Prediciton of Flow Duration Curves for Ungauged Catchments in South India with Calibration free Dynamic Budyko model

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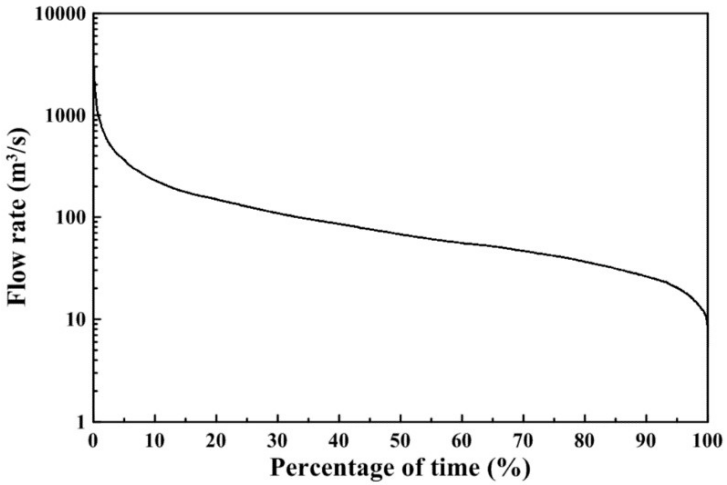
Introduction and Background

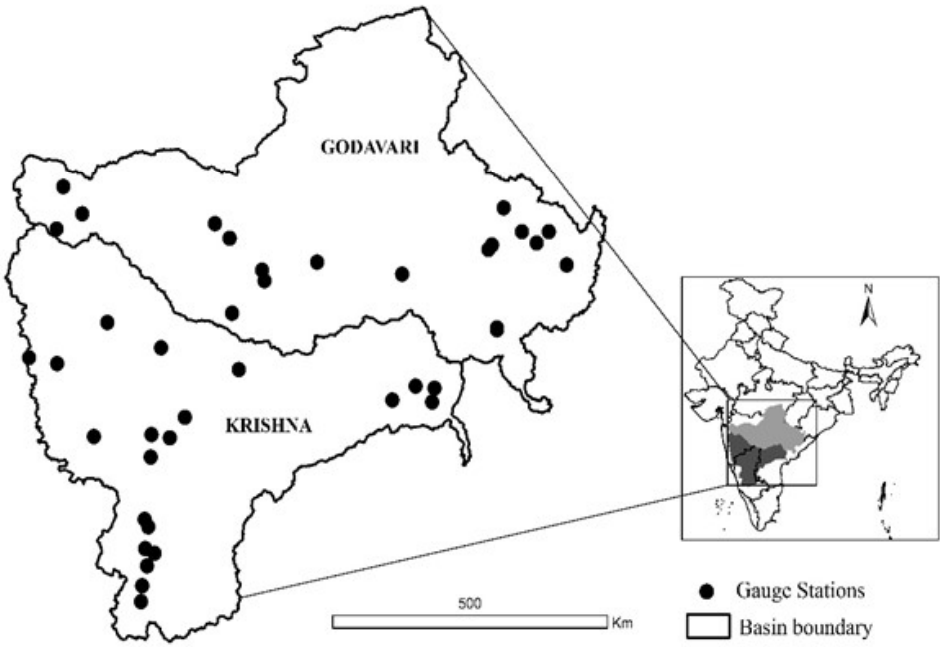


Challenges of FDC prediction in ungauged basins

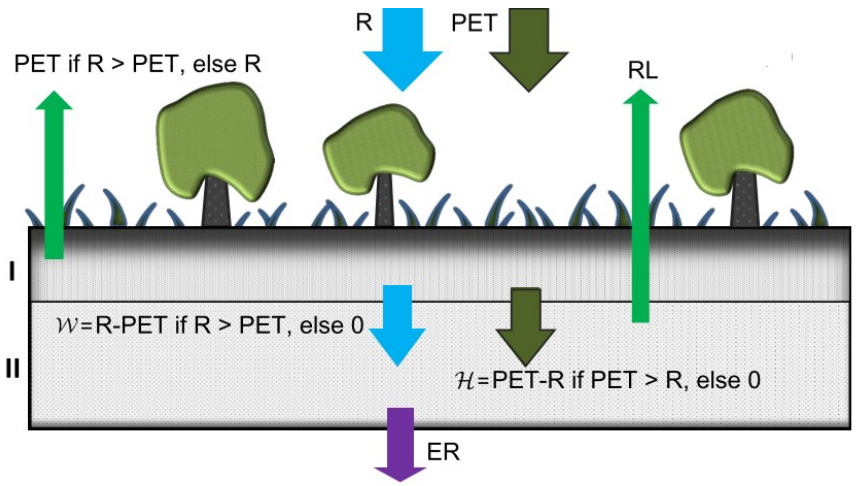
https://www.allacronyms.com/1601075pngu.png

Study are and data

40 catchments of Krishna and Godavari basin
Rainfall data: 0.25 ^{0} resolution
Temperature data: 0.5 ^{0} resolution
Discharge data: CWC



Calibration free dynamic Budyko model



Water and energy availability

$$W(t) = R(t) - PET(t); \quad if\ PET(t) < R(t),$$
$$W(t) = 0; \quad if\ PET(t) \geq R(t)$$

$$H(t) = PET(t) - R(t); \quad if\ PET(t) > R(t),$$
$$H(t) = 0; \quad if\ PET(t) \leq R(t)$$

Past effect of available water and energy on the soil moisture state of catchment is expressed with decay function: $x(t) = \frac{x(0)}{1 + 0.4.t}$

Dynamic hydrologic modeling using the zero parameter Budyko model with instantaneous dryness index (Biswal, 2016)

Mathematical formulation of model

Total functional form of water and energy at any instance of time is given as:

$$FW(t) = \int_{t-N}^{t} W(\tau).\frac{1}{1+0.4\cdot(t-\tau)}\,d\tau$$

$$FH(t) = \int_{t-N}^{t} H(\tau).\frac{1}{1+0.4\cdot(t-\tau)}\,d\tau$$

Instantaneous dryness index $\varphi(t) = \frac{FH_i}{FW_i}$ controls the hydrologic partitioning of 'W' into effective rainfall and rainfall loss.

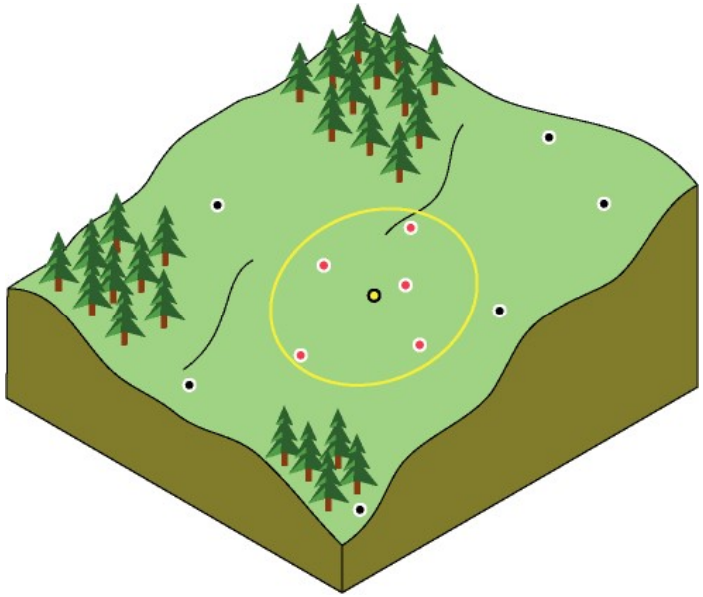
$$Q(t) = -\frac{d}{dt}\left[\int_0^t \left(-Er(\tau)\cdot\frac{1}{1+0.4(t-\tau)}\right)\cdot\,d\tau\right]$$

Statistical based regionalization method

Inverse distance weighted method

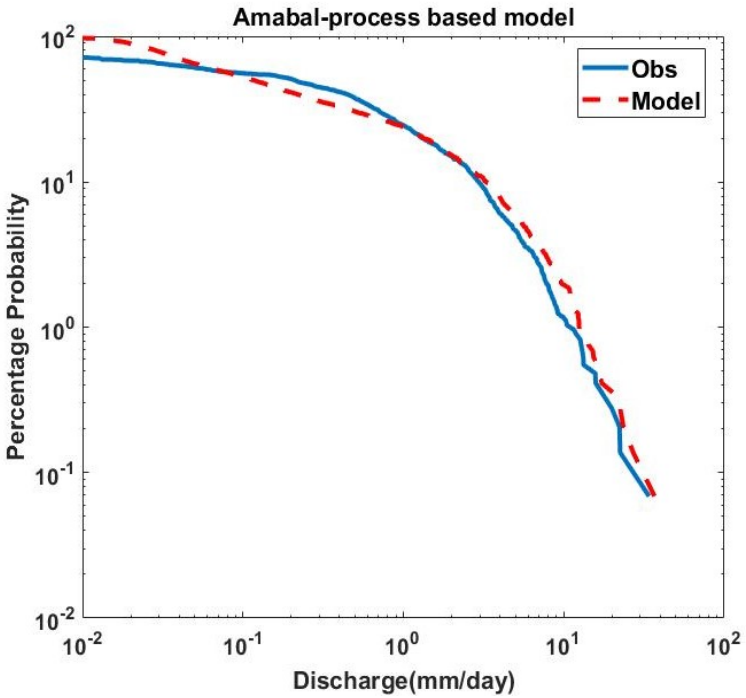
$$Q_u = \sum_{j=1}^{n-1} w_j Q_g^{(j)}$$

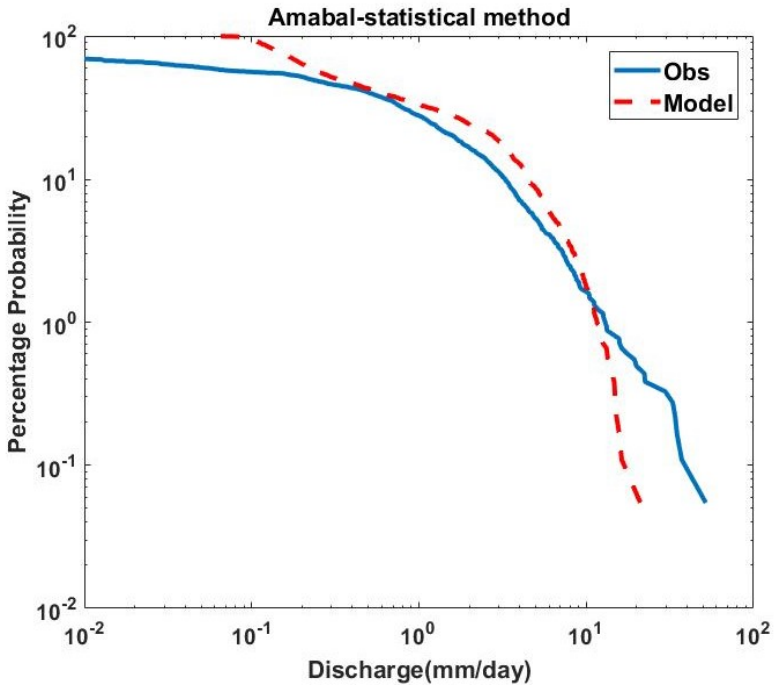
$$w_j = \frac{d_j^{-2}}{\sum_{j=1}^{n} d_j^{-2}}$$



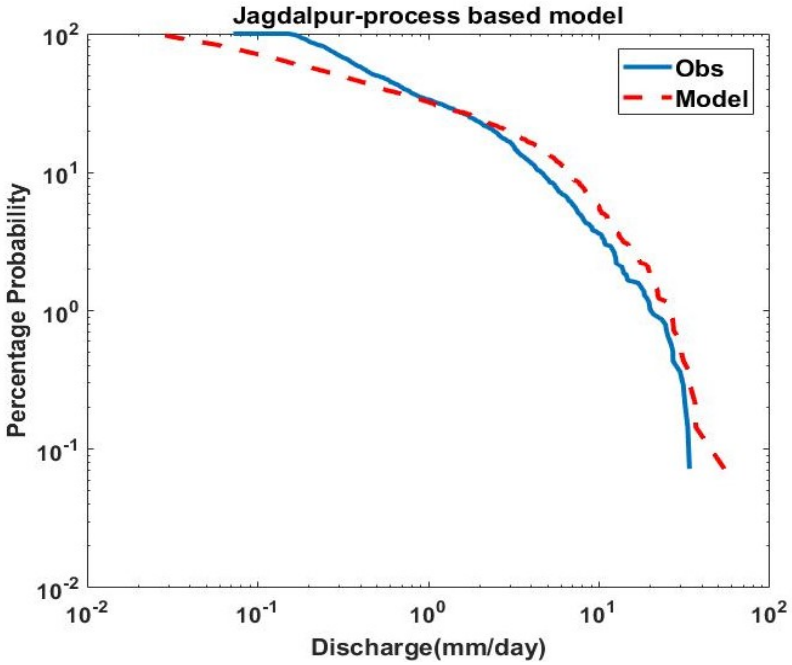
http://pro.arcgis.com/en/pro-app/help/analysis/geostatistical-analyst/GUID-DD4415F3-5B45-424A-A86F-FAF389043926-web.gif

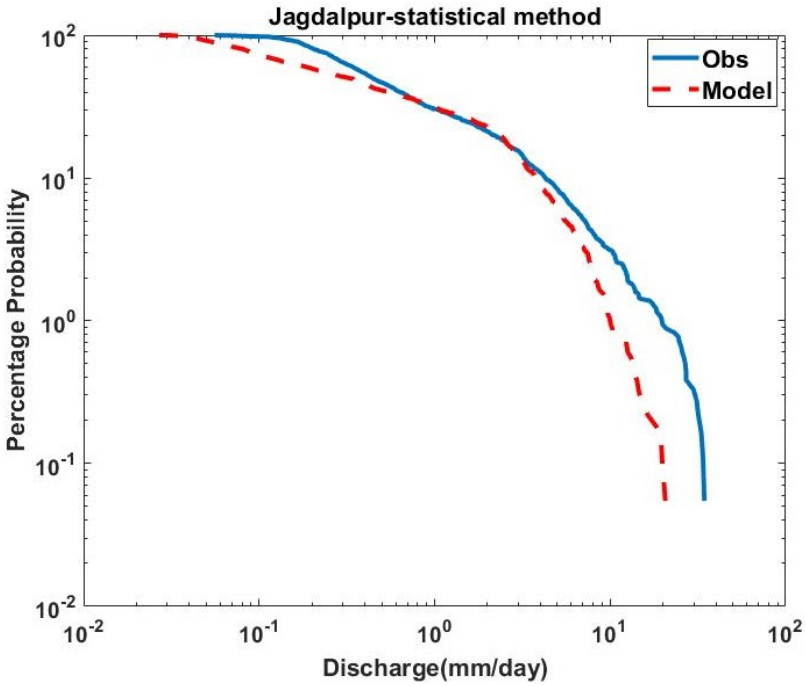
Results of FDC comparison for sample catchments



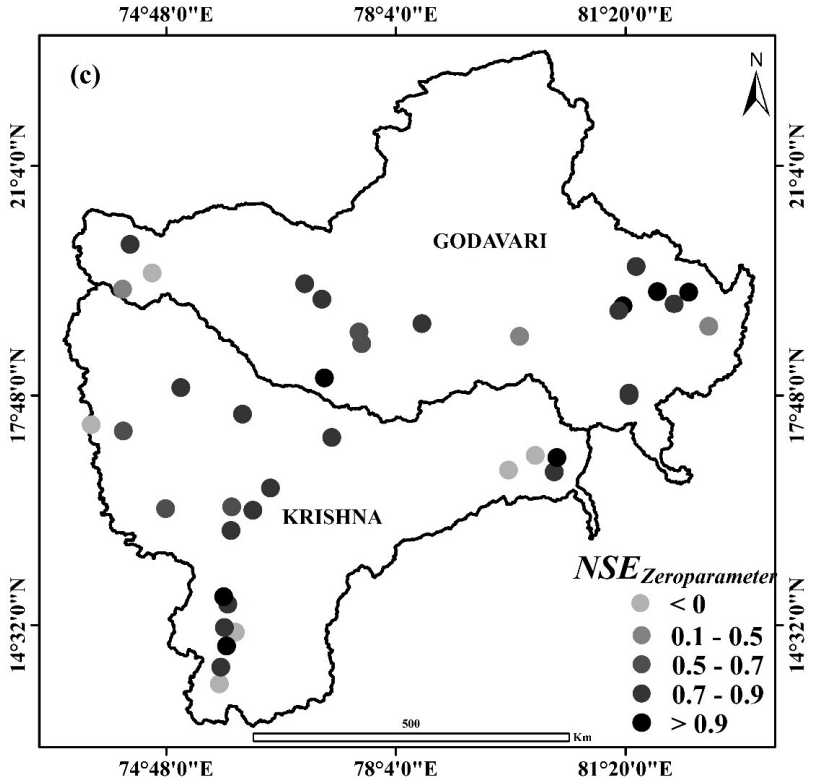


Results of FDC comparison for sample catchments

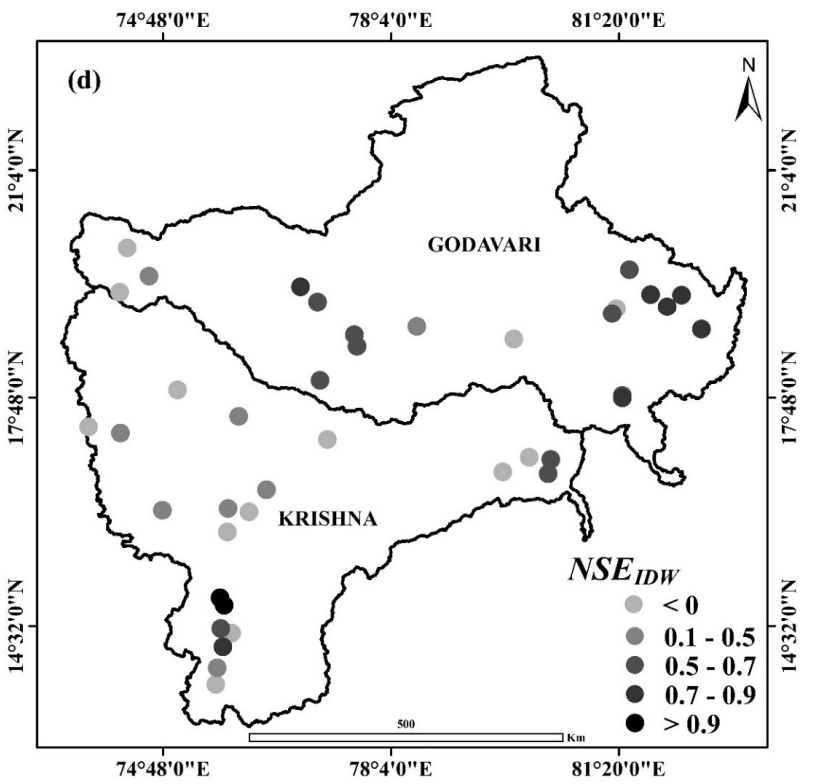




Spatial distributions of NSE across study area

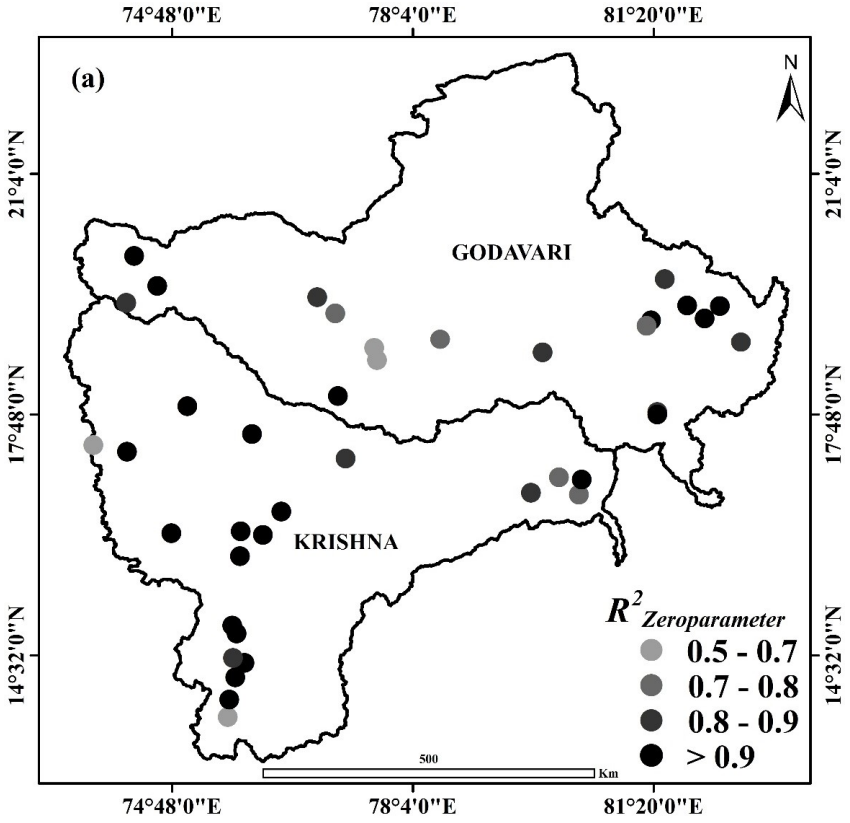


Median NSE 0.77

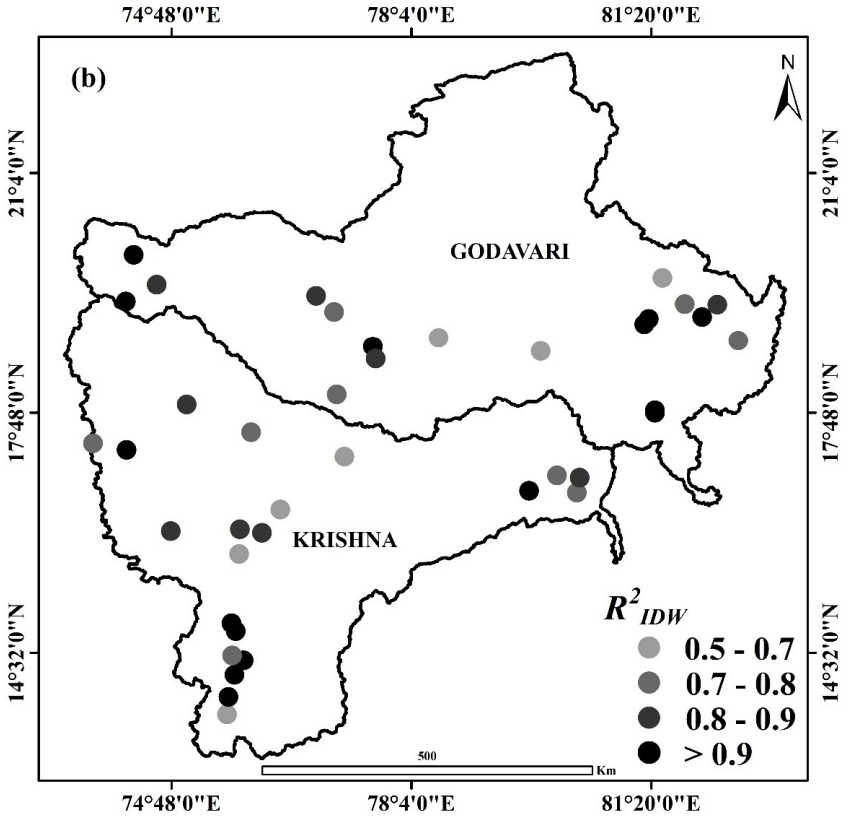


Median NSE 0.43

Spatial distributions of R^2 across study area



Median R^2 0.95



Median R^2 0.88

Conclusions

The model performance is significant compared to standard regionalization method.

Model does not have any calibrating parameter and can be used for prediction in completely ungauged and catchments.

Result suggests that model may be universally applicable.