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INFLUENCE OF RAINFALL DATA RESOLUTION AND CATCHMENT SUBDIVISION ON RUNOFF MODELLING

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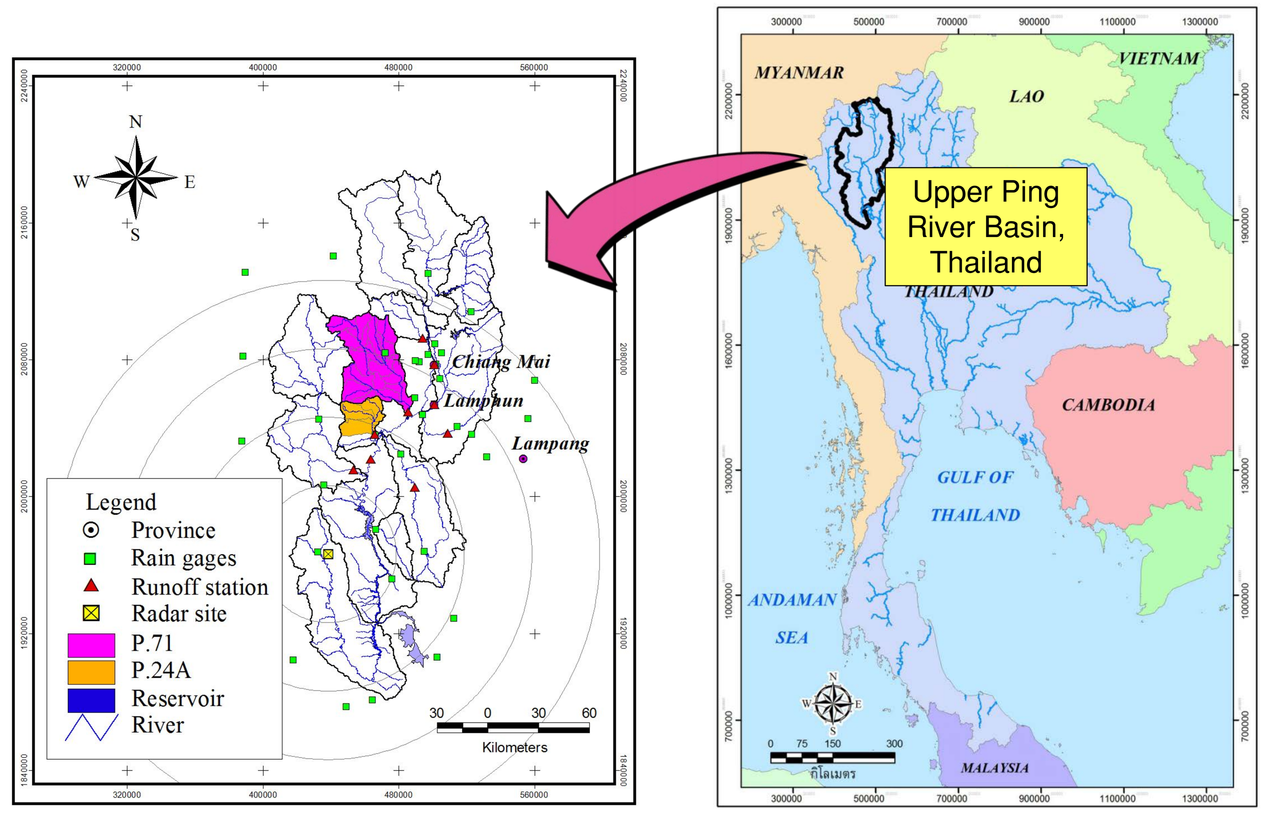
THAILAND

BACKGROUND

- Rainfall and catchment characteristics are significant factors for runoff modelling.
- Application of a semi-distributed model with the complexity of catchment subdivision schemes could account for the spatial variation of rainfall and catchment characteristics.
- However, several studies found that using high-resolution sub-catchment can either increase or decrease model performance.
- Thailand has been facing a serious problem caused by a limited continuous ground rainfall measuring network.
- As a result, the question arising is whether using finer catchment subdivision coupled with the coarse resolution of gauge rainfall could lead to better simulation results compared with using high resolution of radar rainfall product as input.
- Two point locations at the runoff stations P.71 and P.24A located in the upper Ping river basin, northern Thailand, were selected as the study area.

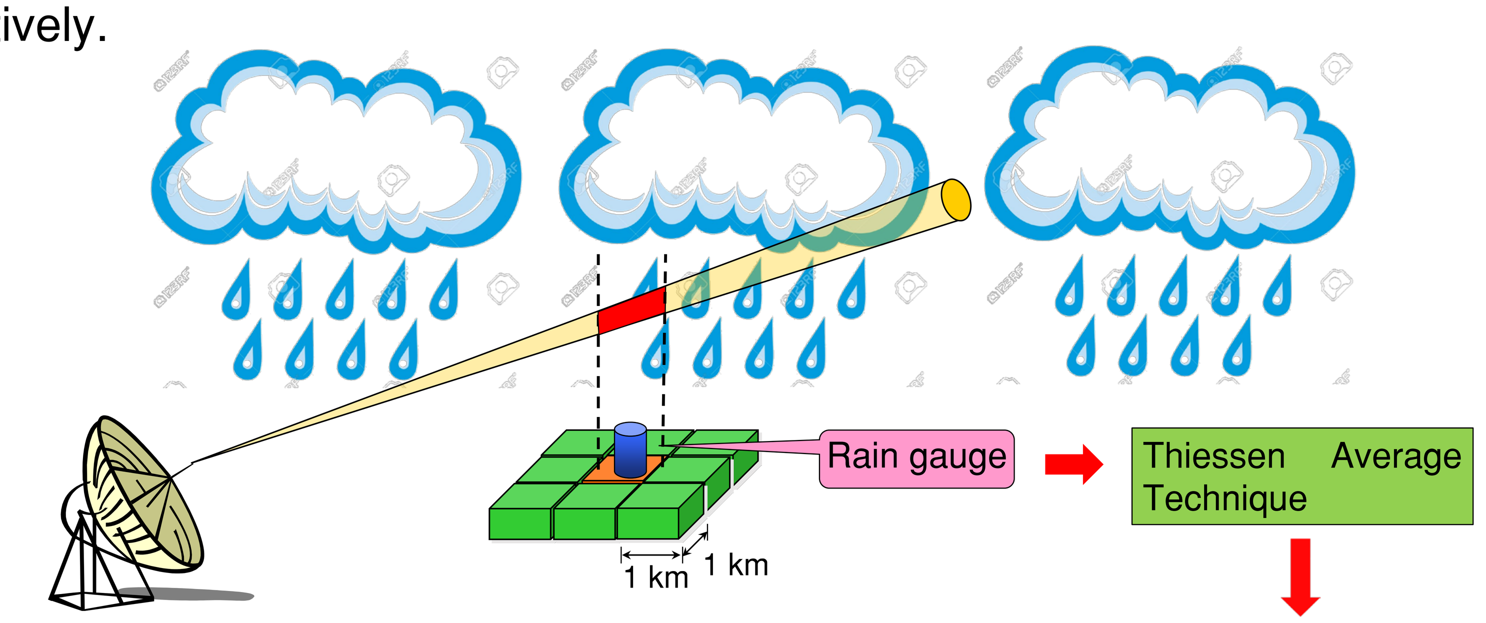


OBJECTIVE

This study demonstrates the relative benefits offered by the application of gauge and radar rainfall products to several scales of catchment subdivision for simulation of the runoff hydrograph in the upper Ping river basin, northern Thailand.

METHODS

- Two point locations at the runoff stations P.71 and P24A in the upper Ping river basin were selected for model calibration over the period of 2004-2005.
- Rain gauge and radar rainfall products were specified as inputs to the semi-distributed hydrological URBS model at each runoff station with five catchment subdivision schemes for runoff simulation.
- Point gauge rainfall (GR) from the sparse rain gauge network and the estimated radar rainfall (RR) at each radar pixel were spatially averaged over each sub-catchment using Thiessen polygons and arithmetic averaging approaches, respectively.



Rain gauge → Thiessen Average Technique → Gauge Rainfall data

Omkoi radar is located in ChiangMai, Thailand → $Z = 74R^{1.6}$ → Gridded Radar Rainfall data

URBS Model Application

- Using non-linear reservoir equation for catchment routing

$$S_{catch} = \beta\sqrt{A}Q^{m}$$

- Using Muskingum method for channel routing

$$S_{chnl} = \alpha f L\left(xQ_u + (1-x)Q_d\right)$$

- Calibration period is 2004
- Verification period is 2005

Five-Catchment Subdivision Schemes

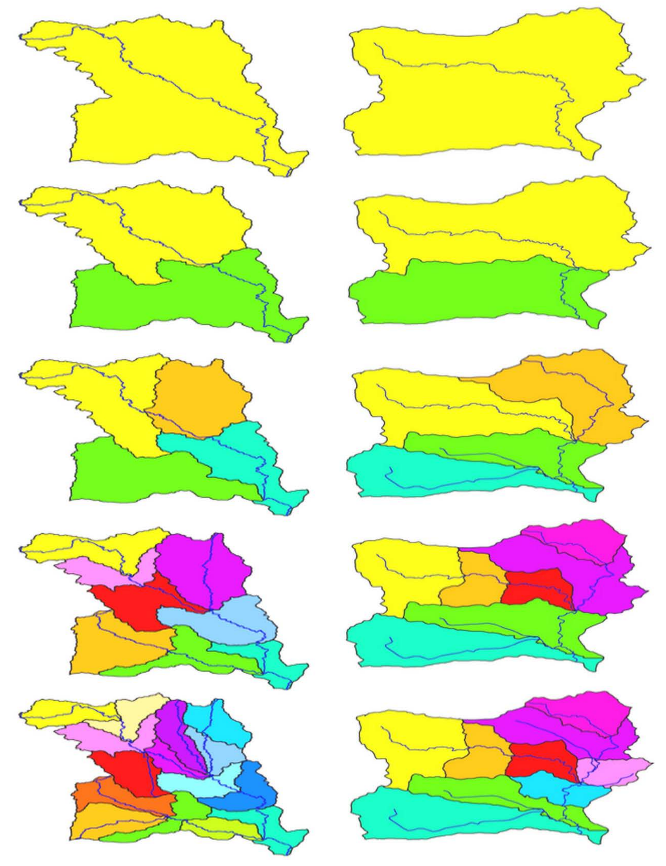
Sub-catchment size is 100% of total area

Sub-catchment size is around 50% of total area

Sub-catchment size is around 25% of total area

Sub-catchment size is around 12% of total area

Sub-catchment size is around 7% of total area



Statistical Measures

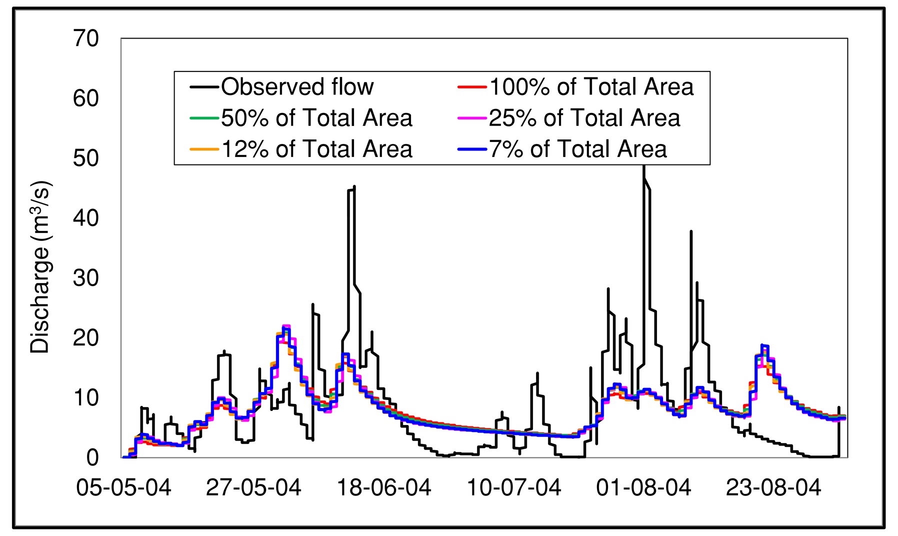
1. Correlation Coefficient (r)
2. Root mean square error (RMSE)

Comparison on runoff accuracy among different scenarios.

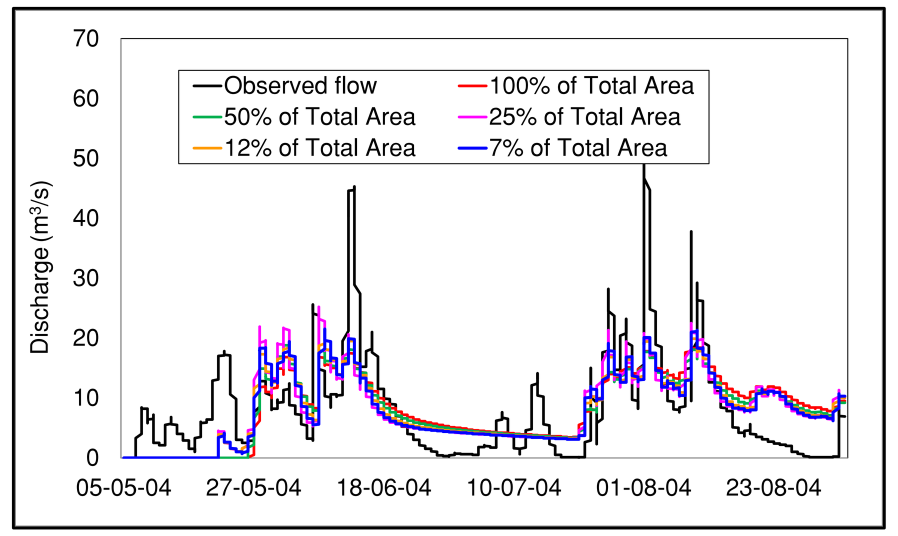
RESULTS

Results for using high resolution of radar rainfall (RR) input appear that the accuracy of runoff estimates is affected appreciably by a number of sub-catchments, and the accuracy of runoff estimates tends to obviously rise with an increase of the number of sub-catchments. On the other hand, there is uncertainty improvement with an increasing number of sub-catchments while the coarse resolution of rain gauge rainfall (GR) input is used.

Results of Runoff Estimate Using Gauge Rainfall at P.71



Results of Runoff Estimate Using Radar Rainfall at P.71



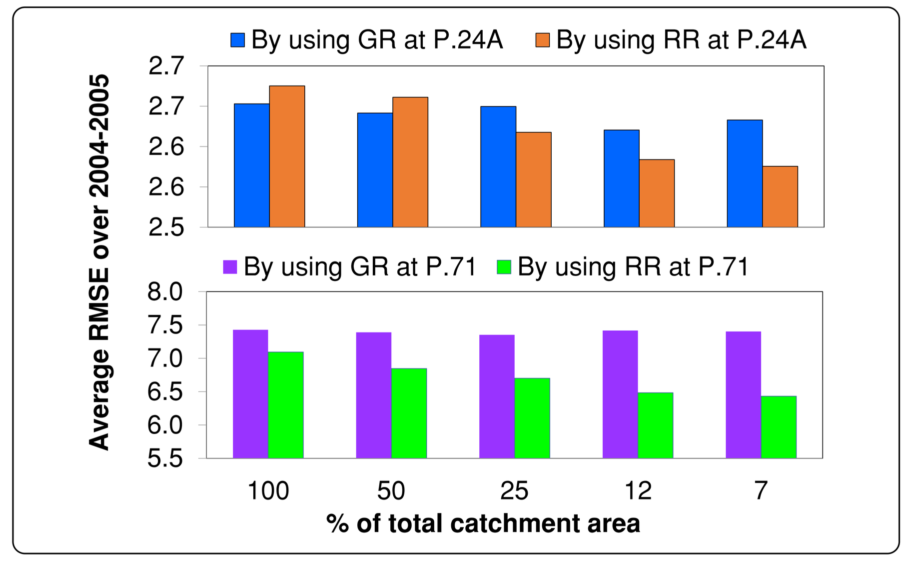
RMSE Comparison among 5 Subdivision Schemes

Runoff Station	% of total catchment area	RMSE (m^3/s) obtained from using *Gauge Rainfall* product 2004	2005	Average	% Increment of average from the minimum RMSE	RMSE (m^3/s) obtained from using *Radar Rainfall* product 2004	2005	Average	% Increment of average from the minimum RMSE
P.24A	100	3.11	2.20	2.65	***1.24***	3.19	2.16	2.68	***3.87***
	50	3.09	**2.19**	2.64	0.80	3.20	2.12	2.66	3.32
	25	3.09	2.21	2.65	1.11	3.13	**2.10**	2.62	1.63
	12	**3.04**	2.20	**2.62**	***0.00***	3.04	2.13	2.58	0.32
	7	3.05	2.22	2.63	0.47	**3.02**	2.13	**2.58**	***0.00***
P.71	100	7.66	7.20	7.43	***1.03***	7.02	7.16	7.09	***10.30***
	50	7.61	**7.17**	7.39	0.53	6.89	6.80	6.85	6.45
	25	**7.53**	7.18	**7.35**	***0.00***	6.82	6.58	6.70	4.20
	12	7.64	7.19	7.42	0.88	6.60	6.36	6.48	0.82
	7	7.60	7.21	7.40	0.69	**6.60**	**6.26**	**6.43**	***0.00***

Represent the minimum RMSE at each station for each simulation period and rainfall input.

Represent the maximum increment percentage compared with the best case.

RMSE Comparison between GR and RR



CONCLUSIONS

1. Use of high resolution of rainfall (RR) together with the finer resolution of sub-catchments gives the higher accuracy of runoff estimates with the maximum percentage improvement of discharge is around 10.3%. However, there is no significant improvement with an increasing of model structural complexity while the coarse resolution of rainfall (GR) input is used.

2. It is therefore necessary to realize the resolution of rainfall input data together with selecting of a suitable hydrologic model for effective enhancing the accuracy of runoff estimation.

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