Basic Structure of Flood Inundation Model in the Mekong Delta
メコンデルタにおける洪水氾濫モデルの基本構造

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Introduction

This study is to develop a flood inundation model in the Mekong Delta that can be used for examining the possibility and effectiveness of semi-control of flood for improvement of agricultural practices in specific areas. The application of hydraulic model can help for analysis the inundation process on the flooding area. In this paper, sub-area based reservoir model is taken into account for the first step before applying hydraulic model. The outcome of this model is expected to be useful for planning of flood control measures and managing the control facilities for irrigated farmland in the Mekong Delta. Temporal and spatial data required for modeling were collected and summarized in **Table 1**.

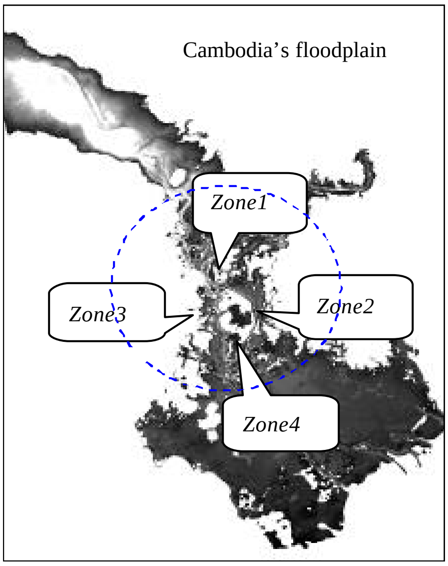

Fig.1 : Zoning of the Mekong Delta

Table 1 : Data collection

No	Data	Description	Sources
1	DEM of the Mekong Delta	100 meter posting, Map:scale:1:100,000	Mekong River Commission (MRC)
2	GIS data from MRC	Land cover/Soil/Drainage/Flood map	Mekong River Commission (MRC)
3	Cambodia's GIS (phase I&II)	Landuse/Drainage/Geology/Raod	Min. Public Work and Transportation
4	Water level (2002~03)	20 stations at variouse point in the floodplain	Min. Water Resources,Phnom Penh
5	Water level (2003)	Mainstream of the Cambodia's floodplain	Min. Water Resources,Phnom Penh
6	Rainfall (1995~2000)	5 stations in the Cambodia's flooplain	Min. Water Resources,Phnom Penh
7	Evaporation (2004)	1 staion in Phnom Penh	Min. Water Resources,Phnom Penh
8	CD with PopMap application	Consist of country map/map each 24 prov.	Min. of Planning, Phnom Penh
9	Agricultural statistics	Cropping pattern from 2000~2004	Min. of Agriculture

The Flood Inundation Model

In the previous approach, the whole Cambodia's floodplain was divided into 4 zones based on the mainstreams network (see **Fig.1**) and water balance there was analyzed (Sothea. K. et al. 2003). For detail analysis of water movement in the zoned areas, the zones were divided again into a total of 24 sub-areas (SA). In the Mekong Delta, water flow is governed by micro-topography such as natural levees, back-mash, natural or artificial channels and embankments. For instance, a part of water from Mekong and Basac rivers is drawing into the back-mash through *Colmatage* canals and this water is used for agricultural production in both rainy and dry seasons. The sub-areas were set considering those governing factors. **Figure 2** shows sub-divided area in the entire flooding area, and **Table 2** presents the size of each divided zone and sub area. For the first step, a simple sub-area based reservoir model is employed. The exchange of flow between sub-area (SA) and the river and neighboring SAs in time step △*t* takes place maintaining the mass balance equation:

$$V_l^{t+1}=V_l^t+(Q_{in}^{t+1}-Q_{out}^{t+1})\Delta t+R-ET_a-Inf \qquad (1)$$

where, V_l is volume of water in floodplain compartment at time $t+1$, Q_{in} is inflow from the river to SA or from SA to SA, Q_{out} is return flow between river and SA or neighboring SAs, R is net rainfall, ET_a is evapotranspiration, Inf is infiltration, t is time.

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The flow into or from of a certain sub-area is determined according to the structures links (Riccardi, 1998) as follows:

1. Flow controlled by wire link

$$Q_{k,i} = m_1 b\sqrt{2g}\left(h_k - h_i\right)^{3/2} \qquad (2) \qquad \text{-if } h_k > h_w \text{ and } h_k > h_i$$

$$Q_{i,k} = m_2 b\sqrt{2g}\left(h_i - h_w\right)\sqrt{\left(h_i - h_k\right)} \qquad (3) \qquad \text{-if } h_i > h_w \text{ and } h_i > h_k$$

The equation (2) is used also for the link between river and SA, whereas equation (3) is used for return flow from SA into river.

2. Flow controlled by culvert link

$$Q_{k,i} = \frac{1}{n} A_{k,i} R_{k,i} \sqrt{\left(h_k - h_i\right)} \qquad (4) \qquad \text{-for full flow through culvert}$$

$$Q_{k,i} = A_{k,i}\sqrt{\frac{gA_{k,i}}{B_{k,i}}} \qquad (5) \qquad \text{-for critical depth}$$

3. Head loss or control section link

This link is used for flow singularity with head loss due to abrupt changes in cross-section. Two flow conditions are possible (free and submerged).

$$Q_{k,i} = \sqrt{2g\left(h_k - h_{Cri}\right)/\left(Cd^{-2}A_{Cri}^{-2} - A_{k,i}^{-2}\right)} \qquad (6)$$

$$Q_{k,i} = \sqrt{2g\left(h_k - h_i\right)/\left(Cd^{-2}A_{Sc}^{-2} - A_{k,i}^{-2}\right)} \qquad (7)$$

In the above equations, $Q_{k,i}$ is discharge flow between SA_k and SA_i; $h_{k,i}$ is water depth between SA_k and SA_i, S is slope of the two SA_k and SA_i; h_w is crest elevation; μ_1, μ_1 are coefficients; h_{Cri} is $A_{k,i}$ is cross-section area of $(SA)_{k,i}$; R is perimeter; g is acceleration of gravity, $B_{k,i}$ is top width of culvert between SA_k and SA_i; h_{Cri} is critical level in control section; Cd is discharge coefficient in control section ; A_{Cri} is wetted area of control section for critical level; A_{Sc} is wetted area in control section.

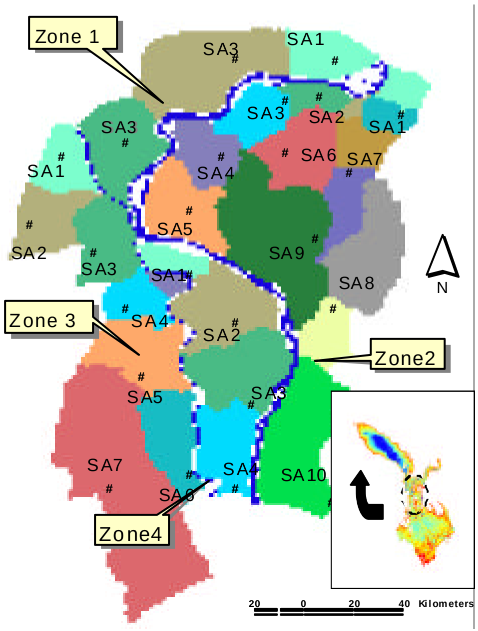

Fig2: Diving zone into sub-area

Table2: The size of sub-zoning

Sub-Area (SA)	Area (km^2)	Water Level station
Zone 1		
Sub-Area 1	127	MRC's WL station (P1)
Sub-Area 2	484	MRC's WL station (P2)
Sub-Area 3	334	MRC's WL station (P3)
Total in Zone 1	945 (1)	
Zone 2		
Sub-Area 1	115	MRC's WL station (P8)
Sub-Area 2	126	MRC's WL station (P9)
Sub-Area 3	197	
Sub-Area 4	214	MRC's WL station (P20)
Sub-Area 5	316	MRC's WL station (P11)
Sub-Area 6	331	
Sub-Area 7	330	MRC's WL station (P12)
Sub-Area 8	608	MRC's WL station (P13)
Sub-Area 9	763	MRC's WL station (P14)
Sub-Area10	613	MRC's WL station (P16)
Total in Zone 2	3613 (2)	
Zone 3		
Sub-Area1	179	Newly WL installation
Sub-Area2	209	
Sub-Area3	281	
Sub-Area4	204	MRC's WL station (P18)
Sub-Area5	350	Newly WL installation
Sub-Area6	295	MRC's WL station (P19)
Sub-Area7	1280	
Total in Zone 3	2798 (3)	
Zone 4		
Sub-Area1	102	MRC's WL station (P6)
Sub-Area2	378	
Sub-Area3	387	MRC's WL station (P7)
Sub-Area4	295	MRC's WL station (P17)
Total in Zone 4	1162 (4)	
(1)+(2)+(3)+(4)	***8518***	

Future Plan

For the next step, a floodplain model based on 1D and 2D hydraulic models (Kazama et al. 2002) together with GIS is to be employed for simulating flood water and the inundation extent in the Delta.

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Reference:

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