Modelling river discharge at sub-daily time-step: Comparison of the performances of the conceptual SWAT model and the process-oriented MARINE model

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Context and objectives

Due to global change, the frequency of intense rainfall events and consequent **flash floods** are expected to increase in the next decades across the Mediterranean coastal basins. To date, few distributed models are able to simulate hydrological processes at basin-scale at a reasonable time scale to describe these flash events with accurate details.

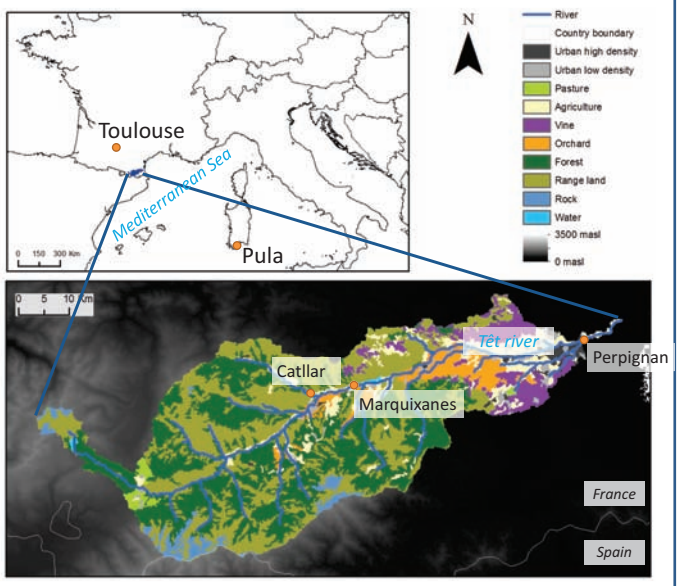
The **MARINE model** is one of them: it is a process-oriented fully distributed model operating dynamically at the rainfall event time-scale. Both infiltration and saturation excess are represented along with subsurface, overland and channel flows. It does not describe ground-water processes since the model's purpose is to simulate individual flood events during which ground-water processes are considered negligible.

The **SWAT model** is a conceptual semi-distributed model assuming several simplifications in equations that dynamically simulates above- and below-ground processes. It has been recently upgraded to sub-daily time-step calculations.

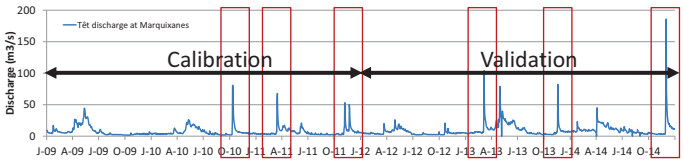
The objective of this study was to assess and compare the performances of these two models when simulating the discharge at sub-daily time-step.

Study site

1380 km², shallow sandy soils
Typical flash flood prone coastal Mediterranean basin

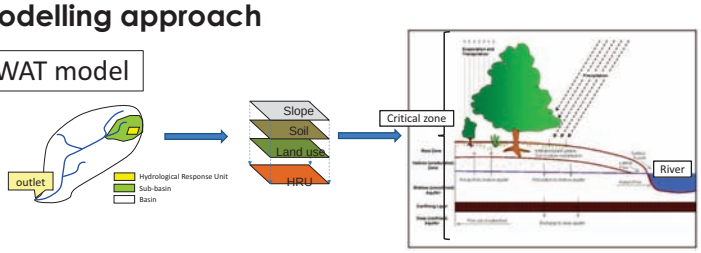


Selection of the flood events :



Modelling approach

SWAT model



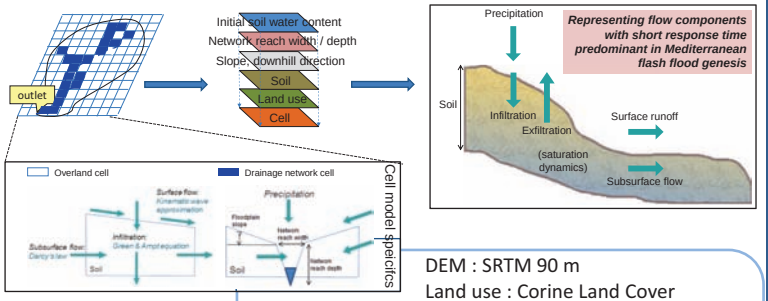
Sub-daily time-step simulation : **Green & Ampt** equation

$$f_{inf,t} = K_e \cdot \left(1 + \frac{\Psi_{wf} \cdot \Delta\theta_v}{F_{inf,t}}\right)$$

where f_{inf} is the infiltration rate at time t (mm/hr), K_e is the effective hydraulic conductivity (mm/hr), Ψ_{wf} is the wetting front matric potential (mm), $\Delta\theta_v$ is the change in volumetric moisture content across the wetting front (mm/mm) and F_{inf} is the cumulative infiltration at time t (mm H_2O).

MARINE model

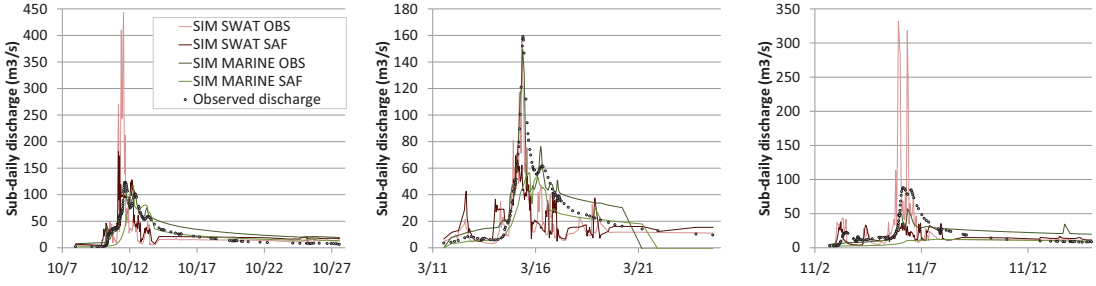
- Regionalization for flash floods
- Physically interpretable parameters to facilitate estimation
- Adaptive time-step (typical range: 1-5 min.)
- Mesh resolution < rainfall resolution (typical range: 200-500 m.)



Input data

DEM : SRTM 90 m
Land use : Corine Land Cover
Soil : FAO classes, INRA soil properties
Sub-daily rainfall : Measured from rain gauges (OBS) / SAFRAN model (SAF)

First results



Flood of October 2010 | Flood of March 2011 | Flood of November 2011

Nash efficiencies :

		MARINE	SWAT
Oct 2010	Rain gauges	0.90	-1.64
	SAFRAN	0.20	0.42
Mar 2011	Rain gauges	0.86	0.39
	SAFRAN	0.25	0.12
Nov 2011	Rain gauges	0.54	-3.02
	SAFRAN	-0.63	0.05

Conclusions & perspectives

The MARINE model gives better results than SWAT, especially when using the rain gauge spatial distribution. The spatial distribution of the gauges (whether measured or simulated) seems to have little effect on the quality of the SWAT simulations. They are however preliminary results. Once improved, the suspended sediments and the soil water content simulated by SWAT will be used as MARINE inputs.

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