Design Project – SIE 2015

Solène Majoulet, Karine Sarrasin

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

crealp – Centre de recherche sur l'environnement alpin / Zentrum für alpine Umweltforschung / Research center on alpine environment

Comparison of two empirical methods and a semi-distributed model to calculate flood
Assess the predictive ability of these models applied to two mountainous watersheds in Valais

OBJECTIVES

– Establish if the rational and SCS-CN methods are applicable in a mountainous context and if they give sufficient results in these areas. If they are, in which situations could they replace the SOCONT model, which is computational more demanding?
– Provide a tool (Matlab code) to Crealp, so that they will be able to use, in some cases, the rational and SCS-CN methods in the future.

RATIONAL METHOD

1850
Very simple
Calculation of **peak runoff** [m³/s]
Use: pipe designing urban hydrology
Hydrograph: **Modified Rational Method**
No calculation of the hydrograph
Empirical method
No baseflow

Main parameters:
Runoff coefficient Cr, rainfall i,
Watershed area A

Basis hypothesis:
block rainfall,
constant Cr

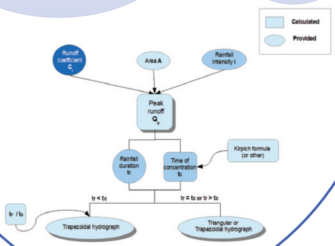


Diagram of the modified- and rational method
– Solène Majoulet and Karine Sarrasin

SCS-CN METHOD

1950
For agricultural watersheds
USA - Soil Conservation Service (SCS)
Calculation of **runoff amount** [mm]
SCS **Dimensionless Unit Hydrograph**
Empirical method
No baseflow

Main parameters:
Curve Number CN
Initial abstractions I_a
Retention F_a
Excess rainfall P_e

Basis hypothesis:
block rainfall
constant CN

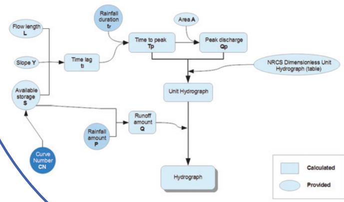


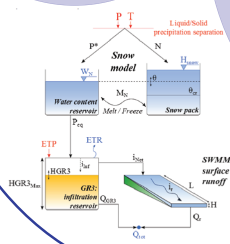
Diagram of the SCS-CN method
– Solène Majoulet and Karine Sarrasin

SOCONT MODEL

2011
Developped at the EPFL
To predict floods in the Rhône river
Need: **calibration** and **validation** before **simulation** of rainfall events
Semi-distributed hydro-logical model

Main parameters:
Degree-day snowmelt coefficient An
Maximum height of the infiltration reservoir HGR3Max
Release coefficient of the infiltration reservoir KGR3
Strickler coefficient Kr

Basis hypothesis:
combination of snow model, infiltration model and runoff model



SOCONT Scheme – *RS MINERVE Technical manual, 2015*

CASE STUDY

Study area

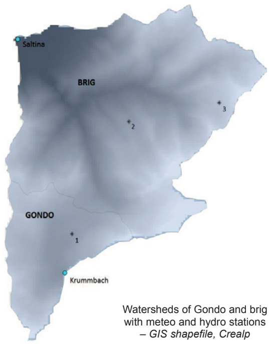
Gondo: 20 km²
Brig: 77 km²

Data

Meteorological stations → P,T
*1: 3 years of data
*2: 3 years of data
*3: 15 years of data
MeteoSuisse SLF

Hydrological stations → Q
- Krummbach: 4 years
- Saltina: 11 years

OFEV



Watersheds of Gondo and brig with meteo and hydro stations
– GIS shapefile, Crealp

METHODOLOGY

> Literature review for the three methods

> Matlab implementation for rational and SCS-CN methods
- For a hypothetical block rainfall (1)
- For a hypothetical 1-h incremental rainfall (2)
- For the real rainfall events (3)

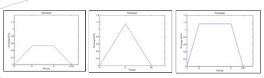
> Analysis of the data - for each watershed -
- Selection of the rainfall events of interest
- Calculation of the slopes and flow path length
- Determination of the soil type and land use (CORINE Land Cover)

> SOCONT
- Calibration (1)
- Validation (2)
- Simulation of the real rainfall events (3)

> Analysis of the hydrographs
- For each method
- For each watershed
- For each scenario (in function of Cr and CN)
- For each rainfall event

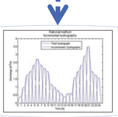
Rational method

(1)



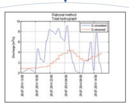
Rational method hydrograph, Hypothetical block rain
– Matlab simulation

(2)



Rational method : 1-h hydrographs and total hydrograph, for hypothetical rain
– Matlab simulation

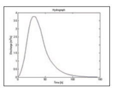
(3)



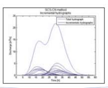
Rational, method hydrograph, slope 6%, Cr 0.32, Gondo
– Matlab simulation

Rough hydrograph: follow the hyetograph
Overestimation of the **peak runoff**: infiltration not enough taken into account
Time to peak shifted: estimated slope to small?

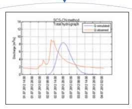
SCS-CN method



SCS hydrograph, Hypothetical block rain
– Matlab simulation



SCS method: 1-h hydrographs and total hydrograph, for hypothetical rain
– Matlab simulation

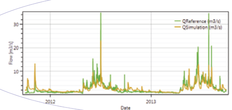


SCS hydrograph, slope 11%, CN 84.11, Brig
– Matlab simulation

Smooth hydrograph
Nash = -1.4
Good estimation of the **peak flow**
Underestimation of Qsim because no baseflow
Time to peak shifted: estimated slope to small?

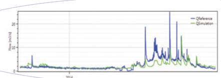
SOCONT

(1)



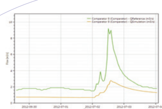
Calibration with SOCONT over 2 year, Brig
– RS MINERVE

(2)



Validation with SOCONT over 1 year, Brig
– RS MINERVE

(3)



Simulation with SOCONT over 1 year, station1, Gondo
– RS MINERVE

Similar shape between simulated and observed runoff
Underestimation of **runoff volume** due to dataset

CONCLUSION

Ability to simulate runoff from rainfall

Rational method – **too simple**, only one parameter to estimate abstractions, not adapted to watersheds bigger than 2.5 km², basically designed to calculate the peak discharge only, not adapted to predict real hydrograph shape, does not take into account the inertia of the watershed during a rainfall event, very sensitive to the area

SCS-CN method – **potential of improvement**, interesting hydrograph shape, but many parameters to define (CN from tables, infiltration curve, antecedent moisture conditions)

SOCONT model – **not perfect but the best**, underestimation of runoff due to dataset, time demanding for calibration

Aknowledgements
To Alain Foehn as external supervisor from Crealp / To Professor Michael Lehning as supervisor / To the OFEV for some additional data / To Professor Fernando Porté-Agel for his advices