Groundwater recharge assessment in Laos and the Lower Mekong Basin

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Enhancing the resilience and productivity of rainfed dominated systems in Lao PDR through sustainable groundwater use (ACIAR Project No. LWR 2010/81)

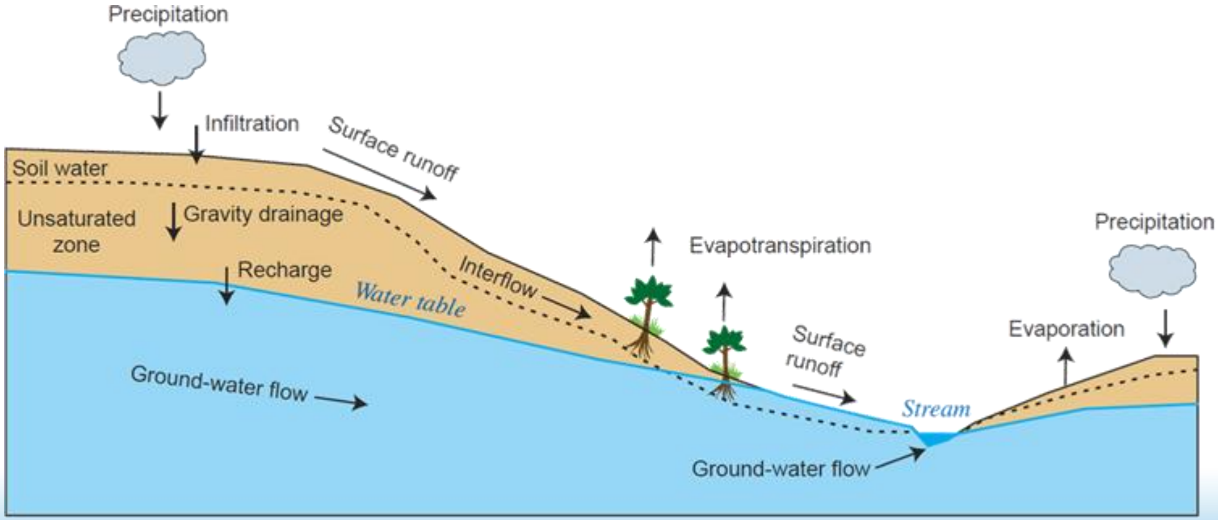
END-OF-PROJECT REVIEW WORKSHOP

16-17 March 2016

OBJECTIVES:

- 1/ Estimate groundwater recharge from streamflow data
  - Hypothesis: Groundwater recharge = river baseflow over multi-year period
  - Apply digital filter to separate baseflow from total streamflow

- 2/ Predict groundwater recharge in un-gauged area using catchment characteristics as explanatory variables
  - Multiple regression analysis



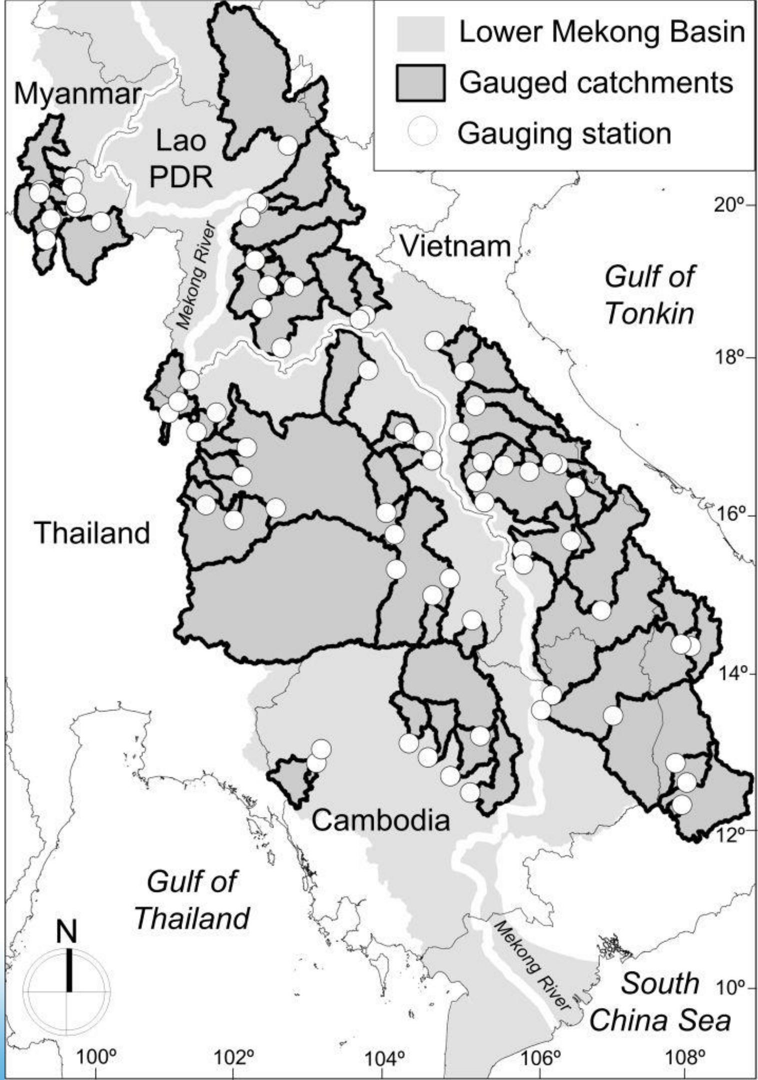
DATA

Flow data

- >70 gauging stations with multi-year records of daily streamflow across the Lower Mekong Basin
- Selection of time series with no influence of upstream hydropower reservoirs
- Data quality control to eliminate dubious data
- 65 flow records

Catchment characteristics

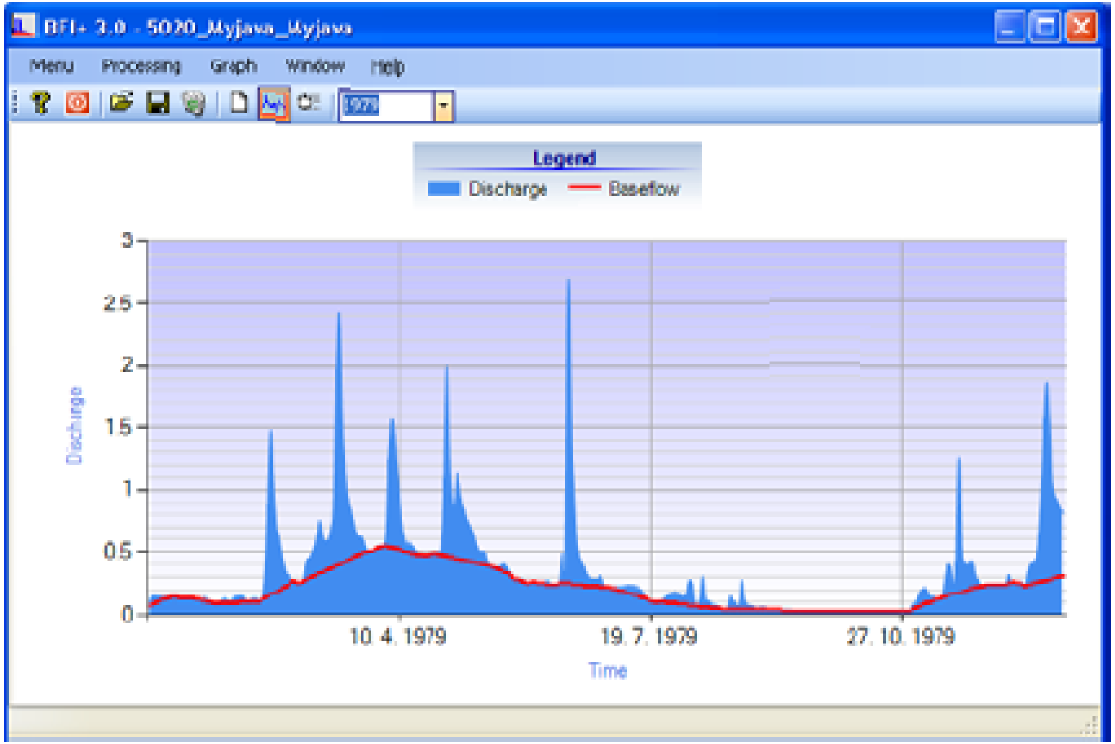
- Calculated using GIS software and gridded products (DEM, Land-use, Climate, Soil, etc..)



BASEFLOW SEPARATION

- 3 base-flow separation methods were applied : local minimum, fixed interval & Sliding interval (Pettyjohn and Henning, 1979)

Conservative approach that provides underestimations of recharge rates (Eckhardt, 2008)



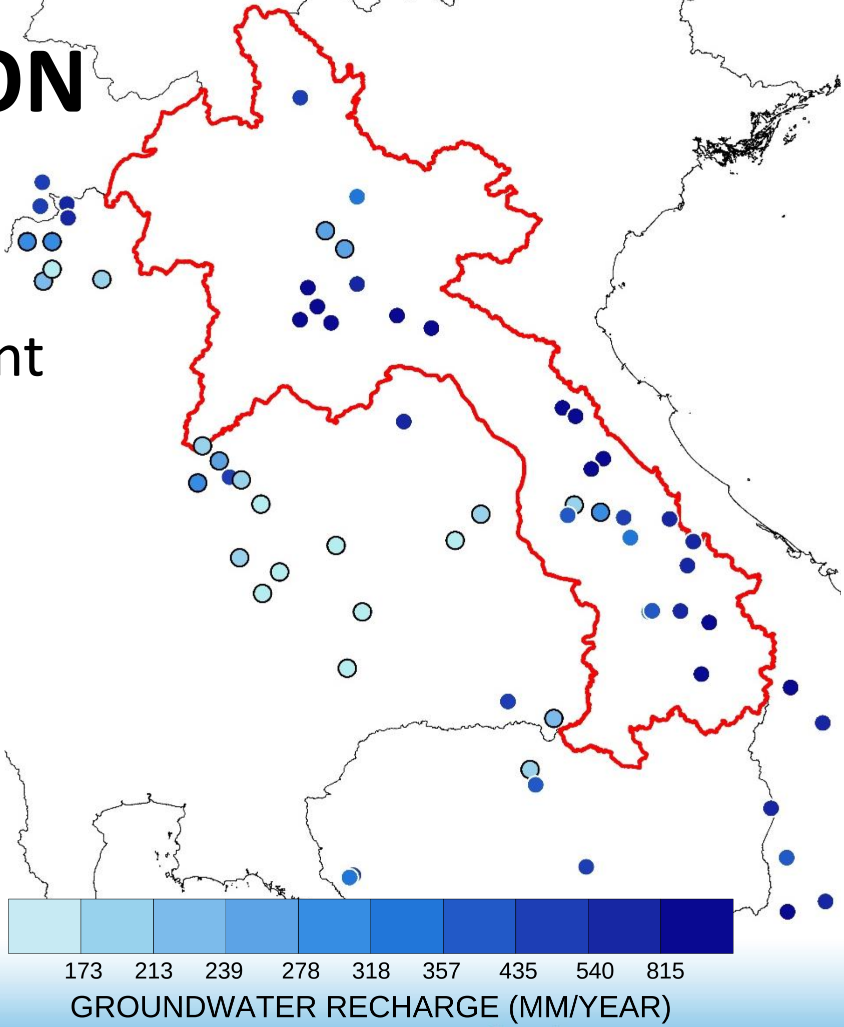
A water-secure world

MULTI-VARIATE REGRESSION

To predict recharge rates in un-gauged areas

- Base flows are correlated to catchment characteristics computed in each gauged catchment: Annual rainfall, land-use, topography, ET, geographic coordinates, soil, temperature

$$Re = \mathrm{f}\ (\mathrm{V}_1, \mathrm{V}_2, \ldots, \mathrm{V}_n)$$



RESULTS

Explanatory variables selected by combined use of algorithms known as '*best subset regression*' and '*step-wise regressions*'. Selection intended to maximize the prediction R-squared (R^2_{pred}) calculated by leave-one-out cross-validations.

Negatively correlated to potential evapotranspiration

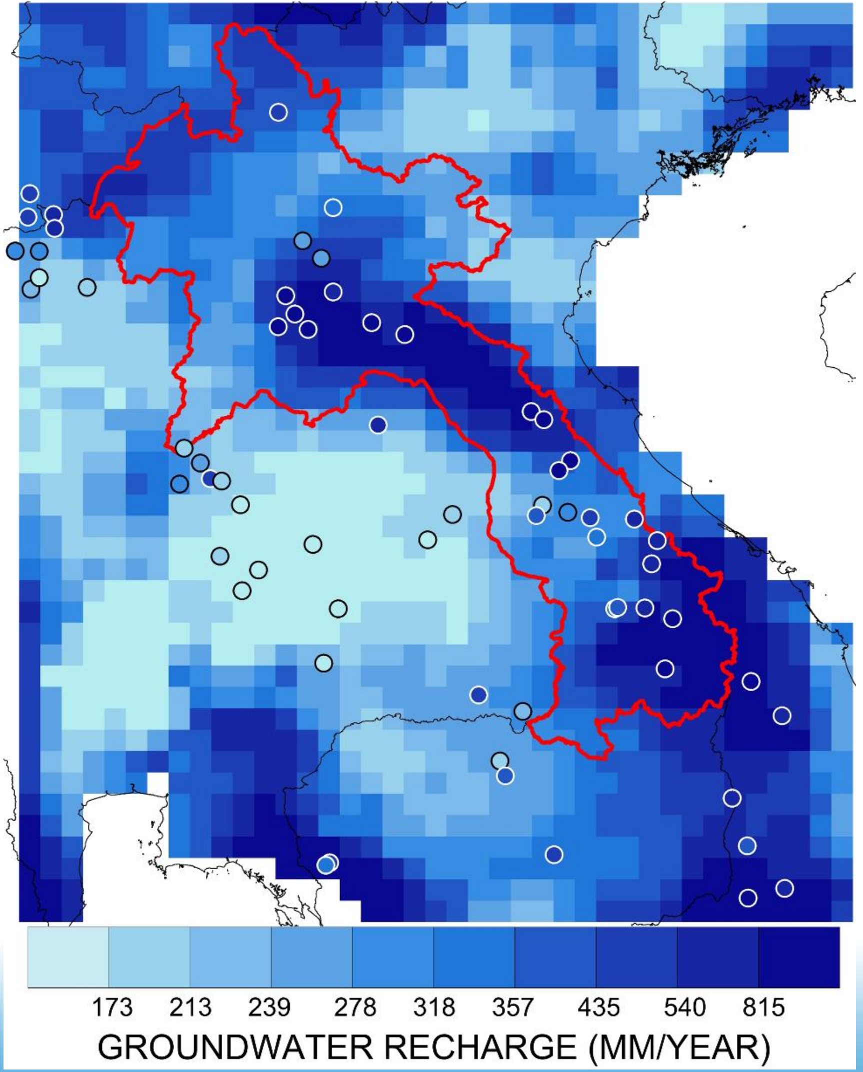
$$\mathbf{Re} = \exp(76.56) \times \mathbf{La}^{-2.79} \times \mathbf{Lo}^{-11.01} \times \mathbf{ET}^{-4.12} \times \mathbf{Ra}^{2.43}$$

$R^2_{pred} = 66.4\%$

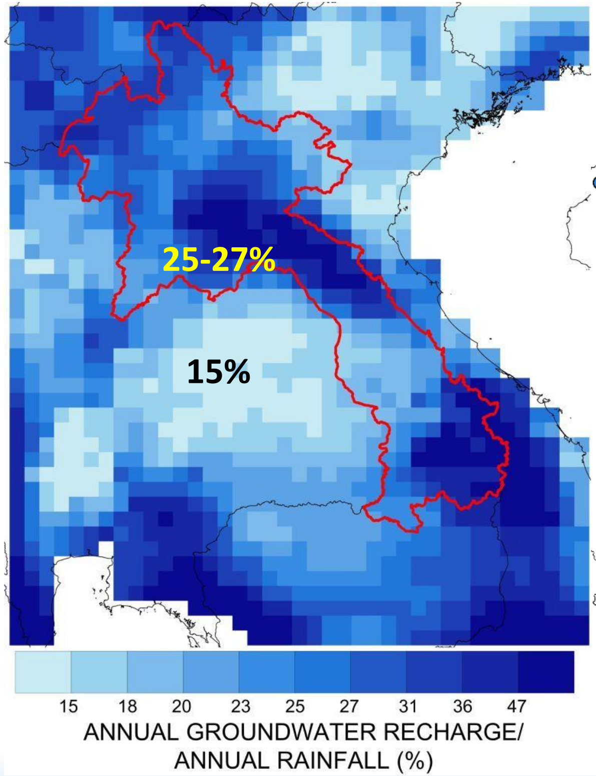
Surrogate variables ?

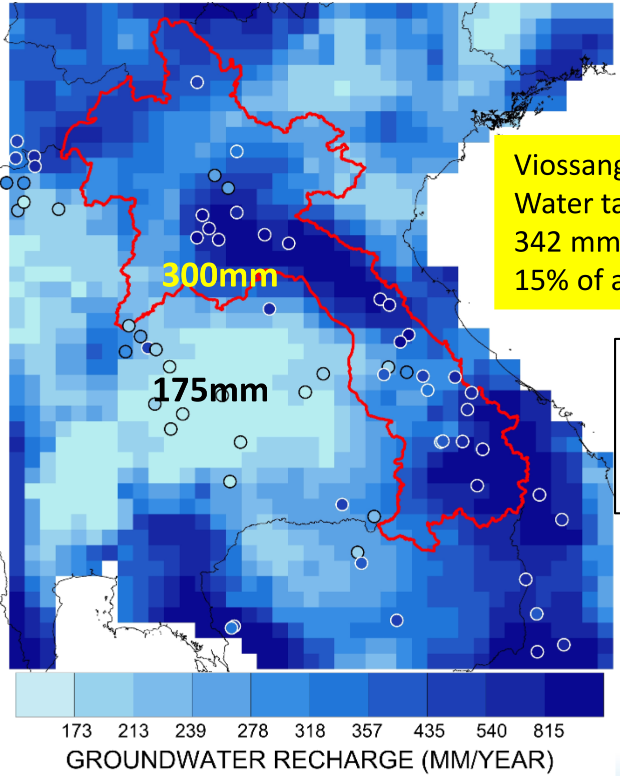
Positively correlated to annual rainfall

<u>**The value of the four selected variables are known at any location.**</u>



DISCUSSION: comparison with other assessments





Viossange et al.:
Water table fluctuation method:
342 mm/year
15% of annual rainfall

Saraphirom et al. 2012 :
HELP3 modelling
250mm/year
2-26% of annual rainfall

CONCLUSION

High uncertainty of digital filters methods (Scanlon et al. 2002). However, our method (local minimum) is **conservative** (Eckhardt, 2008) and **appropriate to assess groundwater resources** for irrigation.

Although geology is not accounted to predict recharge rate in ungauged areas, the power-law model perform well in the Lower Mekong Basin.

This high model efficiency is explained by the fact that our base flow estimations integrate the ability of the aquifers to store and transmit water.

Our approach is a water resource assessment while the previous presentation aimed to map water access, accounting for geological context. Next steps will combine both approaches for cross-validation and refinement of the results.