USING NUMERICAL PREDICTED RAINFALL DATA FOR A DISTRIBUTED HYDROLOGICAL MODEL TO ENHANCE FLOOD FORECAST: A CASE STUDY IN CENTRAL VIETNAM

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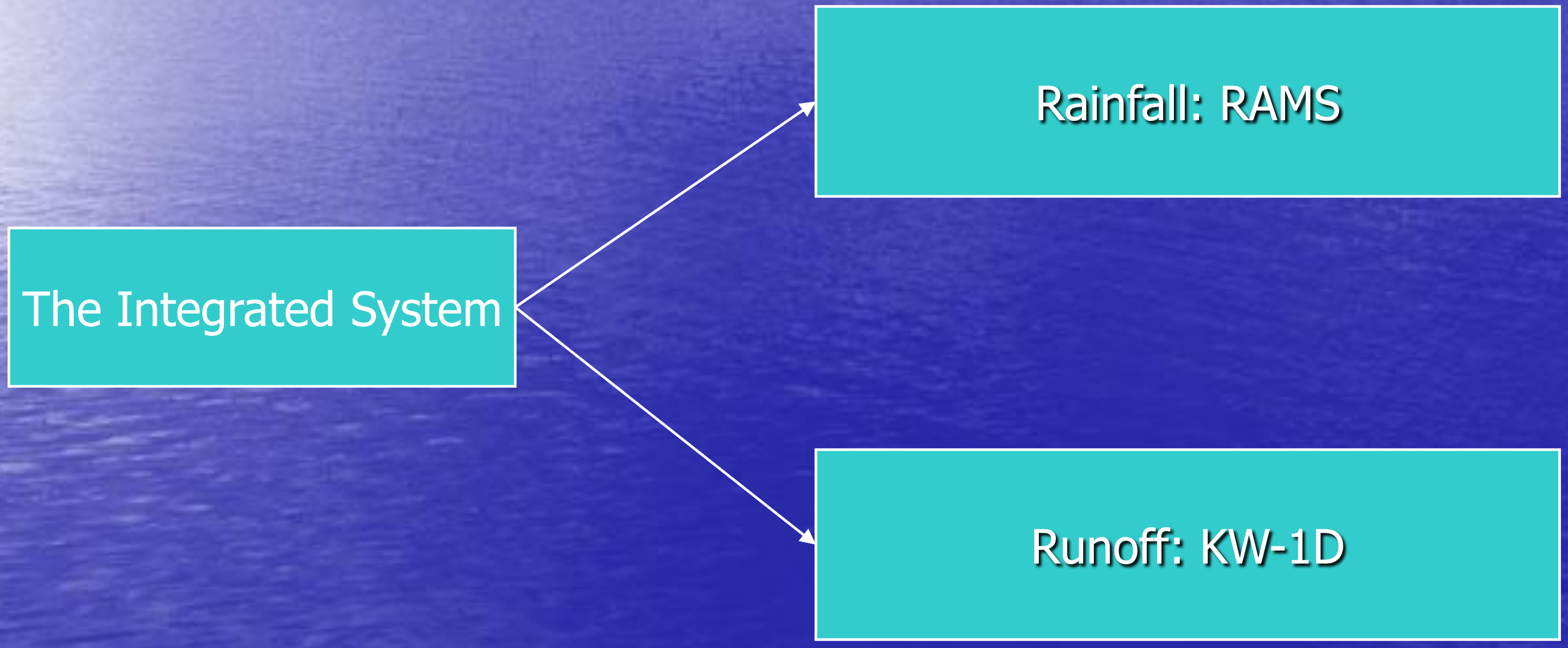
I. Introduction

- About The Central of Vietnam
  - ✓ Placed in Asia Pacific – region having most storm in the world
  - ✓ Have high steep → Transition time is short
  - ✓ Complex topography and various land use
  - ✓ Rainfall distribution isn't homogenous

I. Introduction



II. Methods and Materials

- RAMS Model
- KW-1D Model

RAMS Model

Fundamental Equations

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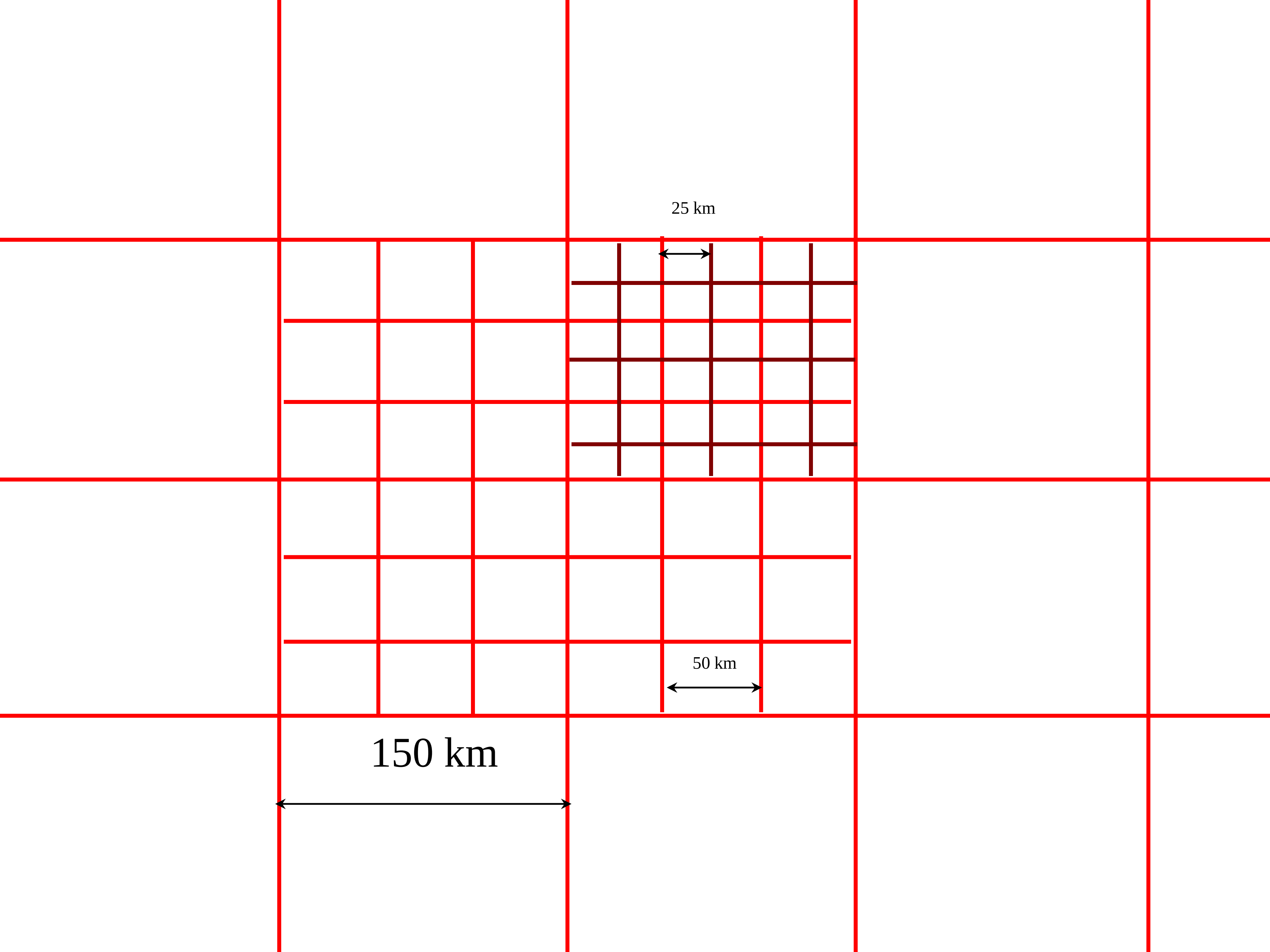
$$\frac{\partial \pi}{\partial t} = -\frac{R\pi_0}{c_v \rho_0 \theta_0}\left(\frac{\partial \rho_0 \theta_0 u}{\partial x} + \frac{\partial \rho_0 \theta_0 v}{\partial y} + \frac{\partial \rho_0 \theta_0 w}{\partial z}\right)$$

With Hydro-static assumption

$$\frac{\partial \pi}{\partial z} = -\frac{g}{\theta_v} + g(r_T - r_v)$$

$$\frac{\partial \rho u}{\partial x} + \frac{\partial \rho v}{\partial y} + \frac{\partial \rho w}{\partial z} = 0$$


25 km
50 km
150 km

KW-1D Model

Deterministic model

Process of water concentration

infiltration

One-dimensional kinematic wave model

$$\frac{\partial Q}{\partial x}+\frac{\partial A}{\partial t}=q \qquad Q=\frac{1}{n}R^{2/3}S^{1/2}A$$

SCS method

$$\frac{F_a}{S}=\frac{P_e}{P-I_a} \qquad P_e=\frac{(P-I_a)^2}{P-I_a+S}$$

$$I_a=0,2S \qquad P_e=\frac{(P-0,2S)^2}{P+0,8S}$$

$$S=25,4\left(\frac{1000}{CN}-10\right)$$

Finite elements method

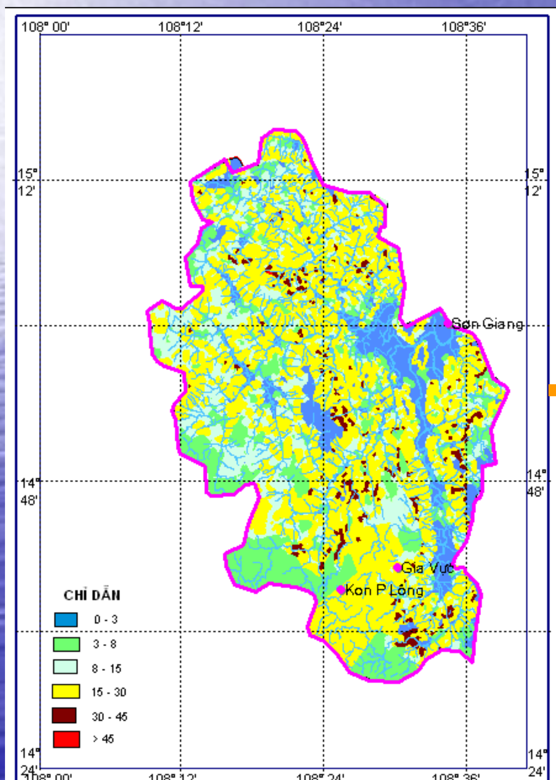
Steps:

- Discretize the basin: Dividing into sub-basin, elements and element-brands
- Select model: One-dimensional kinematic wave model
- Find system of finite elements equations: Weighting residual method of Galekin
- Solve the system of equations: by using Gauss method
- Assemble the system of equations for total calculating area: Link n elements of the net

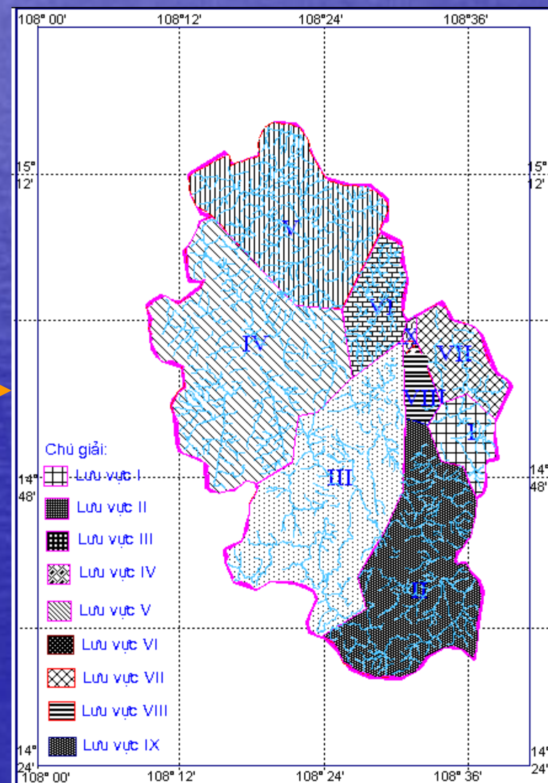
$$\frac{1}{\Delta t}[F_A]\{A\}_{t+\Delta t}-\frac{1}{\Delta t}[F_A]\{A\}_t+[F_Q]\{Q\}_t-q\{f_q\}_{t+\Delta t}=0$$

III. Application

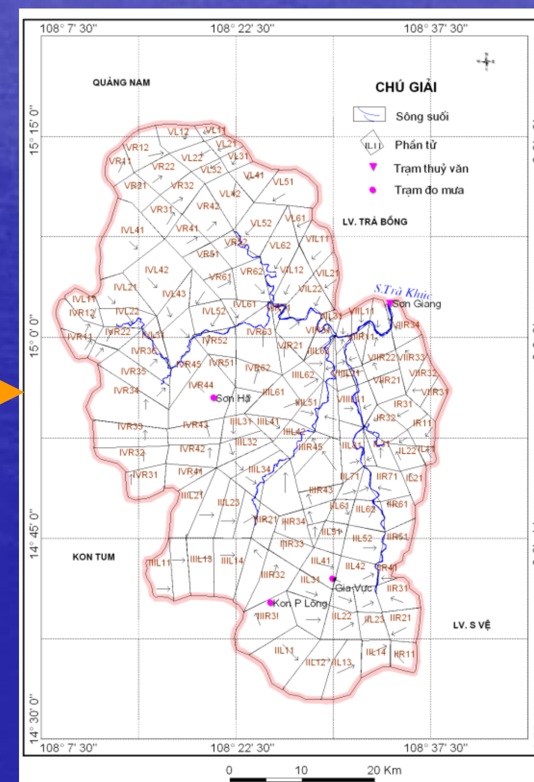
Steepness map



Sub-basins disgram

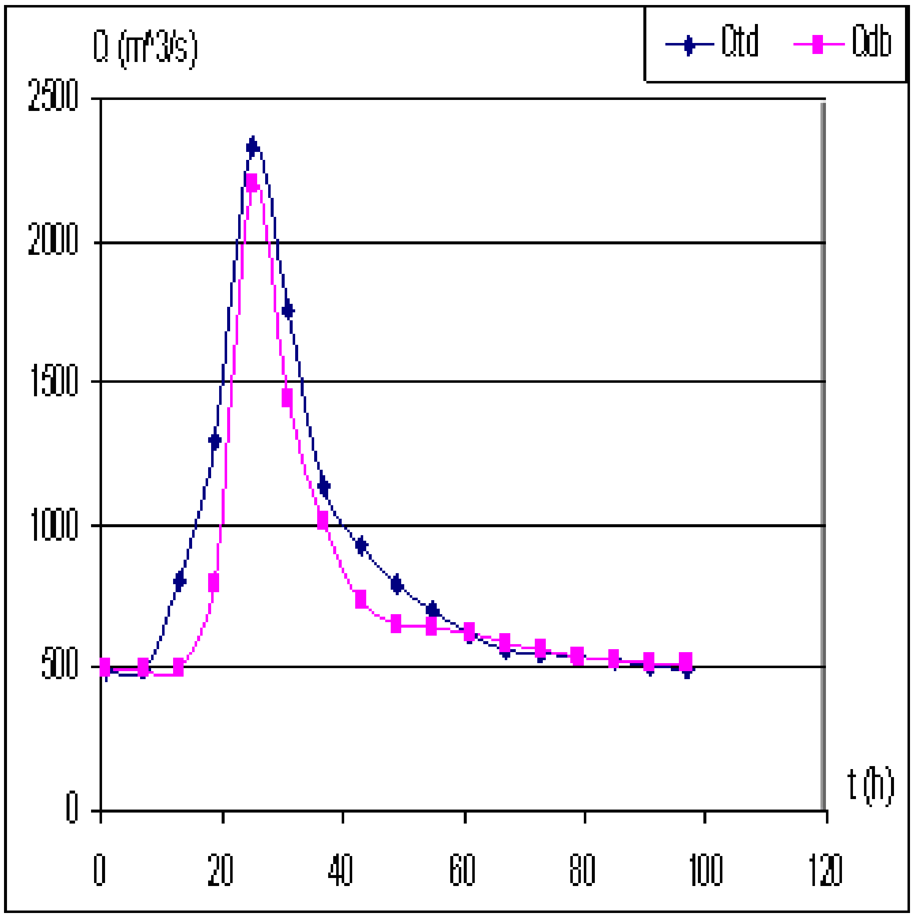


Elements diagram



III. Application

Simulation

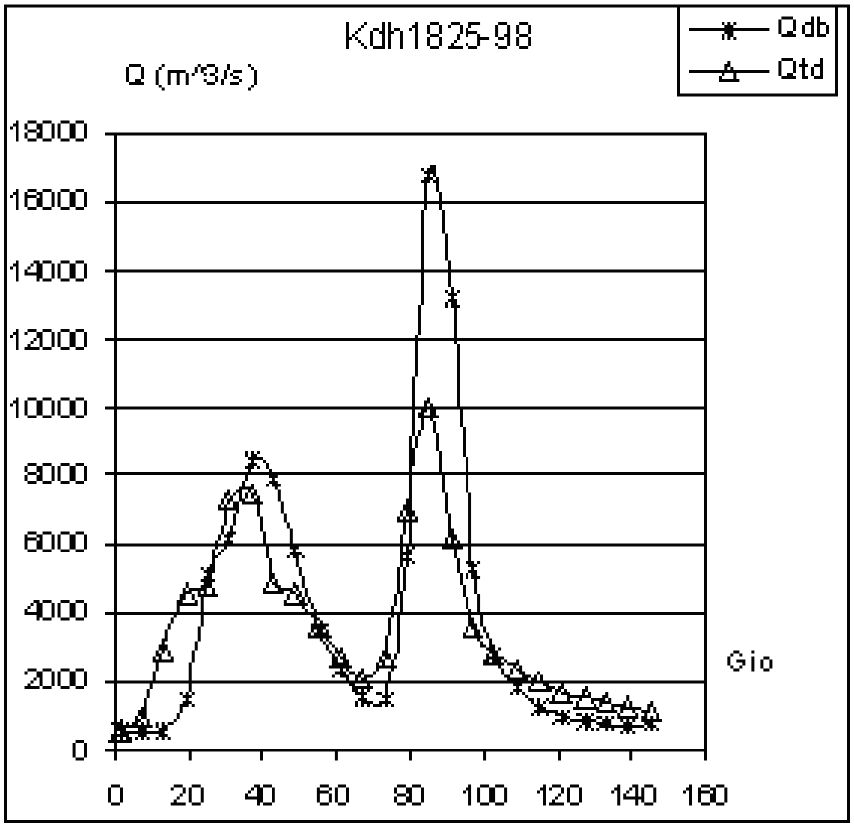


Time (h)	Q_{td} (m^3/s)	Q_{tt} (m^3/s)
1	488	488
7	492	488
13	800	488
19	1300	788
25	2330	2188
31	1620	1441
37	1140	1009
43	926	738
49	786	658
55	700	637
61	623	619
67	565	586
73	550	560
79	542	542
85	527	529
91	506	519
97	492	517
Total Error	13.46%	
Peak Error	6.6%	
R^2	87.07%	

Simulation of the flood from 13h/20/ to 13h/24/XII/2000 Tra Khuc River – Son Giang

III. Application

Simulation

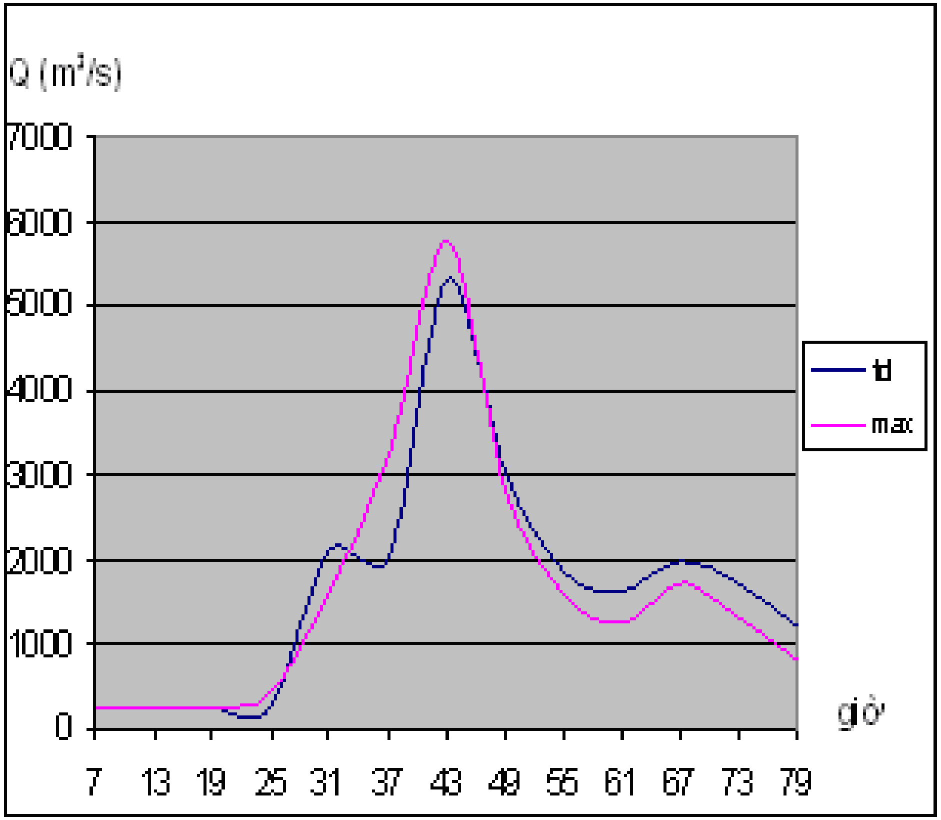


Simulation of the flood from 1h/ 19/XI to 19h/ 25/XI/1998 Tra Khuc River - Son Giang

Time (h)	Qdb (m^3/s)	Qtd (m^3/s)
1	569	569
7	569	984
13	569.01	2890
19	1471.78	4600
25	5118.29	4800
31	6186.69	7270
37	8449.09	7490
43	7921.83	4820
49	5792.2	4540
55	3445.75	3500
61	2358	2670
67	1545.86	2110
73	1477.09	2670
R^2	69%	
Peak Error 1	11,4%	
Peak Error 2	40,6%	
Total Error	6,8%	

III. Application

Forcast:T = 72h



Hours	Q(i) (m^3/s)	Qdb (m^3/s)
7	221	221
13	228	221
19	239	221
25	281	442
31	2110	1606
37	2030	3233
43	5320	5748
49	3050	2867
55	1850	1570
61	1630	1233
67	1980	1700
73	1710	1321
79	1220	819
R^2	90.2%	
Peak Error	8.1%	
Total Error	3.0%	
S/σ	0.31	

The result of forcasting flood from 7.00 AM 16thNov to 7.00 AM 19thNov, 2005 Tra Khuc River-Son Giang

IV. Conclusion

1. RAMS, using three nested-net (level 3), can predict rainfall on a large region with complex topography.
2. One-dimensional kinematic wave model using finite element and SCS methods can simulate the role of sub-basins in forming runoff and can predict the effects of the changeability in space of the basin.
3. The advantages of the integrated system (RAMS and KW-1D model):
   - **Decrease error by sparse rainfall data in operational forecasting.**
   - **Flexile in considering the effect of surface and land use changes on the formation of the flow.**
4. The system can be applied in water resourse management and operational forcasting with 72h lead-time