Hydrological behaviour of a small tropical catchment on volcanic deposits

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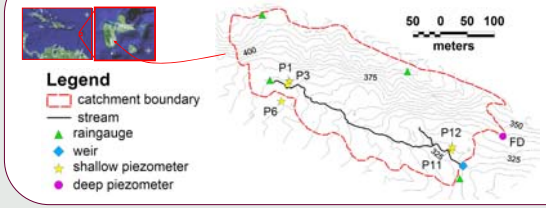
1. Objectives

Volcanic insular reliefs, as the Lesser Antilles arc, are locally subject to a strong anthropic pressure. These regions are characterized by abundant rainfall, a strong heterogeneity of the geometry of the deposits and a high soil infiltration capacity.

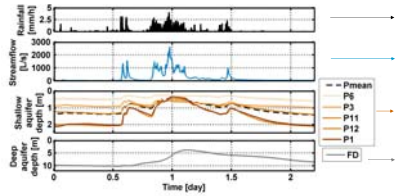
➢ **identification of hydrological processes at the catchment scale**

2. The Féfé experimental catchment, Guadeloupe (FWI)



- surface = 19.5 ha
  mean slope = 12 %
  altitude = 350 m
- annual rainfall : 4230 mm (2003) to 7030 mm (2004)
- Hydrological measurements during 2 years (2003 & 2004)

Characteristics of storm event (18/05/2004) :



➢ High **rainfall** intensities

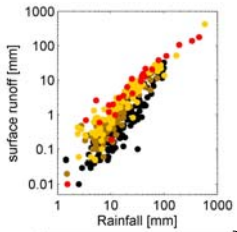
➢ fast and intense response of the **stream** to a rainfall event

➢ fast and low **shallow groundwater** variations

➢ smooth and high **deep groundwater** variations

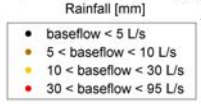
3. Hydrological processes

Runoff process at the evenly time scale



Stormflow events are intense and rapid

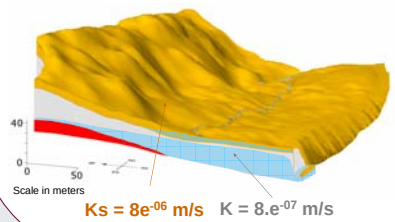
- minimum **response time = 25 min**
- **runoff coefficient = 6 to 24 %** and is correlated to the rainfall volume and the initial soil water humidity



Baseflow is considered like an indicator of the initial soil water humidity of the catchment

Hydrogeologic diagram of Féfé catchment

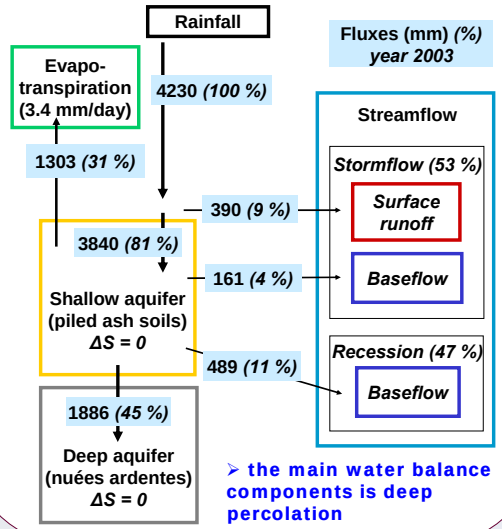
2 aquifer systems in the volcanic deposits



➢ **shallow aquifer in piled ash soils layer** : high infiltration capacity (Ks) in umbric andosols; drainage by the stream and percolation to the deep aquifer; thickness ≈ 6 m

➢ **deep aquifer in the nuées ardentes layer** : medium hydraulic conductivity (K); the underlying weathered breccia layer represent the substratum; thickness = 30 m

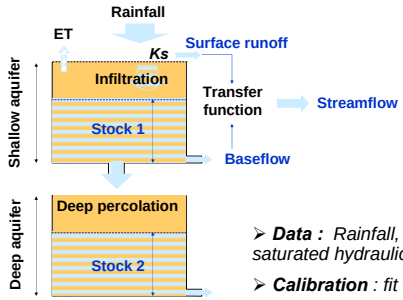
4. Hydrological behaviour



➢ **the main water balance components is deep percolation**

5. Global model approach

Global conceptual model of Féfé catchment



➢ *Runoff production function :* ***hortonian overlandflow***

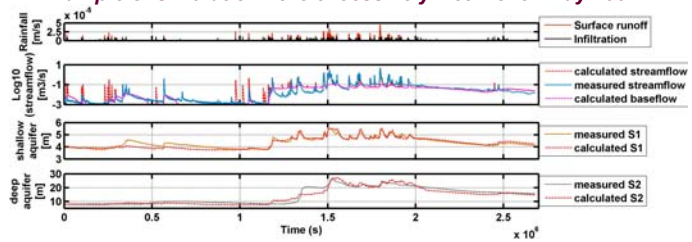
➢ *Transfer function :* ***diffusive wave model*** *(Hayami, 1951)*

➢ *Drawdown of water table :* ***exponential function***

➢ ***Data :*** *Rainfall, evapotranspiration (ET), saturated hydraulic conductivity (Ks)*

➢ ***Calibration*** *: fit of exponential function*

Example of simulation : the excessively wet month may 2004



➢ **high performance of the global model approach**

➢ **highlight problems related to the simulation of low flow events**

	Nash coef. [-]
Streamflow	0.83
Log10(streamflow)	0.81
S1	0.82
S2	0.91

	Measured	Calculated
Streamflow volume [m3]	163 847	154 074
peakflow [L/s]	4 602	4 975

6. Conclusion & perspectives

➢ The main hydrological process is deep percolation; the rapid and intense surface runoff during storm is supposed to be dominated by overland flow; the shallow aquifer is contributing to streamflow (baseflow).

➢ A global conceptual model based on a diagram of the hydrological behaviour of Féfé catchment validate the advanced hypothesis related to water budget components.

➢ In order to characterize the spatial variability of the hydrological processes due to the heterogeneity of the volcanic deposits, a spatial modelling approach is request for next studies.

Reference Hayami S., 1951. On the propagation of flood waves. Disaster Prev. Res. Inst. Bull. Université de Kyoto, Japon,1: 1-16.

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