Erosion characteristics in a shallow water area covered with rigid emergent macrophytes

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ABSTRACT

In recent years, riparian zones by riverside have been remediated by revegetation for the purpose of erosion control, rather than by engineering measures such as concrete revetment. Therefore, it is essential to understand the reaction to shallow water scouring of rigid emergent macrophytes and fitness of the plants in riparian zones. In the past, artificial materials such as acrylic cylinders were mostly used as surrogate plants. However, such materials could neither simulate the protecting function provided by the root system against scouring, nor test the survival rate of plants during floods. In this study, we selected four true emergent macrophytes and planted them in a regular array in a recirculating flume for scouring experiments. Each plant was cultivated in the flume under the low-discharge condition in the first month in order to make its root system develop in the soil. Then we increased the discharge gradually for every two weeks during the following two months. Before the discharge was increased each time, the topographic change and erosion amount through the planted- and unplanted-areas were obtained by the laser scanning leaf topography method and the image analysis technique. The growing conditions of the macrophyes were also recorded weekly. From the results, we found that scouring occurred in the channels among stems of macrophytes, and the sediments mostly accumulated around and behind the stems in the planted-area. The phenomenon seemed different from cylinder simulations in the literature, whose results pointed that the flow around a cylinder would cause deep scours while channels between any two cylinders should be accumulation zones at low discharge.

OBJECTIVES

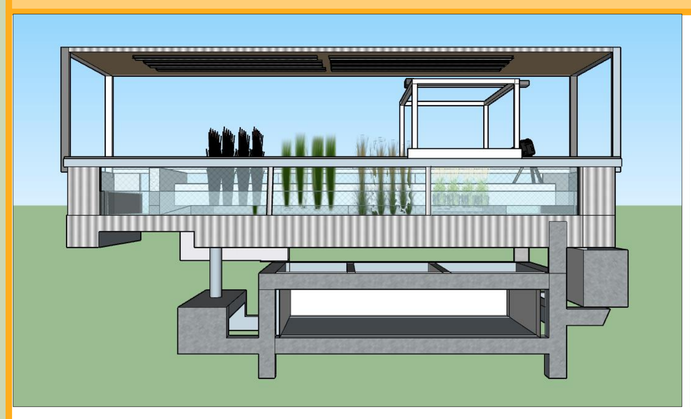
1. Simulating the scour of planted-areas and unplanted-areas in riparian zones under different flow discharge.
2. Compare the growth and survival rates of four different aquatic plants subjecting to different discharge.

PLANT SPECIES SELECTION

1. Selection of common and widely distributed Taiwan native aquatic plants or domesticated species.
2. Select varieties with strong growth potential, low maintenance, and less pest and disease impact.
3. The roots are strong enough to resist the flow..
4. Aquatic plants that can survive within 10 centimeters.

Fig. 1A:Oriental Cat-tail,1B:Common Reed,1C:LanternSeedbox (H), 1D:Shortleaf Galingale

EXPERIMENTAL SETUP



Length：	3m
Width ：	1.2m
Slope ：	2%
Lighting time：	12hr
Height：	1m
Soil ：	Sandy loam
Soil depth	5cm

Fig. 2 Experiment flume

METHODS

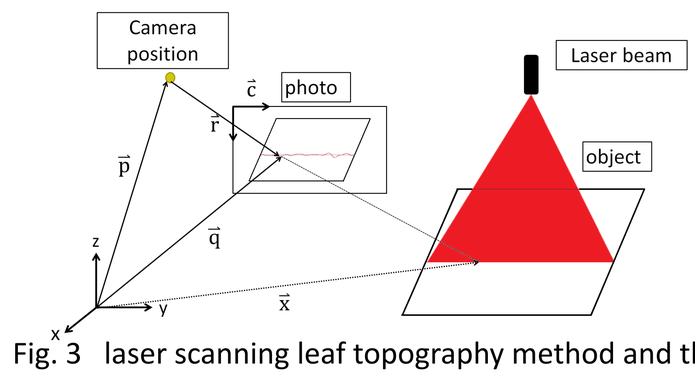


Fig. 3 laser scanning leaf topography method and the image analysis technique (adopted from https://www.wrap.gov.tw/Mobile/paper)

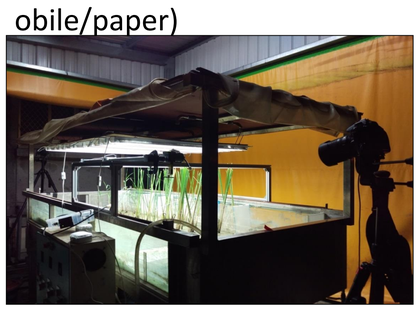


Fig. 4 Scanning the erosion terrain

Fig5 Shooting calibration coordinates

EXPERIMENTAL PROCEDURE

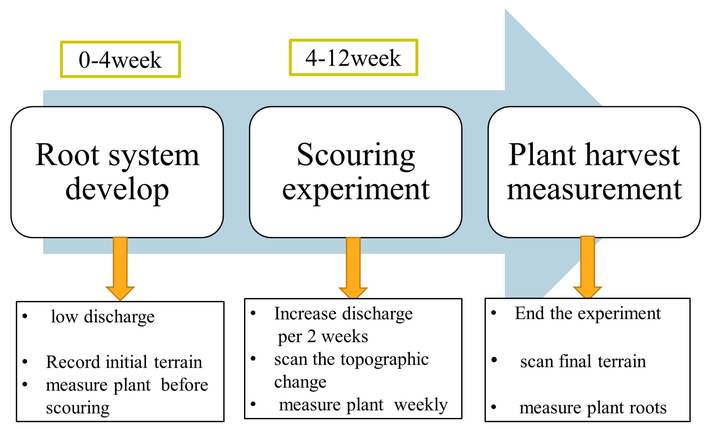


Fig. 6 Flow chart

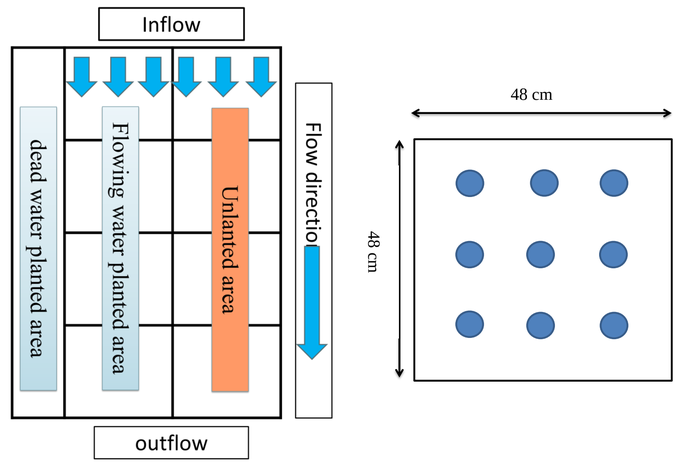


Fig. 7 Configuration diagram

RESULTS AND DISCUSSION

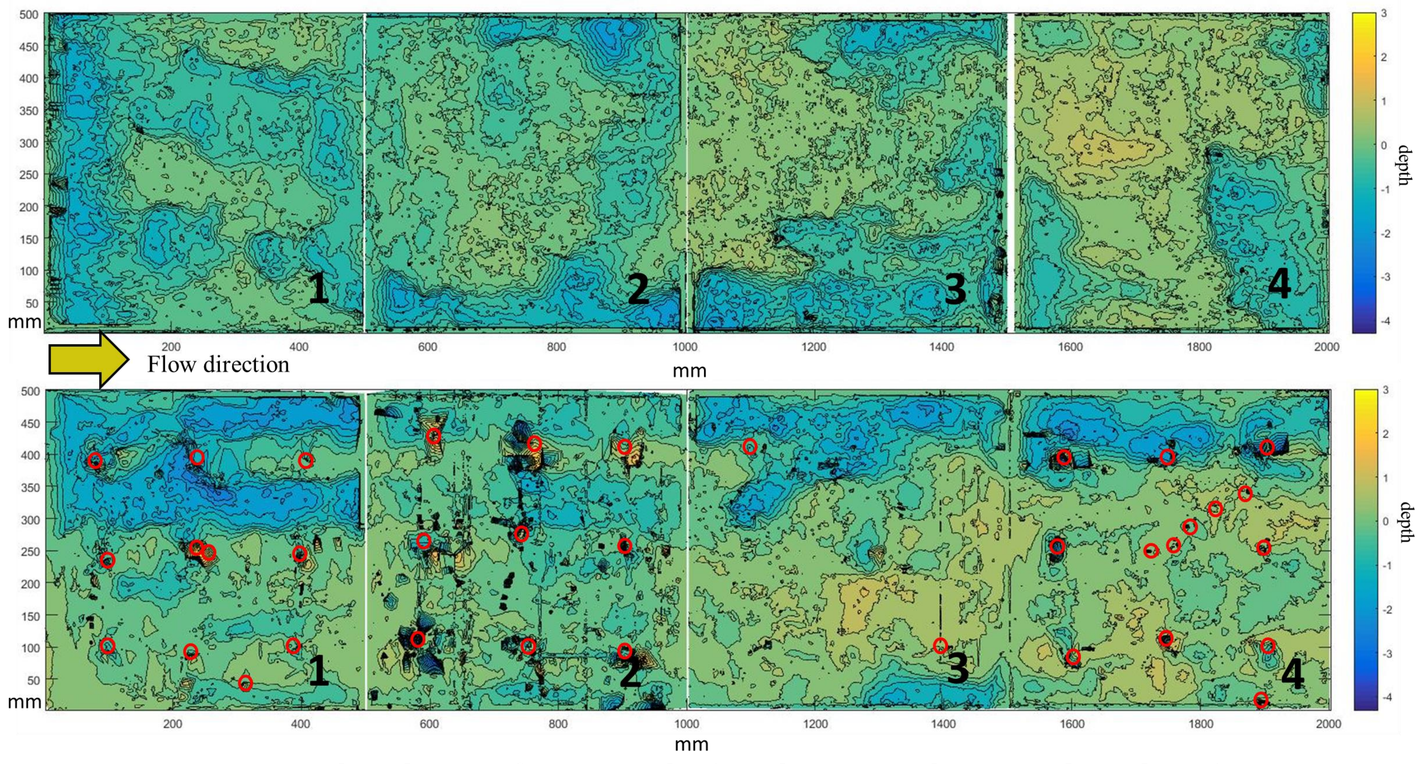


Fig.8 Topographic change after 12 weeks (top: bare area , bottom: planted area)

Bare1	Bare2	Barer3	Bare4	Total bare Area
-1115.1 cm^3	-759.6951 cm^3	-425.8270 cm^3	+302.6902 cm^3	-1997.9 cm^3
Plant1	Plant2	Plant3	Plant4	Total planted area
-1082.3 cm^3	-296.4197 cm^3	-61.2375 cm^3	+144.2380 cm^3	-1295.7 cm^3

Table 1 Scouring/ sedimentation volume measured by topographic change at the end of the experiment.

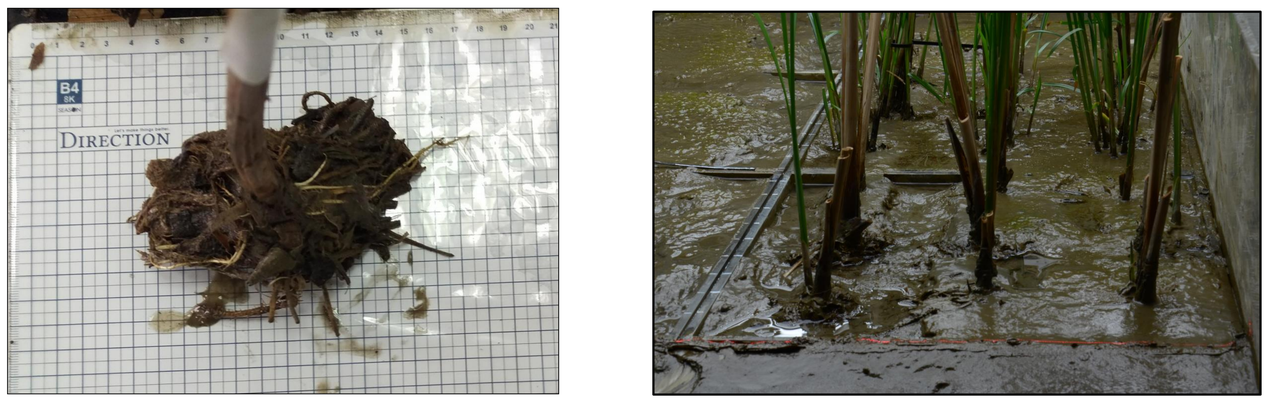


Fig.9 Rhizome diameter is larger than stem above ground and root protection leads to scouring occurred in the channels among stems of macrophytes, and the sediments are mostly accumulated around and behind the stems in the planted-area.