Flow Persistence (FlowPer) Model: Simple Indicator for Watershed Function

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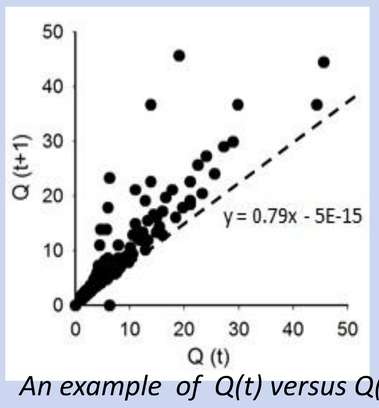
A simple indicator of watershed function can help us in assessing the landscape for better management and use. The condition of watershed function can be seen by the way temporal pattern of rainfall get translated into a temporal pattern of stream flow. How the watershed receive and buffer the rain event are influenced by the configuration of land use and land cover. Therefore, an indicator of watershed function must be able to reflect the changes in land use pattern.

1. Flow Persistence (FlowPer) Model

The Flow Persistence (FlowPer) model is based on temporal autocorrelation of empirical or simulated river flow data that shows "flow persistence".

FlowPer model provides two functions:

- ✓ Summarize the key parameters that can be observed on the flow pattern to assess the watershed condition
- ✓ Serve as a parsimonious "null model" that allows quantification of the changes in watershed function due to changes in land cover/land use

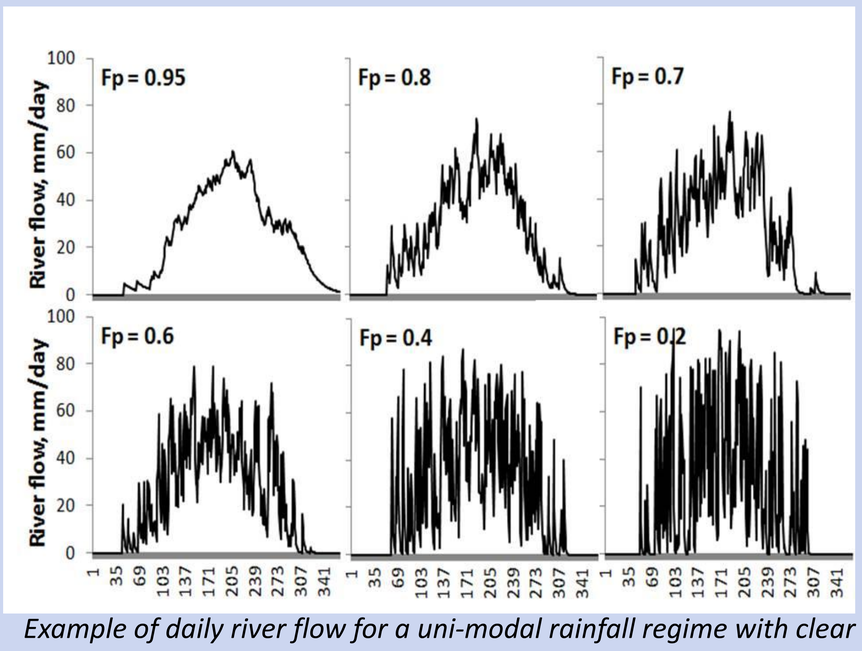


An example of Q(t) versus Q(t-1) showing Fp value (Fp = 0.79)

The basic form of FlowFer model is a recursive relationship between river flow Q on subsequent days:

$Q(t+1) = Fp\ Q(t) + \varepsilon$

Q(t), Q(t+1) = river flow on subsequent days, Fp = flow persistence value ([0< Fp <1]), ε = random variate reflecting inputs from recent rainfall.

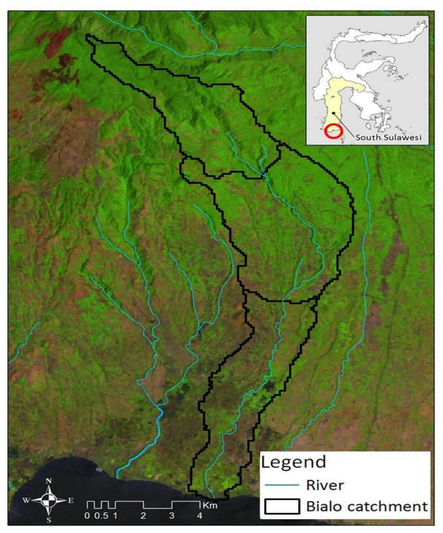


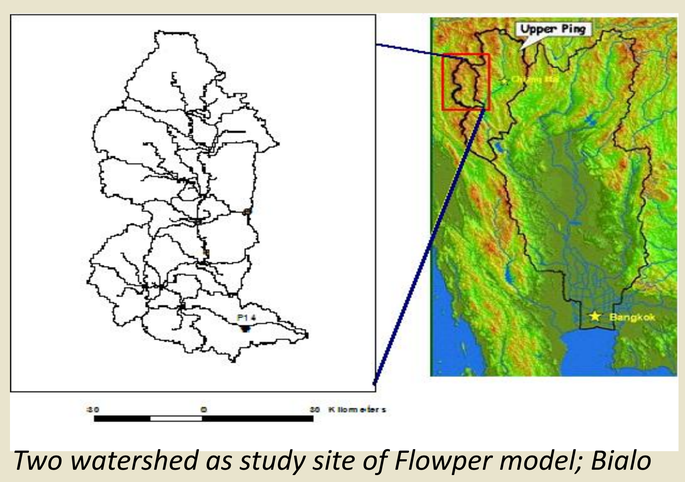
Example of daily river flow for a uni-modal rainfall regime with clear dry season, in response to change in the flow persistence parameter Fp

If Fp = 1 and ε = 0 then river flow is constant, regardless of rainfall indication an ideally buffered system. If Fp = 0 there is no relation between river flow on subsequent days suggesting and extremely "flashy" river that only depends on distribution of ε.

2. Study Cases

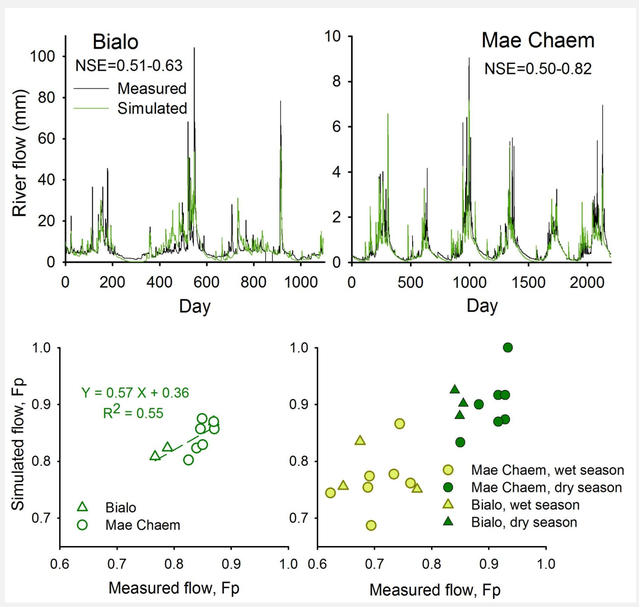
	Bialo-South Sulawesi, Indonesia	Mae Chaem-Ping Basin Thailand
Area	112 km^2	3892 km^2
Land cover	Forest (17.5%), agroforestri (63%), crop (15.3%)	Deciduous forest (40.7%), evergreen forest (28%) , crop (14.9%)
Soil type	Inseptisols (95%) and Entisols (5%)	Entisol (91.5%), Ultisol (6.2%), Alfisol (2.1%) and Inceptisol (0.2%).
Wet season	January - June	April - September
Dry season	July - December	October – March
Rainfall	1106 – 2602 mm	675 – 1334 mm





Two watershed as study site of Flowper model; Bialo watershed (left) and Mae Chaem watershed (above)

3. Calibration of FlowPer

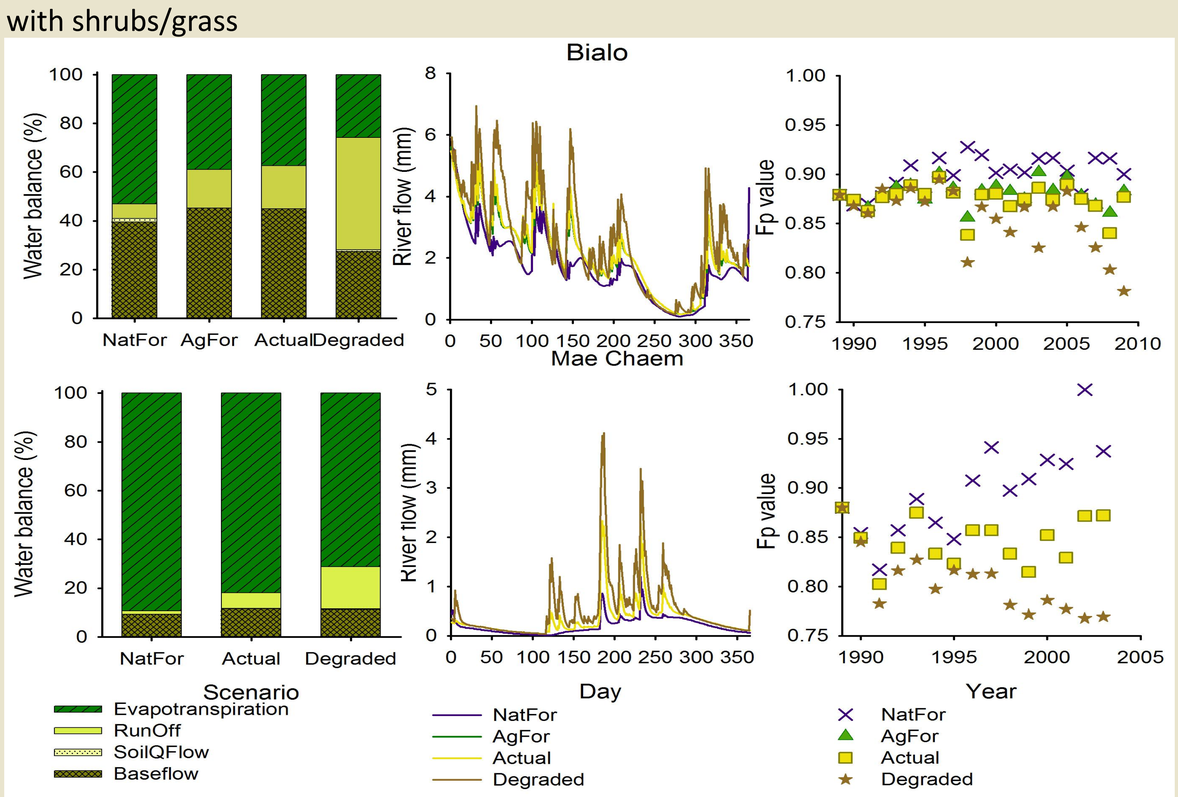


Short period empirical data of river flow were extended to long term data through the use of hydrological simulation model.

Comparison between empirical and simulated Fp can show the performance of calibration process. Inter-annual (left) and seasonal (right) variation of Fp between measurement and simulation

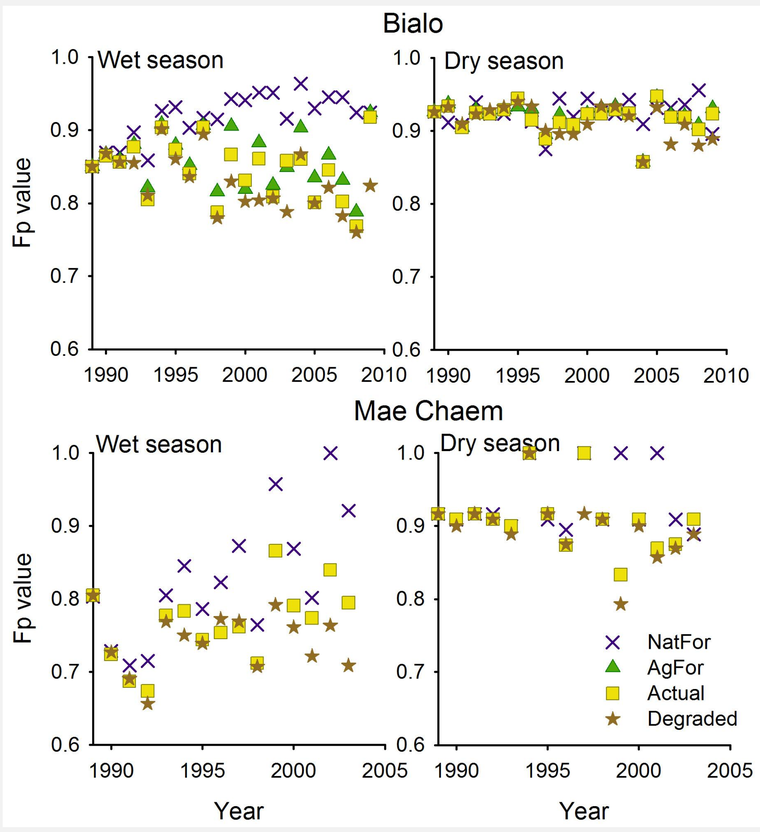
4. Scenario Analysis using FlowPer

In addition to Actual scenario that reflect current land cover condition, 3 scenarios were tested: (1) NatFor = landscape are covered with forest, (2) AgFor = forest, shrubs/grass in Actual are converted into agroforestry systems and (3) Degrade = landscape are covered with shrubs/grass



Effect of land cover change scenarios on water balance (left) and river flow (middle) at the end of simulation year (Bialo: year 2009 and Mae Chaem: year 2003) and trend of Fp-value over the simulation year (right). **Forest with the highest Fp is the best watershed condition with the highest base flow and the lowest overland flow.**

Overland flow as one of the affected water balance component by land cover change, caused the main variation on the Fp value.



Variation of Fp value in the wet and dry season

5. Conclusion

The FlowPer model can be used as an indicator to assess the watershed condition The smaller Fp value indicates that the watershed ability to buffer the rain event is decreasing and the river flow become more fluctuating due to increasing of overland flow.

Acknowledgement

This study is funded by Forest, Tree and Agroforestry: Learning Landscape (FTA.3)

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