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SWAT | Soil & Water Assessment Tool

EESC-USP 60

Comparison of Green-Ampt and Curve Number Infiltration Methods in a single-gauged Brazilian watershed

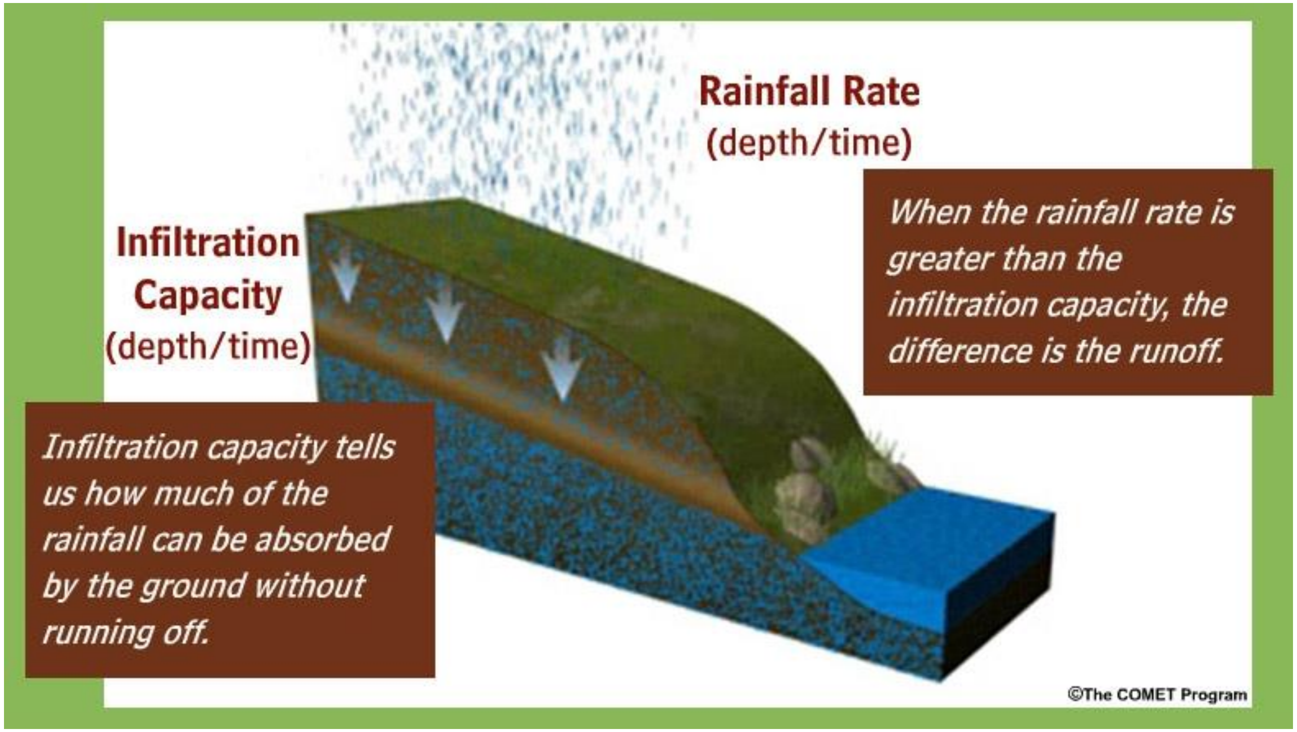
Julio Issao Kuwajima

Toulouse , 2013

Introduction

* The volume and rate of runoff of rain events are of great importance to understand the processes of a watershed.
* The infiltration determines the amount of water available for runoff, evaporation, root uptake, and recharge to the groundwater beneath

Introduction



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Runoff in the SWAT

- The runoff can be estimated in SWAT using :
- SCS Curve Number procedure
- Green & Ampt infiltration method

- The CN is the most common method adopted to predict runoff and does not consider rainfall intensity and duration, only total rainfall volume.
- The GA method is a time-based model and can simulate impacts of rainfall intensity and duration and infiltration processes.

SCS-CN

- Developed by the USDA in the 1950s
- Has gone through more than 20 years of studies and research.
- Very simple
- Function of the precipitation, soil´s permeability, land use and antecedent water content of the soil.

SCS-CN

- The SCS CN equation is (SCS, 1972):
- $Q_{Surf} = \frac{\left(R_{day} - I_a\right)^2}{\left(R_{day} - I_a + S\right)}$

- Q_{Surf}, Acumulated runoff (mm H_2O),
- S, Retention parameter (mm H_2O),
- R_{day}, Rainfall depth for the day (mm H_2O),
- I_a, Initial abstractions.

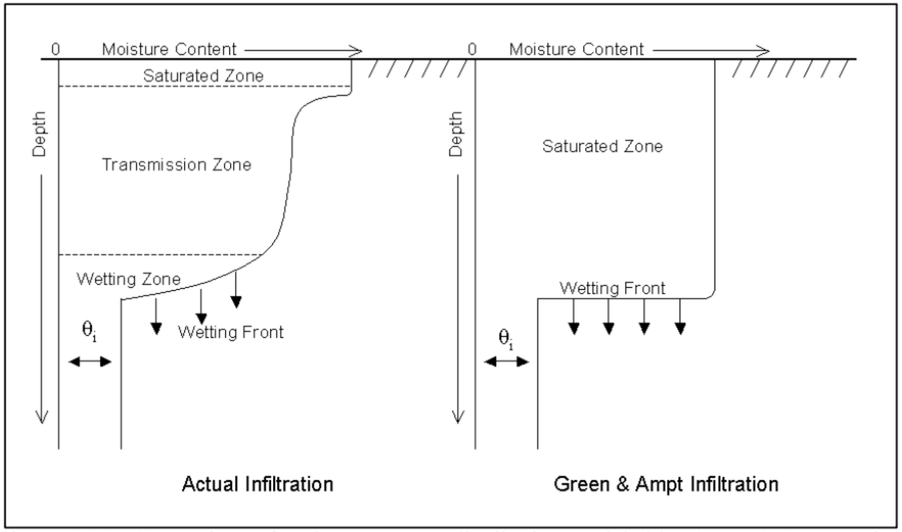
SCS-CN

* $S = 25.4\left(\frac{100}{CN} - 10\right)$ (2)

* S, Retention parameter (mm H_2O),
* CN, Curve Number for the day
* The CN can be obtained from tables with correlations with soil moisture, land cover and soil types.

Green-Ampt

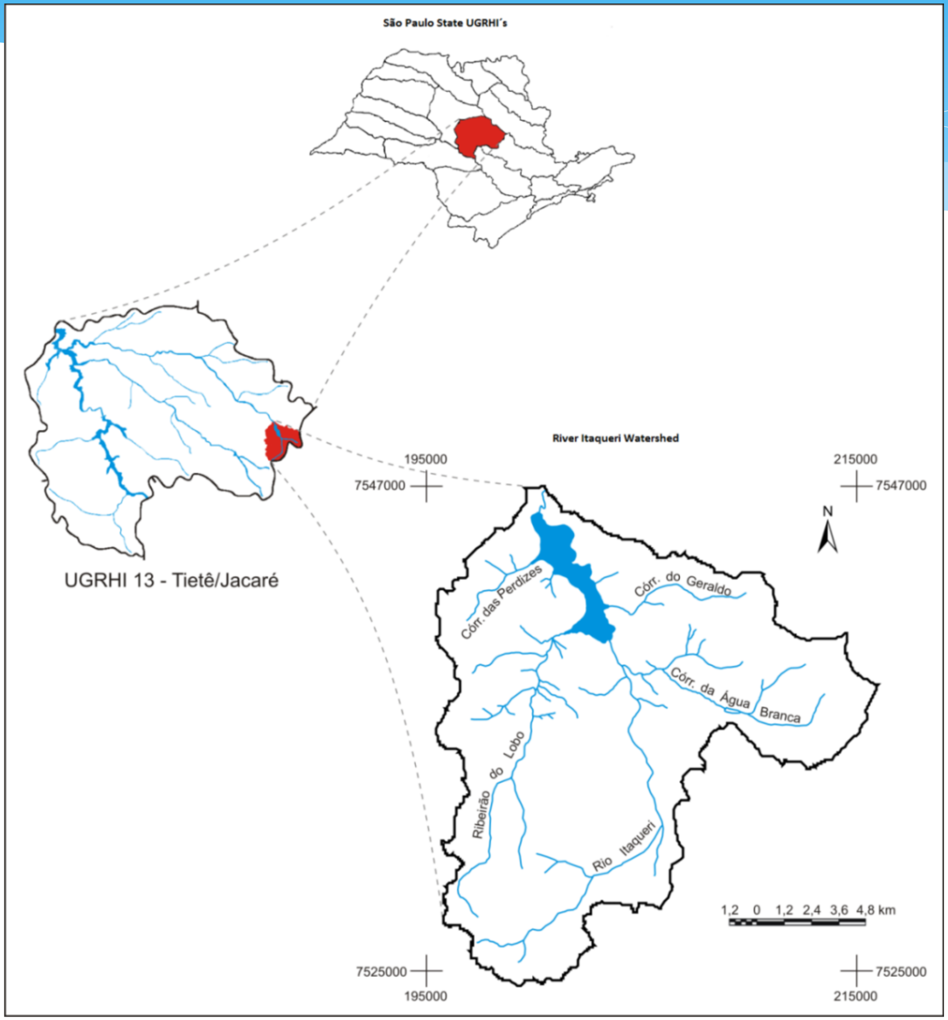
- Homogenous soil profile
- Uniformily antecedent moisture distributed in the soil profile
- The soil above the wetting front is considered to be completely saturated



Green-Ampt

- The Green-Ampt Mein-Larson infiltration model is descrived as:
- $f_{(t)} = K_e \left(1 + \frac{\psi \Delta\theta}{F_{(t)}}\right)$
- Where:
- $f_{(t)}$, Infiltration Rate for time t (mm/hour);
- K_e, Effective hydraulic conductivity;
- ψ, Wetting front matric potential (mm);
- $\Delta\theta$, Variation of moisture content;
- $F_{(t)}$, Cumulative infiltration (mm);

Itaqueri Watershed



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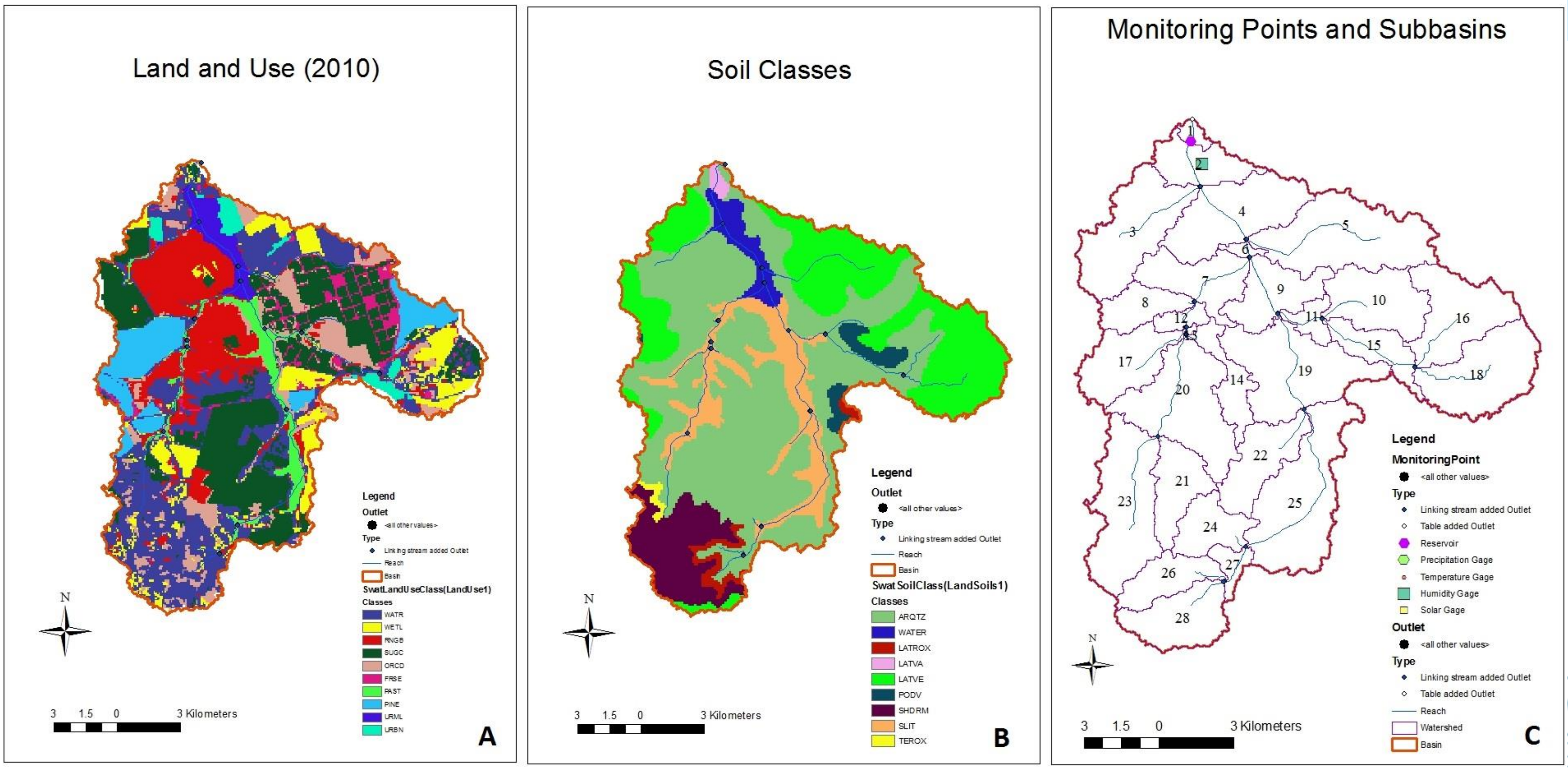
Itaqueri Watershed



Comparison between GA and SCS-CN

Factors	Approach	
	Curve Number	Green & Ampt
Precipitation	Rainfall Amount	Rainfall intensities or rainfall distribution
Soil	Antecedent moisture condition (I,II,III) Hydrologic Soil Group (HSG)	Antecedent soil-water storage (volume) by soil layers or soil depth Soil-water properties by layers or soil depth, i.e., bulk density, saturated conductivity and water entry or bubbling pressure
Cover	Land Use Treatment or Practice Hydrologic conditions	Tillage influences on soil properties Land Use and treatment practices influences on soil properties Ground cover (live or mulch), infleunces on surface soil properties
Soil	Intial abstraction I_a, assumed as 0.2 (S)	Total infiltration prior to surface ponding
Surface	Included with initial abstraction I_a	Estimated soil surface storage as influenced by topography, land use, and tillage
Interception	Included with initial abstraction I_a	Estimated interception storage by ground cover (live and/or mulch)

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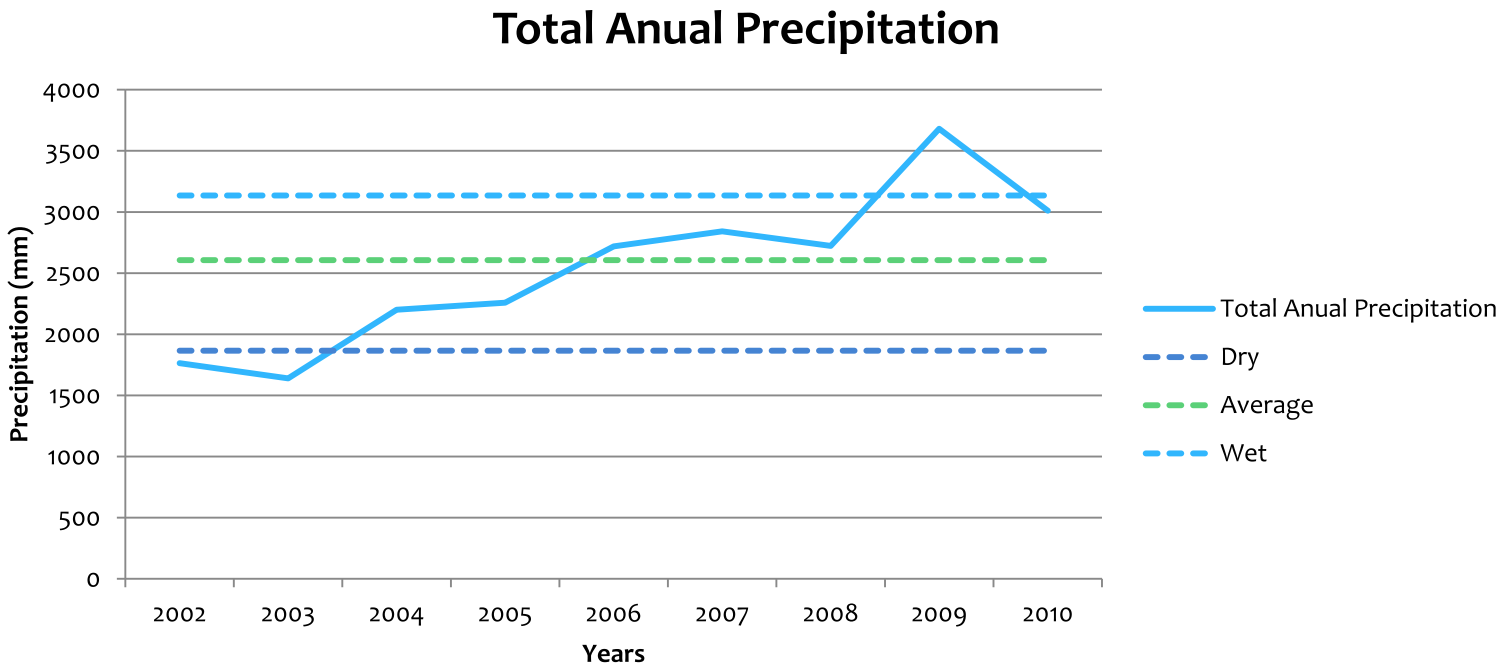
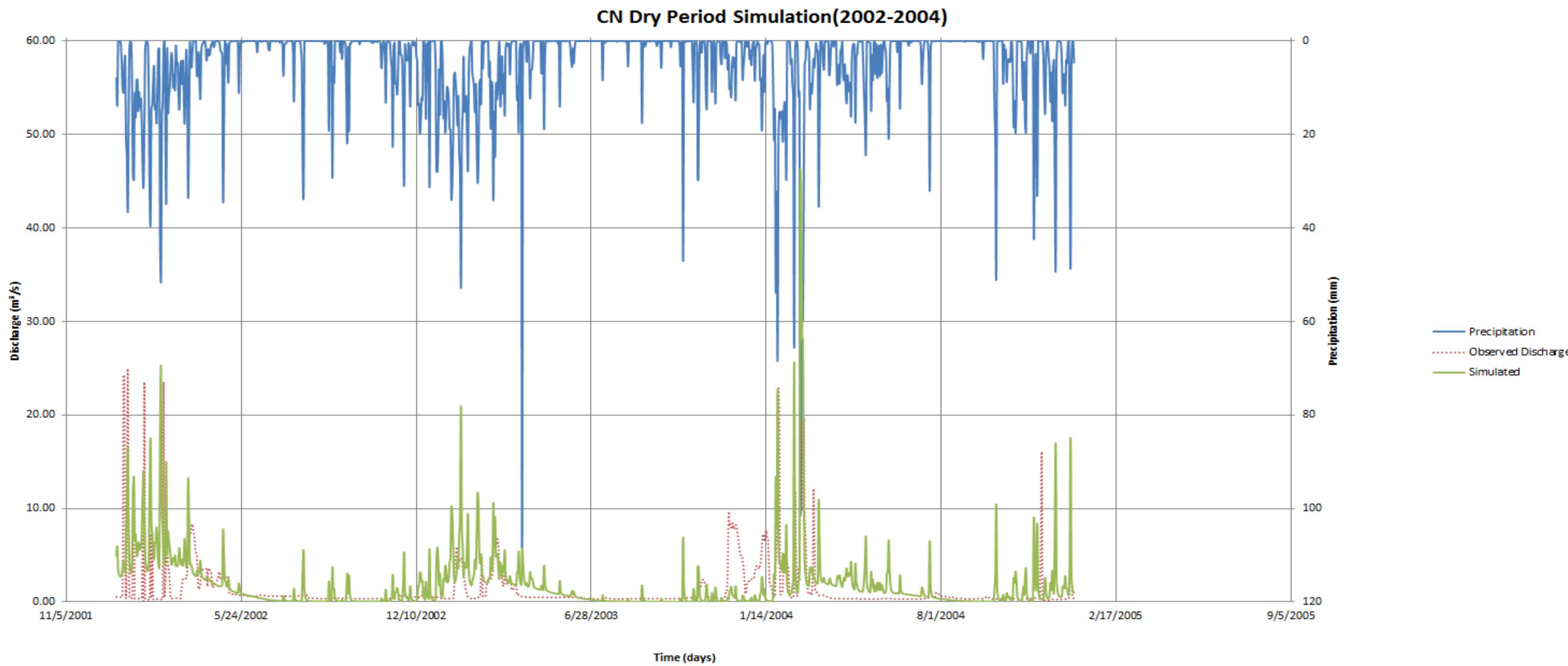
Defining The Simulation Periods

Year	Total Anual Precipitaiton (mm)	Average daily Precipitation (mm)
2002	1763.476	4.831441
2003	1639.532	4.491868
2004	2200.182	6.011426
2005	2257.642	6.185321
2006	2718.853	7.448912
2007	2841.218	7.784159
2008	2722.739	7.439178
2009	3681.07	10.08512
2010	3009.951	8.246441

Defining The Simulation Periods



Dry Period Simulation (2002-2004)



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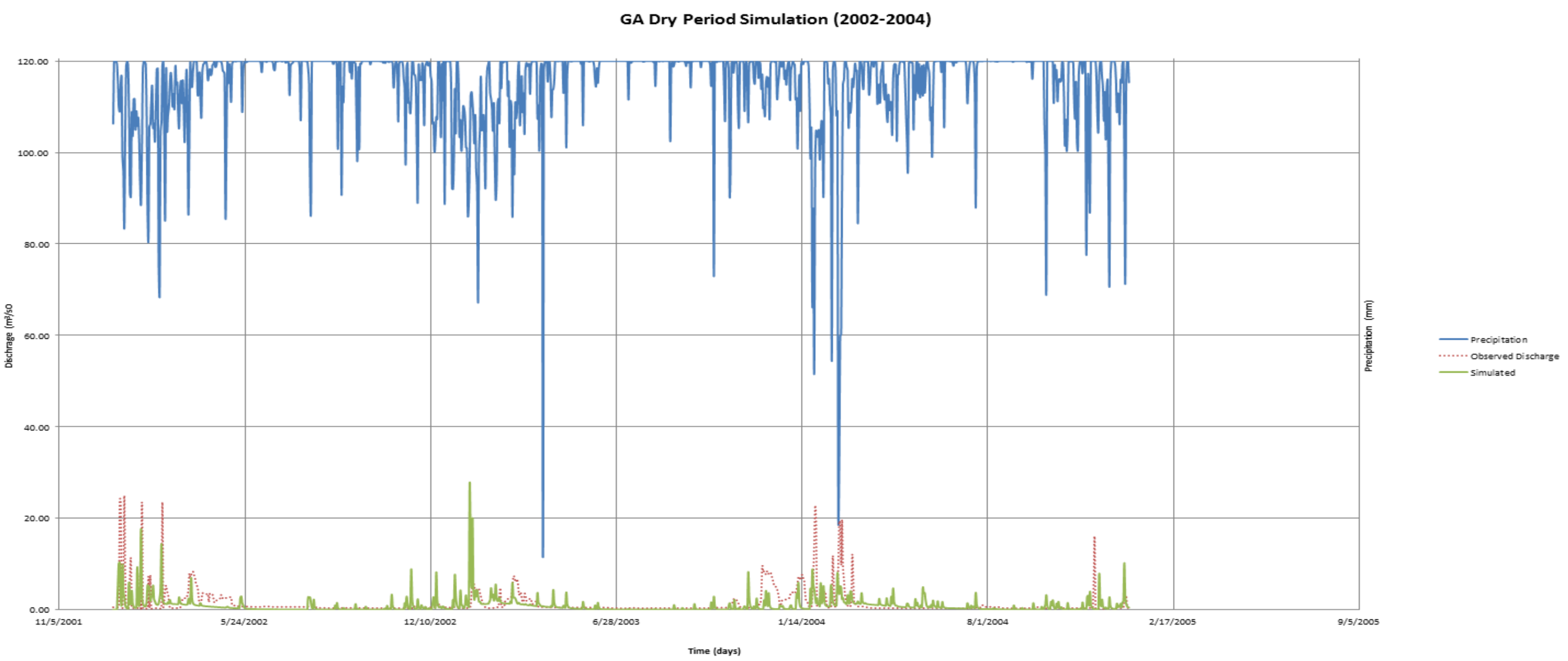
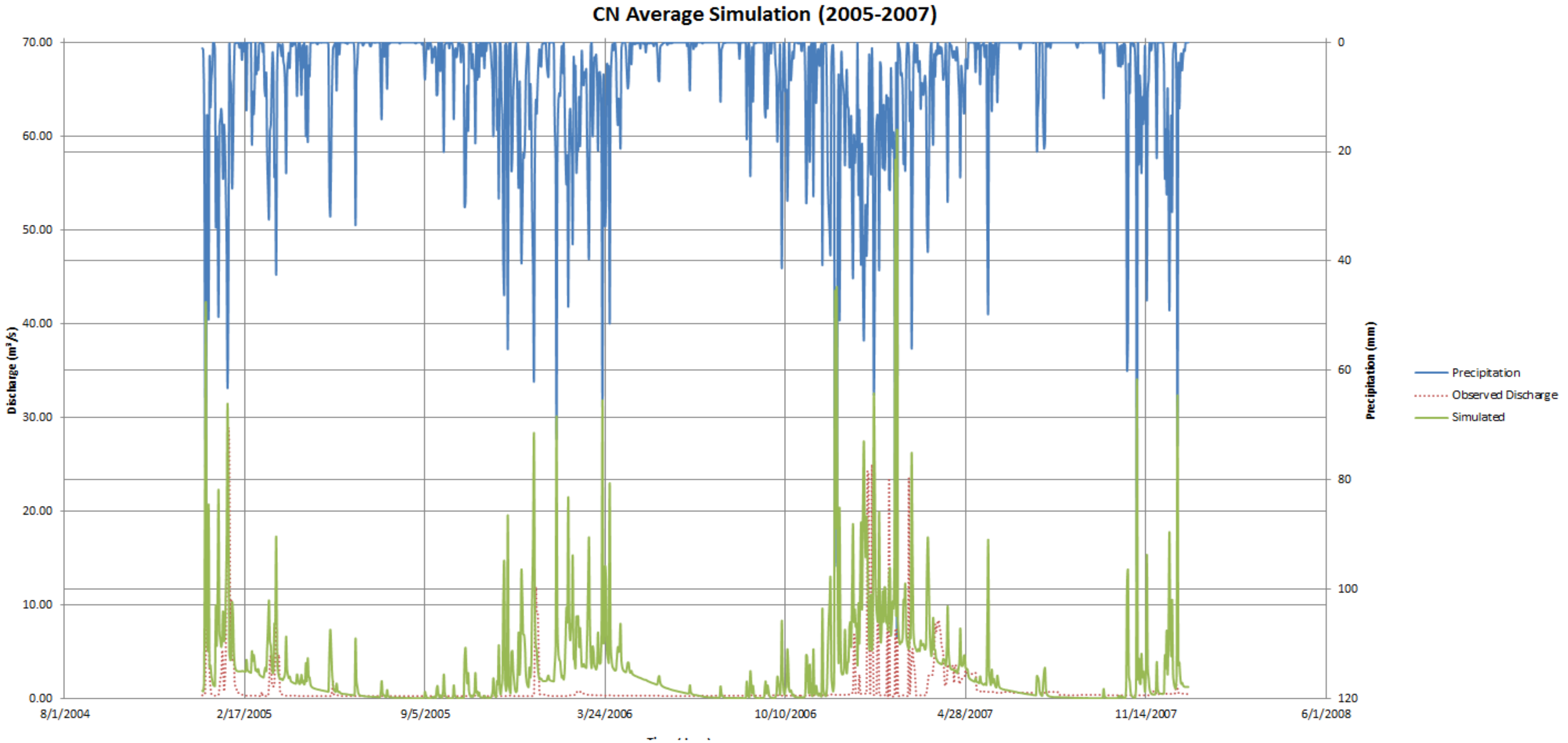
Dry Period Simulation (2002-2004)



Dry Period Simulation (2002-2004)

Runoff Method	NS	R2
Curve Number	-0.231	0.15
Green-Ampt	-0.229	0.11

Average Period Simulation



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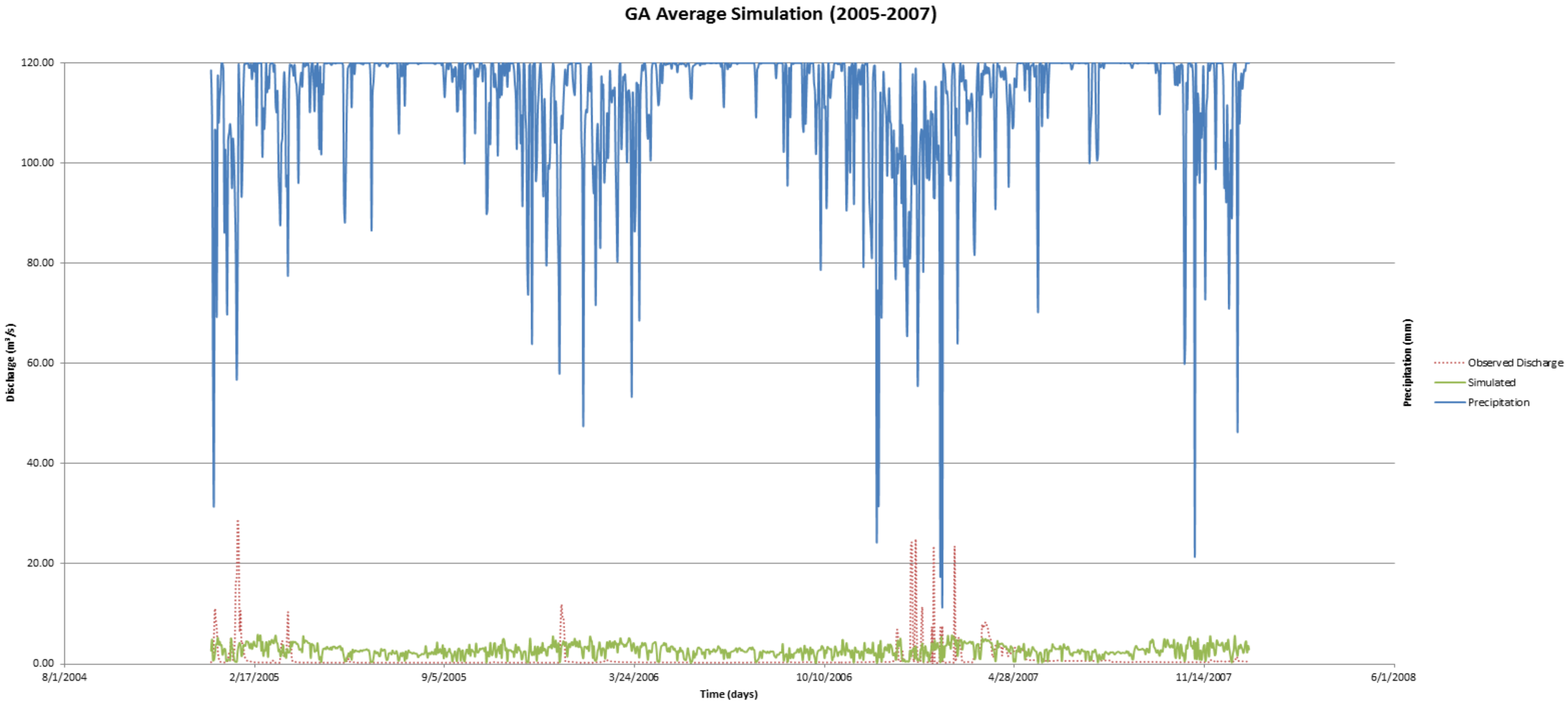
Average Period Simulation



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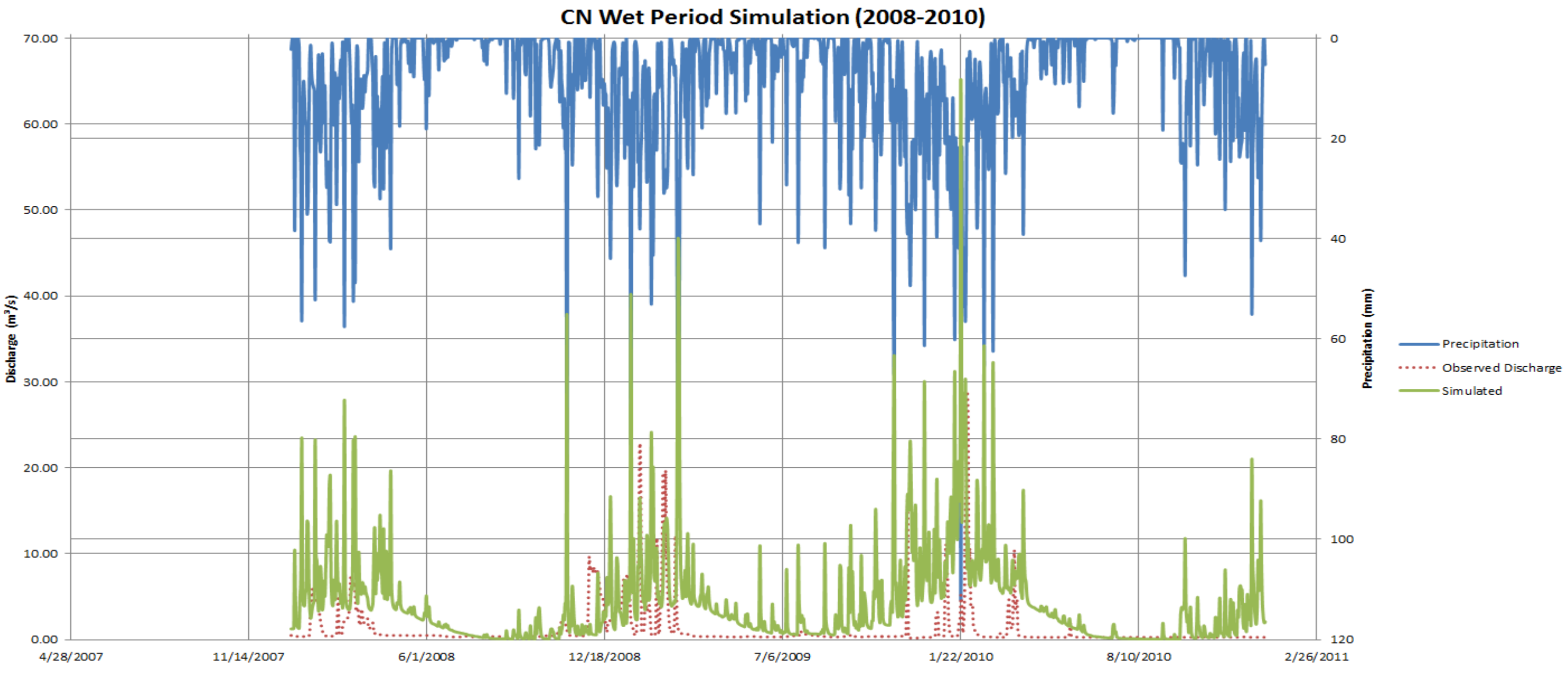
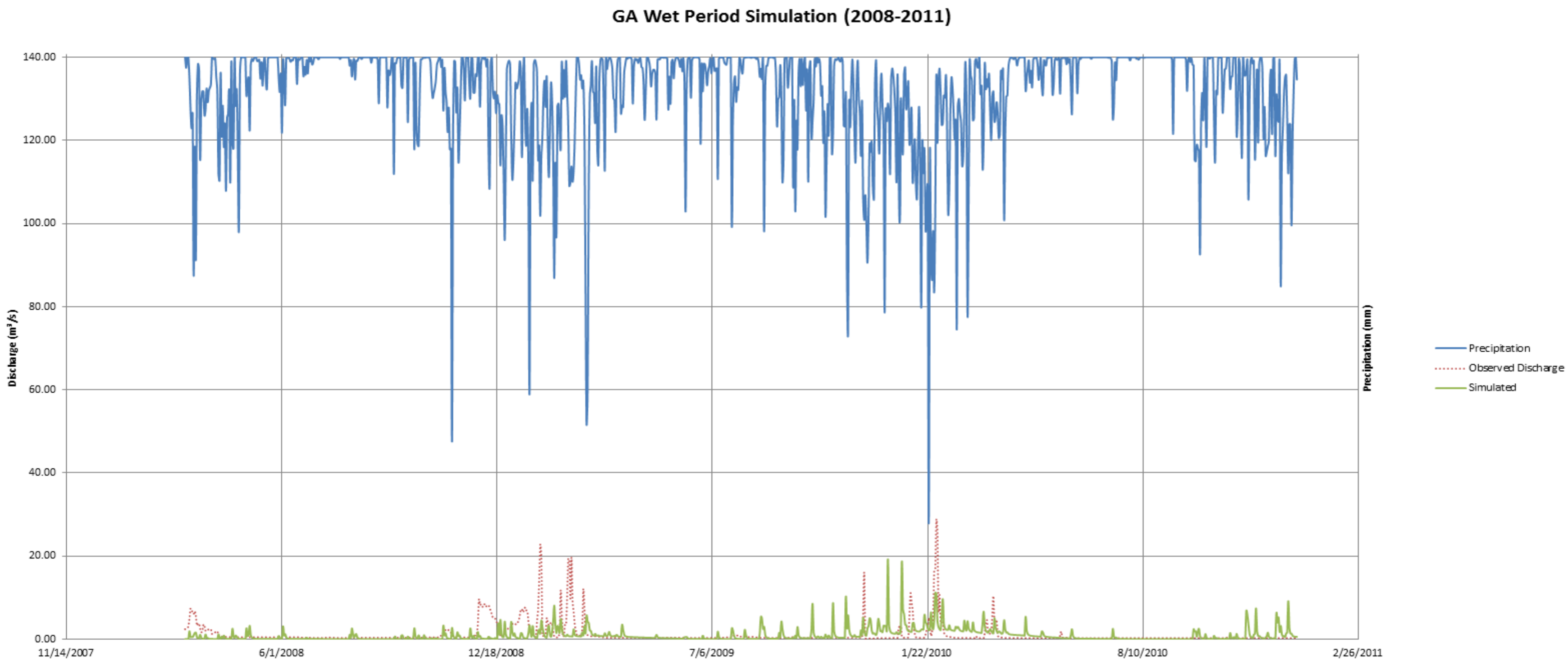
Average Period Simulation

Runoff Method	NS	R2
Curve Number	-0.445	0.05
Green-Ampt	-0.518	0.01

Wet Period Simulation



Wet Period Simulation



Wet Period Simulation

Runoff Method	NS	R2
Curve Number	-0.572	0.03
Green-Ampt	-0.168	0.23

Conclusions

* As expected the GA simulations presented an overall better performance compared to de SCS-CN simulations,
* GA can better represent the storm events of a tropical climate.
* For the dry and wet period the GA presented a slightly advantage to the SCS-CN method and for the average period the SCS-CN presented better results but methods failed to represent the rainfall events.
* The main cause for the superior performance of the Green–Ampt method is because it is a physically based infiltration excess, rainfall–runoff model, and is therefore not suitable for regions where the rainfall rate seldom exceeds the saturated conductivity of the soil, which is not the case in Brazil.

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Merci !