採樣及分析，現地及試驗分析共11組，並依據試驗成果

進行河床質及河道粗糙性質研判，分析結果雙溪河床質粒徑 85.21 ~308.50mm，粗糙係數約界於 0.033~0.038 之間。另針對七處土石流潛勢溪流進行河床表面粒徑調查分析。

(四) 對集水區內土地利用現況及河道沿岸歷年水土保持工程包括整流與防洪工程、防砂工程進行現況調查，並計算集水區洪峰流量以作為未來評估集水區整治規劃設計之參考。

(五) 根據歷年雨量資料統計，推估各河段各控制點不同重現期距之洪峰流量，並以 50 年重現期距之洪峰流量為設計流量，做為河川水位演算之依據。本計畫集水區水理演算結果雙溪出海口控制點 50 年重現期距之洪峰流量為 1,021CMS。

二、現地調查結果及問題

(一) 溪流：依據地形及溪流特性可劃分為 10 個子集水區，現地調查及分析結果發現，以雙溪子集水區（雙溪一福隆段）土砂嚴重淤積造成淹水為本集水區最主要之問題。另分析本計畫集水區年土壤沖蝕量約為 416,065 (m³/年)、平均沖蝕深度為 2.67mm，土壤沖蝕均集中於上游子集水區，其中以枋腳溪子集水區土壤沖蝕量約 12 萬 m³/年最多，顯示本集水區上游坡地水土保持對下游易淹水地區之重要性。

(二) 崩塌地：本計畫依據既有資料、現地調查結果及最新購買之衛星影像，針對區內崩塌地進行重新判釋，調查結果本集水區內現存崩塌地共 114 處，經與以往調查結果交叉比對後發現其中有 82 處為新增崩塌地，32 處為 89 年既有崩塌地，其破壞類型多屬淺層岩盤崩解破壞及平面型破壞，89 年後崩塌地已由原來 167 處減少為 32 處，表示大部分崩塌地均已復育完成。調查分析結果崩塌總面積約 40 萬 m²、總崩塌量約 81 萬 m³，其中以牡丹溪子集水區崩塌量約 15 萬 m³ 最多。

(三) 集水區內土石流潛勢溪流計有 21 條，其中 4 條屬於高潛勢溪流、6 條屬於中潛勢溪流、11 條屬於低潛勢溪流，推估其土石流土砂流出潛能量共約 100 萬 m³。其中以牡丹溪子集水區共 7 條土石流潛勢溪

流出量最多。

- (四) 道路水土保持：本集水區道路水土保持尚稱良好，主要道路台 2、台 2 丙線由公路總局第一區工程處管理，包括維護及擴建計畫工程（外柑至灣穹段及北 38 線部分路段）均列有水土保持計畫書，因此並無災害情形：災害情形較多的地方為上游農路系統，部分路段因未施設排水系統，如遇大雨，道路無法收集坡面逕流，逕流沿路面順流而下，一旦累積足夠的量或流速過快，易造成路面塌陷，或在坡面形成蝕溝，加速土壤沖蝕。

三、改善對策及效益

為達到控制上游土砂下移，必須先計算各子集水區土砂流出量，進而緩和河床坡度以降低輸砂至下游能力並減低河道縱向淘刷等。

(一) 土石流潛勢溪流、野溪及蝕溝整治

野溪整治工程之目的，仍在於減低土砂生產、輸送、淤積所造成的下游地區災害，因此本計畫針對土砂災害較多河段進行整治，目的為緩和河床坡度以降低輸送土砂至下游之能力並減低河道縱橫向淘刷等，預計施設護岸(及固床工)約 10.25 公里及防砂壩 12 座，其中施設護岸後以受保護長度×護岸高度×保護深度 2m 計算，將可減少兩岸崩塌之土砂體積約為 70,200m³。另依據 Takahashi 平衡濃度公式推估本集水區整治後每年可防止 186,507m³ 泥砂流失。

(二) 崩場地處理

崩場地處理目的係安定坡面，保護坡腳穩定，以減少坡面之沖蝕及泥砂來源。依據評估結果，本計畫之崩場地治理面積約 10,400m²、防砂壩 12 座，本計畫如獲實施，除崩場地處理外，包含崩場地間接處理(防砂壩)、河岸及河道不安定土砂處理等，本計畫實施後總防砂量預估可達 50,630m³。

四、治理規劃內容

(一) 分年分期實施計畫

本計畫針對集水區整體調查分析後研擬治理工程，總工程費約 31,260 萬元，以「維護重於治理」的原則建議分年分期實施計畫如下：

分年實施計畫	經費概估(元)
95 及 96 年度治理工程	80,055,000
97 年度治理工程	71,249,000
98 年度治理工程	48,800,000
99 年度治理工程	32,200,000
100 年度治理工程	33,700,000
101 年度治理工程	33,000,000
102 年度治理工程	13,600,000
總 計	312,604,000

(二) 計畫實施成效

本計畫預計在民國 95 年至 102 年間投資約 3 億 1,260 萬元，預期八年整治工作完成後，計畫區域之環境將有效改善，災害發生機率降低，人民安全、社會發展獲得保障。由上述資料得知，本計畫之年計成本為 3,209 萬元，年計效益含直接及間接效益為 5,942 萬元，益本比為 1.85，由此可知本計畫實施符合經濟效益，應屬經濟可行。

而整治率部分，本計畫參照「水庫集水區土砂整治成效評估(2/2)」(陳樹群，2003.12)以土砂整治觀點，藉由集水區土砂整治率評估模式之應用，有效評估水土保持措施之土砂整治成效，在往年長期之整治工程投入及本計畫之規劃整治下，在未來 8 年內預計可達到整治率 49.45%，符合台灣地區治山防災計畫第四期之目標。

(關鍵詞：集水區調查、土石流潛勢溪流、子集水區、防砂工程、益本比、整治率)

Abstract

Shuang-Xi catchment is one of the north coast river systems in Shuang-Xi county township and Gong-Liao township. The background is at list:

1. The area is 14,395 ha.
2. The length river is 28.6 kilometers.
3. The average slope is 2.36%.

There is no anthropogenic exploitation around upstream, so the environmental is primitive. But there is large amount of sand from the steep and un-rebuild branch depositing around downstream when the slope get slow. The flood caused by reduced river width and 21 strips of debris flow endanger life and property.

There are two points of this project. One is investigating catchment and the other is to design the strategy. The result of investigating as list:

1. Basic data

- A. The average temperature and rainfall is 22.5°C and 3,812mm.
- B. There are eight zones being surveying including Coordinate survey, Topographic survey, Leveling.
- C. According to the report of particle size experiment, the roughness index of Shuang-Xi river is around 0.033 to 0.038.
- D. Investigating the landuse and builded structure in the catchment.
- E. According to the rain data, the Q_p of each recurrence interval is calculated, and the $Q_{50}(1,021\text{cms})$ of Shuang-Xi stream estuary is set for design.

2. Analysis

- A. The heavy deposition because of heavy erosion upstream is the most important problem especially Shuang-Xi sub-catchment in the Shuang-Xi catchment.
- B. The landslides are interpreted basic on existing data, field investigation

and latest satellite images. As the result, there are 114 pieces of landslide and 82 pieces of them are new, 32 pieces of them existing in 2000. There are 400,000 square meters and 810,000 cube meters in the Shuang-Xi catchment.

C. There are 21 strips of potential debris flow torrent in the Shuang-Xi catchment including 4 high degree of hazard , 6 medium degree and 11 low degree. All potential amount of sand is 1000,000 cube meters.

D. There is no drainage system on the farm road to collect the surface runoff, and the erosion is getting more.

3. Improvement

A. In order to reduce the amount of sand, the slope of torrent, gully and debris flow is leveled down by building revetments, ground sills and sabo dams.

B. With the same purpose, decreasing the area of landslide by vegetation and revetments is the other way.

4. Plan

Year	Budget(NT)
2006,2007	80,055,000
2008	71,249,000
2009	48,800,000
2010	32,200,000
2011	33,700,000
2012	33,000,000
2013	13,600,000
Total	312,604,000

5. Effects

We expect to invest 312,604,000NT dollar totally. After this project, the situation in the planning area will be improving, the disasters will be decreasing,

people and social development will be protecting. The annual cost will be 32,090,000NT dollars and the annual benefit will be 59,420,000NT dollars.

According to the benefit evaluation model

$$I = B \div C$$

The benefit-cost ratio for this project will be 1.85, so this plan can carry out with economic efficiency.

6. Completeness ratio (CR)

After this project, the CR will be 49.45% in 8 years and it fits in goal.

(**Keywords : Catchment Investigating, Potential Debris Flow Torrent, Sub-Catchment, Sediment Control, Benefit-Cost Ratio, Completeness Ratio**)

計畫名稱	小北坑野溪集水區整體治理調查規劃 The Integrated Regulation Planning of Siao-Bei-Keng River
主持人	周明坤 Chou, Ming-Kun 黃偉倫 Huang, Woei-Luen
計畫年度	94

摘 要

小北坑野溪集水區位於桃園縣龍潭鄉三水村，為霄裡溪支流，於三和國小與霄裡溪匯流(E.L.173.00)，其集水區面積約170公頃，溪流全長約 2.6公里，河幅約5~10公尺，平均坡降約4.5%。

本野溪上游未經開發污染，水流清澈，環境自然清幽，惟其支流坡陡流急，未經整治之河道，常挾帶大量土砂，至主流溢流成災，造成人民生命財產損失；另於彎道曲率半徑較小處凹岸沖刷嚴重，更造成河岸崩塌，阻礙水流，嚴重威脅鄰近民宅安全。

此外，本集水區生態資源豐富，又鄰近新埔鎮照門富麗農村、三水村水土保持戶外教室等著名景點，水土保持局已將三水地區列為重點發展區域；為維護生態環境及配合該社區未來發展，特辦理「小北坑野溪集水區整體治理調查規劃」（以下簡稱本計畫）。

本計畫工作重點與內容可概分為兩大要項，一為集水區現地調查，二為治理方案研擬，茲將報告中提出之成果及資料內容分述如下：

一、基本資料調查

- (一) 集水區基本資料調查、蒐集及建立，包括氣候、水文、地質、土壤、集水區水系等，彙整以上基本資料供集水區地文水文分析，以作為瞭解及評估集水區概況之依據。調查結果本集水區年平均氣溫約 20.3℃，年平均降雨量約 1,981.57mm。

- (二) 河道測量成果，包括導線測量座標成果、地形測量成果、水準測量成果及測量成果圖面，詳請另見測量成果報告書。
- (三) 河道泥砂採樣及分析，現地及試驗分析共三組，並依據試驗成果進行河床質、表面粒徑及河道粗糙性質研判，分析結果小北坑野溪河床粗糙係數約界於 0.034~0.037 之間。
- (四) 對集水區內土地利用現況及河道沿岸歷年水土保持工程包括整流與防洪工程、防砂工程進行現況調查，並計算集水區洪峰流量以作為未來評估集水區整治規劃設計之參考。
- (五) 根據歷年雨量資料統計，推估各河段各控制點不同頻率之洪峰流量，並以 50 年頻率之洪峰流量為設計流量，做為河川水位演算之依據。本計畫集水區水理演算結果小北坑野溪與霄裡溪匯流口控制點 50 年重現期距之洪峰流量為 49.76CMS。

二、治理規劃內容

本計畫針對集水區整體調查分析後研擬治理工程，總工程費達 54,676,000 元，以「維護重於治理」的原則建議分年分期實施計畫如下：

期 別	工程經費(仟元)
第一年	12,300
第二年	12,664
第三年	11,520
後期計畫	18,192
總 計	54,676

本計畫付諸實施後，主要效益分為有形效益及無形效益，前者包括計畫區內淹水災害直接與間接損失之減免，後者則涵蓋民眾生命之保障、生活品質之提升、農村經濟之繁榮、就業機會之增加，及社會基層建設實質展現等，本計

畫施後之效益（包含植直接與間接）約為3,087萬元，以先期溪流整治計畫經費為2,358.8萬元，益本比為1.3。

（關鍵詞：集水區調查、防砂工程、益本比）

Abstract

Xiao-Bei-Keng catchment is a branch of the Xiao-Li stream in Long-Tan township. The background is at list:

1. The area is 170 ha.
2. The length river is 2.6 kilometers.
3. The river width is about 5 to 10 meters.
4. The average slope is 4.5%.

There is no anthropogenic exploitation around upstream, so the environmental is primitive. But there is large amount of sand from the steep and un-rebuild branch depositing around downstream when the slope get slow. The flood caused by reduced river width endangers life and property.

The eco-resources are rich such as Zhao-Men village in Sinpo township and soil-and-water-conservation-outdoor-classroom in San-Shui village.

There are two points of this project. One is investigating catchment and the other is to design the strategy. The result of investigating as list:

1. Basic data

- A. The average temperature and rainfall is 20.3°C and 1,981.57 mm.
- B. There are eight zones being surveying including Coordinate survey, Topographic survey, Leveling.
- C. According to the report of particle size experiment, the roughness index of Shuang-Xi river is around 0.034 to 0.037.
- D. Investigating the landuse and builded structure in the catchment.
- E. According to the rain data, the Q_p of each recurrence interval is calculated, and the Q_{50} (49.76cms) of Xiao-Bei-Keng valley between Xiao-Li stream is set for design.

2. Plan

Stage	Budget(NT)
1 st year	12,300,000
2 nd year	12,664,000
3 rd year	11,520,000
others	18,192,000
Total	54,676,000

3. Effects

After this project, the situation in the planning area will be improving, the disasters will be decreasing, people and social development will be protecting. The annual cost will be 23,588,000NT dollars and the annual benefit will be 30,870,000NT dollars. According to the benefit evaluation model

$$I = B \div C$$

The benefit-cost ratio for this project will be 1.3, so this plan can carry out with economic efficiency.

(Keywords : Catchment Investigating, Sediment Control, Benefit-Cost Ratio)

計畫名稱	抽藤坑溪集水區調查規劃 Chou-Teng-Keng Creek Watershed Management Assessment
主持人	鄭麗瓊 Weng, Debbie L. C. 蔡文鎗 Tsai, Wen-Chiang
計畫年度	94

摘 要

本集水區位於台中縣新社鄉內，為大甲溪支流，集水區面積約為 1,680 公頃，主流長約 11,250 公尺。區內計有台中 007、007-1、008、A033、A034 及 A036 等六條土石流潛勢溪流。崩場地計有 20 處，總崩塌面積為 21.45 公頃；主要災害原因為：一、溪流陡峻溪床河岸易遭淘刷導致溪岸邊坡崩塌，崩落土石岩塊堆積河床阻礙水流，二、河道彎曲受向心力之影響導致河岸沖刷致坡面崩塌，三、中、下游河道坡度較緩土石淤積，影響排洪水量，四、本區內斷層致崩塌面積大，大量土石隨雨水逕流下移造成土石災害，五、橋樑跨度不足或斷面不夠，遭洪水土石流破壞交通中斷。依據上述問題，本集水區擬定五大項治理對策，依序為：一、野溪整治與土石流防治，二、崩場地處理，三、道路水土保持，四、坡地水土保持。針對各項災害，分別研訂以防砂壩、潛壩、梳子壩、固床工、護岸、打樁編柵、掛網噴植、蝕溝控制、橋樑及道路水土保持治理工程俾便實施整治事業，並依工程效果及經費籌措排列優先順序，配合工程需要編列訂定分期計畫，總經費為 134,600,000 元。

本計畫重點區段治理工程完成後，推估求得本集水區之防砂量為 83,280m³。計畫實施後總計可攔阻及減少土石方下移，穩定河床，保護河段合計可達 5,710m，確保兩岸邊坡、農田、房舍、橋樑及人民之安全。保護橋樑計有溪頭一號橋、中和大橋、鳳林橋及富林橋等 4 座。崩場地治理之面積為 21.45 公頃，可防止坡面土壤沖蝕，維持集水區內道路之暢通。間接效益可涵

養水源、減少洪水災害、維護自然生態環境、重振觀光盛況、提高經營效率、增加農民收入及達到保育水土資源及國土保安之目標。整體集水區整治率達20.99%。

(關鍵詞：土石流潛勢溪、崩塌地、蝕溝、整治率)

Abstract

The watershed is located in Taichung County Shin-Shou township, for the Dajia River tributaries. The area of the watershed is approximately 1,680 hectares. The length of the mainstream is approximately 11,250 meters. The potential debris flow creeks in this area include Taichung 007, Taichung 007-1, Taichung 008, Taichung A033, Taichung A034 and Taichung A036. Contained within are landslides, with a total area of 21.45 hectares.

The reasons for the disaster are: 1. The steep river beds collapse easily with the increases speed of the creek flow. The resulting debris will obstructs the flow of the river. 2. The centripetal force flow of the curve channel will erode the creek bank. 3. The river sediment, deposited downstream of the creek, will impact on the drainage of water. 4. Due to the fact that this area is in a fault zone, the collapse is usually large in size and therefore a large amount of soil and rock will be washed downstream whenever there is heavy rain. 5. The bridge span section is damage by debris flow and results in disrupted traffic.

This plan will address the above issues by: 1. creek control and debris flow prevention, 2. landslide management, 3. Soil and Water Conservation assessment of the roads, 4. slopeland soil and water conservation assessment. To achieve our goal Sabo dam, check dam, submerged dam, comb dam, ground sill, embankment, gully control, earth work, soil and water conservation management of road project will be used. In accordance with the project progress and the available project funding the phases of the plan will be sequenced accordingly, The total funding for this project is NT\$ 134,600,000. The expected control ratio will be 20.99 percent.

After completion, this plan is estimated to control 83280m³ of sedimentation, protect 5,710m of creek bank, and manage 21.45 hectares of landslides. This will ensure the protection of farmland, buildings, and bridges... (Sitou first bridge,

Chung-Ho Bridge, Fenglin Bridge , Fulin Bridge etc). Indirect benefits are water conservation, reduce floods, maintenance of natural ecological environment, revitalizing the tourism.

(Keywords : Potential Debris Flow, Landslide, Gully, Control Ratio)

計畫名稱	屏東縣牡丹鄉旭海溪集水區整體治理調查規劃 Project of Xuhai Stream Watershed Management, Mudan Shiang, Pingtung County
主持人	尹念秦 Yin, Nian-Chin
計畫年度	94

摘 要

旭海溪集水區位於屏東縣牡丹鄉，本次辦理治理調查規劃之範圍自旭海溪出海口至上游成溪河段，主流長度約為 4 公里，支流長度約 2 公里，涵蓋子集水區面積約 1121.52 公頃。

治理調查工作除建立本集水區之水文、地文、人文及生態等基本資料，並依據當地環境特性及土地使用需求研提基本治理對策，治理重點以河道棲地及其週邊環境改善為主，在工程的執行上也依據河段區位之適宜性以及地區發展的需求性擬定整治方案，依工程屬性可概分為四大類，一為既有構造物改善及溪岸環境綠美化，二為岸高不足河段增設保護工程，三為旭海草原登山舊道整建，四為裸露崩場地處理及河道清淤維護，重點仍以河洪安全為基礎，再考量溪溝自然環境立地條件設置人為設施，以能營造出河岸的遊憩空間，並同時兼顧河川生態保育為目標，使治理成效結合區內旭海草原景點並與未來的旭海溫泉區等相互串聯成爲一個完整的動線系統，增加本區的遊憩價值，帶動地區產業發展，本溪治理方案共擬分四期執行，於 94 年度編列第一期工程預算 2,442 萬元，並已於 94 年 12 月完工，續於 95 年度提出第二期工程預算 2,500 百萬元，預計於 95 年 10 月完工。

(關鍵詞：水土保持、旭海溪、生態工程、野溪治理)

Abstract

The Xuhai Stream watershed, located in Mudan Shiang, Pingdung County, and the scope of this project is from the outlet to the origin of this stream. The lengths of Xuhai Stream mainstream and branches are 4 km and 2 km respectively. Covered sub-watershed area of this scope is about 1121.52 hectare.

The purpose of this project is to collect data of hydrology, physiography, and human ecology. Furthermore, a fundamental management strategy will be proposed based on the environment and requirement for land utilization. The management focuses on improving this stream's habitat and surrounding environment, and the plan was drawn according to location's appropriateness and development requirement. There are four categories for the project in terms of engineering: 1) improvement of existing structures and stream bank landscaping 2) protective construction for river bank with insufficient height 3) reconstruction of Xuhai grassland ancient path 4) treatment for bare collapse and silt cleaning for watercourse.

The prevention of flooding is the underlying focus of this project and building a rest area based on the natural environment of the stream bank is another major concern. Meanwhile, to enhance the value and to increase the development opportunity for this area, the project will be the bridge between Xuhai grassland spot and the future Xuhai hot spring area.

This project will be implemented through 4 periods. The first period, budgeted for \$24.42 million in 2005, was finished in December of 2005. The second period, budgeted for \$25 million in 2006, will be finished in October of 2006.

(Keywords : Soil and Water Conservation, Xuhai Stream, Ecology Engineering, Management of Wild-Stream)

計畫名稱	梨山地區上游集水區整體調查與治理規劃 Investigation and Remedial Plan for Upstream Catchment of Li-Shan Area
主持人	蘇苗彬 Su, Miao-Bin
計畫年度	94

摘 要

本計畫工作之實施範圍包括梨山地滑地區之上游集水區範圍區域，工作執行之方法包括基本資料蒐集、航照圖之比對與運用以及全面性水土保持調查、崩坍地調查規劃與整體治理策略之規劃。

運用地理資訊系統以地形因素來探討溪流發生土石災害的可能性，並利用 ERDAS 影像分析找出前後期影像變遷之區域，得到可能之裸露地，整體判釋潛在土石災害區域。除了分析計劃區域之集水區外，並包括周圍之相關集水區範圍，提供相關單位注意與維護道路安全之依據。

經由現地探勘與調查分析得知，影響本區穩定性之最重要因素為地表排水之不足與小型崩坍造成之土石流失，治理計畫之方向主要在野溪整治與崩塌地治理。現地勘查成果得知梨山地滑區上游集水區範圍與福壽山農場交接處，有多項急需解決的問題，特別是地表排水結構損壞的問題，因而工程之規劃分為兩個部份，一為應立即進行的修復及加強性之地表排水措施，另一階段為崩塌地整治之建議。

(關鍵詞：梨山、上游集水區、調查、治理規劃)

Abstract

The implementation scope of this project includes upstream catchment area of Li-Shan landslides zone. Works proceeded include collection of background information, aerial photos interpretation and application. Planning in regards to soil and water conservation, landslide investigation and remedial strategy were executed.

After the investigation and evaluation, the major influencing factor in regards to local stability are insufficient capability of surface drainage. Quite a few numbers of small collapses caused debris flow. So, the main treatments are planned on wild creek regulation and sliding remediation. Field inspection concluded that in the fringe zone of Fu-Shou-San Farm, there are a lot of problems to be solved especially the damage of drain structure.

GIS was applied to investigate the influence of geographic factor and debris problem. ERDAS image analysis to study the changed surface helps to find the potential disaster zone. The result can help a lot in planning future work.

(Keywords : Li-Shan, Upstream Catchment, Investigation, Remedial plan)

計畫名稱	通霄沿海集水區整體治理調查規劃 The Integrated Regulation Planning of Tong-Siao Circumlittoral Watershed
主持人	連惠邦 Lien, Hui-Pang
計畫年度	94

摘 要

本規劃針對野溪 70 處點位、崩塌地 44 處、農地水土保持 6 處、既有構造物 32 處及道路水土保持 40 處等進行現地調查，並通過水文水理分析及河床質採樣結果，從水土流失程度、保全對象、既有構造物改善需求及河川不穩定性等因子，綜合評估出 65 處具有水土保持之需求性，其主要治理項目包括野溪治理 23 件、崩塌地治理 11 件、坡地保育 8 件及道路水土保持 15 件，合計達 57 件。

此外，為配合「易淹水地區水患治理計畫」第一階段及第二階段治理計畫，就規劃之重點治理區段實施分年分期治理計畫，以抑止泥砂生產、下移與減低災害之發生，打造安全之環境，帶動地方之發展，促使本規劃區能夠達到保育水土資源、土地合理利用、降低水土災害及涵養水源等目的。

綜合前述，擬針對規劃區提出其治理對策及措施建議，以作為後續相關工程之應用。由於規劃區內崩塌地坡面沖蝕嚴重、表土風化鬆軟，易因豪、暴雨而再度崩塌，影響下游保全對象之安全，應加強相關坡面整治及截排水設施，並配合河道治理措施穩定河床及河岸坡腳，降低災害發生之可能。區內產業之開發應兼顧水土保持之需求，限制過度及不當之開發，以減少環境之負荷，加強規劃區內之水土保持管理與教育宣導，進而促使民眾了解並參與水土保持之推動。

透過水土保持需求性分析後，本計畫擬定本區之分年分期整體治理對策，共分三期，第一期為 9,457.5 萬元、第二期為 5,363.03 萬元、第三期為 533.825 萬元，合計 15,354.355 萬元。

(關鍵詞：水文水理分析、水土流失、坡面沖蝕)

Abstract

The investigation in this project, includes 70 locations of rivulet, 44 locations of collapsing, 6 locations of farmland water and soil conservation, 32 locations of current structure thing and 40 locations of road water and soil conservation. Also sample a result through the hydrologic and hydraulic analyzes and the river bed. From the soil erosion of degree, be subjected to need and the river unsteady etc. factor of protective object, current structure thing improvement. Evaluate 65 needs that locations have water and soil conservation. It mainly manages item to include rivulet to manage 23 and collapses to manage 11 pieces, sloping fields to raise 8 pieces and road water and soil conservation 15 and the aggregate reaches to 57.

Besides, for matching the managing of first stage and second stage with "Regulation Project of Flood-Prone Areas", aim at project the particularly managing of the area implement in the region to expect for cent of manage a project. Can immediately repress sediment production and transport and reduce disaster. Develop safe environment, arouse a development, make this programming area reached conservation Water and soil, land of reasonable make use of, reduce Water and soil disaster and store headwaters etc. purpose.

Accept up, aim at programming area to put forth it to manage counterplan and suggestion to be the application of follow-up related engineering. Because ground in the hillside inside the programming area washes eclipse severity, topsoil morals and custom loose soft, easily once more collapse because of rain-storm, influence the security that the downstream keeps intact object. Should strengthen ground in the hillside possibility that manages and drains facilities, and matches with course of river to manage the river bed of the measure stability and river shore, reduces disaster occurrence. The development of industry inside the area should give attention to both the need of water and soil conservation and limit an excessive and

not appropriate development to reduce the burden of environment. Strengthen the water and soil conservation management in the programming area and education to guide, then urge the people understand and participate in the promotion of water and soil conservation.

Analyze through the need of the water and soil conservation, the whole this project manages a counterplan. Total is divided into three periods, Issue 1 is 94,575,000 dollars, Issue 2 is 53,630,300 dollars, and Issue 3 is 5,338,250 dollars. Add up total 153,543,550 dollars.

(Keywords : Hydrologic and Hydraulic Analyzes, Soil Erosion, Sloping Fields Flushes)

計畫名稱	萬里礮溪集水區整體治理調查規劃 The Wan-LI Watershed Management Planning
主持人	鄭麗瓊 Weng, Debbie L. C. 蔡文鎗 Tsai, Wen-Chiang
計畫年度	94

摘 要

本集水區位於台北縣萬里鄉及金山鄉境內，集水面積約 3,238 公頃。規劃重點除針對災害嚴重之區位辦理治理工程規劃且融入生態工法設計外，更針對社區環境之美化需要提具改善構想完成本規劃工作，結合治山防災、社區願景規劃及落實整治需求等三大範疇，達成土石流災害防治、突發性災害緊急處理及環境綠美化之目標，以減少土砂災害發生、保育水土資源與促進土地合理利用以保護農村。奠定國土保安與建設農村新風貌轉型發展之新契機。經檢討本集水區問題及水土保持需求性後，針對野溪整治、崩塌地處理、道路或農路水土保持改善及富麗農村措施改善措施等，彙總整治構想，建議分四期實施治理工程，預估工程總經費達 94,440 仟元。預計本計畫實施後之直接效益為：1.穩定河床，保護河岸；2.保護橋樑，維持道路暢通；3.防止土石沖蝕，穩定邊坡。間接效益部分則有：1.保育水土資源，維護國土資源；2.涵養水源，減少洪水災害損失；3.維護自然生態環境，提振觀光事業；4.提高土地利用價值，增加農民收入。整體集水區整治率推估可達 42.46%。

(關鍵詞：土石流、崩塌地、整治率)

Abstract

The Wan-Li watershed, situated in Wan-Li Township, Taipei County. The total area of the watershed is 3238 hectares. In order to reduce debris flow damage, protect soil and water resources and promote reasonable land use to protect farms, this plan will incorporate natural methodology that will prevent debris flow, beautify the community and disaster control. This will in turn ensure the safety of public domain and establish a fresh new image for the farm land. After discussion of how to cure this area, treatment of landslide areas, incorporating soil and water conservation into the Road, etc, it is recommended that this plan be implemented in four phases at an estimated cost of NT\$94,440,000. This plan will result in:

1. Stabilized river beds and protect river banks,
2. Protection of bridges,
3. Maintain the accessibility of roads,
4. Prevent soil erosion and promote the stability of the hillside,

Indirectly it will also have the following benefits:

1. Protection of soil and water resources,
2. Promote water vitality and reduce flood damage,
3. Promote the natural habitat,
4. Promote tourism,
5. Increase the value of the land and in turn increase farmer income.

The total control ratio of this plan is estimated to be 42.46%.

(Keywords : Potential Debris Flow, Landslide, Control Ratio)

計畫名稱	潭子內集水區整體治理調查規劃 Managing and Investigative Plan of Whole Tan-tsu-nei Watershed
主持人	陳智誠 Chen, Niki
計畫年度	94

摘 要

本集水區位於台北縣金山鄉北側區域內，集水區範圍北接石門鄉與金山鄉交界，東接磺港漁港，南接金山鄉三和國小，西接石門鄉與金山鄉交界。集水區面積約 1,509ha，上游無工業區及高污染產業，原水質清澈環境自然幽靜，惟 90 年、91 年象神及納莉颱風帶來豐沛豪雨，山坡地多處崩塌，河道沿線嚴重受創，造成人民生命財產之損失。

此外，本集水區生態資源豐富，環境景觀除有田野、濱海風光外，另有朱銘美術館、法鼓山、金寶山墓園、筠園、金山青年活動中心及溫泉等觀光景點，為能提升集水區流域環境保護與生活休憩及規劃各村落特色與整治願景，特辦理「潭子內集水區整體治理調查規劃」（以下簡稱本計劃）。

本計畫工作重點與內容可概分為兩大類，一為集水區基本資料調查，二為治理方案研擬，茲將報告書中提出之成果及資料內容分述如下：

一、基本資料調查

(一) 集水區基本資料調查，包括氣象、水文、地質、土壤、生態環境、溪流、土石流危險溪流、崩塌地、危險村落分布及現況等，彙整以上基本資料供集水區規劃進行分析，以作為集水概況之依據。

(二) 河道泥砂採樣及分析，現地及分析試驗共三組，並依據試驗成果進行河床質、表面粒徑及河道粗糙性質研判，分析成果進行規劃設計野溪之河床粗糙係數約界於 0.032~0.036 間。

(三) 對集水區內土地利用現況及歷年集水區內整治工程進行現況調查，並計算集水區洪峰流量以作為未來評估集水區整治規劃設計之參考。

(四) 根據歷年雨量資料統計，推估各河段不同頻率之洪峰流量，並以 50 年頻率之洪峰流量為設計流量，做為河川水位演算之依據。本計畫集水區水理演算結果，以三和國小兩湖分校下游野溪 50 年重現期距洪峰流量最大為 60.97cms。

二、治理規劃內容

本計畫針對集水區整體調查分析後，建議第一期進行整治計有五案，分別為西湖村野溪整治工程第一期、西湖村野溪整治工程第二期、潭子內橋東側野溪整治工程、三和國小兩湖分校下游野溪整治工程第一期及三和國小兩湖分校下游野溪整治工程第二期，總工程費達新台幣 21,809,000 元，實施計畫及經費如下：

工程名稱	工程內容	工程經費 (仟元)	備註
西湖村野溪整治工程第一期	砌塊石護岸(H=1m)L=525m，固床工需 18 座	4,688	
西湖村野溪整治工程第二期	砌塊石護岸(H=1m)L=515.8m，固床工需 18 座	4,803	
潭子內橋東側野溪整治工程	預鑄式階梯型生態槽護岸(H=2m)L=179.1m，固床工需 5 座，新設取水工 9.6m。	3,677	
三和國小兩湖分校下游野溪整治工程第一期	砌塊石護岸(H=3m)L=216.6m，固床工需 11 座	4,189	
三和國小兩湖分校下游野溪整治工程第二期	砌塊石護岸(H=3m)L=186.5m，固床工需 7 座，拱型版橋 1 座，親水設施 2 座、混凝土路面鋪築 79.8m ²	4,452	

(關鍵詞：集水區、治理、調查、粗糙係數、洪峰流量)

Abstract

This watershed is located on the north area of Jin-shan township, Taipei county. The north boundary of this watershed is the border between Shi-men and Jin-shan township, east boundary is Huang-gang fishing port, south boundary is near San-Ho elementary school, west boundary is the border between Shi-men and Jin-shan township as north. The area of this watershed is about 1,509ha, with no highly polluted industries at upstream, and limpid water, secluded environment here.

However, Xangsane typhoon (2001) and Nari typhoon (2002) bring great rainfall caused many slopes arose landslides, heavily damage along the stream channel, and also took life and wealth away from human beings.

Besides, the biological resources in this watershed is plentiful and also many scenic spots which includes countryside, brink of the sea, Ju-ming exhibition hall, Fa-gu mountain, Jin-bau-shan graves, Yun-yuan, Jin-shan youth center and hot spring.

In order to rise environmental protection, livelihood leisure, the distinguishing feature of villages and the purpose of managing watershed, transacted “Managing and investigative plan of whole Tan-tsu-nei Watershed”.

The worked-points and contents in this plan could be divided into two parts roughly, first part is to investigate data base of watershed, second part is to plan managing strategy, we condensed the achievement and data which were mentioned in this report as followings:

1. Investigating data base

- a. Investigating data base of watershed includes weather, hydrology, geology, soil, ecological environment, creeks, debris flow hazardous creeks, landslides, distribution of hazardous villages etc.

Categorizing above-mentioned data base and analyzed them, took them as a

reference for general situation of watershed.

- b. We obtained soil-sand samples in stream channels and analyzed them, the amount of tests for in-situ test and analysis test are three.

According to the resultant of tests to differentiate bed material, surface grained-size and the roughness properties of channel, coefficient of roughness for designing creek bed is about 0.032~0.036 after analyzing.

- c. Investigating the land use at present and historical managing engineering in the watershed, and calculated the flood peak discharge in the watershed, took it as a reference which can estimate managing plan and design of watershed in the future.

- d. According to historical rainfall data, we calculated different flood peak discharge for each paragraph of stream channel, and took the flood peak discharge which was calculated by 50-year frequency as designing flow.

After calculating, a 50-year return-period maximum flood peak discharge is 60.97cms, which is located on downstream of San-ho elementary school Liang-hu department.

2. Managing strategy

After analyzing and investigating whole watershed, we suggested five cases in first managing stage as followings:

- a. First stage of Shi-hu village creek managing engineering
- b. Second stage of Shi-hu village creek managing engineering
- c. The east side creek of Tan-tsu-nei bridge managing engineering
- d. First stage of downstream of San-ho elementary school Liang-hu department managing engineering
- e. Second stage of downstream of San-ho elementary school Liang-hu department managing engineering °

Total budget is NT 21,809,000, details of this plan are as following:

Case Name	Engineering items	Budget
First stage of Shi-hu village creek managing engineering	Masonry revetment(H=1.0m, L=525 m) ground sill (18 place)	NT 4,688,000
Second stage of Shi-hu village creek managing engineering	masonry revetment(H=1.0m, L=515.8 m) ground sill (18 place)	NT 4,803,000
The east side creek of Tan-tsu-nei bridge managing engineering	pre-cast stair revetment(H=2.0m, L=179.1 m) ground sill (5 place) stream diversion works(9.6 m)	NT 3,677,000
First stage of Downstream of San-ho elementary school Liang-hu department managing engineering	masonry revetment(H=3.0m, L=216.6m) ground sill(11 place)	NT 4,189,000
Second stage of downstream of San-ho elementary school Liang-hu department managing engineering	masonry revetment(H=3.0m, L=186.5m) ground sill 7 place arch slab-bridge 1 place paddle installation 2 place PC pavement 79.8m ²	NT 4,452,000

(**Keywords : Watershed, Managing, Investigating, Coefficient of Roughness, Flood Peak Discharge**)

計畫名稱	安通溪及磯崎集水區生態資源調查及規劃 Ecological Resources Investigation and Planning for the Anton Stream and Geechi Watershed
主持人	林昭遠 Lin, Chao-Yuan
計畫年度	93

摘 要

隨著國際保育潮流之興起，國內逐漸重視自然生態之維護，進而促成生態工法於國內萌芽起步，行政院農業委員會水土保持局為順應此趨勢，亦擬定生態工法中長期計畫（91—93 年度止）。為了解實施該工法對當地自然環境復育之影響及各示範集水區自然生態資源資料之建立，本計畫於 93 年 4—11 月安通溪及磯崎集水區進行各種自然生態資源及生物棲息地調查，參酌訪問及蒐集當地相關資料，建立該區之動植物名錄。

調查成果顯示，安通溪集水區共紀錄維管束植物 313 種、鳥類 23 科 47 種、兩棲類 4 科 10 種、爬蟲類 3 科 4 種、昆蟲綱 11 目 81 種（含水生昆蟲 8 目 15 種）、蛛形綱 2 種、魚類 4 科 5 種。本區保育類動物（野生動物保育法）達 16 種之多，其中鳥類有鳳頭蒼鷹、台灣松雀鷹及大冠鷲等 11 種，兩棲類有莫氏樹蛙、褐樹蛙及虎皮蛙 3 種，爬蟲類有眼鏡蛇及雨傘節 2 種。磯崎集水區共紀錄維管束植物 560 種、鳥類 23 科 41 種、兩棲類 3 科 8 種、爬蟲類 2 科 2 種、昆蟲 10 目 75 種（含水生昆蟲 6 目 12 種）、魚類 2 科 3 種。依據「野生動物保育法」保育類動物本區達 14 種之多，其中鳥類有鳳頭蒼鷹、台灣松雀鷹及大冠鷲等 10 種，兩棲類有莫氏樹蛙、褐樹蛙及虎皮蛙 3 種，爬蟲類有雨傘節 1 種。

依據兩區之調查成果，分析各項生物資源之調查資料並探討該區棲地與生態環境指標，提出相關建議如下。

- 一、減少工程或人爲開發對環境之衝擊：調查期間，兩區皆適逢河川整治及道路施工，集水區生態資源受到嚴重干擾，應嚴格管控施工品質，以防棄土阻塞河道，減少生物棲息空間。
- 二、避免外來種入侵：生態工法區應避免種植外來種植物，因其生長速度快，並易造成原生種之浩劫，建議以台灣原生種之誘鳥（苦楝、構樹、白雞油等）及誘蝶植物（長穗木、冇骨消、欒樹等）來吸引生物。
- 三、水生生物作爲環境污染指標：安通及磯崎集水區的生物相當類似，可藉由水生昆蟲作爲兩地溪流的环境污染指標，目前兩個集水區的水質都是屬於未受污染或稍受污染的環境，因此，網石蠶、扁蜉蟬科以及石蛉科幼蟲就成爲代表溪流生態變化的環境指標。
- 四、具當地特色之指標生物：綠蓑鷺及鉛色水鷓可作爲安通溪河川生態的代表性生物；日本樹蛙，又名「溫泉蛙」，由於其喜在溫泉區活動，因此，將日本樹蛙定爲代表安通地區環境特色的指標性生物。每年 3—5 月，磯崎集水區可發現大量紫斑蝶過境，建議每年建立完整的監測紀錄，並可將紫斑蝶過境的季節作爲當地活動的主軸。
- 五、棲地復育建議：磯崎集水區因河川流量小，因此，建議河川整治時除了注意洪水安全流暢外，也應努力確保生物多樣化棲息及生育場所，避免河道直線化及斷面均一化，以創造更多的深潭、淺灘供水生生物棲息。安通集水區雖河川流量較多，現階段應特別注意道路施工問題，杜絕棄土流入河道，污染河川。

（關鍵詞：安通溪、磯崎集水區、生態資源調查、生態工法）

Abstract

The eco-technology methods are development under international tendency and domestic conservation concepts. A mid-long-term plan is proposed, from year 2002 to year 2004, by the Soil and Water Conservation Bureau. In order to understand the influences by the implemented eco-technology methods and natural ecological resources, this project conducted the ecological resources and biological habitat investigation between April to November, 2004 in Anton Stream and Geechi Watershed. The fauna and flora categories are established by field investigation and data collection.

From the investigation results, there are 313 species of vascular plants, 23 families 47 species of birds, 4 families 10 species of amphibious, 3 families 4 species of reptiles, 11 orders 81 species of insects including 8 orders 15 species aquatic insects, 2 species spiders, 4 families 5 species fish. There are 16 endangered fauna according to the Wildlife Conservation Law including *Accipiter trivirgatus*, *Accipiter virgatus fuscipectus*, *Spilornis cheela*, and so on, for 11 species of birds, *Rhacophorus moltrechti*, *Rhacophorus robustus*, *Rana tigerina rugulosa* for 3 species of amphibious, *Naja atra*, and *Bungarus multicinctus* for 2 species of snakes in Anton Stream Watershed. There are 560 species of vascular plants, 23 families 41 species of birds, 3 families 8 species of amphibious, 2 families 2 species of reptiles, 10 orders 75 species of insects including 8 orders 15 species aquatic insects, 2 species spiders, 2 families 3 species fish. There are 14 endangered fauna according to the Wildlife Conservation Law including *Accipiter trivirgatus*, *Accipiter virgatus fuscipectus*, *Spilornis cheela*, and so on, for 10 species of birds, *Rhacophorus moltrechti*, *Rhacophorus robustus*, *Rana tigerina rugulosa* for 3 species of amphibious, *Bungarus multicinctus* for 1 species of reptile in Geechi Watershed.

The proposed suggestions based on the investigation results, biological resources analysis, and habitat indices are listed as follows:

1. Reducing Engineering and human impacts on the environment.

The biological resources are deeply interfered during investigation periods. It should be control engineering quality to prevent channel blockage by debris and habitat deterioration.

2. Preventing exotic species.

The exotic species may cause original species catastrophe for their fast growth, therefore, it should be avoided in eco-technology area. The native species for bird-seducing such as *Melia azedarach* L., *Ficus microcarpa*, *Fraxinus formosana*, and so on, and butterfly-seducing species such as *Stachytarpheta jamaicensis*, *Sambucus formosana*, *Koelreuteria formosana* are suggested.

3. Using aquatic insects as environmental pollution index.

The pollution evaluation can be based on the aquatic insects for the similarity of these two watersheds. Currently, the water quality for both Anton and Geechi watersheds are unpolluted or minor-polluted. Therefore, *Heptageniidae* and *Corydalidae* can be used as stream ecological indicators.

4. Using local representative Bio-indicator

Butorides stria and *Rhyacornis fuliginosus* can be used as stream ecological representatives. *Buergeria japonica* also named geyser frog can be used as environmental bio-indicator. Besides, *Euploea sylvester* population visit among March to May every year, it should be recorded completely and used as main topic.

5. Habitat restoration suggestions.

It should maintain biodiversity and habitat during low stream discharge and channel capacity for floods. It also need create pools and riffles and prevent straight an uniform channels. Currently, it need pay more attention on the road

construction to prevent debris intrusion and pollution.

(**Keywords : Anton Stream, Geechi Watershed, Ecological Resources Investigation, Eco-Technology Methods**)

計畫名稱	基隆河圓山子分洪（瑞芳地區）野溪集水區整體治理調查規劃 The Soil and Water Conservation Management Assessment at Wild Creek Watersheds at Ruei-Fang Township Region in the Upstream of 「Keelung River Yuanshantzi Flood Diversion Project」
主持人	鄭麗瓊 Weng, Debbie L. C. 蔡文鎗 Tsai, Wen-Chiang
計畫年度	93

摘 要

基隆河員山子分洪工程上游（瑞芳地區）野溪集水區調查規劃面積約 1,819 公頃。涵蓋台北縣瑞芳鎮弓橋里、侯硐里、光復里與碩仁里之全部及柑坪里之一小部。其中包括高土石流潛勢溪有 3 條，中土石流潛勢溪有 9 條，而低土石流潛勢溪有 1 條。以台北 A067、台北 A068、台北 A069、台北 A066、台北 A071、台北 A072、台北 A073、台北 A076 等土石流潛勢溪流及金字橋野溪上游崩塌情況較為嚴重。崩塌土石量共約為 4,998,350m³，分佈於各野溪支流中、上游溪段，若逢暴雨恐有下移，形成土石災害。

本計畫區之各野溪支流集水區內之災害現況提具治理對策，俾配合整體基隆河整治計畫中有關「坡地保育計畫」之實施，確實達成涵養水源、穩定邊坡、控制沖蝕與生態復育等功效之標的，進而保護當地居民之生命財產安全與道路交通順遂。本計畫集水區之土砂量主要源自河道堆積土石、溪谷兩側山崩落石、源頭崩塌、地表沖蝕及人為開發形成鬆動土石所造成。本計畫區之崩塌地總面積約 99.97 公頃，佔集水區面積約 5.5%。各野溪溪段檢討辦理整治工程所需經費成本預估為 52,850 千元。預計可保護之河段合計達 313.6 公尺，免於洪水橫向沖刷破壞。且辦理治理之崩塌地共達 76 公頃，降低這些地區之土石流料源供

應，減少土石流發生機率。

(**關鍵詞**：土石流潛勢溪、崩塌、沖蝕)

Abstract

This assessment covers an area of 1,819 hectares. It encompasses Rueifang Township, Kong-Chew Li, Hou-Tong Li, Guang-fu Li and Shu-ren Li and part of Kang-Ping Li. This area contains three of high-potential debris flow, nine of middle potential debris flows, and three of low potential debris flow rivers. Taipei A067, Taipei A068, Taipei A069, Taipei A066, Taipei A071, Taipei A072, Taipei A073, Taipei A076 and the Ging Chech chow creek are the areas which have the most severe damage. The total volume of landslide is about 4,998,350 m³. The debris is mainly located an upstream portions of the creeks, and therefore is potentially a severe debris flow hazard whenever there is heavy rain.

The disaster recovery management of this project is incorporated into the Keelung River improvement plan as part of the slope conservation... It will revitalize the water of the river, improve slope stability, provide erosion control and ecological restoration, and promote the safety and prosperity of the local residents.. The watershed of debris currently accumulate upstream of the creeks, are the result of landslides on both sides of the valley and local constriction development. The total area of landslide is about 99.97 hectares, about 5.5 percent of total area of the watersheds. The review of the field for training works requirements for the estimated cost of NT\$52,850,000. The protection of the river is expected to total up to 313.6 meters from the floods. And management's failure to handle a total of 76 hectares, of landslides in these areas to reduce the source of supply is expected to reduce the probability debris flow.

(Keywords : Potential Debris Flow, Landslides, Erosion)

計畫名稱	新樂水田野溪集水區整體治理調查規劃 Investigation and Planning for the Integral Control on the Watershed of Hsin Le Shui Tien Wild Creek
主持人	周明坤 Chou, Ming Kun
計畫年度	93

摘 要

本集水區位於新竹縣尖石鄉境內，為油羅溪上游水田部落之溪流，於新樂大橋與油羅溪匯流，其集水區面積約1,536公頃，溪流全長約7.28公里，河幅約5~30公尺，平均坡降約12%。本野溪經水田部落保育協會封溪護漁多年，上游未經開發污染水流清澈，環境自然清幽，惟該段野溪未經整治之河道，高莖作物及溪床大塊石阻礙水流，洪水來臨溢流成災，兩岸農田流失，造成人民生命財產損失，另於彎道曲率半徑較小處凹岸沖刷嚴重；艾利颱風期間，更造成水田橋下游田宅旁河岸崩塌，阻礙水流，嚴重威脅鄰近民宅安全；為保護原住民部落、維護生態環境及為該部落未來發展轉型奠定新契機，以自然生態工法規劃設計並配合綠美化景觀工程，為該部落未來發展轉型奠定新契機，遂成立本計畫。

本計畫工作重點與內容可概分為兩大要項，一為集水區現地調查，二為治理方案研擬，茲將報告中提出之成果及資料內容分述如下：

一、基本資料調查

- (一) 集水區基本資料調查、蒐集及建立，包括氣候、水文、地質、土壤、集水區水系等，彙整以上基本資料供集水區地文水文分析，以作為瞭解及評估集水區概況之依據。調查結果本集水區年平均氣溫約22.2℃，年平均降雨量約2,907mm。

- (二) 河道泥砂採樣及分析，現地及試驗分析共兩組，並依據試驗成果進行河床質、表面粒徑及河道粗糙性質研判，分析結果水田野溪河床粗糙係數約界於 0.034~0.045 之間。
- (三) 對集水區內土地利用現況及河道沿岸歷年水土保持工程包括整流與防洪工程、防砂工程進行現況調查，並計算集水區洪峰流量以作為未來評估集水區整治規劃設計之參考。
- (四) 根據歷年雨量資料統計，推估各河段各控制點不同頻率之洪峰流量，並以 50 年頻率之洪峰流量為設計流量，做為河川水位演算之依據。本計畫集水區水理演算結果水田野溪下游段控制站 50 年重現期距之洪峰流量約為 422CMS。

二、現地調查結果及問題

- (一) 坡面沖蝕情形：根據通用土壤流失公式(USLE)各因子依現況地形水系劃定之子集水區推求得年泥砂產量，約為 42,000(m³/yr)，平均沖蝕深度為 3.59(mm)，其主要肇因於其地形坡度較陡所致。另由河道輸砂能力計算結果可得知，集水區內所產生之泥砂量均隨逕流下移，不致淤積影響河道通洪。
- (二) 崩塌地：依據水土保持局「北部地區崩塌地調查成果」集水區內有 5 處 A 級崩塌地、3 處 D 級崩塌地，除新竹 0051 崩塌地位於位於水田部落上方，仍有潛在威脅之外，餘大部分崩塌地植生均已恢復。於現場調查發現有 3 處新增崩塌地，多屬於地表裸露，並無大規模崩塌情形。依據上述調查成果，集水區內之崩塌地面積達 28 公頃，另受艾利風災影響所產生之崩塌地共 2 處，崩塌面積約 0.6 公頃，依照推估崩塌厚度配合崩塌地面積求得崩塌量為 157,979 立方公尺。
- (三) 集水區內存在新竹 A031 土石流潛勢溪流，全集水區面積 180 公頃，地層屬新第三紀沈積岩，岩性主要以砂頁岩為主。土石流上游存在一新竹 0051 之 A 級崩塌地，面積約 14.78 公頃，中游地勢平緩，下游河道中多堆積大量土石材料，本區以往曾有土石流發生。推估土石流潛能流出量約為 17 萬 m³。
- (四) 道路水土保持：依據現場調查結果，本集水區內道路可分為水田道路、

水田道路支線、水田林道、新樂農路等，除水田林道外有多處需施設道路擋土牆及排水溝設施，其肇因多為地形陡峭、立地條件不佳，且道路設置後，天然穩定之坡面遭受破壞，開挖坡面或填方坡面土方鬆軟，尤其艾利颱風豪雨過後，邊坡易造成沖刷破壞。

三、改善對策及效益

- (一) 野溪治理：野溪整治時將儘量採用地方特色、近自然工法及親水設施。採用工法包括：砌石護岸、砌石潛壩、階梯式砌石固床工等。設計乃依照：規模最小化、外型緩坡化、內外透水化、表面粗糙化、材質自然化及成本經濟化等六項之原則來進行。預計施設護岸約 1,600 公尺、混凝土鋪石固床工、施設觀景平台及配合地形設置滯洪池，主要分佈於主流水田大橋下游，若加上既設護岸，受保護之河岸長達 3,000m，實施後將可穩定河床，保護河岸，改善水田部落之河道安全。
- (二) 土石流潛勢溪流治理：依計畫區考量生態改善、當地仍有大量堆積土石及上游之不安定崩場地，建議於新竹 A031 土石流潛勢溪流進行既設防砂壩改善、中游段增設防砂工程及崩場地穩定處理及崩場地穩定處理。
- (三) 崩場地處理目的係安定坡面，保護坡腳穩定，以減少坡面之沖蝕及泥砂來源。依據調查分析結果，建議打樁編柵，設置縱向排水並植生復育、坡腳 RC 護岸，坡面鋪網植生及設置潛壩 2 座、集水井。
- (四) 道路水土保持：本計畫選定九處道路水土保持改善工程，施作擋土牆約 220m，實施完成後方可增進水田部落往關西之道路安全，提升土地利用價值及便利交通，促進地方繁榮與進步。

四、治理規劃內容

本計畫針對集水區整體調查分析後研擬治理工程，總工程費約 6231.4 萬元，以「維護重於治理」的原則建議分年分期實施計畫如下：

期 別	工程經費 (萬元)	備 註
第一年	3,181.4	
第二年	1,930	
第三年	1,120	
總 計	6.231.4	

本集水區整治規劃實施後可直接減少洪災損失及土壤流失，保護農田、房舍、道路及人民生命財產安全，增進集水區內土地利用之價值，並進而帶動觀光。效益包括：

- (一) 穩定河床，保護河岸；
- (二) 防止土石沖蝕，穩定邊坡；
- (三) 保護道路邊坡，維持交通暢通；
- (四) 增加景點，吸引觀光。

(關鍵詞：新樂、水田野溪、現地調查、治理規劃)

Abstract

This watershed is located in the Jia Shih Township, Hsin Chu County, belonging to the tributary of Shui Tien Tribe (STT) in the upstream of You Luo Chi (YLC) and converging on the YLC at the Hsin Le Bridge (HLB), its basin area, length, width and average slope are about 1,536 ha, 7.28km, 5~30m and 12%, respectively. Although the streamlocked (i.e. no fishing) action and protective fish carried out by the STT Conservation Association (STTCA) for many years and clear flow results from its undeveloped and unpolluted upstream with naturally calm and secluded surroundings, high stem crop and bed boulder interrupt the flow in its section of that uncontrolled channel, overflow during flood results in damage, lost farmland along its both banks and the loss of resident life and property, in addition to serious scour on the concave bank with smaller bend curvature radius. During the Aere Typhoon, the bank near field residence in the Shui Tien Bridge (STB) downstream collapses, resulting in flow block and a severe threat of nearby residence safety. Thus, this project has been carried out in order to protect the aboriginal' s tribe, maintain the ecological environment and establish the new moment on such tribe development and reform in the future via planning and design with the natural ecological engineering method (NCEM) in match with the afforestation, beautification and landscape engineering.

Work keynotes and relevant contents can be divided into 2 major items, i.e. 1.watershed site survey; 2.control plan study and proposal. The proposed results and data contents in this report are to be described, respectively as follows:

I. Basic Data Survey

(I) Watershed basic data survey, collection and establishment include climate, hydrology, geology, soil and watershed tributary, etc. and are collected to provide the watershed geologic and hydrological analysis on the basis of

understanding and evaluating the watershed general situation. Survey results show that annual average temperature and rainfall are about 22.2°C and 2,907mm in this basin, respectively.

(II) There are 2 sets of channel silt and sand sampling and analysis, site and test analysis, according to the test result, the analysis for bed load, surface grain size and channel roughness characteristics is to be completed; the analysis result shows that the bed roughness coefficient for the Shui Tien wild creek (STWC) is approximately between 0.034 and 0.045.

(III) It's been carried out for the current survey on the existing land use within the watershed and statistical water and soil conservation engineering along the channel bank over the years including flow control, deflood and sediment control engineering; the watershed peak flood is calculated as the reference of evaluation on planning and design for the watershed control in the future.

(IV) According to the statistical records of rainfall data over the years, it's been estimated at each control point in every channel section for the peak flood in various recurrence, the peak flood in 50 years recurrence is used for the design discharge on the basis of the stage calculation; the result of the hydrological analysis indicates the peak flood in 50 years recurrence is about 422CMS at the control station in the downstream channel section of the STWC.

II. Site Survey Results and problem

(I) Slope Scour Case: Mainly due to its steeper topographic slope, the estimated yearly sediment yield and average scour depth are about 42,000m³/yr and 3.59mm/yr, respectively via the unification soil loss equation (USLE) for every factor in the delimited subwatershed, judging from the current topography and tributary. Moreover, it's shown by way of the calculation

result of the capacity of the channel sediment transport that sediment yield within the watershed all moves with runoff downward, not resulting in deposit effect on the channel deflood.

(II) Landslide: According to the Water and Soil Conservation Bureau (WSCB)

「Landslide survey in the north region」, there are 5 and 3 landslide sites in grade A and D within watershed, individually; except Hsin Chu 0051 landslide located above the STT, there still exists the potential threat and the vegetation on most landslides has been restored. It's found in site survey that there are 3 newly increasing landslide, mostly belonging to bare ground surface and no collapse cases exist in large scale. Depending on the survey result mentioned-above, the collapse area is up to 28ha within the catchment; additionally, landslide up to 2 sites with 0.6ha or so collapse area results from the Aere Typhoon damage influence and collapse volume is 157,979 cubic meters, obtained via estimated collapse thickness and matching area.

(III) Hsin Chu A031 for the debris flow potential creek exists within the watershed, total basin area is 180ha, the formation belongs to sedimentary rock; its features mainly consists of Neogene sandstone and shale. Grade A landslide with approximate 14.78ha area for the Hsin Chu A051 lies in the upstream of this debris flow, the topographic slope is flat and mild in its midstream, there are many heaps of debris stuff in the downstream channel, the debris flow has formerly happened in this area; the estimated potential outflow of such relevant debris flow is about 0.17million m³.

(IV) Water and Soil Conservation on Road: The road type within this catchment can be classified as Shui Tien main and branch road and wood lane and Hsin Le farm road, etc.; except this wood lane, there are many sites in need of installing the facilities of road retaining wall and drainage ditch resulting from steep landform, bad basic ground condition, damage on the naturally

stable slope; loose earthwork on the excavation or backfill slope. Especially, after the strike of the Aere Typhoon and storm, the relevant slope is easy to result in scour damage.

III. Improvement Strategy and Benefit

(I) Wild Creek Control: Local features, qusa-nature engineering method and waterfront facility are used for the wild creek control as soon as possible, chosen engineering methods include dry stone wall slope protection, submercible dam and step bedding engineering, etc; the design execution are based on 6 criteria, i.e. minimized size, outer type with mild slope, previously inner and roughing surface, naturalized stuff and economized cost. It's expected to install about 1,600m slope protection, concrete boulder-pitching bed engineering, landscape platform and detention pool in match with landform major distributed in the downstream of the STB main; if the existing slope protection is included, then the length of protected embankment is up to 3,000m. Moreover, the stable bed, protective bank and the STT's channel safety are available after this project execution.

(II) Debris Flow Potential Creek Control: Despite the consideration on ecological improvement in the project scope, considerable heaps of debris and unstable landslide in the upstream still exist in the local area; it's suggested in the Hsin Chu A031 debris flow potential creek that relevant work on the improvement of the existing sabot dam, new installation of sediment and landslide stabilization control in the midstream is to be carried out.

(III) Landslide Control Goal: These objectives are slope stabilization and toe-stability protection to reduce the slope erosion and grit source; according to survey analysis result, proposal includes piling and wattling, installing longitudinal drain with vegetation restoration, RC slope protection, slope

netting and vegetation and 2 sets submercible dam and collector.

(IV) Soil and Water Conservation on Road: 9 sites are selected in this project for the improvement engineering in soil and water conservation on road, the retaining wall is about 220m under construction, after its finish, the road safety of the STT toward Kuan Hsi is available to be upgraded, land use value and convenient transportation can be increased; the local prosperity and progress is obtainable to be promoted.

IV. Control Planning Contents

Control engineering is to be proposed as a result of watershed integral survey and analysis, total engineering cost is about 62.314millions NTD; according to the principle of 「Maintenance is more important than control」, the project execution is to be suggested in various phase year by year and shown as follows:

Stage Term	Engineering Cost (10 ⁴ NTD)	Notes
1 st year	3,181.4	
2 nd year	1,930	
3 rd year	1,120	
Total	6.231.4	

Also after the completion of planning for this watershed integral control, the loss of flood damage and soil erosion is directly reducible, farmland, cottage, road and resident' s safety of life and property can be protected, the increase of the value of land use within the watershed as well as the tourism promotion are available.

Relevant benefits include as follows:

- (I) Stabilize bed and protect bank.
- (II) Prevent soil from erosion and stabilize slope.
- (III) Protect road slope and maintain traffic smoothly.

(IV) Increase sight-seeing sites and attract tourism.

(Keywords : Hsin Le, Shui Tien Wild Creek, Site Survey, Planning for Control)

計畫名稱	南勢溪集水區整體治理調查規劃 The Integrated Regulation Planning of the Watershed of Nan-Shih River
主持人	連惠邦 Lien, Hui-Pang
計畫年度	91

摘 要

本案就計畫集水區範圍內之現況、水文水理資料、水土保持問題、泥砂生產量、相關人文及產業活動，廣泛蒐集背景資料，並經由實際現場測量調查工作、泥砂採樣分析、地形及溪流測量展繪等工作，進行集水區內可能肇生之水土保持問題剖析，並依其問題嚴重性、保護對象及交通便利性，將整體集水區進行為期 3 年之分期分區治理規劃。

本計畫除了就合約內容之八處重點河段進行工程配置及細部設計，亦調查全區水土保持及林地狀況，並針對崩場地、道路水土保持、溪流沖淤等問題提出整體治理規劃，同時具體提出 56 處必須予以處理維護之地點，並依問題嚴重性、保護對象及交通便利性，將其規劃成爲期 3 年之分期分區治理時程，共計所需工程經費約 100,157 仟元。

（**關鍵詞：水文水理、泥砂採樣分析**）

Abstract

In this project, aim at to plan the current conditions of the area, the hydrologic and hydraulic analyzes, related humanities and industry activity of data, water and soil conservation problem, soil sand and extensively collect background data. Also through physically measure inquisition work, soil sand to sample works such as analysis, geography and rivulet diagraph etc. on the scene. Carrying on inside the watershed may the output water and soil conservation problem analyze. Also depend on it problem seriousness, protect object and the transportation convenience, carry on whole watershed the cent expects to divide into the programming of the managing of area for three years.

According to the contract content, this project in addition to with 8 point river segment carry on engineering allocation and minute part to design outside, also investigate the whole area water and soil conservation situation and woodland condition, and aim at to collapse ground, road water and soil conservation, rivulet of flush and pile up etc., put forth whole manage a programming. Concretely put forth 56 locations that have to handle maintenance in the meantime. Also according to the problem seriousness, protect object and the transportation convenience, become its programming to expect the cent of three years to expect to divide into area to manage a schedule, add up to the engineering budget needed about 100,157,000 dollars.

(Keywords : Hydrologic and Hydraulic Analyzes, The Sand Sample Analyzes)

計畫名稱	梨山地區地層滑動整治計畫成效評估 Performance Evaluation on the Renovation Work for Li-Shan Landslide
主持人	蘇苗彬 Su, Miao-Bin
計畫年度	91

摘 要

梨山地區地層滑動整治計畫在整體治理計畫完成之際，應進行評估作業，針對治理的成效做成評定，對梨山地區的長期安定性做成檢討，並擬定長期的安全維護管理應進行的事項及對後續必要的工程處理做成建議。

工作範圍主要的梨山地滑區為過去曾發生大規模地盤滑動所涵蓋的區域，其地質主要是由崩積層及破碎板岩所組成，主要地滑區可分成西、東南及東北三個區域，每個地滑區並由數個上下相關連之滑動體所構成，屬於大面積之深層地盤滑動。由於滑動體頭部裂隙發達，加上其上方覆蓋之崩積層及風化板岩層透水性佳，降雨時引起地下水位上升，為造成本區地滑災害的主要誘因。整體之治理方式為施以地表排水、橫向集水管、集水井、排水廊道等整治工程，其成效有待評估後續的安全狀況予以確定。

整體而言，梨山地區地層滑動整治計畫，其成效經評定是有效的，確實協助維持梨山地區之邊坡穩定，其效益相當可觀，然地滑地之治理為長期水土保持安定之一環，仍有多項建議後續應進行之事項應持續推動。

(**關鍵詞：梨山地滑、整治計畫、成效評估**)

Abstract

The performance evaluation on the renovation work for Li-Shan landslides was conducted after the project of investigation and renovation plan was finished. Discussion was focus on the long term safety for this area. And, suggestion in regards to future needs was given.

Li-Shan is located at the west wing of control ridge of Taiwan Island. The geological formation in this area is mainly the miocene Lu-Shan formation. The rock types of this formation are dark to grey slates with heavy schistosity. Based on the investigations, it could be recognized that Li-Shan has experienced more than one landslide activity in the history. Main area of sliding can be divided into three zones, namely, west, southeast and northeast zone. Each zone was connected together by a few sliding blocks. It was confirmed that rainfall induced the increase in water pressure is the main factor which triggers the landslide of the highly weathered rock slope. Remediation plan was concentrated on drainage for the endangered slope including surface drains, horizontal drains, wells and drainage galleries.

As a whole, the achievement was judged to be effective for the remedial work. It really helps to maintain stability of Li-Shan area. But, for the long run, some works are suggested to be implemented in the future.

(Keywords : Li-Shan Landslide, Remediation Plan, Evaluation)

計畫名稱	梨山地區地層滑動整治計畫成效評估 Performance Evaluation on the Renovation Work for Li-Shan Landslide
主持人	蘇苗彬 Su, Miao-Bin
計畫年度	91

摘 要

在完成「梨山地區地層滑動整治計畫成效評估」後，為廣徵各界意見及成果之交流，召開了此研討會，共有以下主題：

- 1.梨山地區地層滑動整治計畫之一：回顧與展望；
- 2.梨山地區地層滑動整治計畫之二：監測系統與資料庫；
- 3.梨山地區地層滑動整治計畫之三：梨山地區的地質；
- 4.梨山地區地層滑動整治計畫之四：梨山地區管理基準值訂定；
- 5.梨山地區地層滑動整治計畫之五：成效評估與後續處理；
- 6.梨山地區地層滑動治理規劃；
- 7.中橫公路的現況及未來；
- 8.德基水庫集水區的治理規劃。

(**關鍵詞：研討會、梨山、治理計畫、成效評估**)

Abstract

After finishing the performance evaluation on the renovation work for Li-Shan landslides, a symposium was arranged on this topic in order to collect opinion and criticism from others so as the exchange of experiences. Main topics reported were as followings :

1. Review and perspective;
2. Monitoring system and data base;
3. Geology of Li-Shan area;
4. Criterion for safety management;
5. Effectiveness evaluation and future work;
6. The remediation plan;
7. Current status and future of central cross-island route;
8. Management plan for Teh-Chi Water Reservoir catchment area.

(**Keywords : Symposium, Li-Shan, Remediation Plan, Evaluation**)

計畫名稱	清水溪集水區土砂災害重點區段整體治理調查規劃 Control Planning in Debris Flow Disaster Zone at the Chin-Sui Creek
主持人	鄭麗瓊 Weng, Debbie L. C. 蔡文鎗 Tsai, Wen-Chiang
計畫年度	91

摘 要

本計畫集水區土砂災害重點整體治理調查規劃範圍包含：一、南投縣竹山鎮桶頭里地區，二、雲林縣古坑鄉內湖、石壁地區，及三、嘉義縣阿里山鄉阿里山溪地區等三處不連續的集水區，合計集水區面積約為 5,940 公頃。其間計有雲林 001，雲林 A002，草嶺 B031-1，草嶺 B031-2，嘉義 003 及嘉義 A002 等五條土石流潛勢溪流。崩場地則有 97 處，總崩塌面積為 413.86 公頃。主要災害原因為：一、溪流陡峻溪床河岸易遭侵蝕、淘刷導致溪岸邊坡崩塌，崩落土石岩塊堆積河床阻礙水流，二、河道彎曲迂迴導致河岸破壞、坡面崩塌，三、中、下游河道土石淤積，影響洪水宣洩，四、崩塌面積廣大，大量土石隨雨水逕流下移造成土石災害，五、橋樑跨度不足或斷面不夠，遭洪水土石流破壞交通中斷，六、坡地超限利用，造成土壤沖蝕及淺層崩塌等現象。分別研訂以防砂壩、潛壩、梳子壩、固床工、護岸、溪床疏浚、打樁編柵、草種撒播、蝕溝控制及橋樑道路水土保持治理工程俾便實施整治事業，並依工程效果及經費籌措排列優先順序，配合工程需要編列訂定分期計畫，總經費為 3 億 2 仟 6 佰 28 萬元，評估計畫實施之整治率為約 61.60%。

預計可攔阻及減少下移之土石方約為 150,642m³，穩定河床，保護河岸之河段合計可達 5,710m，確保兩岸邊坡、農田、房舍、橋樑及人民之安全。橋樑之保護計有龍眼宅橋等 9 座以上之橋樑。間接效益則可涵養水源、減少洪水災

害、維護自然生態環境、重振觀光盛況、提高經營效率、增加農民收入及達到保育水土資源及國土保安之目標。

(**關鍵詞：崩塌地、侵蝕、土石流、坡地超限利用、整治率**)

Abstract

The area covered by this plan includes the 3 non continuous water shed areas of Nan-Tou county, Chu-Shan Township Tong-Tou Li, Yun-Lin County Ku-Kang Township Nei-Man and Shu-Pi, Ya-Li-Shan Creek in Gai-Yii County Ya-Li-Shan Township. The total area of this is 5,940 hectares. There are five debris flow creeks that feed into these watersheds. They are Yun-Lin 001, Yun-Lin 002, Chao-Ling B031-1-, Chao-Ling B031-2, Gis-Yi 003 and Gis-Yi A002. There are 97 landslide areas in this region amounting to 413.86 hectares. The reasons leading to these landslides are:

1. erosion of the river beds and riverbanks by natural river flow,
2. The curvature of the river itself makes it prone to erosion and therefore collapse of the riverbank slopes,
3. The accumulation of the debris interferes with the drainage of the water,
4. Debris from the upstream collapse causes large debris flow downstream,
5. The span of bridge causing debris flow and washes out downstream roads,
6. Illegal use of slopelands causing erosion and degradation of the land.

In order to cure this situation this plan will use sabo dam, check dam, comb dam, landslide treatment, road improvement, slopeland stabilization, soil and water conservation plan for slopeland, and greenization of the slopes.

Dependent on the effectiveness of the construction and the funding available this plan is devised into several phases. The estimated total cost is NT\$ 326,280,000. The control ratio of watershed is estimated to be 61.60%.

(Keywords : Landslide, Erosion, Debris Flow, Improper use in Slopeland, Control Ratio in Watershed)

計畫名稱	蘭陽溪繼光橋上游治理規劃工程 Project of Lan-Yang River Management (Ji-Guang Bridge) at Upstream
主持人	莊聿今 Jhuang, Yu-Jin
計畫年度	91

摘 要

本計畫為民國 91 年在蘭陽溪上游（繼光橋以上）區域進行的治理規劃工程報告，主要驗證於民國 83—90 年所進行集水區之治理成效，並瞭解支流之沖淤情況，依據現況之保全需要，編列治理工程，分期予以治理而達到蘭陽溪整治目標。於集水區現況問題中，主要為野溪沖蝕、崩塌、道路、土石災害與水土保持的需要性，因此本計畫將治理區域區分成三個工區：

- 1.第一工區（蘭陽主流段）：修復三號潛壩缺口、崩場地（151 號）治理、丁壩與順壩之挑流工程、箱籠與型塊設置。
- 2.第二工區（蘭陽溪右岸）：蝕溝(20、21、32~34 號)治理、崩場地(20、23、32~34 號)治理、土石流攔阻工程（20 號）、土石流緩衝林帶、沖積扇截角工程、土石流疏導與抑制工程。
- 3.第三工區（蘭陽溪左岸）：蝕溝（84 號）治理、崩場地（73~75、81、82、84、125~128 號）治理、土石流淤積工程、道路（編號 18）與農路（編號 12、24）之改善工程。

（關鍵詞：蘭陽溪、水土保持、繼光橋、集水區）

Abstract

This project of Lan-Yang River management (Ji-Guang Bridge) at Upstream was begun in 2002. The result of management (1994-2001) in watershed area, and understand state of scour and fill in branches watershed. According to situation is now safety, we are planning the management projects to achieve an objective of Lan-Yang River management. In the watershed problems has scour of wild-stream, landslide, road, rock calamities and applicability of the Soil and Water Conservation. So this project is divided into three regions of management area:

1. The first work area (main stream of Lan-Yang River): To recondition gaps in the dike (#3), the landslide (#151) management, plane wall jet engineering of the spur dikes, and to set up gabion and Concrete Blocks.
2. The second work area (Lan-Yang River's right bank): The gullies (#20, #21, #31~34) management, the landslide (#20, #23, #32~34) management, the engineering of turns debris flow in #20, vegetated Buffer Strip, alluvial Plain of corner cut engineering, channelize and control the debris flow.
3. The third work area (Lan-Yang River's left bank): The gullies (#84) management, the landslide (#73~75, #81, #82, #84, #125~128) management, the roadway (serial number 18) and the Farm Road (serial number 12, 24) improvement program.

(**Keywords : Lan-Yang River, Soil and Water Conservation, Ji-Guang Bridge, Watershed**)

索引

	頁數
九份二山紀念園區植物手冊 -----	29
上坪溪集水區整體治理調查規劃 -----	143
土石流及崩塌地源頭水土保持處理工作手冊 -----	35
大坑溪上游集水區整體治理調查規劃 -----	174
大村及三家春集水區上游坡地水土保持規劃 -----	177
小北坑野溪集水區整體治理調查規劃 -----	217
山坡地可利用限度分類標準檢討 -----	107
山坡地查報取締實務研討會及執行成效研究 -----	131
山坡地管理作業參考手冊 -----	109
山腳村七鄰崩塌地整體治理調查規劃 -----	180
不同植被水土保持功能之調查規劃 -----	92
水土保持相關法規解釋函彙編專家系統 -----	137
北區土石流防災專員培訓 -----	184
生態工程推行成果評估與研究（94—96年） -----	1
石門水庫白石—秀巒子集水區整體治理調查規劃 -----	186
石門水庫集水區水土保持管理及土石流防災教育宣導計畫 -----	111
安通溪及磯崎集水區生態資源調查及規劃 -----	241
利用遙控無人載具進行易淹水地區上游環境資訊蒐集建置與分析 -----	101
坡地保育多元化經營之研究 -----	42
坡地植生工程暨植生調查應用手冊 -----	17
坡地植生草類與綠肥植物 -----	31
坡地植生與保育功能之調查研究 -----	44
坡地集水區分析整合系統研發 -----	113
抽藤坑溪集水區調查規劃 -----	222
東港溪等上游集水區整體調查規劃 -----	145
花蓮地區治理成效風貌展現規劃 -----	190
南勢溪上游集水區整體治理調查規劃 -----	192
南勢溪集水區整體治理調查規劃 -----	259
屏東縣牡丹鄉旭海溪集水區整體治理調查規劃 -----	226
後龍溪及中港溪等上游集水區整體調查規劃 -----	153
研修山坡地管理作業參考手冊及研編查詢網頁計畫 -----	115

美濃集水區整體治理調查規劃 -----	204
烏山頭水庫集水區山坡地整體治理調查規劃 -----	206
草帶法應用植物及土壤保育之效益評估 -----	56
埤仔溝溪集水區自然生態工法博覽會規劃及設計 -----	94
基隆河圓山子分洪（瑞芳地區）野溪集水區整體治理調查規劃 -----	246
培地茅於崩塌裸露地之應用與規劃設計 -----	96
推動生態綠化策略及苗木培育分析方法 -----	46
梨山地區上游集水區整體調查與治理規劃 -----	228
梨山地區地層滑動基準檢核及監測系統維護資料分析 -----	158
梨山地區地層滑動管理基準檢核及監測系統維護資料分析 -----	208
梨山地區地層滑動整治計畫成效評估 -----	261
梨山地區地層滑動整治計畫成效評估 -----	263
清水溪集水區土砂災害重點區段整體治理調查規劃 -----	265
通霄沿海集水區整體治理調查規劃 -----	230
通霄溪集水區上游坡地水土保持整體治理調查規劃 -----	160
野溪生態調查及棲地改善模式之建置（第二年）-----	58
集水區生態工法規劃設計參考模式之建立（第二年）-----	61
集水區生態資源調查手冊 -----	90
集水區自然生態工法規劃設計參考模式之建立 -----	99
集水區研發技術應用暨多元化發展 -----	164
塘下橋集水區上游坡地水土保持整體治理調查規劃 -----	166
新樂水田野溪集水區整體治理調查規劃 -----	249
萬里磺溪集水區整體治理調查規劃 -----	234
農路調查與環境修復衝擊評估 -----	119
運用衛星影像輔助山坡地變異點判釋 -----	126
網際網路地理資訊系統、土石流資訊系統、工程管考系統維護提昇 -----	139
遙測技術在崩塌地、土石流量化分析及坡地管理監測之應用（二）-----	141
潭子內集水區整體治理調查規劃 -----	236
緩衝綠帶帶寬與適用植物之研究 -----	50
緩衝綠帶帶寬與適用植物之研究（第二年）-----	38
緩衝綠帶帶寬與適用植物之研究（第三年）-----	21
衛星影像輔助山坡地監測與管理教育訓練 -----	133
衛星影像變異點查證網際網路管理系統開發(1/3)-----	135
衛星影像變異點查證網際網路管理系統開發(2/3)-----	129
整合衛星影像輔助山坡地變異點判釋及石門水庫集水區現況監測 -----	104
濁水溪上游集水區整體調查規劃 -----	170
濁水溪上游集水區整體調查規劃圖表與解說彙編 -----	172

應用生態指數探討九份二山、華山及草嶺地區植生復育之空間分布與調查分析	52
環都市周邊山坡地防災與生態工程之研究（第二年）-----	25
雙溪集水區上游坡地水土保持整體治理調查規劃 -----	210
邊坡穩定生態工程圖冊查詢系統建置及穩定性分析之研究 -----	27
蘭陽溪繼光橋上游治理規劃工程 -----	268

Index

	Page
A Pictorial Guide of Watershed Management Planning for Jhuoshueisi -----	172
Application and Design of Staking-and-Wattling and Vetiver Grass on Bare Slopes -----	96
Assessment of Effectiveness of Grass Strip in Soil Conservation -----	56
Changed Point Areas Inspection and Management System (1/3) -----	135
Changed Point Areas Inspection and Management System (2/3) -----	129
Chou-Teng-Keng Creek Watershed Management Assessment -----	222
Control Planning in Debris Flow Disaster Zone at the Chin-Sui Creek -----	265
Determination of the Width of Buffer Strip and Suitable Grass Species -----	50
Disaster Mitigation and Ecological Study of Hillside Areas Surrounding Major Cities (2nd year) -----	25
Ecological Engineering Expo—Pi-Tsia-Ko Creek Watershed -----	94
Ecological Resources Investigation and Planning for the Anton Stream and Geechi Watershed -----	241
Educational Training on Slopeland Management and Monitoring Via Satellite Images -----	133
Establishing and Development of the Graphic Displays Information Systems of Ecological Engineering on Slope Stability and Stability Analytical Method -----	27
Establishment of Ecological Investigation and Habitat Enhancement Model for Creeks (2nd Year) -----	58
Establishment of Expert System for Compiling the Declaratory Statutes of Soil and Water Conservation -----	137
Grasses and Green Manures Used on the Slopeland -----	31
Handbook of Debris Flow and Landslide Source Treatments for Soil and Water Conservation -----	35
Handbook of Plants in Jioufenershan Memorial Park -----	29
Handbook of Watershed Ecological Resources Survey -----	90
Identification of Land Use Changes in the Slope Lands and Landslides in the Shihmen Reservoir by Using Satellite Imagery -----	104
Identification of Land Use Changes in the Slope Lands Using Satellite Imagery	126
Integral Investigation and Management Project of Da-Ken Creak	174

Upstream Watershed -----	
Integrated Assessment and Planning for Upper Watersheds of DongGang River --	145
Integrated Investigation and Planning of Water-Soil Reservation at Upper Stream	166
Land Slope on Tongha Bridge Watershed -----	
Integrated Shihmen Reservoir Watershed Management Plan-A Case Study of	186
Baishih- Shiouluan Sub-Watershed -----	
Integrated Watershed-level Planning and Design Model of the Natural Ecological	61
Engineering Methods (Second Year) -----	
Integrated Watershed-level Planning and Design Model of the Natural Ecological	99
Engineering Methods -----	
Integration of the Slopeland Watershed Analysis System -----	113
Investigation and Planning for the Integral Control on the Watershed in the	192
Upstream of Nan Shih Chi -----	
Investigation and Planning for the Integral Control on the Watershed of Hsin Le	249
Shui Tien Wild Creek -----	
Investigation and Planning of the Watersheds of Hou-Long Stream and	153
Zhong-Gang Stream -----	
Investigation and Planning on the Function of Plant Cover for Soil and Water	92
Conservation -----	
Investigation and Remedial Plan for Upstream Catchment of Li-Shan Area -----	228
Investigations on Slopeland Vegetation and Its Conservation Functions -----	44
Managing and Investigative Plan of Whole Tan-tsu-nei Watershed -----	236
Manual of Slopeland Vegetation Engineering and Investigation Method -----	17
North Debris Flow Disaster Prevention Education, Publicity and Training	184
Observer -----	
Performance Evaluation on the Renovation Work for Li-Shan Landslide -----	261
Performance Evaluation on the Renovation Work for Li-Shan Landslide-----	263
Project of Lan-Yang River Management (Ji-Guang Bridge) at Upstream -----	268
Project of Xuhai Stream Watershed Management, Mudan Shiang, Pingdung	226
County -----	
Promoting the Strategies of Ecological Greening and Analysis of Nursery Stock	46
Growing Method -----	
Reevaluation of Criteria for Safety Management and Maintenance of	158
Monitoring Systems of Li-Shan Landslide Area -----	
Reevaluation of Criteria for Safety Management and Maintenance of	208
Monitoring Systems of Li-Shan Landslide Area -----	
Reference Handbook for Slopeland Management Practices -----	109

Research for Slope Land Violation Investigation and Enforcement Practice	131
Conference and Implementation Benefits -----	
Research of Strip Width and Suitable Grass Species for Grass Buffer Strips (III) -	21
Research of Strip Width and Suitable Grass Species for Grass Buffer Strips (II) --	38
Review of Classification Standard for Slope Land Utilizable Limitation -----	107
Slope Land Management Reference Handbook Modification and Inquiry Website	115
Improvement Project -----	
Soil and Water Conservation Management and Debris Flow Disaster Prevention	111
Education and Publicity Plan for SHIH-MEN Reservoir Watershed -----	
The Application and Diverse Development with Watershed RD Technology -----	164
The Inquisition of Agricultural Roads and The Valuation of Repair Environment	119
Impact -----	
The Integrated Regulation Planning of Shuang-Si River -----	210
The Integrated Regulation Planning of Siao-Bei-Keng River -----	217
The Integrated Regulation Planning of Soil and Water Conservation on	160
Tong-Siao Watershed -----	
The Integrated Regulation Planning of the Watershed of Nan-Shih River -----	259
The Integrated Regulation Planning of Tong-Siao Circumlittoral Watershed -----	230
The Maintenance and Upgrade of Internet Geographic Information System, The	139
Debris flow Information System, The Engineering Management System -----	
The Minon Watershed Management Planning -----	204
The Project of Application of the Technology of Remote Sensing on collapse,	141
Debris-Flow Quantification Analysis and Slope Management (2) -----	
The Promotion Plan of the New Rural Village's Appearance with Hualien Region	190
The Renovation Planning for the Landslide in the 7th Neighborhood, Shan-Jiao	180
Village -----	
The Soil and Water Conservation Bureau (SWCB) Council of Agriculture(COA)	1
Assessment and Research on the achievements of Ecological Engineering	
Methods(III) -----	
The Soil and Water Conservation Management Assessment at Wild Creek	246
Watersheds at Ruei-Fang Township Region in the Upstream of 「Keelung River	
Yuanshantzi Flood Diversion Project」 -----	
The Spatial Distribution and Investigation Analysis of Vegetation Recovery for	52
Chufenursan, Huasan, and Tsaolin Areas Using Ecological Indices -----	
The Study of Multiple Management in the Preservation on Slope Areas -----	42
The Sun-Pie River Watershed Investigation And Planning -----	143
The Upstream Management of Soil and Water Conservation on Da-Tsuen and	177

San-Jia-Tsuen Watersheds -----	
The Wan-LI Watershed Management Planning -----	234
The Wu-Shan-Tou Reservoir Watershed Management Planning -----	206
Using Remotely Piloted Vehicle to Collect and Analyze Environment Information in Flood-prone Area -----	101
Watershed Management Planning for Jhuoshueisi -----	170

國家圖書館出版品預行編目資料

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