UNIVERSITE PAUL SABATIER

TOULOUSE III

Laboratoire des Mécanismes et Transferts en Géologie

STAGE DE MASTER RECHERCHE
HYDROLOGIE HYDROCHIMIE SOL ENVIRONNEMENT

TITLE: HYDROLOGICAL MODELLING OF RIO BENI WITH CONCEPTUAL MODELS.
TITRE: MODELISATION HYDROLOGIQUE DU RIO BENI A L'AIDE DE MODELES CONCEPTUELS

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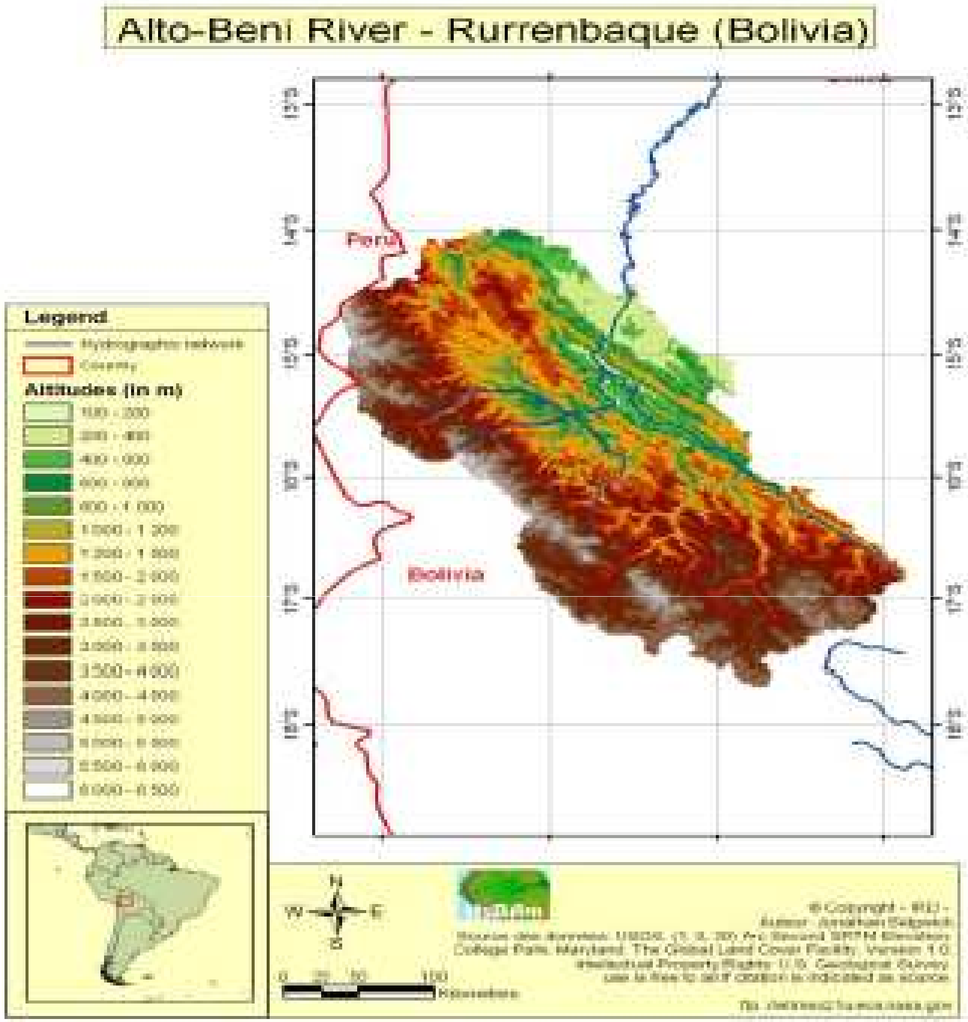


Figure 1 : Location of the watershed, in Bolivia. (The DEM of the watershed at 93m resolution.)

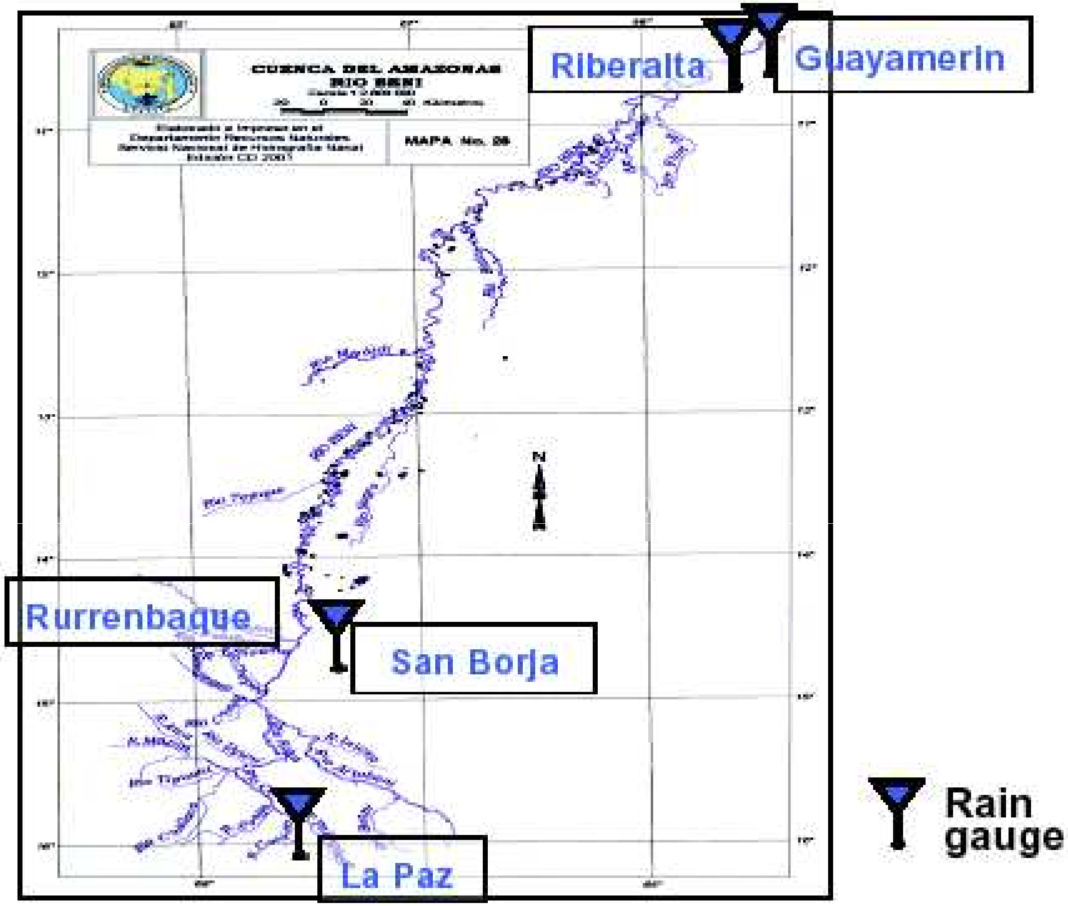


Figure 2: Drainge network of Rio Beni and localisation of the 5 rain gauge stations

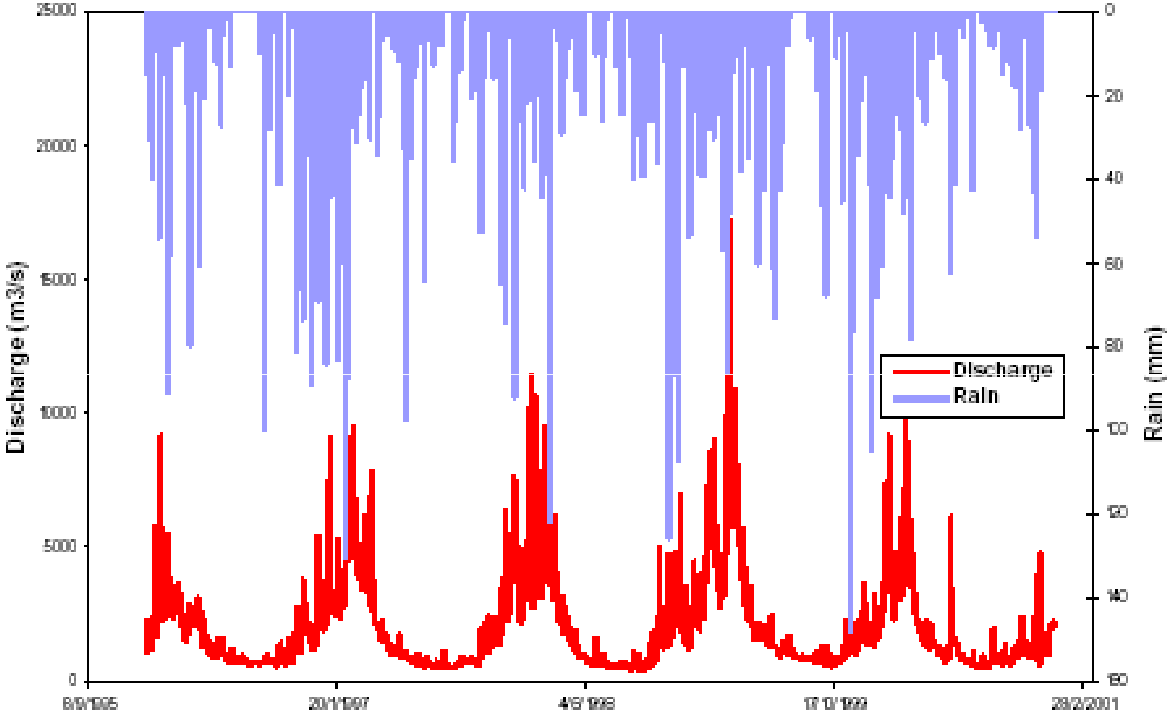


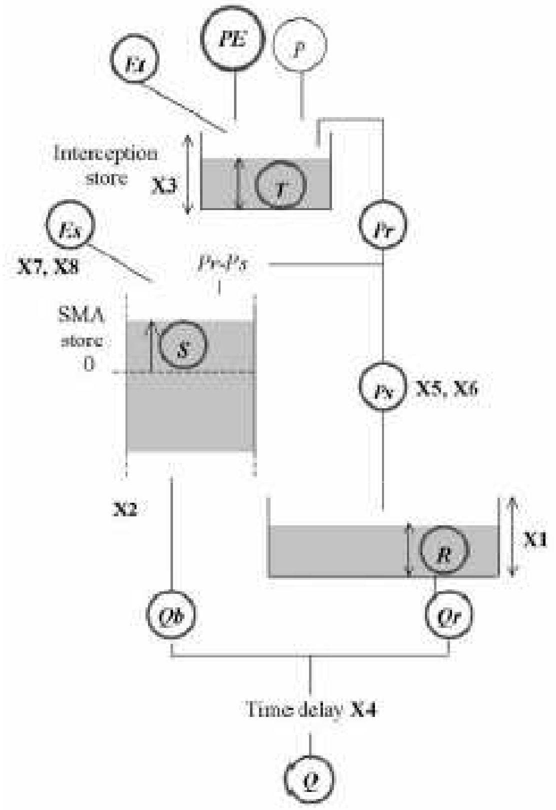
Figure 5: Daily measured discharge and rainfall at Rurrenbaque from 1996 – 2000

Model	Aim and Application	Optimized Parameters
ABCD **(Thomas, 1981)**	Model the budget and longterm prevision. Handle water ressources and longterm hydrological evolution.	Soil saturation capacity Soil humidity and evapotranspiration Recharge of groundwater Groundwater emptying constant
CATPRO **(Raper and Kuczera, 1991)**	Study of hydrosalinity and exchange between the groundwater tables of rivers.Characterization of changes in environment.	Interception parameters Maximum capacity of the soil reservoir Maximum hypodermic discharge Maximum recharge of the groundwater Saturation constant Groundwater emptying constant Evapotranspiration coefficient
GEOR (Georgakakos and Baumer, 1996)	To use the humidity of the soil to simulate monthly timestep.	Maximum capacity of two soil layers Exponent Runoff parameters
HAAN **(1972)**	Hydrological model for small rural watersheds and for the prevision of monthly water budget.	Secondary capacity of soil reservoir Maximum infiltration capacity Maximum percolations Proportion of the percolation forming the base flow
SDIO (Langford and O'Shaughnessy, 1977)	To account humidity of soil for modelling rainfall-discharge.	Interception parameters Slope of the field Rapid runoff parameters Evapotranspiration parameters Ground water reservoir constant Exchange parameters

Table 1: Brief description of monthly hydrological models

Model	Aim and Application	Optimized Parameters
GR5J	Model rainfall-discharge with few parameters	Maximum capacity of the soil reservoir Maximum capacity of the routage reservoir Unit hydrogram duration Percolation to saturation Groundwater emptying constant
GR	Model rainfall-discharge in non-gauged watersheds	Maximum production capacity of reservoir Maximum routage capacity of the reservoir Duration for the unit hydrogram Underground exchange parameters
GRHUM	To account the interface between soil-vegetation-atmosphere in a rainfall-discharge model	Constant function of the drainage model of Thomas Constant time of the unit hydrogram Underground exchange parameter Maximum routage capacity Evaporation parameters, to be determined based on the physical characteristic of the watershed
TOPMODEL	Use of the topgraphy index and the notion of the variable contributive area for modelling rainfall-discharge.	Maximum capacity of interception and infiltration reservoirs Infiltration parameters Groundwater emptying constant Routage parameters Parameter dependent on topography index

Table 2: Brief description of weekly hydrological models



Parameter	Definition
Model Inputs	
P	rainfall
PE	potential evapotranspiration
Internal State Variables	
Et	evaporation during the interception phase
T	water content of the interception reservoir
Pr	effective rainfall after interception
Es	evaporation from soil moisture accounting reservoir
S	water content of the soil moisture accounting reservoir
Ps	amount of water that reaches the routing reservoir
R	water content of the routing reservoir
Qb	percolation flow from the soil moisture accounting reservoir
Qr	outflow from the routing reservoir
Q	streamflow
Model Parameters	
X1	capacity of the quadratic routing reservoir (mm)
X2	outflow parameter of the exponential store
X3	capacity of the interception reservoir (mm)
X4	pure time delay (day)
X5, X6	parameters defining the distribution curve of the topographic index
X7, X8	actual evaporation computation coefficients

Figure 8: Structure of conceptual TOPMODEL (after Perrin 2000)

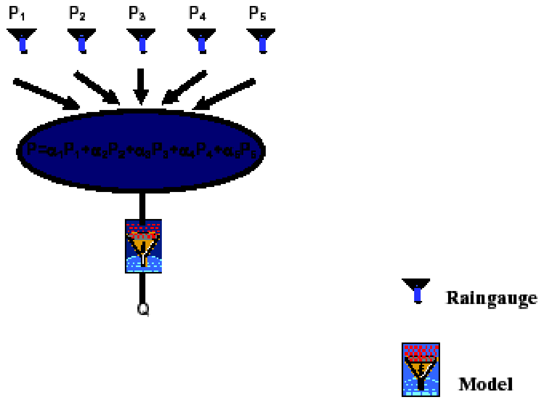


Figure 9a: Approach 1,where P is monthly rainfall input to the model, $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ are weighted factors and P_1, P_2, P_3, P_4, P_5 are rainfall from the 5 stations.

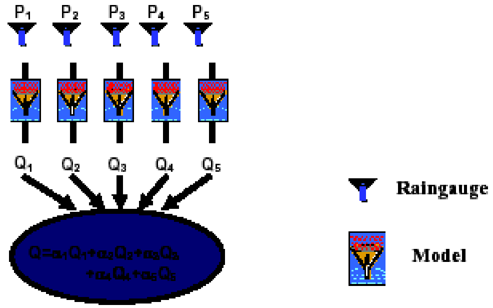


Figure 9b: Approach 2, where Q is the final discharge obtained from the optimized parameters $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ and Q1, Q2, Q3, Q4, Q5 are the discharges got from the model.

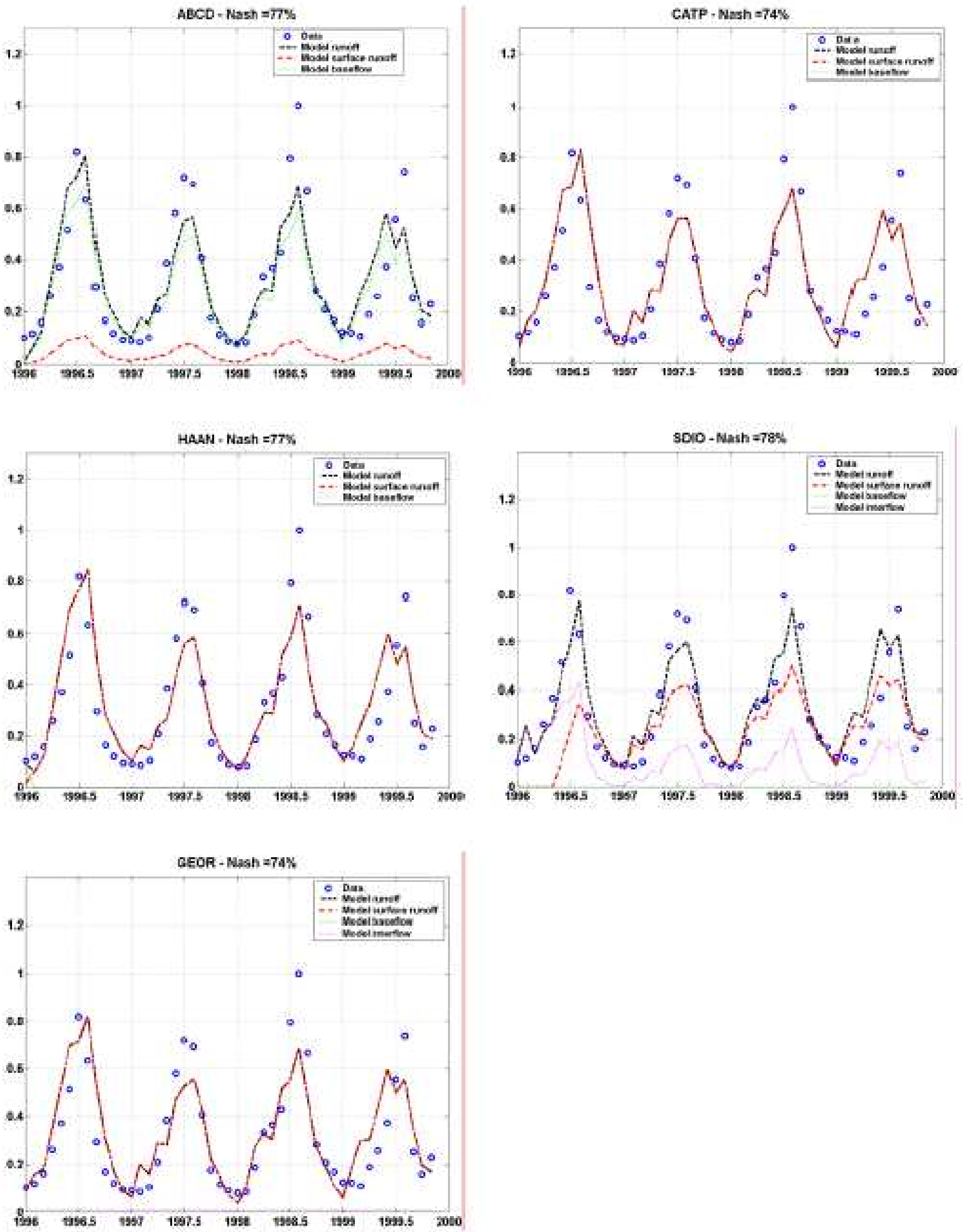


Figure 10: Simulations of monthly time scale by approach 1

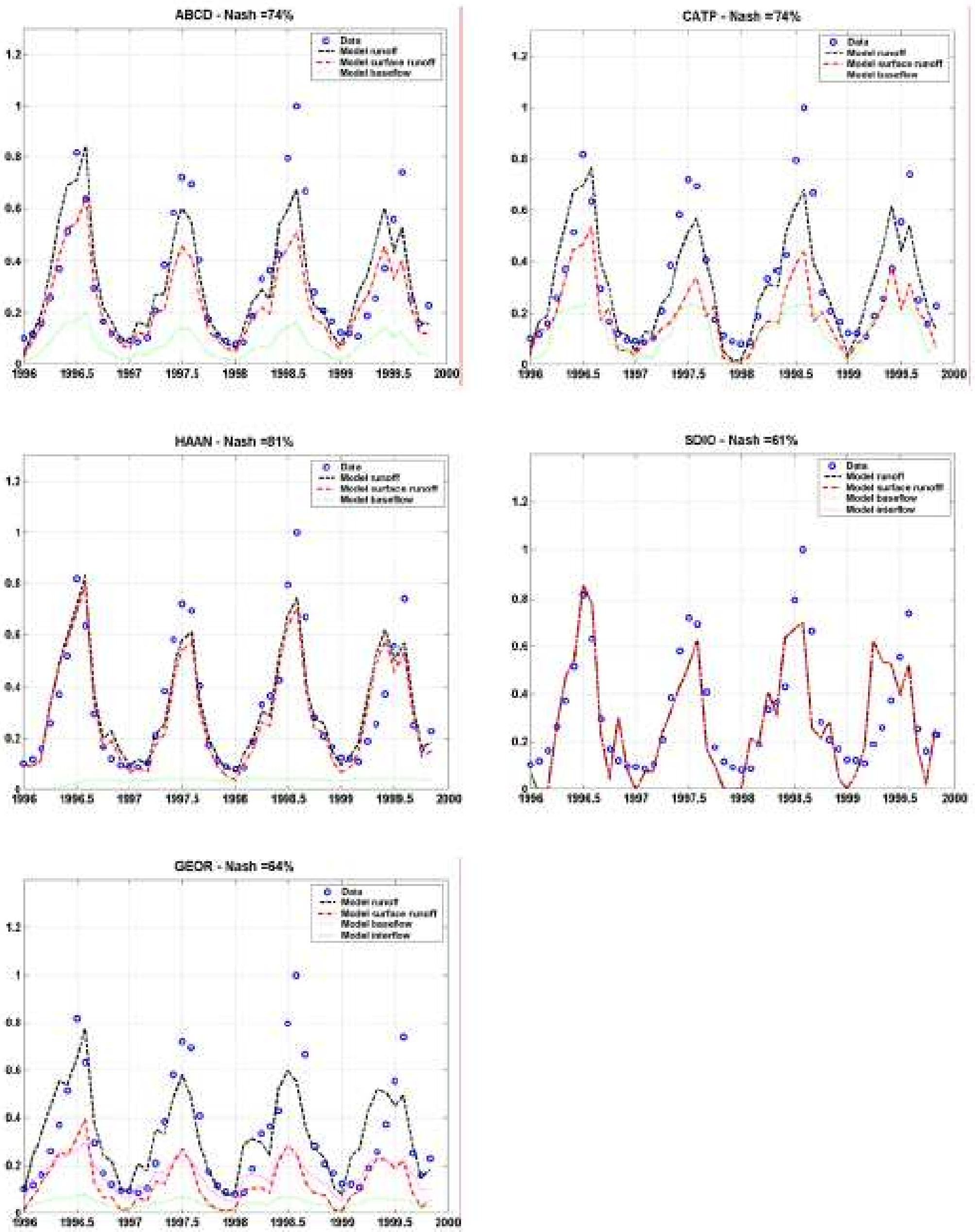


Figure 11: Simulations of monthly time scale by approach 2

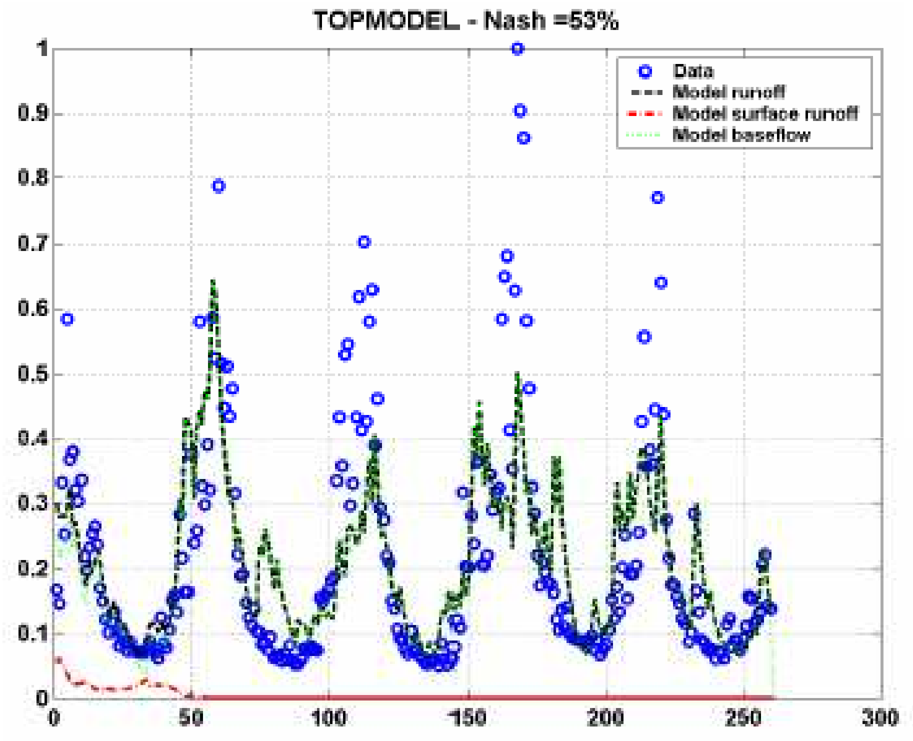


Figure 12: Weekly time scale simulation by TOPMODEL from 1996-1999

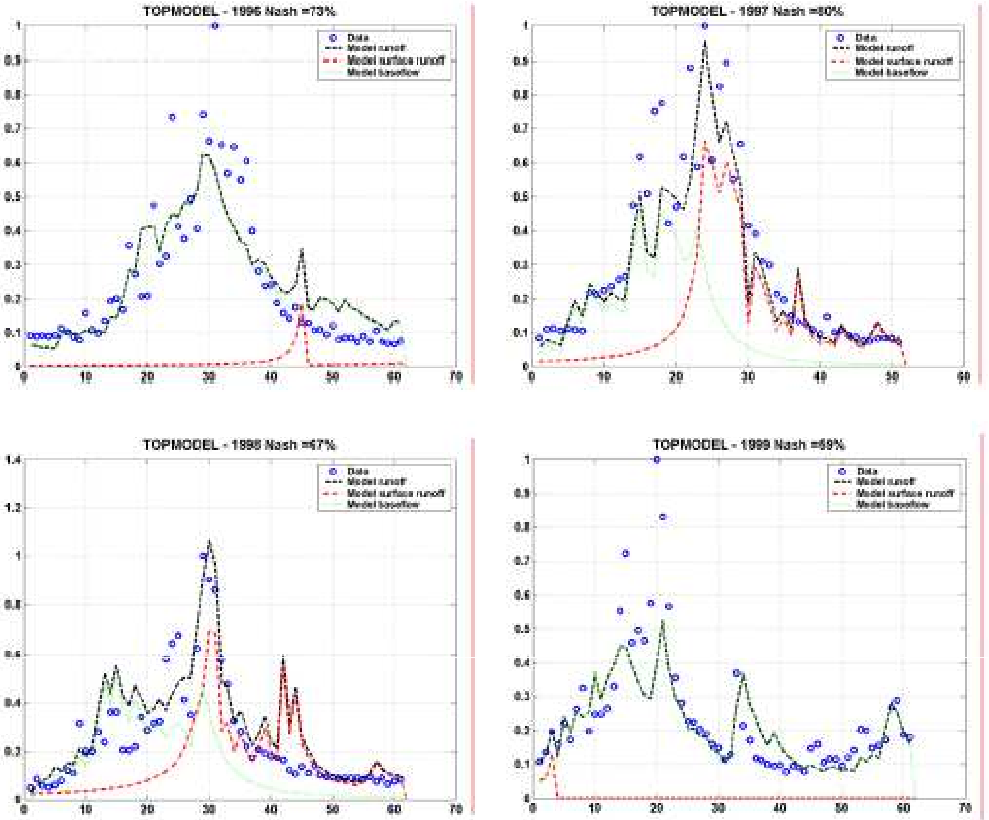


Figure 13c: Simulations for weekly time scale for individual years

Model	1996 – 1999
ABCD	52
GR5J	51
GR	47
GRHUM	55
TOPMODEL	53

Table 4: Nash coefficient expressed in percentage for weekly time scale: 1996 – 1999

Model	1996	1997	1998	1999
GR5J	75	77	55	67
GR	67	74	51	62
GRHUM	76	76	56	63
TOPMODEL	73	80	67	59

Table 5: Nash coefficient expressed in percentage for weekly time scale: individual years

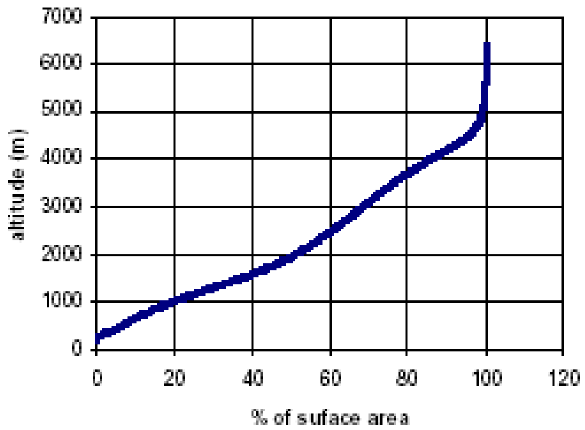


Figure 15: Hypsometric curve

Simulation for one year (1996) was carried out with the physically distributed model (*Fig 16*). The simulation obtained was not very consistent, but could be improved with data adapted to a distributed model.

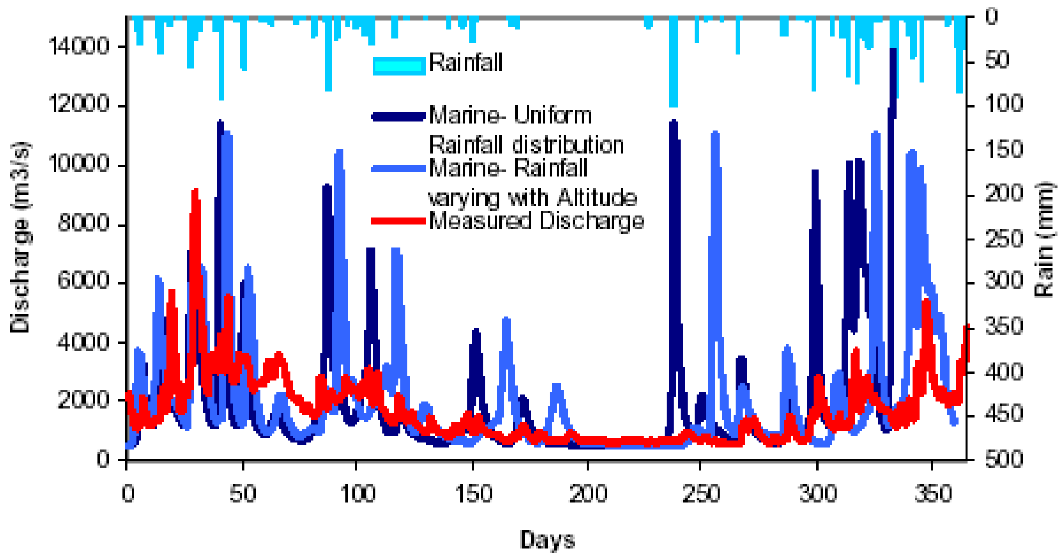


Figure 16: Preliminary simulation of the model MARINE for the year 1996