Paper presented at the 22nd Asian Conference on Remote Sensing, 5 - 9 November 2001, Singapore.

GIS APPLICATION FOR ADMINISTRATION AND MANAGEMENT ON BUNG RACHANOK RETARDING BASIN MULTI-PURPOSE PROJECT

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KEY WORDS: Bungrachanok, Phitsanulok, GIS, Retarding Basin, inundate area, flooding.

"ABSTRACT" Bung Rachanok retarding basin multi-purpose project had located on Muang district, Phitsanulok province. The main problem of this project is flood which impacted on the residential, agricultural areas and others especially during the big monsoon come in. The mean annual rainfall around on this area was about 1,836.73 mm.. Geographic Information System (GIS) is a tool for decision making on the location of conveyance structures with flood dike protection, housing, building, planted zoning and infrastructure system in this project. The 9 spatial data of the land use , soil suitability, contour lines, sloping areas, transportation, ,crop plantation, infrastructures, water body uses, streams or canals and socio-economic data were interpreted and analyzed by using GIS . The run off this project area was calculated. The terrain analyze was applies for study flood flow. The suitable locations of the conveyance structures, flood dike protection, housing, building, planted zoning and infrastructure system were defined by calculation from their slopes, horizontal and vertical interval due to the water and flood flow. All layers of spatial data were considered with many structures above that each model were set-up and re-adjusted. There for each structure above should be done for the flood safety and be water enough for agriculture and fishery in dry season including water uses.

INTRODUCTION

Bung Rachanok is the swamp area in the east of Phitsanulok province. Bung Rachanok have a potential to store a great deal of water for the whole year round. In rainy season, this place had served the over flow water from the upstream. In some years such as in 2000, the heavy rain fall and over flow of upstream have been occurred and damage to those area nearby Bung Rachanok. Therefore, it is better to using GIS technology for flood control and planning which is very necessary for the local government agencies..

OBJECTIVES

1). To manage flood control in Bung Rachanok and retarding basin area by using GIS technology.
2). For better decision making process in water resources planning and development in catchment of Bung Rachanok

THE STUDY AREA

The catchment area of Bungrachnok retarding basin is 5,431.2 ha, covered 3 sub-districts. Wang Thong and Wang Pikul sub-district is in Wang Thong district and Samorkare sub-district is in Muang Phitsanulok. There is main river namely Wang Thong River which flowed at the eastern size of the study area. Sometimes, flooding and over bank has been occurred by the effect of Wang Thong River, as shown in Fig. 1. Khokchang stream is a natural inflow to study area. Bungrachnok retarding basin's elevation is ranged between 29 – 47 m above the mean sea level (MSL). The soil series in study area had been identified into 6 groups, there are 4 groups of soil series suitable for paddy field and other 2 groups of soil series suitable for orchards.

The water balance in the study area at each month excluding inflow and outflow of underground water showed as the Fig. 2 and equation below.

$$S_{i+1} = (S_i + P_i + R1_i – E_i – T_i – I_i) – R2_i$$

Where S_{i+1} is the volume (m^3) of water storage in the next day (i+1),
S_i is the volume (m^3) of water storage each day (i)
P_i is volume (m^3) of rainfall in each month (i)
$R1_i$ is the volume of inflow
E_i is evaporation volume in each day i
T_i is plant transpiration in each day i
I_i is infiltration in each day i
$R2_i$ is the volume of outflow at day i

P_i = $54312127.409 * RF_i / 1000$ m^3
Where RF_i is rainfall at i (mm.)
R1 (m^3) = Catchment area x Rainfall x Runoff coefficient

$R1_i$ = $160 \times RF_i \times RO_i \times 10$ m^3
Where RO_i is the runoff coefficient at day i

$E_i = rE_i * A_i / 1000$ m^3 ($A_i = 1.0684*10^7*Ln(P_i + R1_i + S_i) - 1.5457*10^8$ m^2 ; $r^2 = 0.8957$)
Where rE_i is the rate of evapotranspiration at day i
A_i is inundate before inflow coming at day i
S_1 = 1,042,000 m^3 ; Date 1st April 1995
A_i = 3,383,000 m^3 ; When $H_i \leq 37$ m (MSL)

$T_i = 33845764.165 * rT_i / 1000$ m^3
Where rT_i is rate of plant evaporation at day i

$I_i = rI_i * A_I / 1000$
Where rI_i is rate of infiltration at day i

$H_i = 1.6639Ln(P_i + R1_i + S_i - E_i - T_i - I_i) + 12.163$ meter ; $r^2 = 0.887$
Where H_i is the flood depth before outflow

$Qi = 1.65 * L * (H_i-38)^{1.5}$ m^3/Sec
Where Qi is the rate of outflow
L is the length of flood dike protection was 20 m.

$R2_i$ = $Qi*86400$ m^3/day
= 0 ; when $(P_i + R1_i + S_i - E_i - T_i - I_i) \leq 6,175,160.72$ m^3
Where $R2_i$ is the volume of outflow at day i
Note r^2 is the correlation, which calculated by using the linearity regression analysis

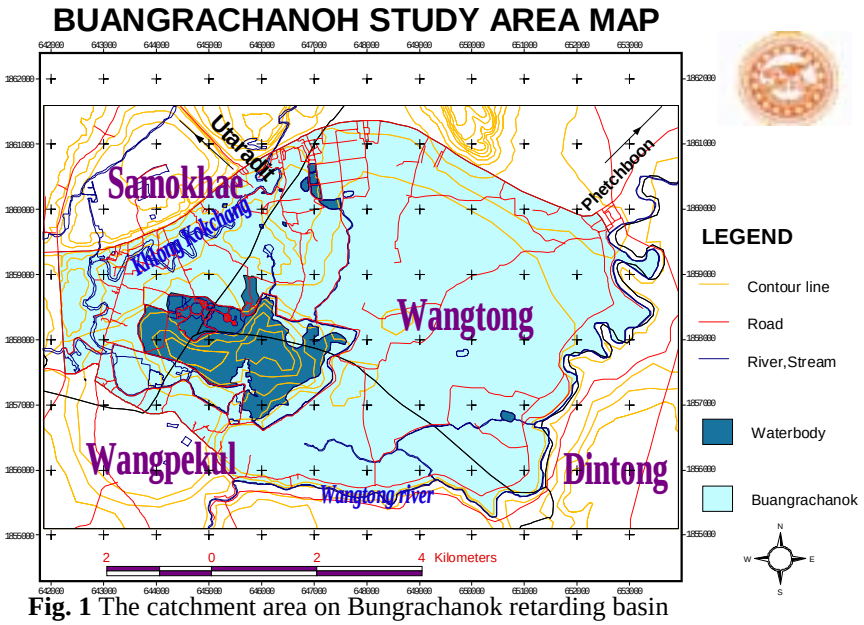

Fig. 1 The catchment area on Bungrachanok retarding basin

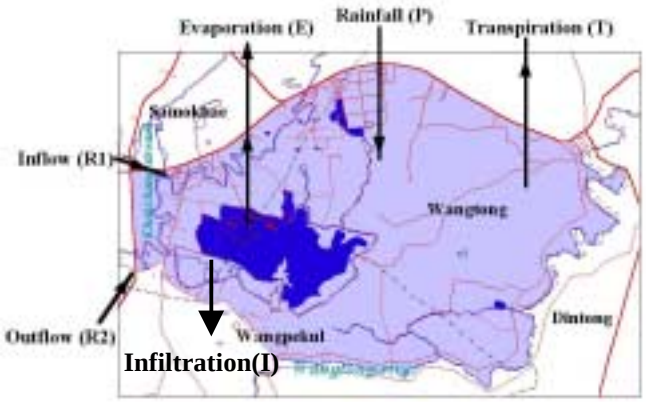

Fig. 2 Hydrological cycle in the Bungrachanok retarding basin

METHODOLOGY

Workflow is as follows,

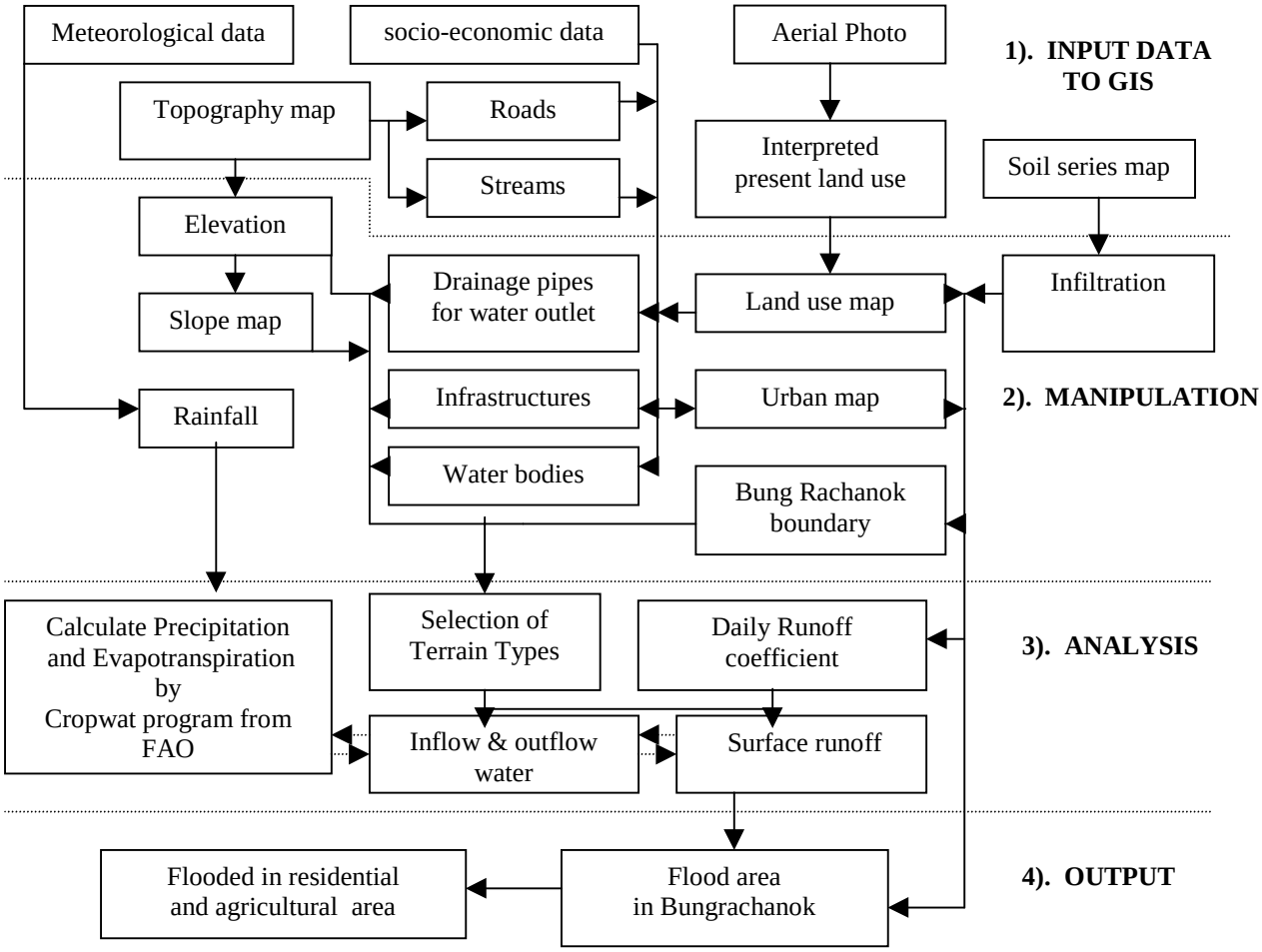

Fig. 3 Methodology of GIS and hydrology processes steps of using GIS and calculation as ;

1) Input meteorological data, socioeconomic data, topography map, aerial photos, roads and streams network, interpreted present land use and soil series to geographic information system (GIS)
2) Manipulation on elevation, slope map, rainfall, outlet pipes for water drainage, infrastructures, water bodies, land use map, urban map Bungrachanok boundary and soil suitability for planting.
3) Calculation on precipitation and evapotranspiration by using Cropwat program from FAO.
4) Analysis drainage area, inflow and outflow from monthly runoff coefficient distribution.
5) Output data are residential and agricultural flooding area ,including flood area in Bungrachanok

RESULTS AND CONCLUSIONS

From the terrain GIS module for analysis of Bungrachanok found that the total area is 54.312 km^2. The attitude of the study area is ranged between 29 to 47 m. The maximum volume of Bungrachanok for storage water will be totally 380.840 million cubic meters as shown in Table 1.The total rainfall was 1,836.74 mm, in 1995. The peak rainfall was in August, while the drought was in January 1996.

Table 1 The relationship between storage volume of water and depth of water (MSL) in Bungrahanok

Elevation of the Mean Sea Level (m)	Area vary in MSL (km^2)	Accumulated areas ($1x10^6 x m^2$)	Maximum level of water storage ($1x10^6 x m^3$)	Accumulation volume of water ($1x10^6 x m^3$)
Less Than 37	3.383	3.383	1.042	1.042
37-37.5	3.144	6.527	2.478	3.519
37.5-38	3.745	10.272	4.200	7.719
38-39	4.271	14.544	12.408	20.127
39-40	7.521	22.065	18.304	38.431
40-41	10.596	32.661	27.363	65.794
41-42	21.650	54.311	43.486	109.280
42-43	0.001	54.312	54.312	163.592
43-44	0.000	54.312	54.312	217.904
44-45	0.000	54.312	54.312	272.216
45-46	0.000	54.312	54.312	326.528
46-47	0.000	54.312	54.312	380.840
Total	54.312	-	380.840	-

Note : There is weir at outflow portion with crest height is +38.00 m. (MSL)
The annual runoff volume into the study area can be calculated by the following equation:

The result of calculation inflow and outflow, without inflow water from Wang Thong River and the drainage of the outflow will begin at the water level is more than +38 m. MSL had shown in Fig. 4. The heavy rainfall presented in August 1995. The maximum of rainfall, inflow, storage water, evapotranspiration, plant transpiration, infiltration, rate of out flow and outflow were 67 mm., 14.056 x 10^6 m^3, 7.180 x 10^6 m^3, 0.012 x 10^6 m^3, 0.193 x 10^6 m^3, 0.014 x 10^6 m^3, 61.981 m^3 /sec and 5.355 x 10^6 m^3, respectively. Flooding in August happened 3 times. The first flooding occurred during on 1^{st} – 3^{rd} August 1995, the maximum depth of overflow was 0.37 m. and the overflow volume was 6.937 x 10^6 m^3. The second flooding occurred during 5^{th} –16^{th} August 1995, the maximum depth of overflow was 0.71 m. and the overflow volume was 6.770 x 10^6 m^3. The third flooding occurred during 18^{th} –31^{th} August 1995, the maximum depth of overflow was 0.24 m. and the overflow volume was 6.394 x 10^6 m^3. The detail showed in Table 2.

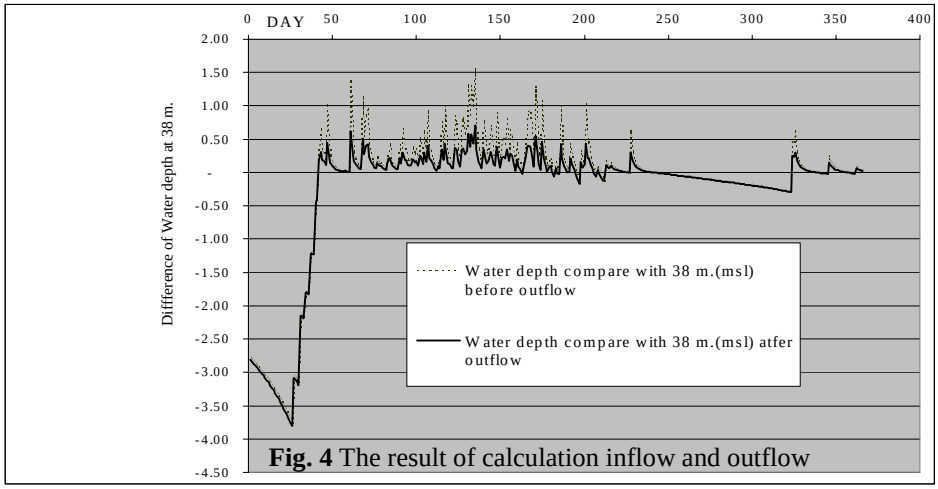

Fig. 4 The result of calculation inflow and outflow

Table 2 The result of calculated flood in August,1995 at Bungrachanok area

Date	Rain Fall (mm)	Storage before outflow(S) m^3	Total inflow (S+P+R1-E-T-I) m^3	Outflow (R2) (m^3)	Storage after outflow(S) (m^3)	Flooding level (H-38) (m)
1	33.9	5,731,905	9,008,960	2,071,776	6,937,184	0.37
2	16.2	6,937,184	8,395,690	1,637,522	6,758,168	0.33
3	0.0	6,758,168	6,564,445	425,919	6,138,526	0.17
4	0.0	6,138,526	5,982,253	129,055	5,853,199	-
5	29.4	5,853,199	8,679,549	1,838,094	6,841,456	0.35
6	21.4	6,841,456	8,852,962	1,961,036	6,891,926	0.36
7	9.7	6,891,926	7,681,966	1,141,203	6,540,763	0.28
8	18.5	6,540,763	8,225,731	1,518,051	6,707,680	0.32
9	54.1	6,707,680	12,032,403	4,176,250	7,856,153	0.58
10	14.8	7,856,153	9,149,905	2,171,880	6,978,024	0.38
11	50.0	6,978,024	11,873,074	4,068,986	7,804,088	0.57
12	22.0	7,804,088	9,844,663	2,664,479	7,180,184	0.43
13	67.0	7,180,184	13,837,080	5,355,118	8,481,962	0.71
14	1.9	8,481,962	8,435,400	1,665,512	6,769,888	0.33
15	0.0	6,769,888	6,528,177	405,172	6,123,005	0.17
16	1.6	6,123,005	6,049,011	158,198	5,890,813	0.10
17	1.5	5,890,813	5,823,690	67,330	5,756,360	-
18	29.9	5,756,360	8,555,113	1,750,040	6,805,073	0.34
19	2.6	6,805,073	6,800,364	565,967	6,234,397	0.20
20	3.3	6,234,397	6,329,268	295,881	6,033,387	0.14
21	7.9	6,033,387	6,587,118	439,004	6,148,114	0.17
22	22.1	6,148,114	8,150,090	1,465,081	6,685,009	0.31
23	10.1	6,685,009	7,428,937	970,141	6,458,795	0.25
24	0.0	6,458,795	6,183,934	221,704	5,962,231	0.12
25	3.9	5,962,231	6,066,471	166,085	5,900,386	0.10
26	34.8	5,900,386	9,191,067	2,201,117	6,989,950	0.39
27	0.0	6,989,950	6,693,668	501,606	6,192,062	0.18
28	0.0	6,192,062	5,882,989	89,039	5,793,951	0.07
29	15.6	5,793,951	7,104,681	757,098	6,347,583	0.23
30	11.4	6,347,583	7,236,967	843,028	6,393,940	0.24
31	7.7	6,393,940	6,900,904	627,971	6,272,933	0.21

Note : The above calculation excluded over topping flow from Wang Thong river.

Moreover, from land use overlaying, we found that the maximum flooding area in paddy field in 13th August 1995 was about 681.28 ha but it was not much damage. The flood in residential area covered 10 villages in 84.97 ha, there are Nong Tor, Samorkher, Don Muong, Bungrachanok, Wang Phrom, Wang Saphan, Wang Pikul, Nong Tasri, Wang Padu and Dong Khoi villages. Those inundate in residential area had been shown in Table 3 and Fig. 5 and 6.

Table 3 The inundate area both in paddy field and residential area

Items	**Villages name**	**Sub-district**	**District**	**HECTARES**	**Households**
1	Nong Tor	Samorkher	Muang	6.304	134
2	Samorkare	Samorkher	Muang	17.865	157
3	Don Muong	Wang Thong	Wang Thong	1.005	152
4	Bungrachanok	Wang Thong	Wang Thong	0.191	183
5	Wang Phrom	Wang Thong	Wang Thong	22.169	164
6	Wang Saphan	Wang Thong	Wang Thong	25.748	131
8	Wang Pikul	Wang Pikul	Wang Thong	3.175	184
9	Nong Tasri	Wang Pikul	Wang Thong	2.440	89
10	Wang Padu	Wang Pikul	Wang Thong	3.026	137
11	Dong Khoi	Wang Pikul	Wang Thong	3.050	145
Total				**766.173**	**1,476**

RECOMMENDATION

GIS technology can be applied for the calculation of flooding both in time and area which is a capable to for water resources management especially for flood warning and people migration in the future if daily data or hourly data had been input to the model.

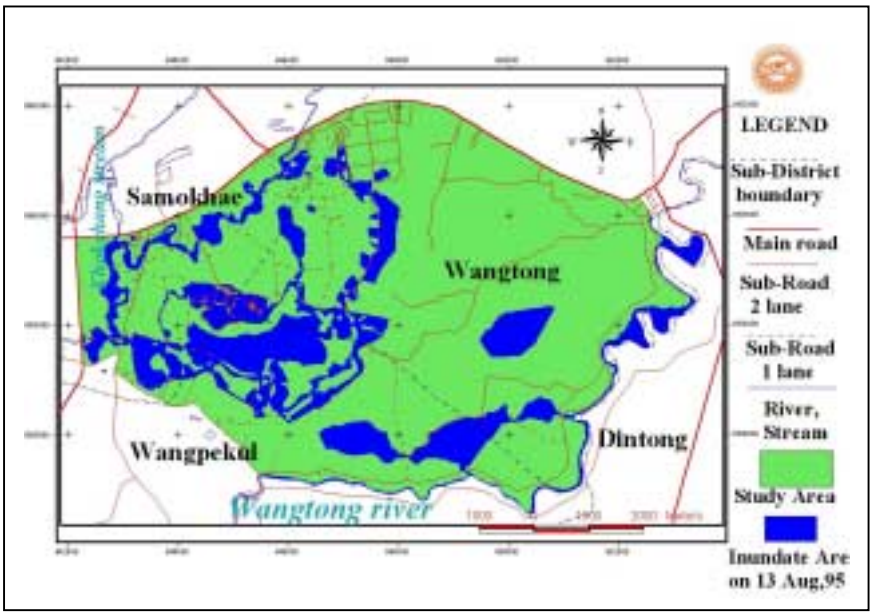

Fig. 5 Flooding map in 13th August 1995, at Bungrachanok retarding basin.

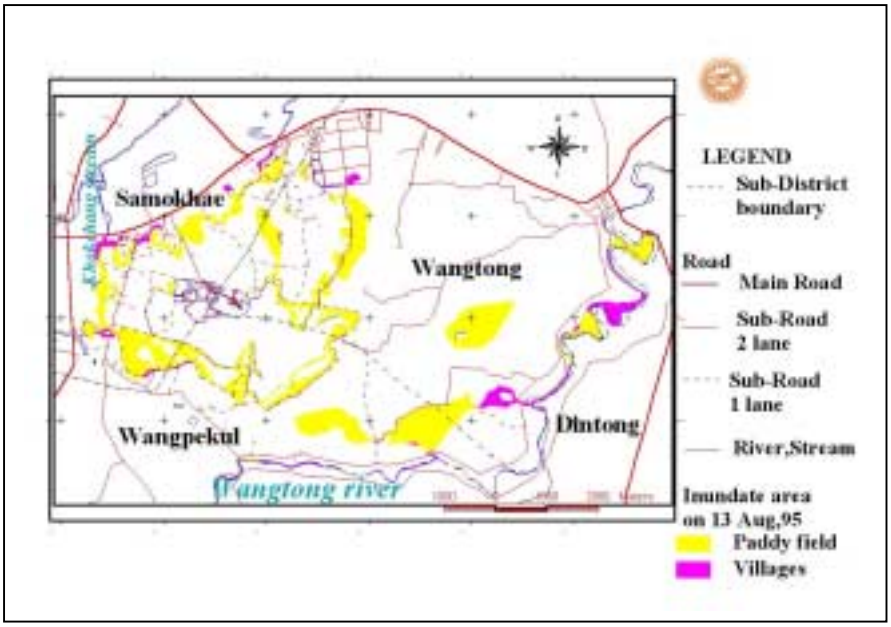

Fig. 6 Flooding map for paddy fields and villages in 13th August 1995, at Bungrachanok retarding basin.

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