



# SCALING THE FLOOD REGIME WITH THE SOIL HYDRAULIC PROPERTIES OF THE CATCHMENT

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## INTRODUCTION

Changes in land use generate changes in the hydraulic properties of soil, mainly due to the variation of root depth, which depends on the vegetation type. Two parameters especially affected are the soil water content in the root zone (static storage  $H_u$ ) and the saturated hydraulic conductivity ( $K_s$ ).

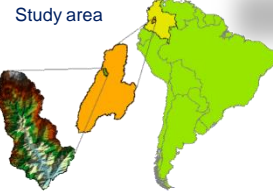
We test the hydraulic properties of soil and  $K_s$   $H_u$  present a scalable behavior to the flood regime

In order to characterize the flood regime, we use order moments and a GEV model

We simulated changes in the land cover of a watershed through hydrological modeling, in a case study with different land uses in order to have different samples corresponding to different periods of time.

To carry out frequency analyses of floods we relate changes in land use to the variation of the probability distribution function parameters.

## MATERIALS AND METHODS



The study area is located in the Combeima River catchment in Colombia - South America

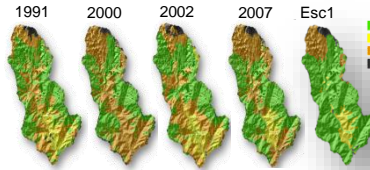
### Soil data

- Soil hydraulic properties were estimated using pedotransfer functions (Schaap, 1999).
- Root depth was varied for each land use:

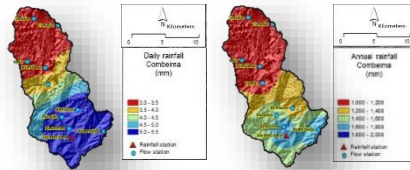
- ✓ Forest
- ✓ Grassland
- ✓ Crops
- ✓ Impervious surfaces



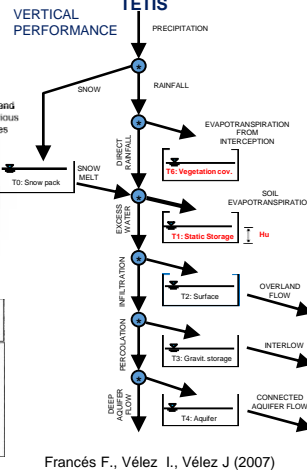
### Land Use / Cover Maps



### Rainfall Spatial variability



### Distributed Hydrological Model TETIS



### Wide Sense Simple Scaling

Gupta & Waymire (1990) studied the behavior of the empirical moments of rain on the spatial scale to characterize the statistical structure of the rain and in this case applied to the soil hydraulic properties in a catchment.

$$Y_i = \lambda_i^r Y_1$$

$n$  is the scaling exponent and  $\lambda_i$  is the scale ( $\lambda_i > 0$ ). If  $Y_i$  has finite moments  $E[Y_i^r]$  of order  $r$ , and the random variables  $Y_i^r$  and  $\lambda_i Y_1^r$  follow the same probability distribution. It can be:

$$\log E[Y_i^r] = r n \log \lambda_i + \log E[Y_1^r]$$

To examine the scaling properties of the statistical moments, linearity expresses as:

$$\log m_r(\lambda_i) = n_r \log \lambda_i + a_r$$

With intercept  $a_r$  and slope  $n_r = r \cdot n$  which is by linear regression for each  $r$  (Vascóva, 2001).

### Flood Frequency Analysis

#### GEV Distribution

$$f(y) = \begin{cases} \exp\left[-\left[1 - k \frac{(y-\beta)}{\alpha}\right]^{1/k}\right] & k \neq 0 \\ \exp\left[-\exp\left[-\frac{(y-\beta)}{\alpha}\right]\right] & k = 0 \end{cases}$$

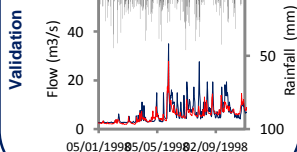
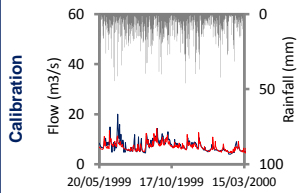
$\beta + \alpha/k \leq y < \infty$  for  $k < 0$   
 $-\infty < y < +\infty$  for  $k = 0$   
 $-\infty < y \leq \beta + \alpha$  for  $k > 0$   
 $\alpha, \beta, k$ , parameters scale, location and shape

#### Parameters Maximum Likelihood Estimator

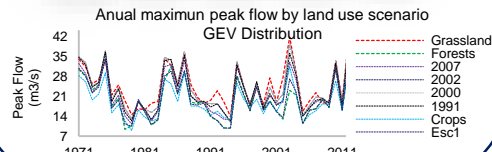
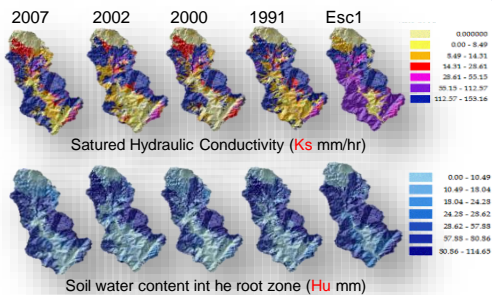
$$\frac{1}{n} \sum_{i=1}^n \left[ \frac{1 - k - (y_i - \beta)^{1/k}}{y_i} \right] = 0$$
$$-\frac{5}{\alpha} + \frac{1}{\alpha} \sum_{i=1}^n \left[ \frac{1 - k - (y_i)^{1/k}}{y_i} \left( \frac{x_i - \beta}{\alpha} \right) \right] = 0$$
$$-\frac{1}{n} \sum_{i=1}^n \left[ \frac{\ln(y_i) \left[ 1 - k - (y_i)^{1/k} \right]}{y_i} + \frac{1 - k - (y_i)^{1/k}}{k} \left( \frac{x_i - \beta}{\alpha} \right) \right] = 0$$

## MAIN RESULTS

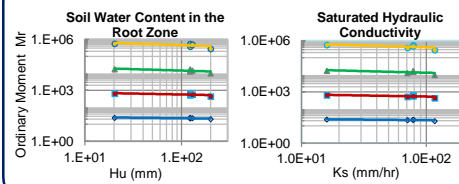
### Distributed Hydrological Model



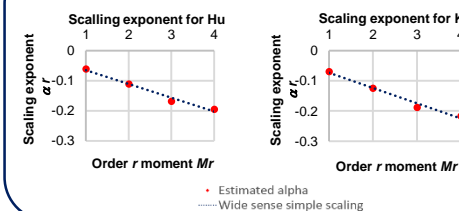
### Simulation scenario Change land use / cover



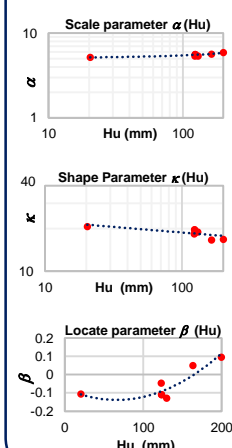
### Testing Scaling Behavior of Soil Hydraulic Properties



### Scaling exponents r for different moment orders



### GEV Parameters Behavior



## CONCLUSIONS

- TETIS results show that changes in land use/cover affect the flood regime
- Grassland increases the flood quantiles, meanwhile forest covers show a decrease of peak flow
- Flood regime presents a scaling behavior in relation with the soil hydraulic properties (static storage and saturated hydraulic conductivity)
- Scaling with soil hydraulic properties allows adjustment of the parameters of the GEV distribution
- So, the proposed methodology allows to evaluate the effect of changes in land use on flood regime by power equations.

## REFERENCES

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## ACKNOWLEDGEMENTS

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