The water balance of a forested tropical basin near Manaus: Impacts of climate variability on the hydrological cycle

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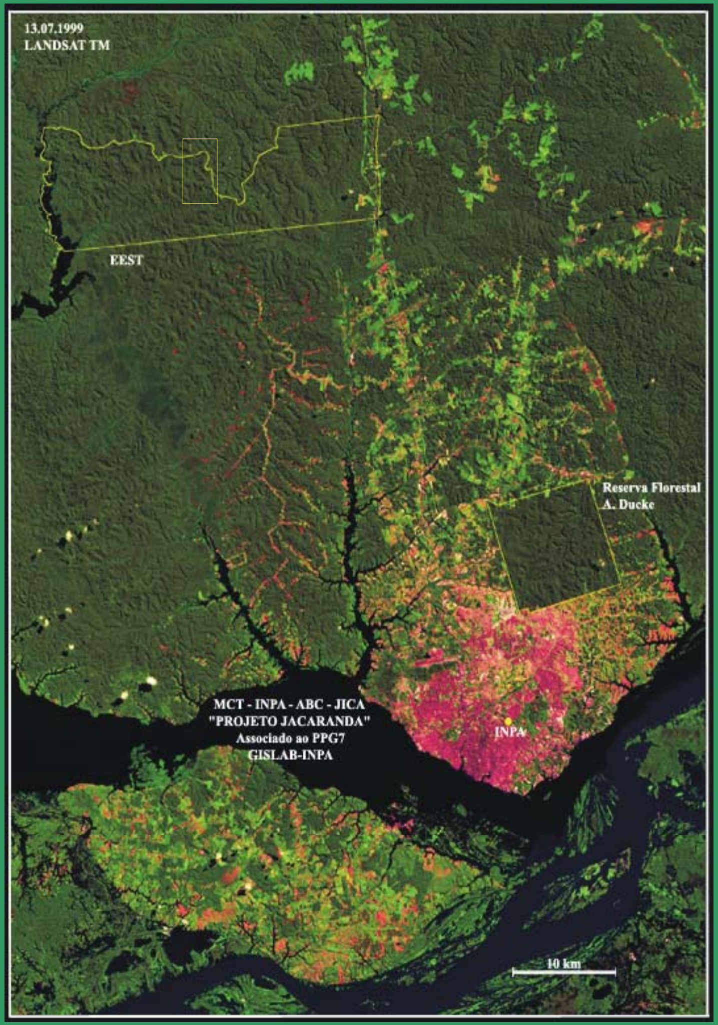
Impacts of climate variability on the hydrological cycle: Asu Basin location (Landsat)



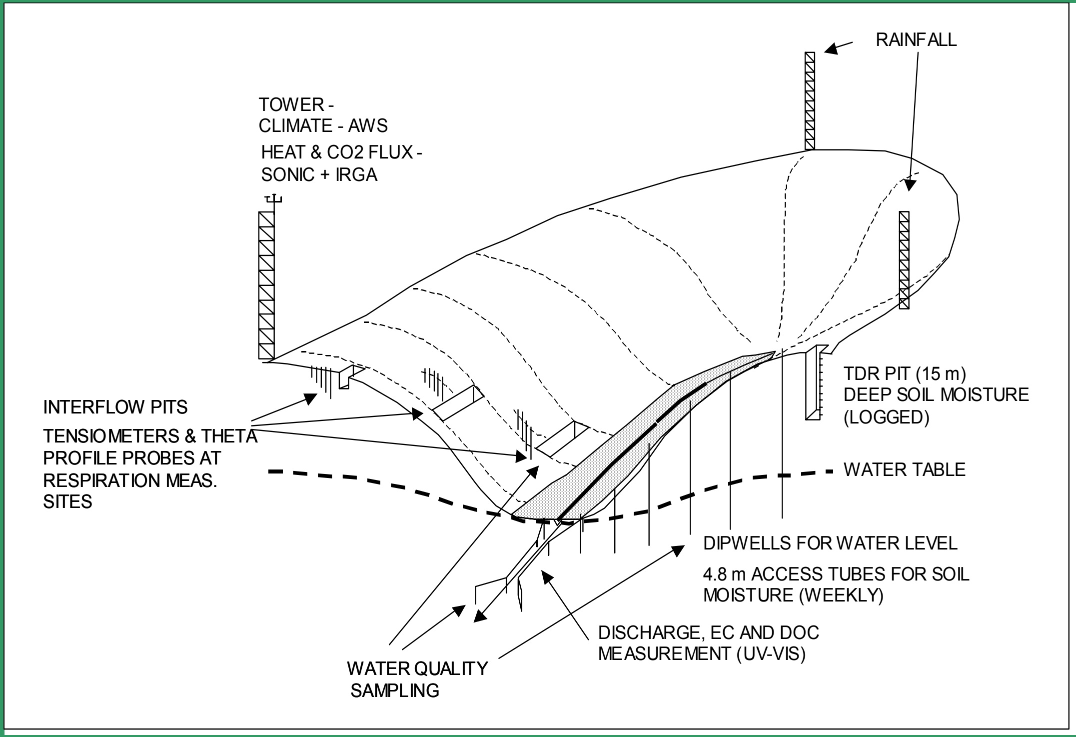
(From Hodnett et al. 2004)

Impacts of climate variability on the hydrological cycle: Schematic representation of the Asu catchment

- Rainfall
- Runoff
- Groundwater storage
- Soil moisture storage
- Interception
- Evaporation fluxes
- CO_2 fluxes

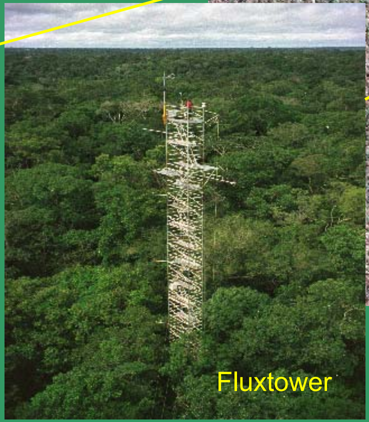
In streamflow, groundwater, intercepted water

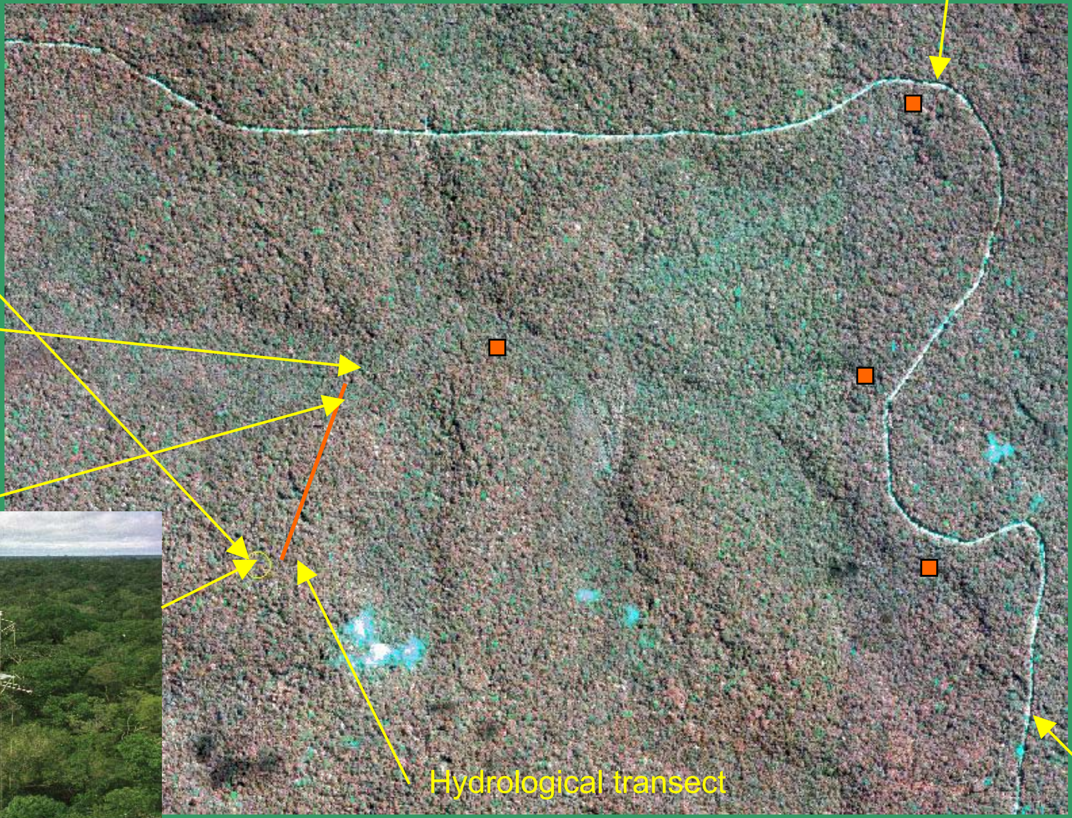
- DOC
- POC
- Nutrients
- CWD (coarse woody debris)



(From Hodnett et al. 2004)

Impacts of climate variability on the hydrological cycle: Instrument location





Hydrological transect

(From Hodnett et al. 2004)

Impacts of climate variability on the hydrological cycle: Catchment details

Area:	6.8 km2
Maximum elevation	90m asl
Maximum relief variation	~60m
Topography	Dissected plateau, slopes up to 30%
Mean annual rainfall	~2400mm
Dry season (=less wet season!)	June – September
Geology	Flat bedded unconsolidated sediments (sands and clays) of the Barreiras formation
Soils	Oxisols (85% clay) on plateau Deep sandy soils in valley, transitional on slopes
Vegetation	Terra firme forest (~180 species ha^{-1}, dbh >10cm)

(From Hodnett et al. 2004)

Impacts of climate variability on the hydrological cycle: Instrument types

- Streamflow – Starflow, ultrasonic doppler velocity + pressure transducer for depth, logged ½ hourly, calib. by salt dilution)
- Raingauges – tipping bucket with single channel event logger, ½ hourly
- Soil moisture
  - Neutron probe to 4.8m (manual, weekly)
  - Delta-T profile probe 6 depths to 1m (logged, hourly)
  - Campbell CS615 FDR in deep shaft to 14.2m depth (logged, hourly)
- Water level
  - Manual well dipper
  - Pressure transducers – Diver (logged, ½ hourly)
- Interception – 2 x 36m x 0.05m troughs, each with large tipping bucket with event logger (logged every 5 min)
- DOC – s::can UV-vis Specrolyser, in situ in stream (also used in lab)
- CWD – large net trap

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1) Water balance based on micrometeorological estimations:

ΔStorage = Rainfall - Discharge - Transpiration - Interception

Transpiration: Measured at the flux tower or estimated using Penman-Monteith (parameterization of Wright et al. 1996)

Interception: Estimated using tank type model (Cuartas et al. 2004)

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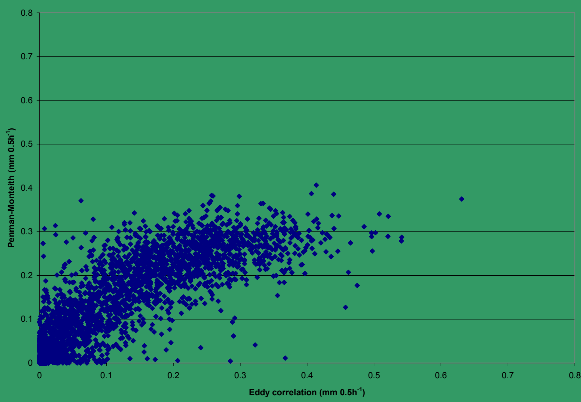
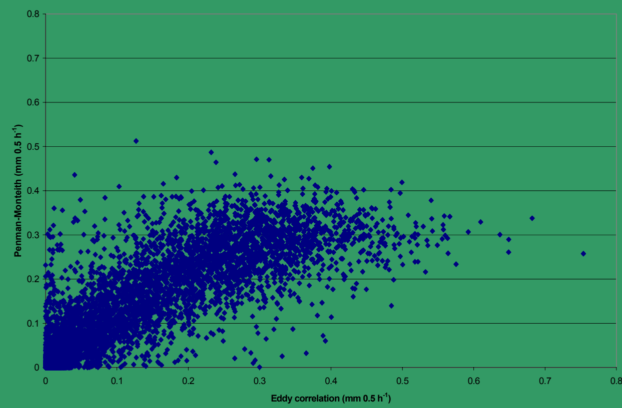
Transpiration estimations: comparing eddy correlation and Penman-Monteith

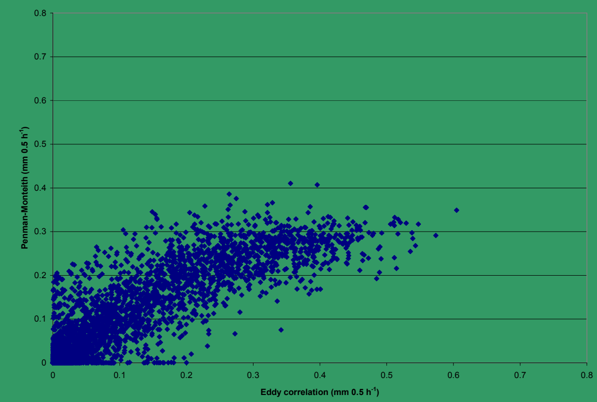
2001



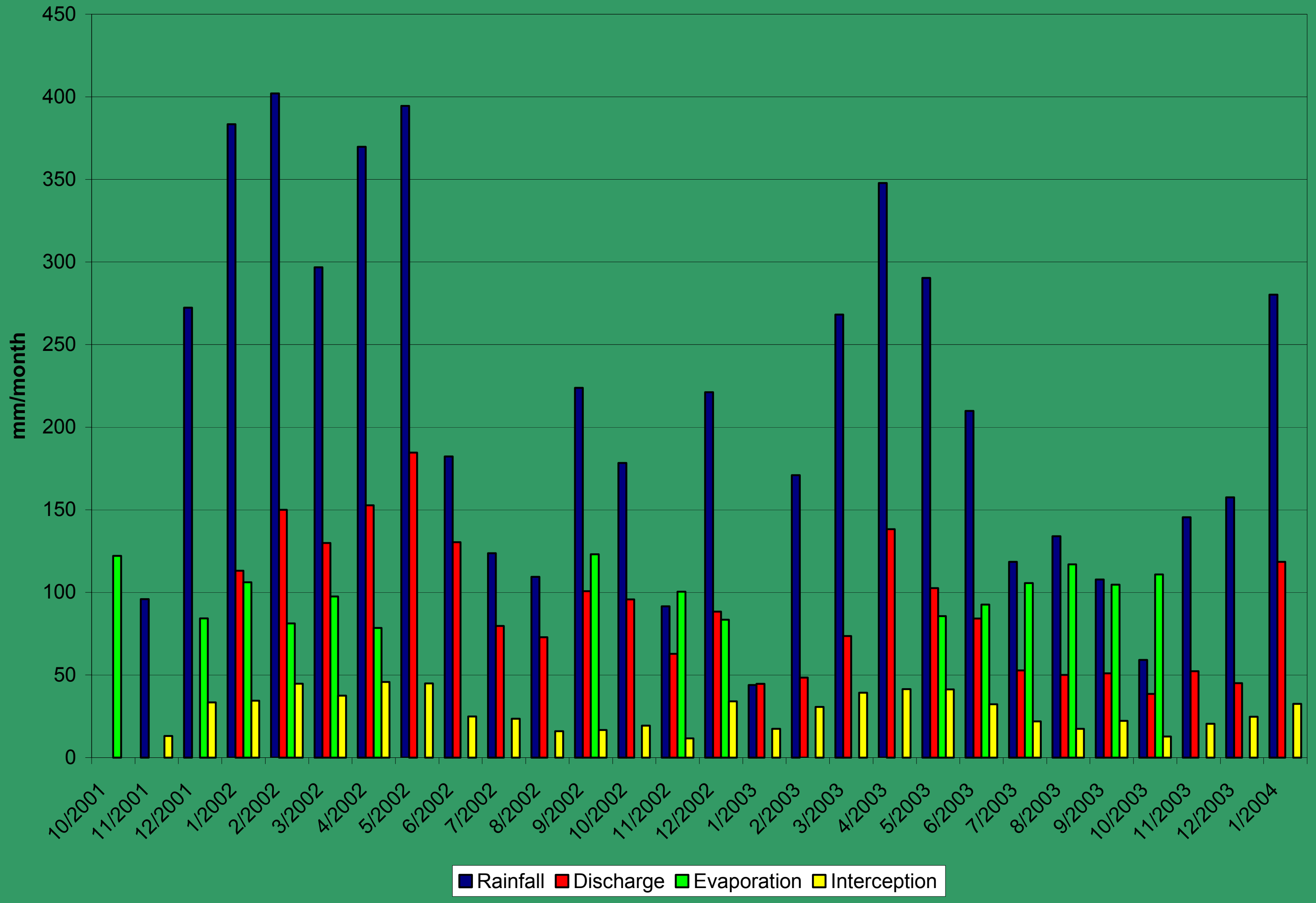
2002



2003



Impacts of climate variability on the hydrological cycle: Montlhy calculations



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Water Balance summary

	Discharge (mm day^{-1})	Rainfall (mm day^{-1})	Transpiration (mm day^{-1})	Interception (mm day^{-1})	**ΔStorage (mm day^{-1})**
01/10/2001-30/09/2002	3.941	8.538	3.464	0.984	0.149
01/10/2002-30/09/2003	2.445	5.98	3.28	0.901	-0.646
01/10/2001-31/12/2003	2.943	6.932	3.346	0.906	-0.263

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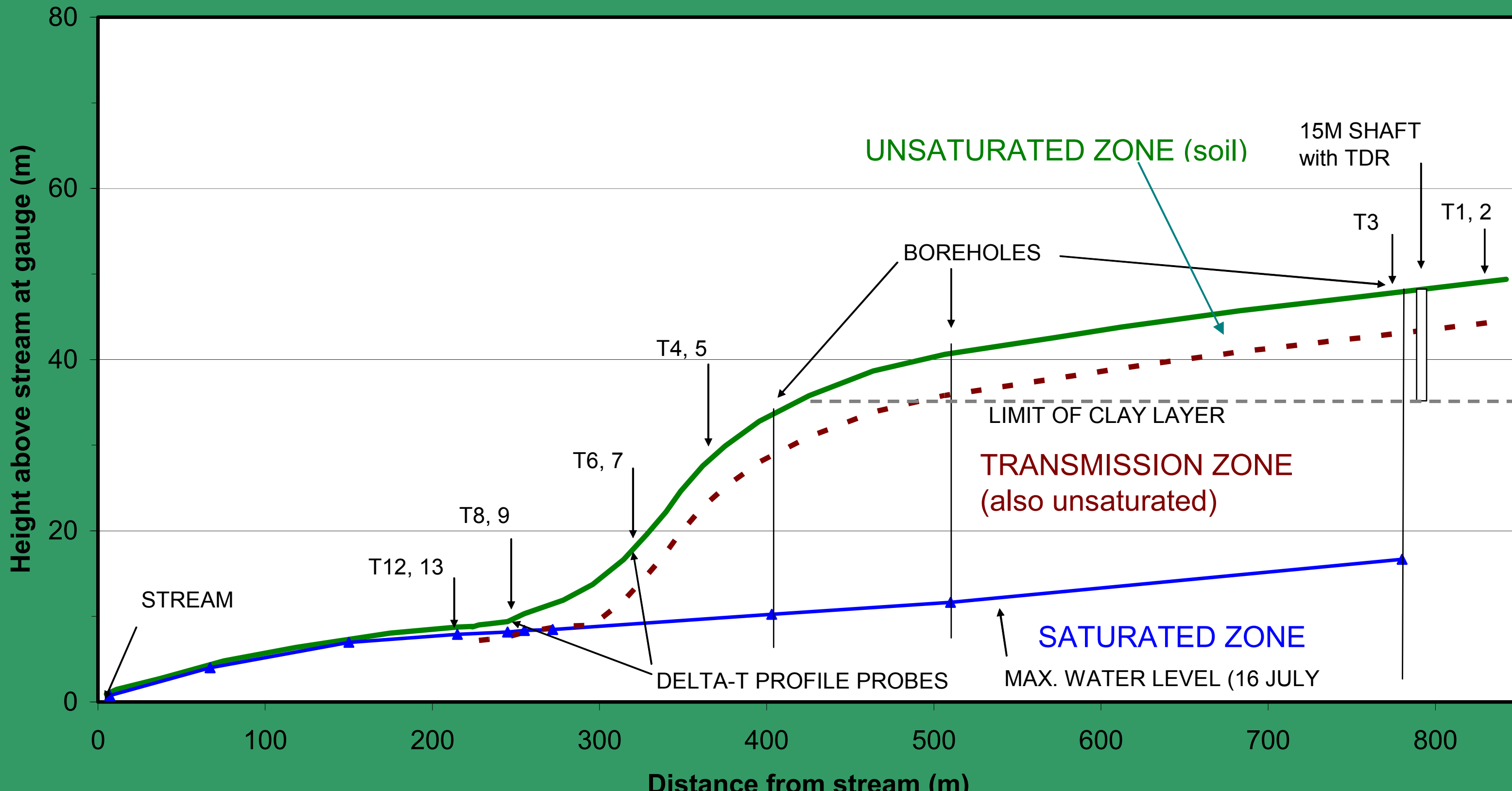
2) Looking at other indications: Storage at the hydrological transect



(Adapted from Hodnett et al. 2004)

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Basin water balance

ΔStzone + ΔSuns + ΔSsat =

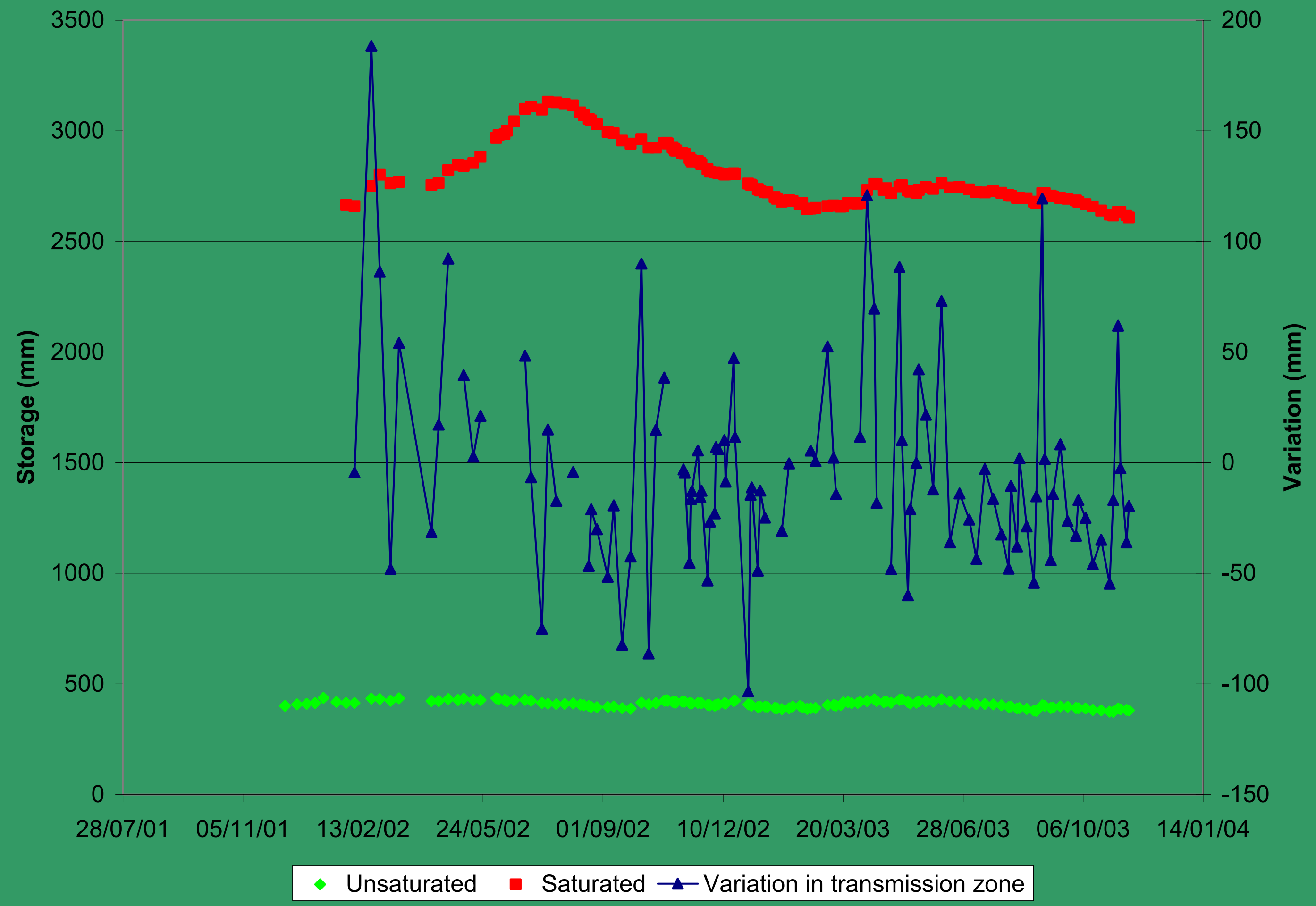
Rainfall - Evaporation – Discharge

We don’t know what happen in the transmission zone!!

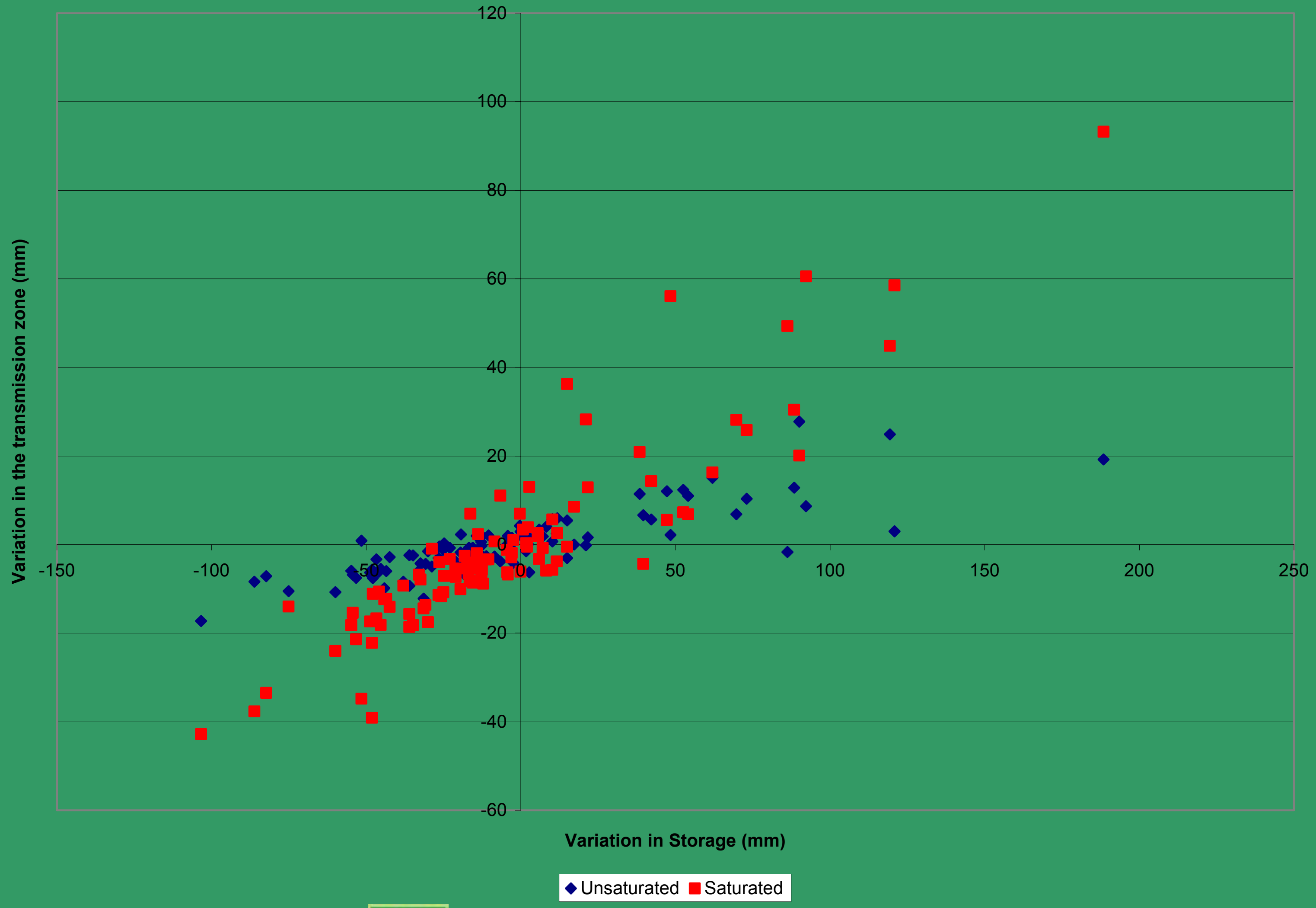
Let’s assume that:

-basin leakage in not significant;
-the hydrological transect is a good representation of the basin response in terms of storage.

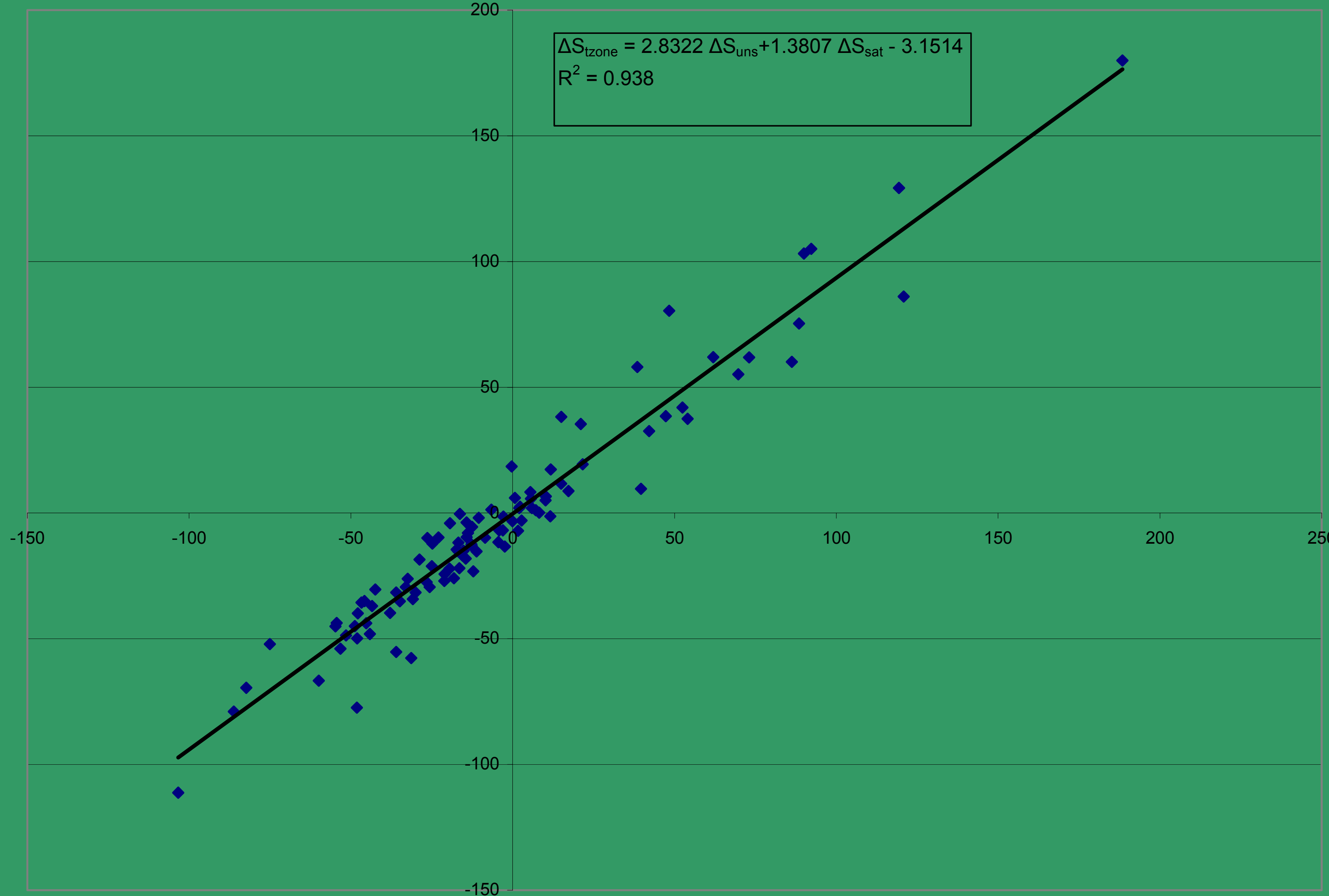
Impacts of climate variability on the hydrological cycle: time variation of storage



Impacts of climate variability on the hydrological cycle: relationship between storages



Impacts of climate variability on the hydrological cycle: estimating transmission zone variation



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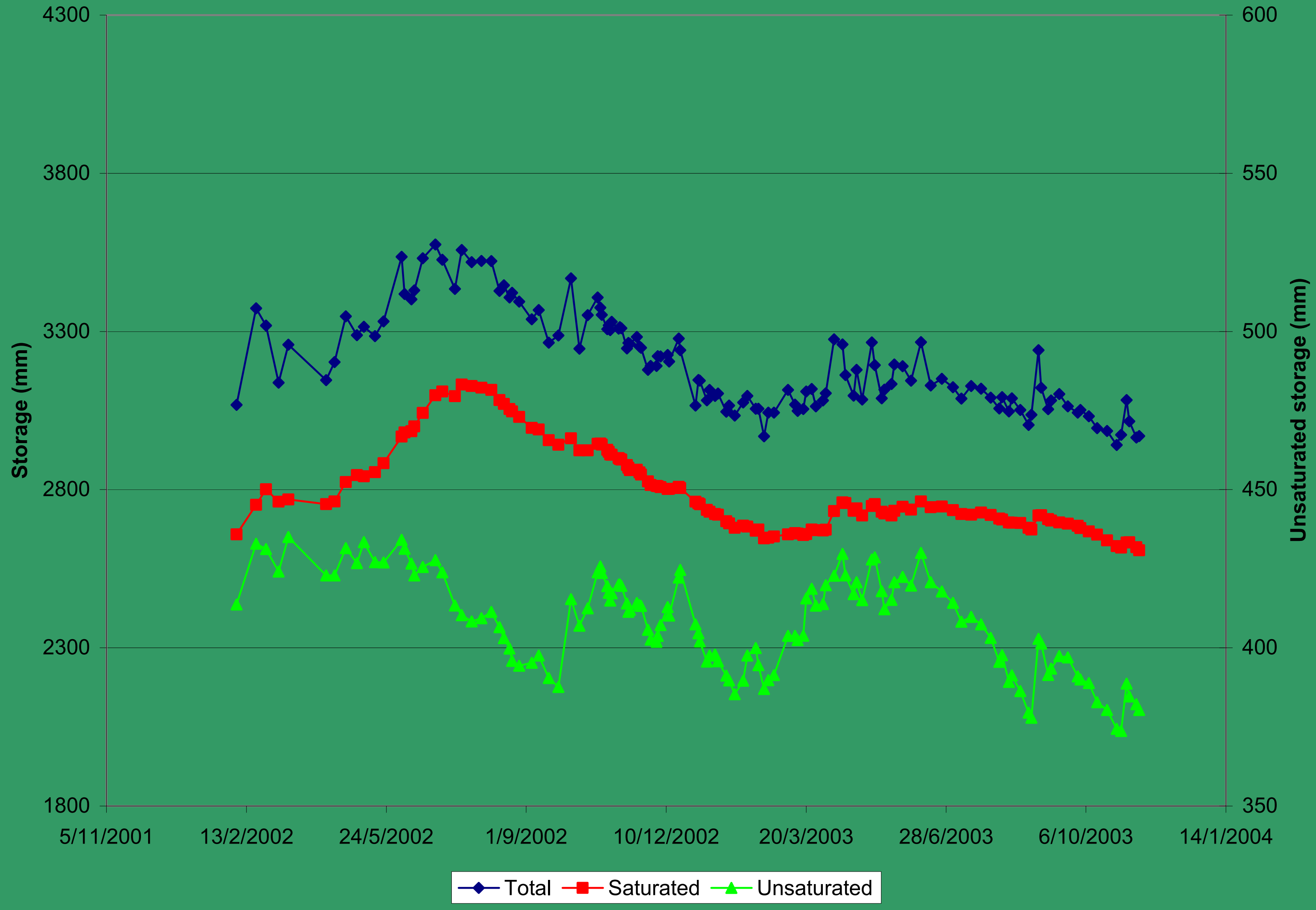

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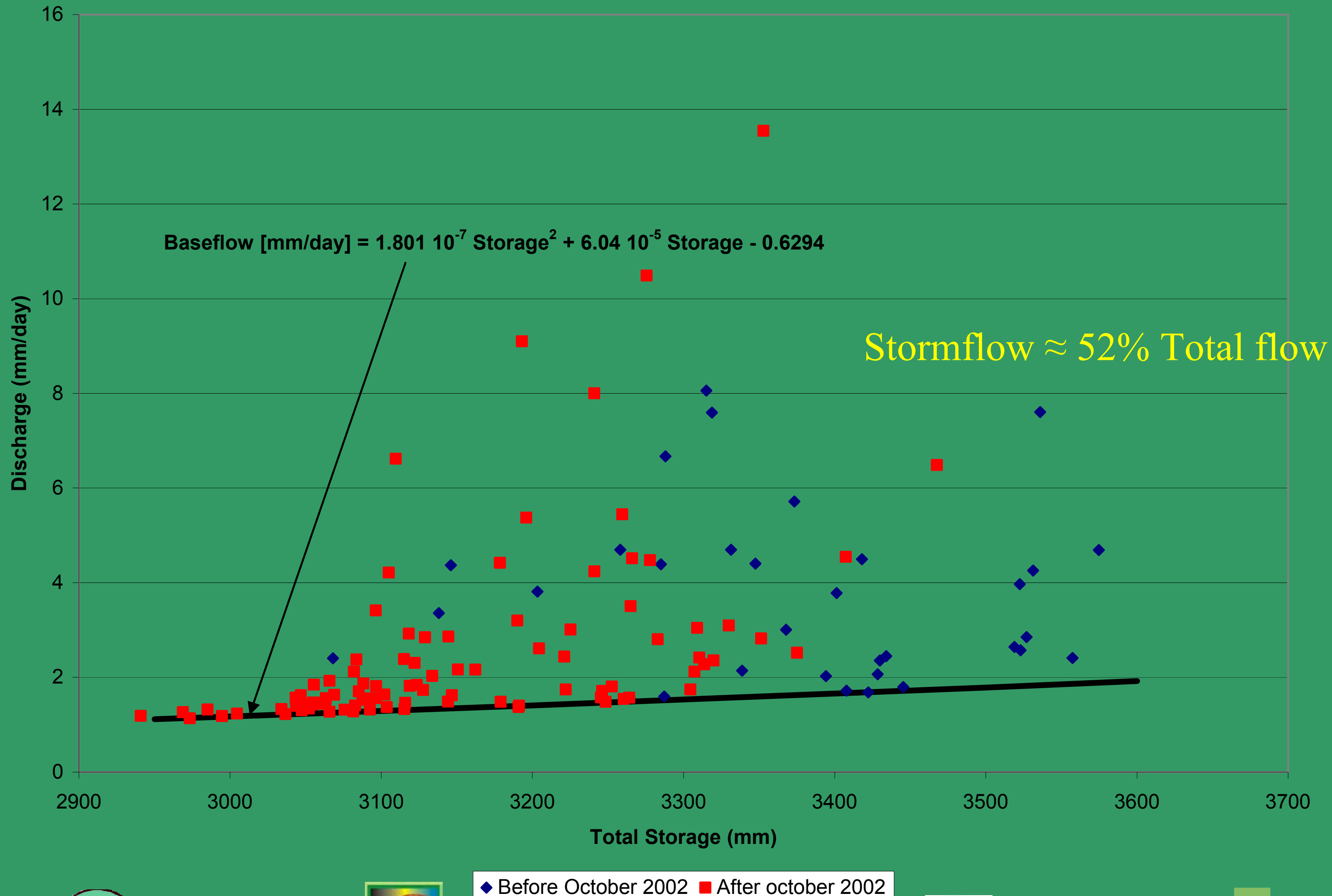

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Impacts of climate variability on the hydrological cycle

Conclusions:

-Apparently, it is not possible to close the basin balance on a annual basis.

-Interannual variability of rainfall has impact on basin storage.

-The storage contributes more than 0.6 mm/day during the 2002-2003 season, helping to reduce the effects of rainfall deficit on discharge.

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Conclusions:

-We hypothesize that this memory mechanism plays an important role during years of climatic extremes (e.g. El Niño/La Niña).

-It is necessary to determine if the recovery of basin storage could have a hydrological impact on the following season after a dry year