

# Investigation and Developing for Ecological Engineering Methods of Stream in Taiwan

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**Abstract:** The Ecological Engineering Method (E. E. M.) had researched after year 1996 in Taiwan. The project entitled "Establishment of Ecological Investigation and Habitat Enhancement Models" has been assigned for implementation. The achievements of the project consist that analyses of relevant difficulties resulted from the promotion of E. E. M., investigations of the influence of construction of concrete structure on stream habitat, analyses of instrumentation data from the construction areas applied E. E. M., establishment of automatic monitoring station for environmental instrumentation of stream habitat and the education and training.

**Key words:** ecological engineering method; stream habitat; creatures resources

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## 1 Introduction

Since 1996, relevant sectors of different level had made enormous efforts on investigating and promoting the Ecological Engineering Method (E. E. M.) in Taiwan. Meanwhile, a project entitled "Establishment of Evaluation Indices and Design Reference Book of Ecological Engineering Method in Stream" had been completed in 2002 and the relevant knowledge and results had also been transferred to the construction & research departments for technical support in practice. The project entitled "Establishment of Ecological Investigation and Habitat Enhancement Models" has been assigned for implementation by Bureau of Soil and Water Conservation. This project attempted to integrate the relevant theories and technologies from worldwide and apply them onto the stream system for ecological consideration. In the project, the watersheds of Tou-bian-keng Creek in Taichung County; Mu-dan Creek in Taipei County; and Liou-chung Creek in Tainan County were selected as the main areas of study and a systematic field investigations and analyses were also carried out on various aspects with ecological concern such as structures types, planning pattern, creature group and structural landscape ecology. Eventually, this project is capable of integrating a large quantity of information from field investigation and establishing series of design chart and hand book for practical usage. The project entitled "Establishment of Ecological Investigation and Habitat Enhancement Models" has been completed after year 2003. The achievements of the project consist of: (1) Analyses of relevant difficulties resulted from the promotion of E. E. M.

(2) Investigations of the influence of construction of concrete structure on stream habitat. (3) Analyses of instrumentation data from the construction areas applied E. E. M. (4) Establishment of automatic monitoring station for environmental instrumentation of stream habitat. (5) Preparation of a draft for the field investigation and habitat enhancement of stream ecology. (6) Compilation of case histories of E. E. M. (7) Exhibition of the simulation of habitat enhancement from the results of researches. (8) Education and training of E. E. M. and compilation of case histories from world-wide countries, compilation of the proceedings of conference "Habitat Enhancement using Ecological Engineering Method", and printing of final report.

Firstly, the experiments for establishing the model of ecological investigation were concentrated on the Watershed of Tou-bian-keng Creek in Taichung County. Secondly, the spot for studying the establishment of the model of habitat enhancement was placed in the Watershed of Mu-dan Creek in Taipei County. Finally, the Watershed of Liou-chung Creek was selected in Tainan County as instrumentation spot for studying the differentiation of aquatic ecosystem before and after the enhancement using E. E. M.

### (A) Watershed of Tou-bian-keng Creek

Tou-bian-keng Creek originates from one of the tributary of Wu River Drainage Basin with area about 8 725 hectares.

### (B) Watershed of Mu-dan Creek

Mu-dan Creek originates from the Drainage Basin of Shuang Creek in Taipei County with area about 2 600 hectares.

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(C) Watershed of Liou-chung Creek

Liou-chung Creek is located at the Tainan County and the tributaries and main streams at upstream include Chi-chung Creek, Ba-chung Creek, and Jiou-chung Creek. The watershed possesses an area around 1977 hectares.

2 Ecological Investigations and Instrumentations on the Physical and Chemical Environments of Aquatic and Terrestrial Areas of Stream Reach

2.1 Hydraulic and Hydrological Investigation of Stream Reach

(1) Measurement of cross sectional area of stream reach

Selecting the measurement points with equal spacing along the direction perpendicular to the stream flow and measures the depth of measurement point using measuring pole with calibrated division.

(2) Measurement of flow velocity

Selecting 1 ~ 3 lines passing through the stream and surveys the width of stream using plastic ruler. Along the passing lines, measure the depth and flow velocity at different point with spacing of 1 m using velocity meter of type FP101/FP201.

(3) Situation of stream flow

2.2 Investigation of Quality of Stream Water

The investigation items consist of (1) Temperature; (2) pH value; (3) dissolved oxygen; (4) electricity conductivity; (5) turbidity.

2.3 Investigation of Creatures Resources

(1) Riparian plants

(A) Quantitative analyses of plant society

(a) density; (b) frequency; (c) cover; (d) Important Value Index (IVI)

(B) Species diversity of plant society

(a) Species richness; (b) Simpson index of diversity; (c) Shannon index of diversity; (d) evenness index

(2) Fishes

In general, the electro-fishing method is appropriate for the investigations of fish resources at the upstream and middle stream reaches. Accordingly, the method was adopted for the present project and portable electro-fishing equipment was used for site investigation. Field investigation was performed once for every season.

(3) Shrimps and crabs

It was common to capture shrimp and crab species during the electro-fishing. However, some species may settle at the pool habitat where the equipment is difficult to reach. Therefore, for each instrumentation station 5 sets of cages with small size were prepared for accessory support.

2.4 Results and Analyses of Site Investigations

(1) Hydraulic & hydrological investigations and analyses

The field investigations and related analyses have been lasted for 12 months since the onset of the 1st year project.

The detail analyses have been listed and depicted in the report.

(2) Investigations and analyses of water quality

The field investigations and related analyses have been lasted for 12 months since the onset of the 1st year project. The detail analyses have been listed and depicted in the report.

(3) Investigations and analyses of plants in revetment

Based on the results of cluster analyses, the vegetative plants in revetment can be grouped as follow:

(A) Woodwardia- Pteris multifida Poir. type;

(B) India-charcoal trema- Macaranga tanarius. type;

(C) Pilose beggartick- Taiwan kudzubean type;

(D) bare layer- other;

(E) Pennisetum purpureum- Taiwan kudzubean type;

(F) Wedelia trilobata A. S. Hitchc. - Pilose beggartick type;

(G) Pilose beggartick- Pteris multifida Poir. type.

(4) Investigations and analyses of fish species

(A) Tou-bian-keng Creek

Totally, 5 species were found from investigation and *Zacco pachycephalus* has the highest appearing frequency and quantity. It can be seen that *Rhinogobius rubromaculatus* is the predominant specie in the upstream of stream reach while *Rhinogobius candidianus* has the predominance at the downstream. The conservative specie *Sinogastromyzon puliensis* can only be recorded at the Neidheng Bridge station. The invaded species include *Oreochromis niloticu*, *Tilapia zillii*, and *Shubunkin*. From current field investigations, it was found that *Zacco pachycephalus* and *Rhinogobius candidianus* were species possessed extreme predominance both in weight and quantity.

(B) Liou-chung Creek

Totally, 14 fish species were categorized from field investigation, namely, *Anguilla marmorata*, *Acrossocheilus paradoxus*, *Candidia barbata*, *Microphysogobio alticorpus*, *Zacco pachycephalus*, *Carassius auratus*, *Rhinogobius candidianus*, *Rhinogobius giurinus*, *Rhinogobius maculafasciatus*, *Tilapia zillii*, *Oreochromis niloticu*, *Clarias fuscus*, Taiwan snakehead, and *Carassius cuvieri*. *Zacco pachycephalus* has the highest appearing frequency while Taiwan snakehead has largest quantity. Among all species, only one specie namely, *Anguilla marmorata* was categorized as conservative specie.

(C) Mu-dan Creek

According to the results of investigation from three monitoring stations within two years duration, there totally 14 fish species were found and it displays an obvious longitudinal distribution along stream reach. In the upstream, the *Varicorhinus alticorpus* is predominant specie whereas in middle stream *Acrossocheilus paradoxus* and *Zacco pachycephalus* possess predominance. Subsequently, *Zacco pachycephalus* and *Carassius cuvieri* become predominant in the downstream. However, the invaded

species such as *Tilapia zillii* and *Shubunkin* can only be found at the downstream reach.

(5) Investigations and analyses of shrimp and crab species

(A) Distribution of shrimp and crab species in Tou-bian-keng Creek

(B) Distribution of shrimp and crab species in Liou-chung Creek

(C) Distribution of shrimp and crab species in Mu-dan Creek

### 3 Establishment of Handbook for Investigation of Ecological Resources in Watershed

Based on the experiences of field investigation and the relevant literature reviews, a handbook entitled “Handbook of Field Investigation for Ecological Resources in Watershed ”has been compiled and printed with the contents composed of: Investigation Items, Investigation Methods, Investigation Flow Charts and Biological Index.

### 4 Planning and Design of Habitat Enhancement and Design Reference Book

In addition to hydraulic calculation, erosion and deposition analyses of stream channel, detail design for habitat enhancement for 4 check dams have been conducted in the project and the stream channel has a length of about 800 m . Meanwhile, the detail design of revetment and sill in Mu-dan Creek was also completed and the length of stream channel is about 300 m. Regarding the image simulation, 2 dynamic image simulations for habitat enhancement, 23 and 7 static photo simulations for Liou-chung Creek, and Mu-dan Creek respectively were completed in the project.

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广应用现有科技成果和实用技术, 提高科技成果贡献率。使科学技术尽快转变为现实的生产力。

#### 3.8 加强生态环境建设的执法力度

认真贯彻《森林法》、《水土保持法》、《环境保护法》等法律法规。采取行政、经济和法律手段, 坚决制止破坏生态环境

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### 5 Achievements of Design Method and Image Simulation for Habitat Enhancement

The definition and the principle of visual simulation, simulation techniques and simulation types were depicted respectively. Additionally, commercial software Photoshop and 3ds 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. The 3D simulations of habitat enhancement for dam structure in Liou-chung Creek and sill structure in Mu-dan Creek are presented.

### 6 Brochure Compilation and Printing for Case Histories of Ecological Engineering Method

Using 4 case histories of stream regulation works in demonstrative watersheds, namely, Dintzlan Creek, Houfantzkeng Creek, Jangping Creek and Hua-shan Area, series of brochures and propaganda poster were designed and printed to share the experiences and achievements with general public. The completed works were delivered to the relevant sectors and the works were composed of two brochures entitled “Regulation of debris flow in Hua-shan Area ”and “Dintzlan Creek ”; and two propaganda posters entitled “Houfantzkeng Creek ”and “Jangping Creek ”.

### 7 Education and Training Works of Ecological Engineering

A Taiwan-Japan Conference on Ecological Engineering has been held( July, 2004; March, 2005) and a field trip abroad for site investigation on ecological engineering aspects was also taken in 2004 and 2005.

建设的不法行为。一方面要强化对开发项目的环境管理和资源管理, 对生态环境有影响的基本建设项目, 都要严格执行环境影响评价制度, 并建立起资源评价制度, 对建设项目进行论证、评估和审查。另一方面加强对在建项目的监督管理力度, 严格执行建设项目 “三同时 ”管理制度。