Hydrological modelling of the Bafing River (Senegal River basin): towards better management of the Manantali multipurpose dam

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Scientifical context and objectives

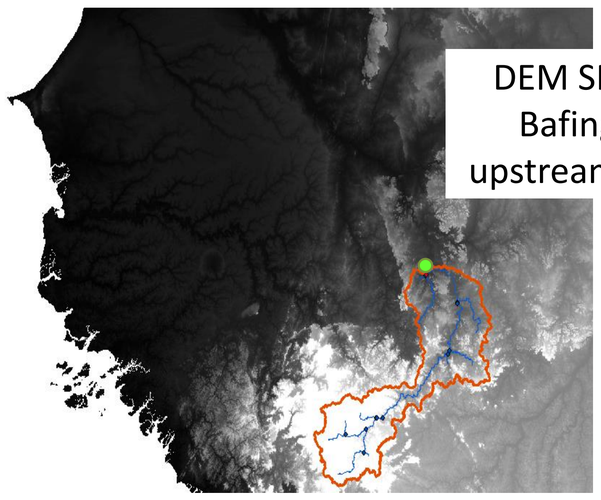
The Senegal River natural flow is highly irregular. Climate change, climate variability and high variation of flow have led the four countries sharing the Senegal River basin to build two dams : (1) the Manantali Dam, which is a multipurpose dam built in the upstream part of the river basin, on the Bafing main tributary, and (2) the Diama Dam, which sustains low flow by insuring a minimum water level in the valley, supplies water for irrigation, navigation and hydropower, and stops the sea intrusion. River basin hydrological modelling tools seem appropriate tools to optimize the management of these two dams. The main objectives of this preliminary study are (1) to apply the physically based SWAT model to the Bafing river basin, upstream Manantali Dam to better assess the hydrology of this subbasin and (2) to suggest a better use of the water stored in the Manantali dam reservoir.

Study site and data

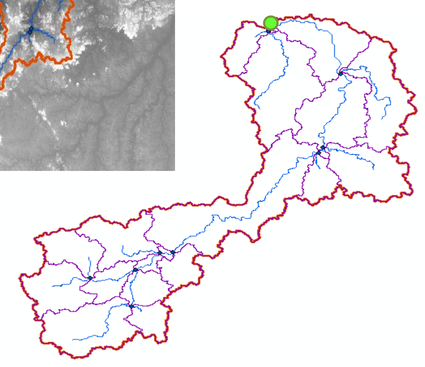
The Senegal river basin is located in the Sahelian and sub tropical area of West Africa. Is is generally divided into tree parts : the upper Bafing basin, the Valley and the Delta.
Rainfall in the upper basin in Guinea : 2,000 mm/year
Rainfall in the valley and delta ~500 mm/year
Climatic regime in the basin : 3 seasons

- a rainy season, from June to September
- a cold-dry off-season, from October to February
- a hot-dry off-season, from March to June.

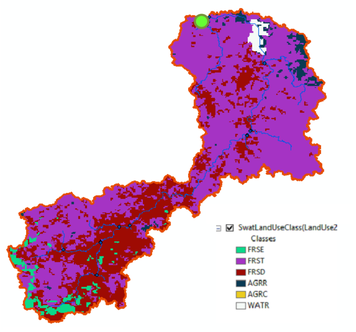
The high-water period or flood stage occurs between July and October and the low-water period lasts from November to Mai/June.



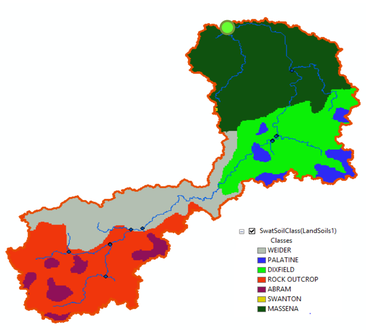
DEM SRTM 90 m and Bafing River Basin upstream Manatali Dam



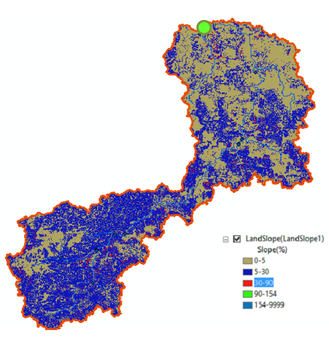
River basin sub-basin delineation: 21 sub-basins and 21 HRU



Land use



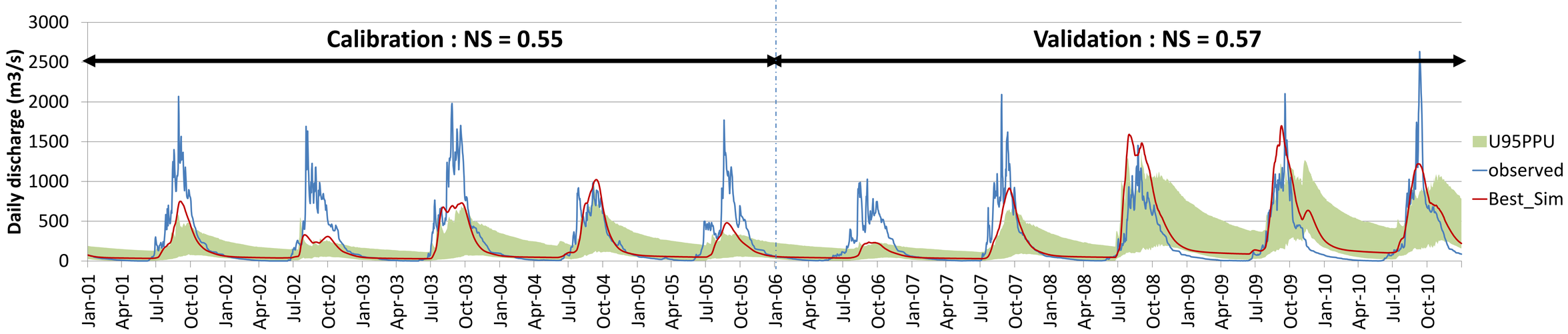
Soils



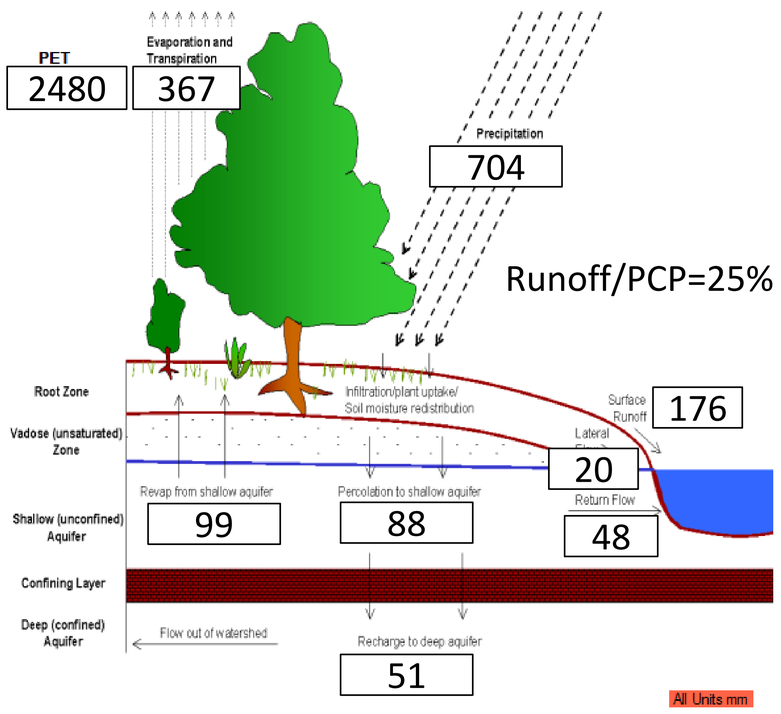
Landslopes

Climate inputs : CFSR Global Weather Data
Data for discharge calibration : daily flow measured at Bafing Makana Gauge, located upstream Manantali Dam (Latitude : 12.55, longitude -10.283)

Results



Parameter name	Min	Max	Fitted value	Sensitivity rank
1:R__CN2.mgt	-0.1	0.1	0.085	7
2:V__ALPHA_BF.gw	0.01	1	0.22	2
3:V__GW_DELAY.gw	0	500	426	5
4:V__GW_REVAP.gw	0.02	0.2	0.08	10
5:V__GWQMN.gw	0	5000	2525	20
6:V__RCHRG_DP.gw	0.01	0.99	0.37	4
7:V__REVAPMN.gw	0	500	155	16
8:V__CH_K2.rte	0.01	100	68	8
9:V__CH_N2.rte	0.025	0.15	0.12	14
10:V__CH_K1.sub	0.01	100	1.31	3
11:V__CH_N1.sub	0.025	0.15	0.06	6
12:V__ESCO.hru	0.7	0.9	0.73	12
13:V__EPCO.hru	0.7	1	0.80	21
14:V__LAT_TTIME.hru	0	180	21	1
15:V__CANMX.hru	0	100	38	15
16:V__OV_N.hru	0.01	0.6	0.39	19
17:R__SOL_K(..).sol	-0.1	0.1	-0.08	9
18:R__SOL_AWC(..).sol	-0.1	0.1	-0.08	13
19:R__SOL_BD(..).sol	-0.1	0.1	-0.09	11
20:R__SOL_CBN(..).sol	-0.1	0.1	0.06	17
21:V__SURLAG.bsn	0.05	24	18	18



Conclusions

The SWAT model is able to reproduce the daily discharge in the 38 218 km² Bafing basin.
Next steps are:

- To test rainfall data from rain gauges
- To apply SWAT to the other parts of the whole Senegal River basin (Valley and Delta)
- To introduce the daily discharge released by the Manantali Dam
- To assess the sediment transport throughout the basin.

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