Investigations of Vegetation changes and Corresponding Hydraulic Characteristics of Guandu Wetlands

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ABSTRACT: The aerial photos from 1978 to 1994 were used to analyze the temporal variations of the vegetation changes of the Guandu Nature Reserve that the marsh habitat, dominated by *Cyperus* and *Phragmites*, has changed into a swamp habitat, dominated by *Kandelia*. The variations of the water surface elevation (w.s.e.) due to increase of coverage area of *Kandelia* were also obtained in this study. The mangrove spreads cause a significant impact upon ecosystem and flood control operations. When considering the factors of flood protection and sediment deposition of wetland, the optimal mangrove-removal ratio is between 10% and 20%.

A horizontal two-dimensional model, TABS-2, was applied in this study to simulate the hydraulic and sediment transport characteristics of this estuarine wetland. Four cases with different mangrove-removal rates were investigated. It is found that the w.s.e. decreases as the mangrove-removal ratio increases. When the mangrove-removal ratio of Kandelia reaches 20%, the variations of the decrease of w.s.e. of the wetland became insignificant. The optimal mangrove-removal ratio is between 10% and 20% when considering the factors of flood protection.

1 GENERAL INSTRUCTIONS

The Guandu Nature Reserve (25o 07’ N, 121o 027’ E) lies in the west of the Guandu floodplain, which is located in the confluence of the Keelung and Tanshui Rivers, approximately ten kilometers from the river mouth. The vegetation in the reservation comprises *Kandelia*, *Phragmites* and *Cyperus*. Recently, due to dike construction and other environmental effects associated with human development, *Kandelia* spreads progressively and becomes the main species in this wetland.

The original types of plant in this area are shrubs and trees adapted to the harsh seashore environment, having large and smooth leaves. Some of these plants are oceanic drift plants, whose lightweight and fibrous fruits ride ocean currents and take root in faraway places. Analysis of aerial photographs taken from 1978 to 1994 revealed that the marsh habitat has changed into a swamp habitat. The area covered by Kandelia has increased from 0.04 hectares in 1978 to 20.75 hectares in 1994 (see also Table 1).

Table 1 The variations of mangrove coverage area in Guandu mangrove wetland

Year	Area (ha)	Increasing rate (%)
1978	0.041	*
1979	0.140	245.07
. .	. .	. .
1993	19.499	21.4
1994	23.546	20.75

2 MATERIALS AND METHODS

2.1 *Horizontal two dimensional model, TABS-2*

A horizontal two dimensional numerical model, TABS-2, to simulate the hydraulic and sediment transport simulation is applied in this study.

The TABS-2 model is a two dimensional, depth-averaged, finite element hydrodynamic numerical model developed by the Waterways Experiment Station of U.S. Army Corps. It computes w.s.e. and horizontal velocity components for subcritical, free-surface flow in two-dimensional flow fields. TABS-2 also computes a finite element solution of the Reynolds form of the Navier-Stokes equations for turbulent flows. Friction is calculated according to the Manning or the Chézy equation, and eddy viscosity coefficients are used to define turbulence characteristics. Both steady and unsteady state problems can be analyzed. Please refer to SMS 7.0 Users Manual (2000) for more details.

2.2 *Mesh* generation *and*

The digital image of the study site can be obtained by scanning part of a USGS quadrangle map. The finite element mesh generated from the digital maps defines only the x and y coordinates for the numerical node. The bathymetric information thus can be surveyed using field data and interpolated onto the finite element mesh.

The x, y and z coordinates of this study site were provided based on the Water Resources Agency field data surveyed in 2003 and adjusted using the Taipei Government 1:5000 DTM data.

2.3 *input of boundary* conditions

Under the steady hydraulic simulation case, the upstream and downstream boundary conditions, including the two year, five year, ten year, and 20 year floods and the river mouth w.s.e., were cited in the investigations conducted by the Water Resource Organization (1996). The upstream and downstream boundary conditions were presented in Figure 3 and 4.

2.3 *Mangrove-removal cases*

Twelve cross-sections were chosen, as presented in Figure 2, to observe the variation of w.s.e. and riverbed elevation. Four mangrove-removal cases were established to discuss the hydraulic effect and sediment retention, including the 0, 20, 30 and 50 percentage removal ratios. Figure 2 illustrates the location of the mangrove-removal cases.

The western part of the mangrove swamp is older than the others, and so the mangroves in this area are taller and wider than those in the eastern area. However, the taller trees induced higher w.s.e. and thus raised the risk of flood bypassing the dikes. Therefore, the priority areas for mangrove removal were identified as being in the western and southern areas, respectively. Table 2 describes and defines the four mangrove-removal cases.

Table2 Four mangrove-removal cases description

Case no.	mangrove-removal ratio（%）	Mangrove-removal area（ha）
Case 1	0	0
Case 2	20	4.52 （6 elements）
Case 3	30	6.77 （9 elements）
Case 4	50	11.29 （15 elements）

3 RESULTS AND DISCUSSION

3.1 *Hydraulic analysis results*

The results simulated by TABS-2 demonstrate that for a 20% mangrove-removal ratio, moderate reduction of w.s.e. occurs throughout the 2-year return period flood, with a decrease in w.s.e. of 4mm – 76 mm. Increasing mangrove-removal ratio to 30% or 50% produced a 6mm – 75mm reduction in w.s.e.

In other works, larger reduction than 20% had no further effect on w.s.e. for a 2 year flood, nor for 5, 10, 20 year flood. The observed trends of five, ten and 20 year flood elevation reductions were almost identical to those for two year flood.

Therefore, the trend of changes of w.s.e. for 20% mangrove-removal ratio was similar to cases where mangrove-removal ratio was increased to 30% and 50%, resulting in a 6 – 75 mm w.s.e. decrease. The trends of 5, 10 and 20 years flood w.s.e. reductions were similar to the two years flood. The results were shown in Figure 5, 6, 7 and 8.

4 PHOTOGRAPHS AND FIGURES

The figures are shown as follows:

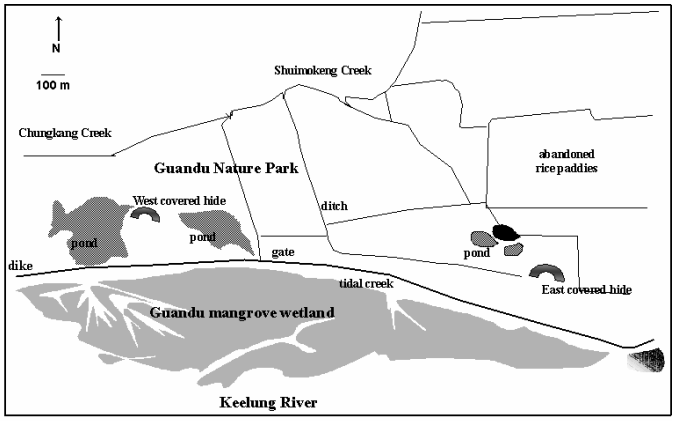

Figure 1. The schematic plot of study site

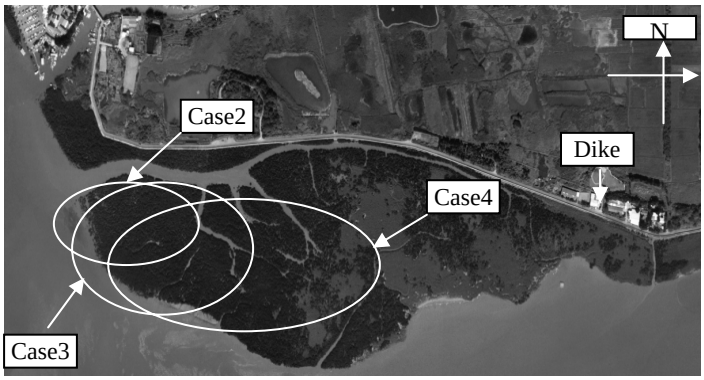

Fig.2 The schematic location of mangrove-mangrove-removal cases

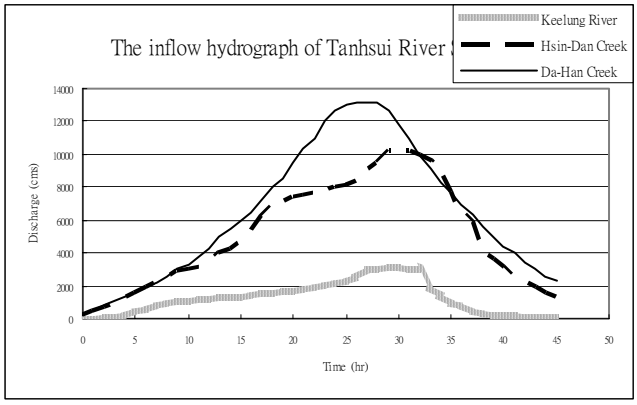

Figure 3. The 200-year flood hydrograph of Tanshui River System

(Source: Water Resources Agency, 1996)

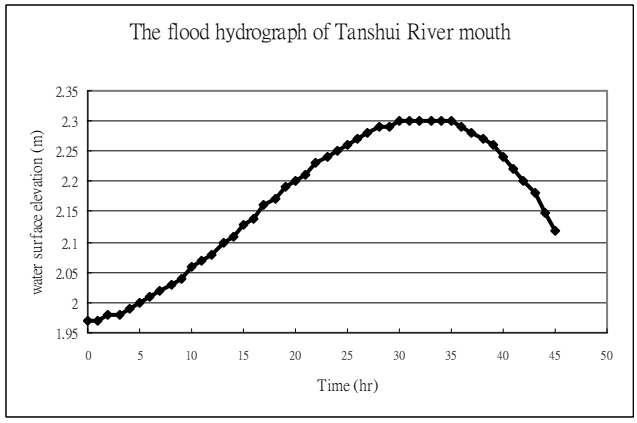

Figure 4. The 200-year flood hydrograph of river mouth (Water Resources Agency, 1996)

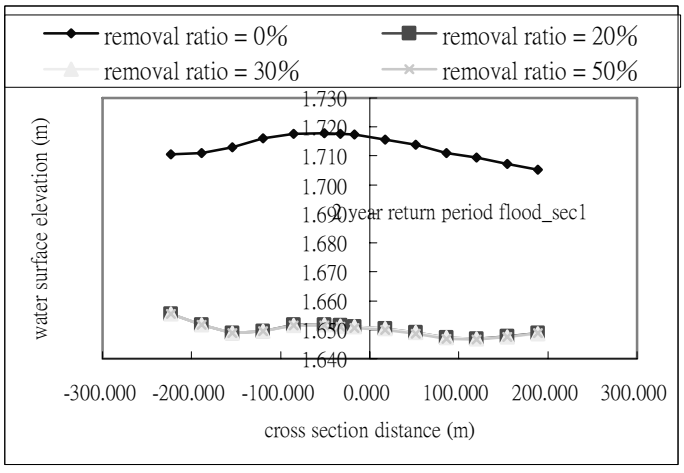

Figure 5. The w.s.e. variation according to four mangrove-removal cases under 2-year flood

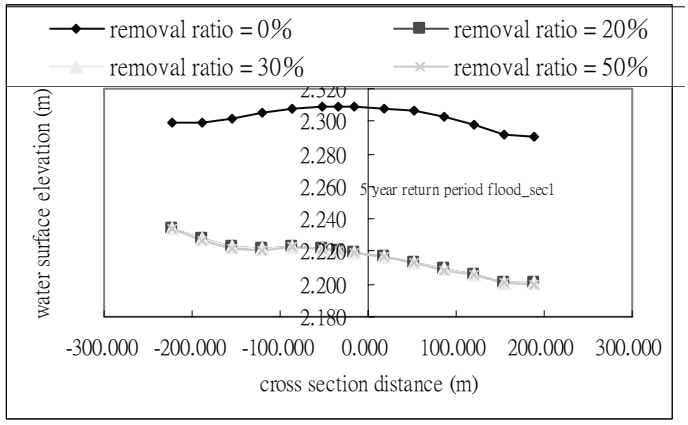

Figure 6. The w.s.e. variation according to four mangrove-removal cases under 5-year flood

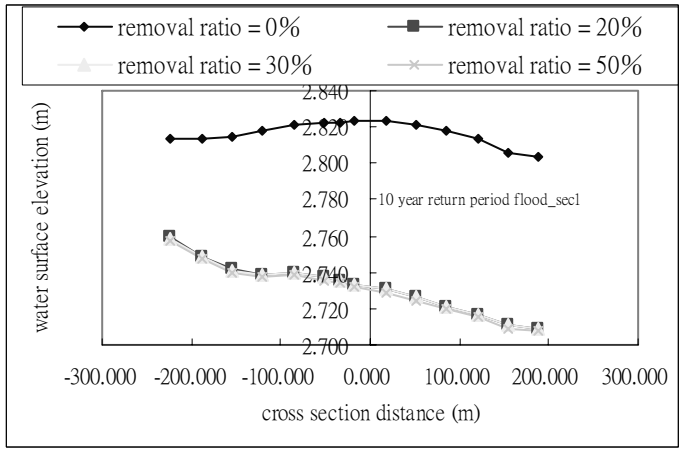

Figure 7. The w.s.e. variation according to four mangrove-removal cases under 10-year flood

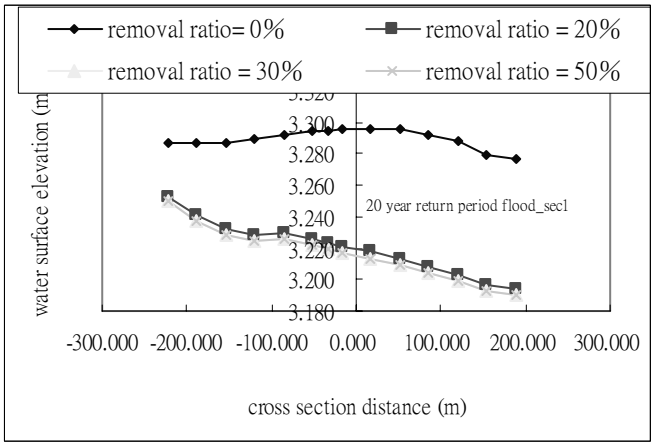

Figure 8. The w.s.e. variation according to four mangrove-removal cases under 20-year flood

5 PREFERENCES, SYMBOLS AND UNITS

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