Added value of H-ADCP data in rainfall-runoff models driven by satellite rainfall input in a tropical basin

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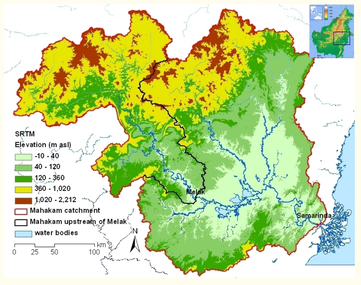
1. Background

Despite the importance of hydrological records, large regions in the world remain ungauged. Therefore, building hydrological models in poorly gauged basins is a timely challenge. Satellite radar provides a potential means of obtaining distributed rainfall estimates.

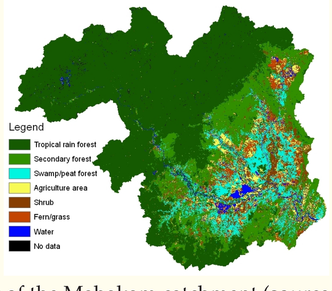
Aim: to explore added value of discharge data derived from horizontal acoustic Doppler current profiler (H-ADCP) measurements in rainfall-runoff model driven by rainfall estimates from the Tropical Rainfall Measuring Mission (TRMM).

2. Study area & data collection

The focus of this study is the Mahakam catchment, a meso-scale tropical basin (77,100 km2) in East Kalimantan, Indonesia.



The Mahakam catchment with SRTM digital elevation model.



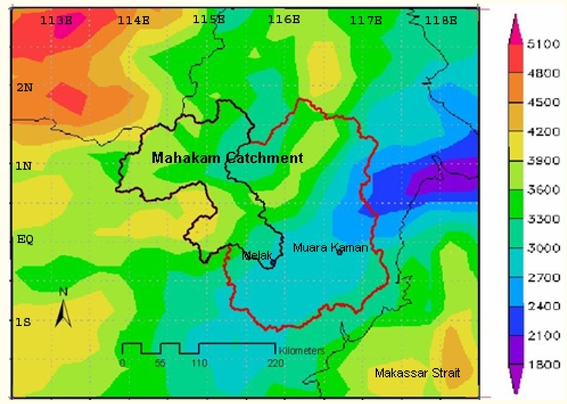
Land cover of the Mahakam catchment (source: SarVision)

H-ADCP discharge measurements were carried out in March 2008 - August 2009. For the same period a rating curve was developed for the gauge station at Melak. The discharge series obtained were split into calibration and validation data sets.

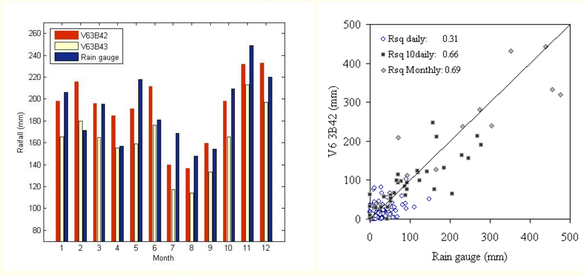
TRMM Multi satellite Precipitation Analysis (TMPA) products v6 3B42 and 3B43 were used.

3. TRMM data analysis

High rainfall depth occurred in the mountainous area upstream of the Mahakam. Lower rainfall depth occurred in the middle Mahakam area.



Accumulated rainfall (mm) for 2008 from v6 3B42.



Left: Comparison of TMPA and monthly rain rate average of six rain gauges (1998–2002).
Right: TMPA v6 3B42 vs rain gauge at Barong Tongkok (2001).

4. Model set-up & calibration

The HBV (Hydrologiska Byrans Vattenbalansavdelning) light version[1] and VIC (Variable Infiltration Capacity)[2] models were used in rainfall-runoff modelling of the Mahakam catchment upstream of Melak (25,700 km^2). We applied the HBV model with lumped input and the VIC model with distributed input forcing with a grid size of $0.25\,^\circ$.

The HBV model was calibrated to get optimal parameter set by trial and error method in combination with Monte Carlo run. The VIC model was calibrated by optimizing parameters in the soil parameter file. Model performance was evaluated using Nash-Sutcliffe Efficiency (NSE) coefficient.

5. Results

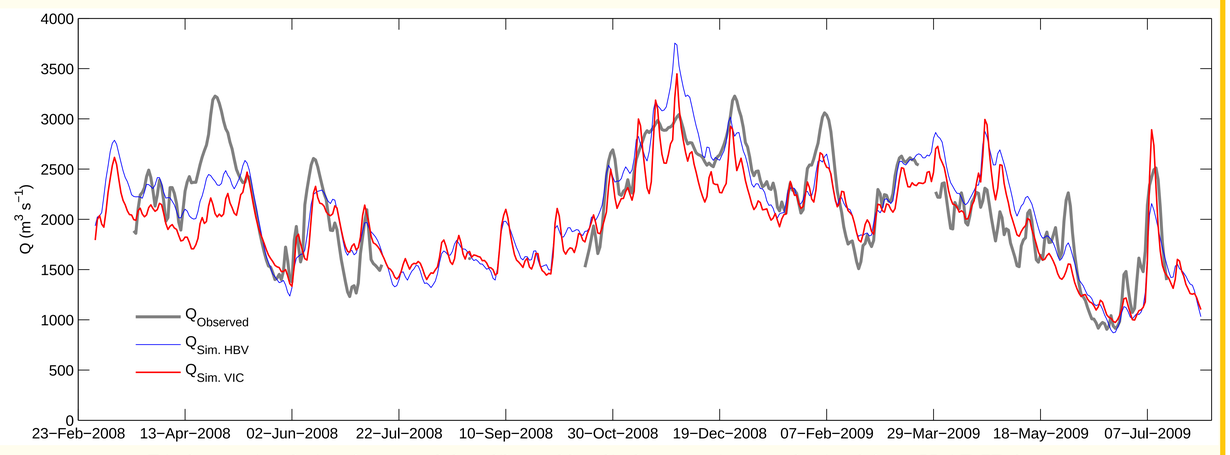
Discharge estimates for Melak obtained from the rating curve and those from H-ADCP measurements differed somewhat. Overall, discharge estimates from rating curve did not capture the details of discharge dynamics that was highly hysteretic.

The HBV model produced a more consistent discharge simulation with an NSE of 0.7 during the calibration period and 0.6 during the validation period. The VIC model performed similarly during calibration with the NSE value of 0.7, but dropped to 0.3 during validation.

NSE of models calibrated with different discharge data source

Q data source	HBV_{Cal}	HBV_{Val}	VIC_{Cal}	VIC_{Val}
Rating curve	0.72	0.64	0.74	0.29
H-ADCP	0.73	0.64	0.74	0.29

TRMM Rainfall estimates is useful in a poorly gauged basin, however, there is accuracy concerns. Therefore, consistency of model performance during calibration and validation periods is important in model evaluation.



Discharge simulation from models calibrated by discharge estimates obtained from H-ADCP data.

6. Conclusions

Data series from H-ADCP measurements have an added value by providing accurate discharge estimates for calibrating and evaluating rainfall-runoff models driven by TRMM rainfall estimates.

Model evaluation showed that both HBV and VIC models performed similarly when a discharge data source was used for calibration.

The Result indicated that the HBV model, with a relatively simple model structure, produced a more consistent discharge simulation than that of the VIC model, with a more complex model structure.

References, affiliation & funding

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[2] Liang, X., D.P. Lettenmaier, E.F. Wood, and S.J. Burges, A simple hydrologically based model of land surface water and energy fluxes for general circulation models, *J. Geophys. Res.,99, 1994.*

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This research has been supported by the Netherlands organisation for scientific research, under grant number WT 76-268.