ON THE BRUTSAERT BASE FLOW RECESSIONS AND THEIR GEOMORPHIC ORIGINS

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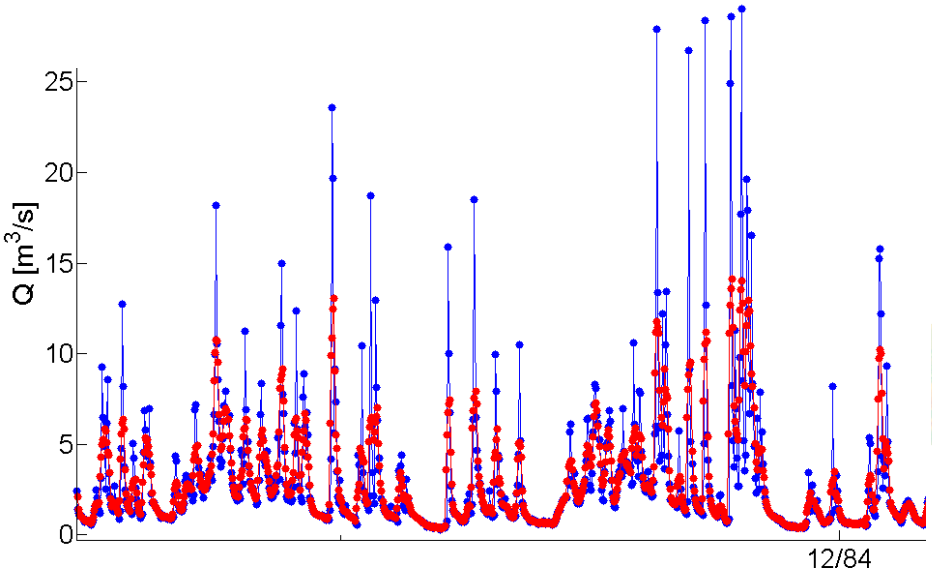

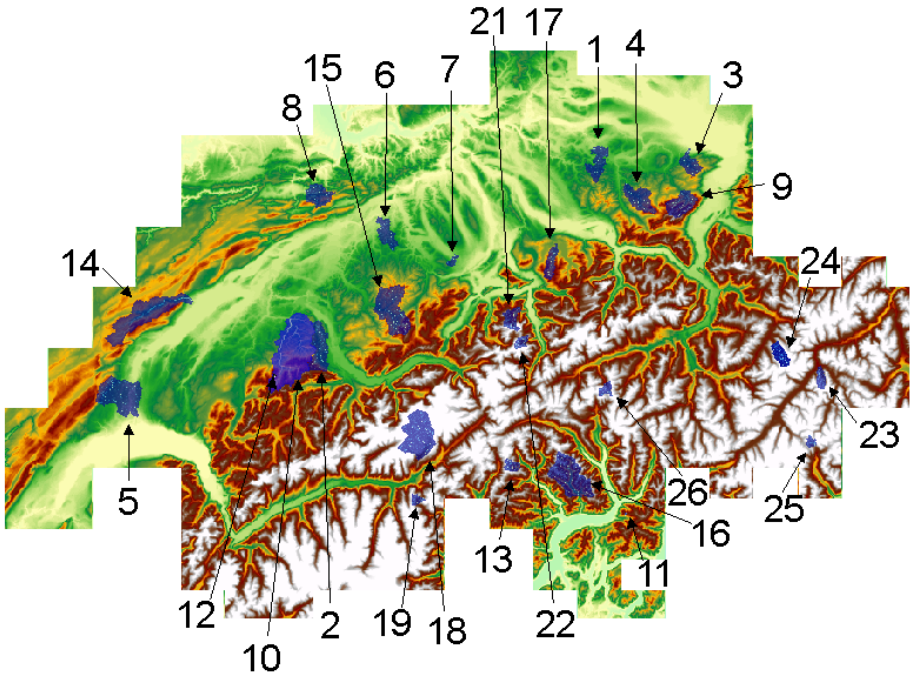

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Regionalized Drought Flow Hydrographs From a Mature Glaciated Plateau

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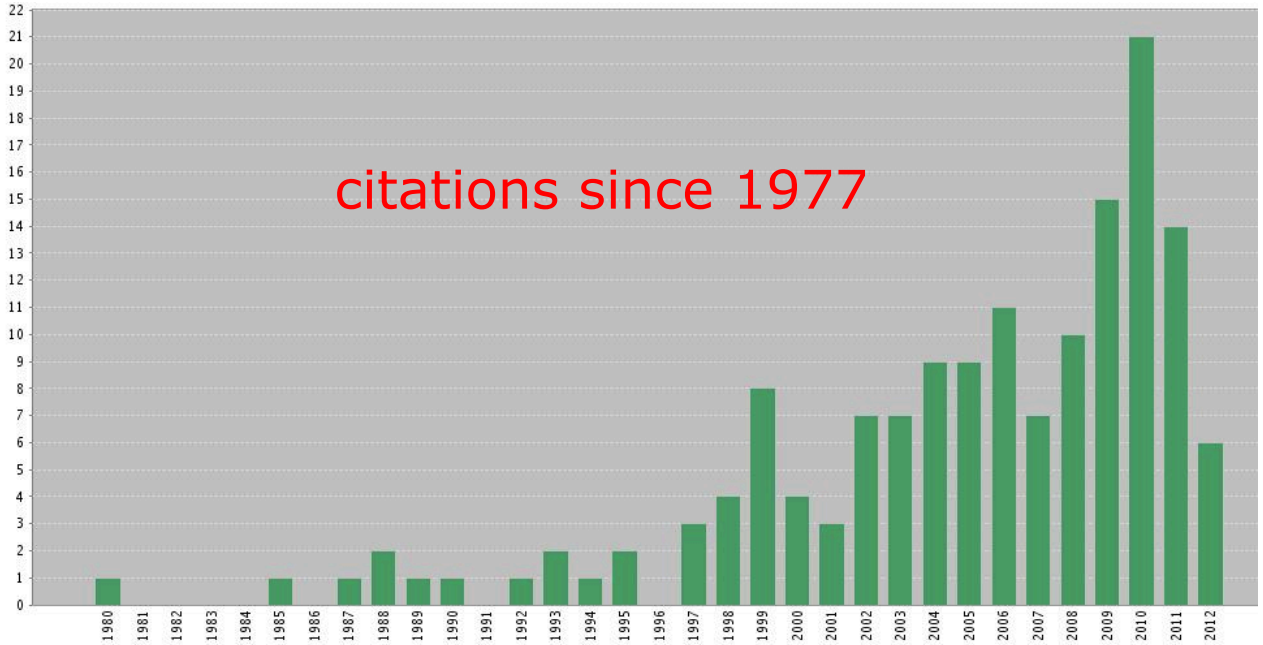
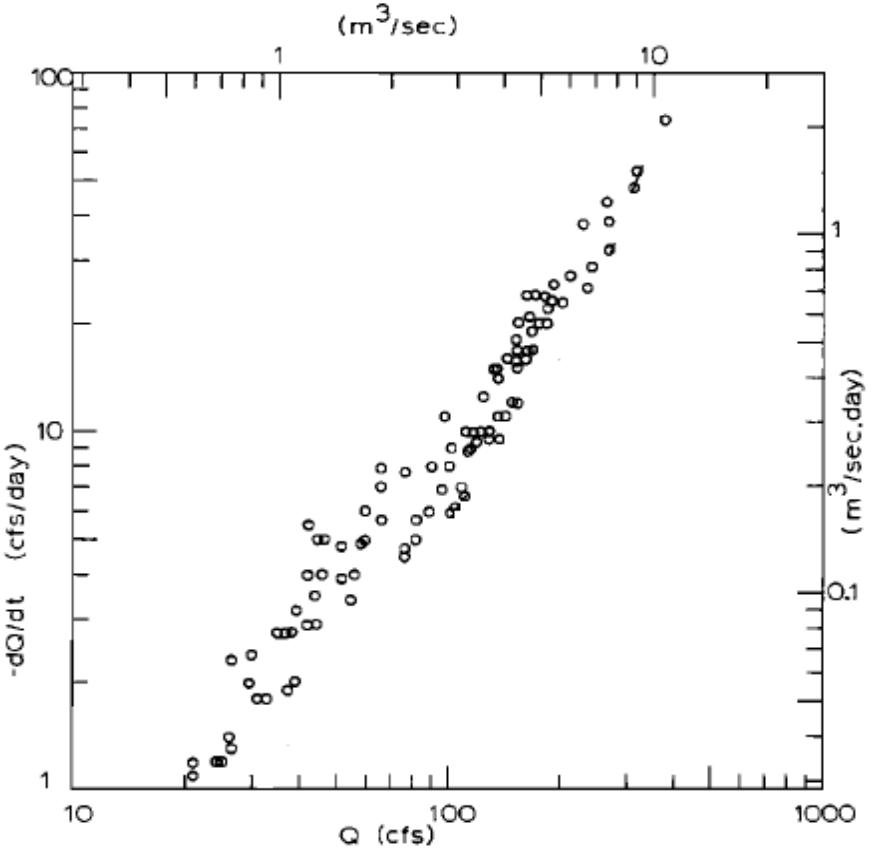
The drought or base flow characteristics of six basins in the Finger Lakes region are obtained by considering for each available record the lower envelope of $|dQ/dt|$ as a function of Q, where Q is the flow rate. This procedure avoids the uncertainty regarding a proper time reference after each rainfall event, and it eliminates the effects of evapotranspiration. The results suggest that among several expressions, Boussinesq's nonlinear solution of free surface groundwater flow is best suited to parameterize the observed hydrographs. The obtained parameters can be related to the basin characteristics, viz., drainage area and the total stream length, in accordance with relationships derived on the basis of the Dupuit-Boussinesq aquifer model. This result allows the determination of drought flow parameters for ungaged sites within the region.

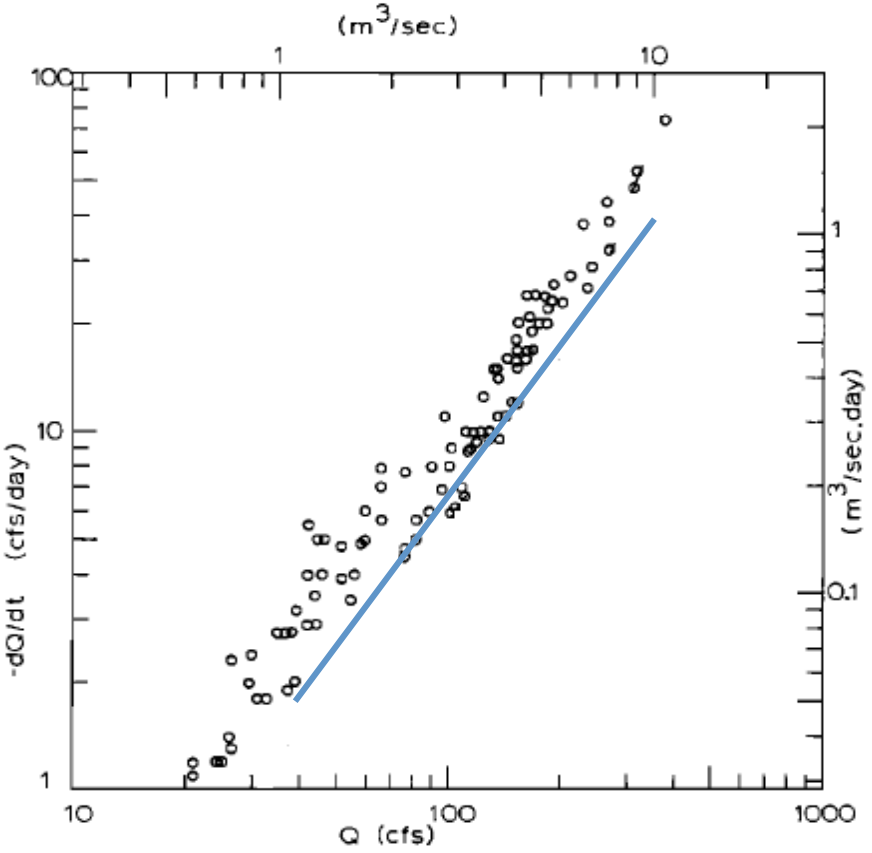


$$-\frac{dQ}{dt} \propto f(Q) \sim Q^{\beta}$$



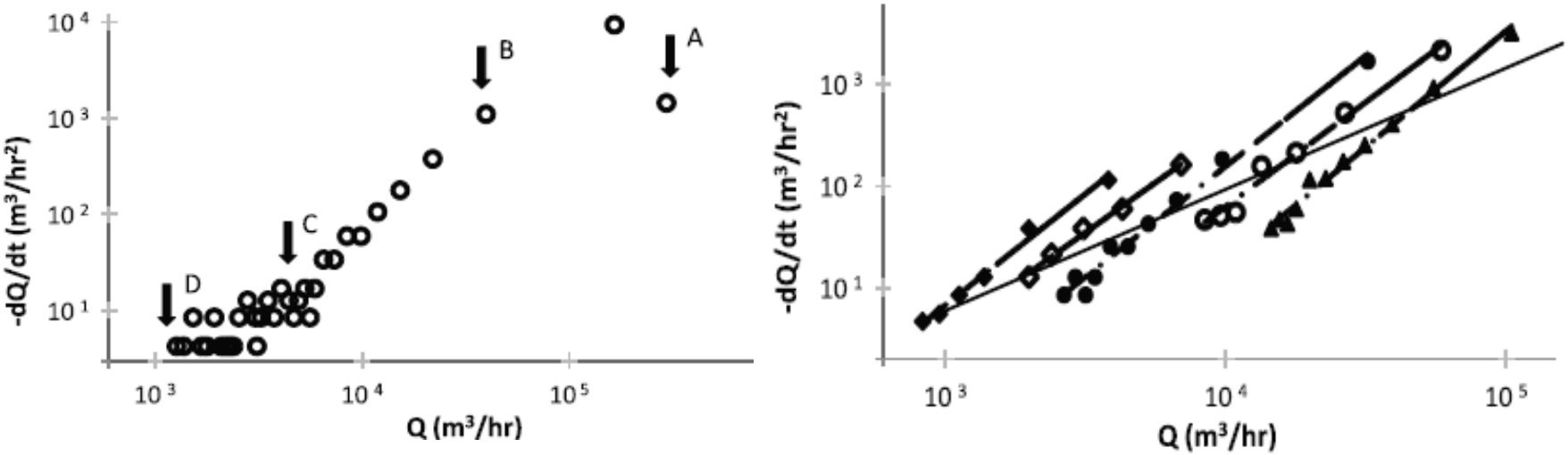
Brutsaert and Nieber, *WRR*, 1977

$$-\frac{dQ}{dt} \propto f(Q) \sim Q^{\beta}$$



Brutsaert and Nieber, *WRR*, 1977

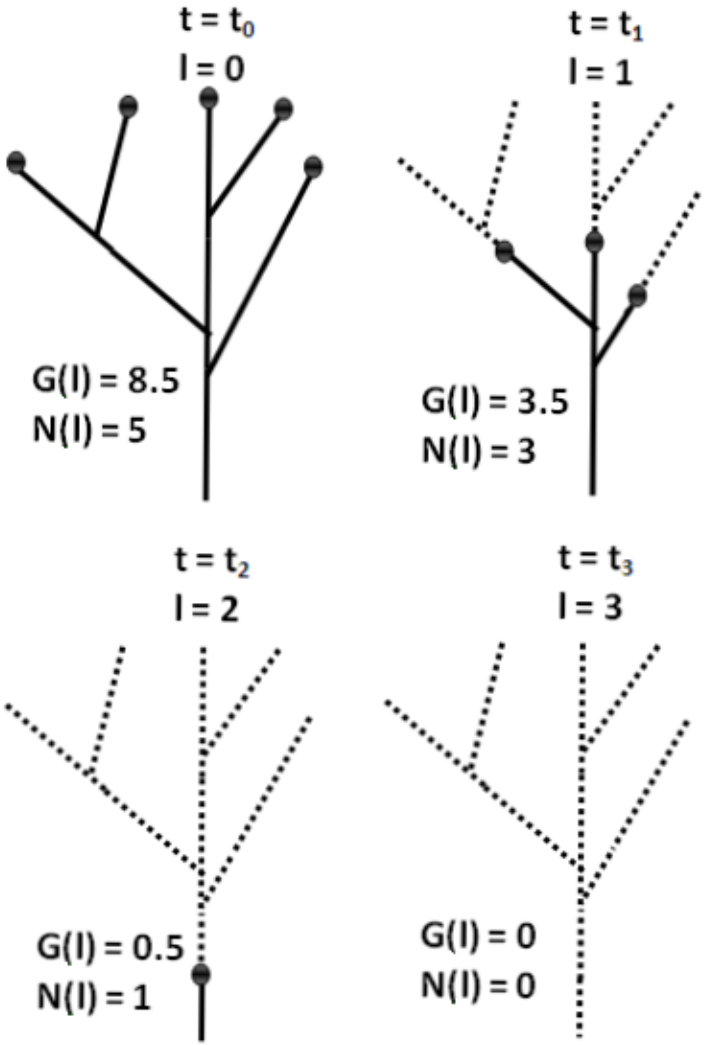
power law scaling & individual recession events



curves for different events shifted

simultaneous fit of all events –> underestimation of β values

catchment desaturation →
Active Drainage Network (ADN)

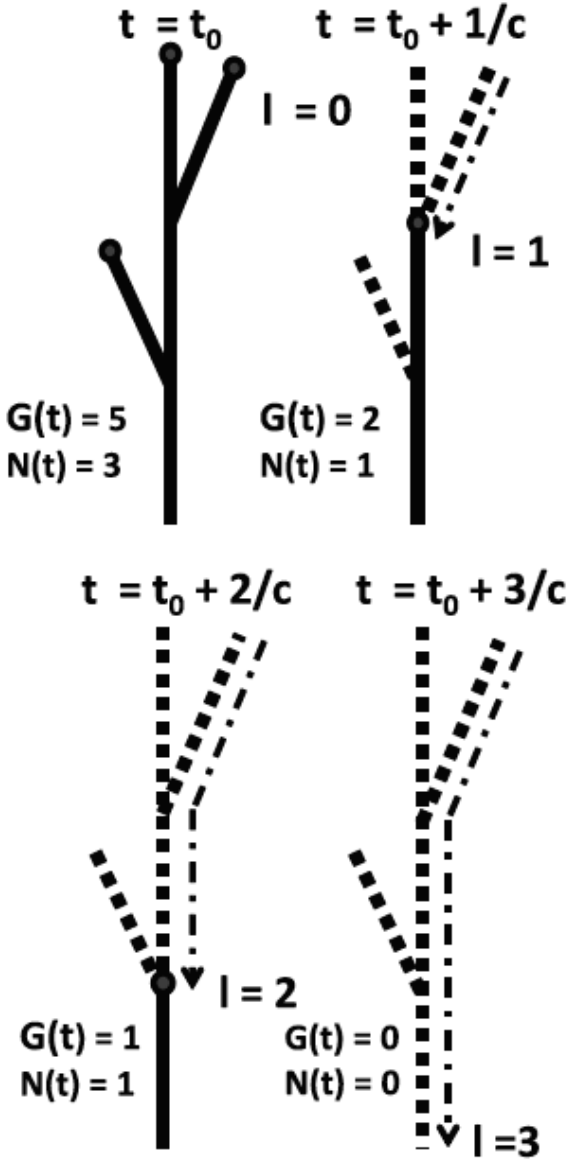


l = downstream distance from the channel heads

N(l): number of channel sources at distance *l* from their channel head

G(l): total length of AND located at a distance ≥ *l* from channel heads

Biswal and Marani, *GRL*, 2010



$$Q(t) = q\, G(t)$$

$$c = \frac{d\ell}{dt}$$

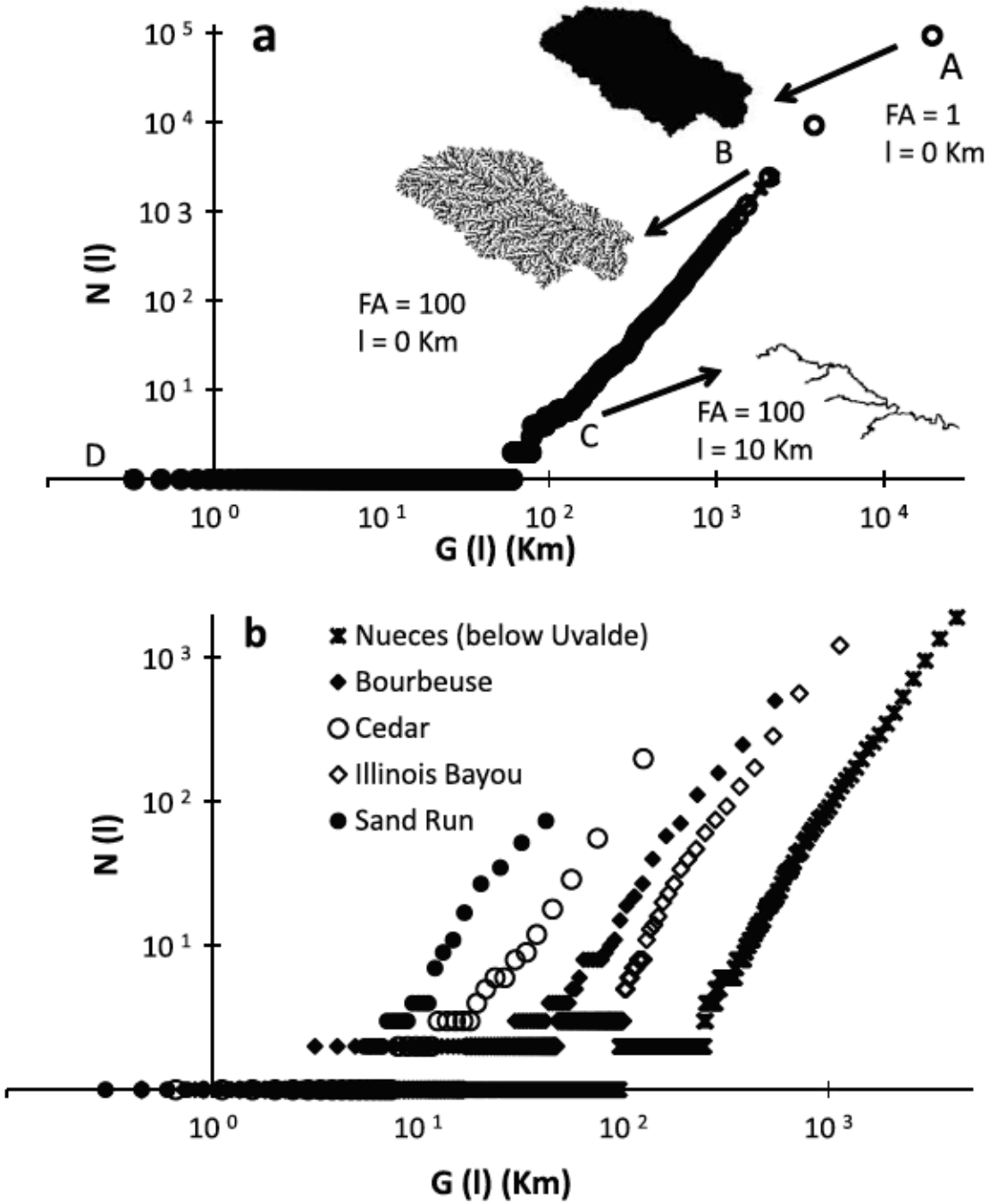
$$\frac{dQ}{dt} = q\frac{dG}{dt} + G\frac{dq}{dt} =$$

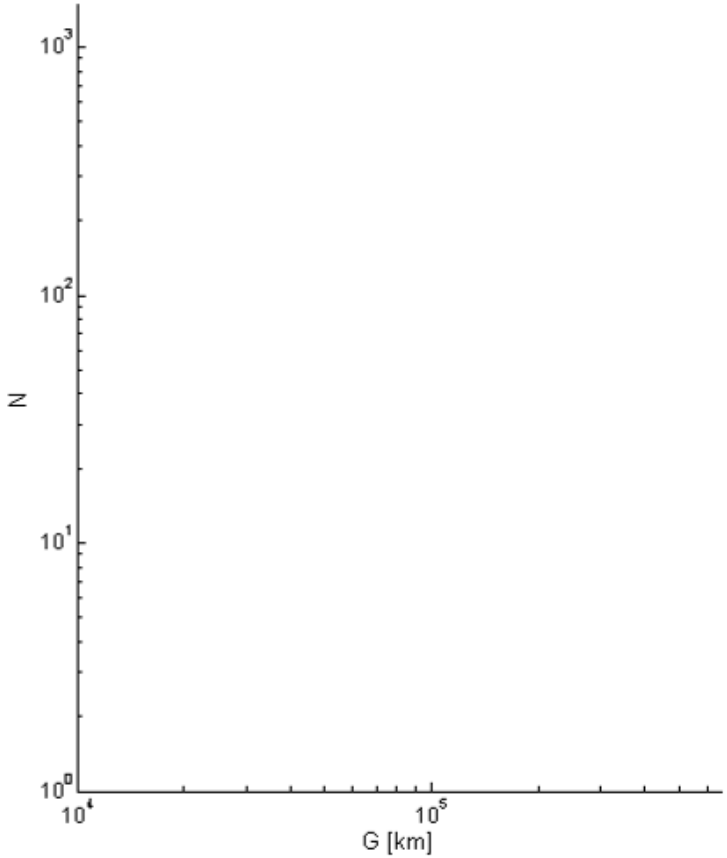
$$= \underline{-qcN(t)} + \underline{G\frac{dq}{dt}}$$

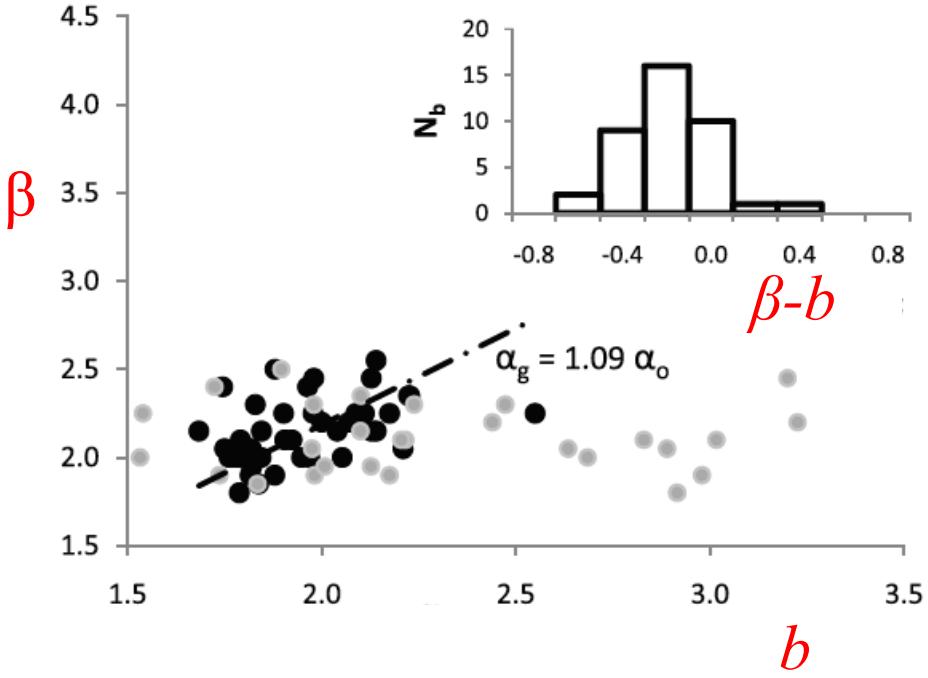
geomorphology

Brutsaert

Biswal & Marani, GRL, 2010


a
10^5
10^4
10^3
10^2
10^1
N (l)
A
B
C
D
FA = 1
l = 0 Km
FA = 100
l = 0 Km
FA = 100
l = 10 Km
10^0
10^1
10^2
10^3
10^4
G (l) (Km)
b
Nueces (below Uvalde)
Bourbeuse
Cedar
Illinois Bayou
Sand Run
10^3
10^2
10^1
N (l)
10^0
10^1
10^2
10^3
G (l) (Km)

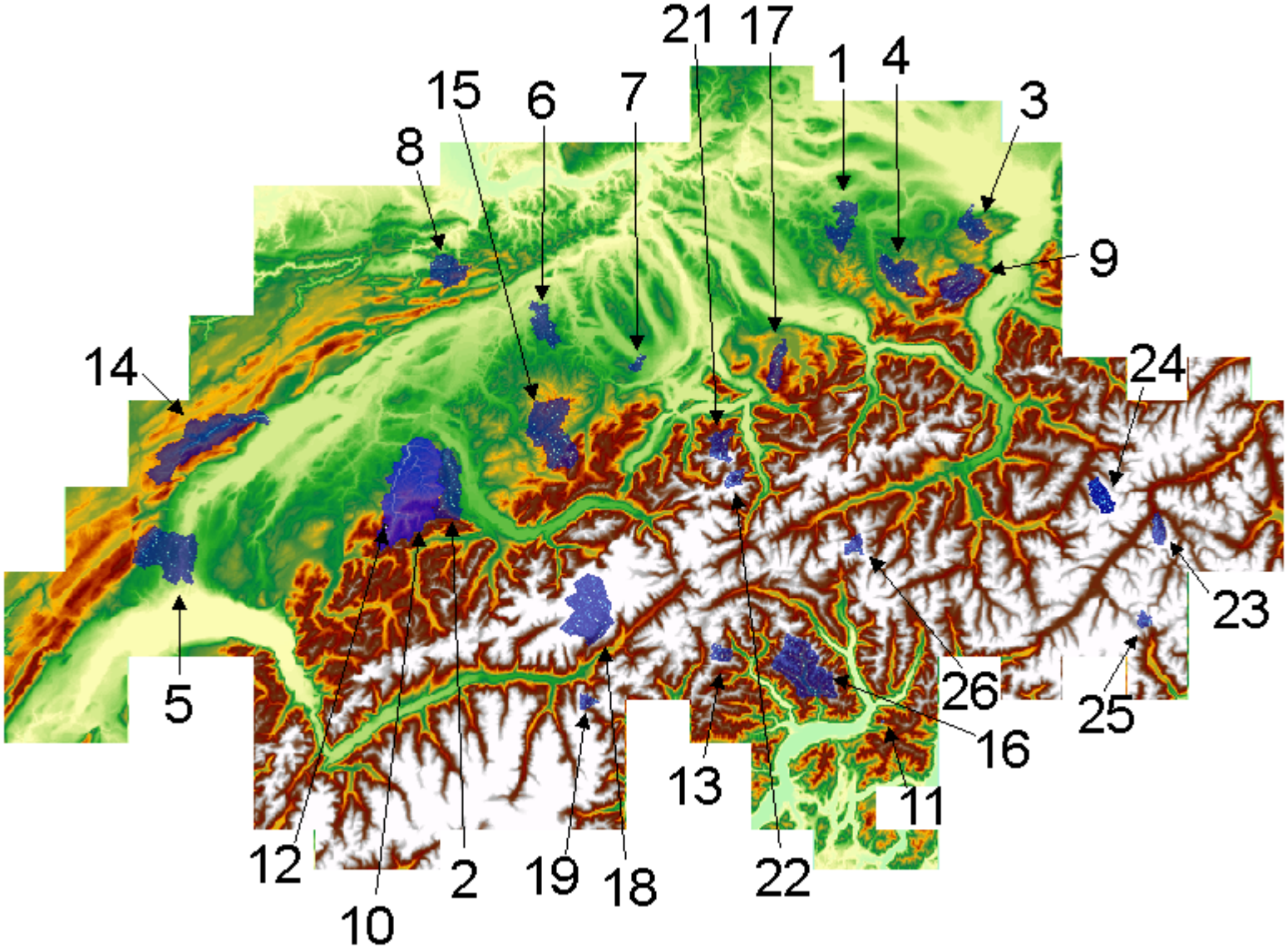

10^3
10^2
10^1
10^0
N
10^4
10^5
G [km]



$$\frac{dQ}{dt} = -CQ^{\beta} \quad \Rightarrow \quad \beta = b$$

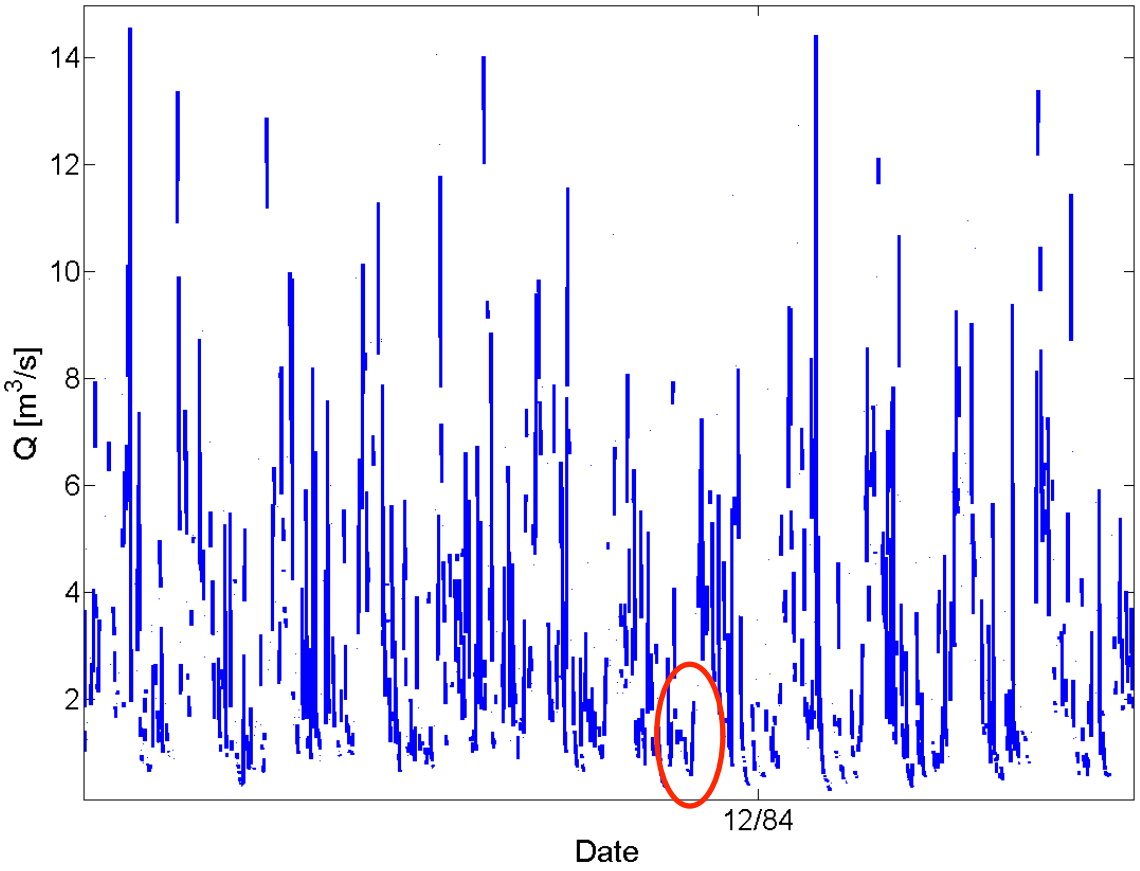
$$N(l) \propto G(l)^{b}$$

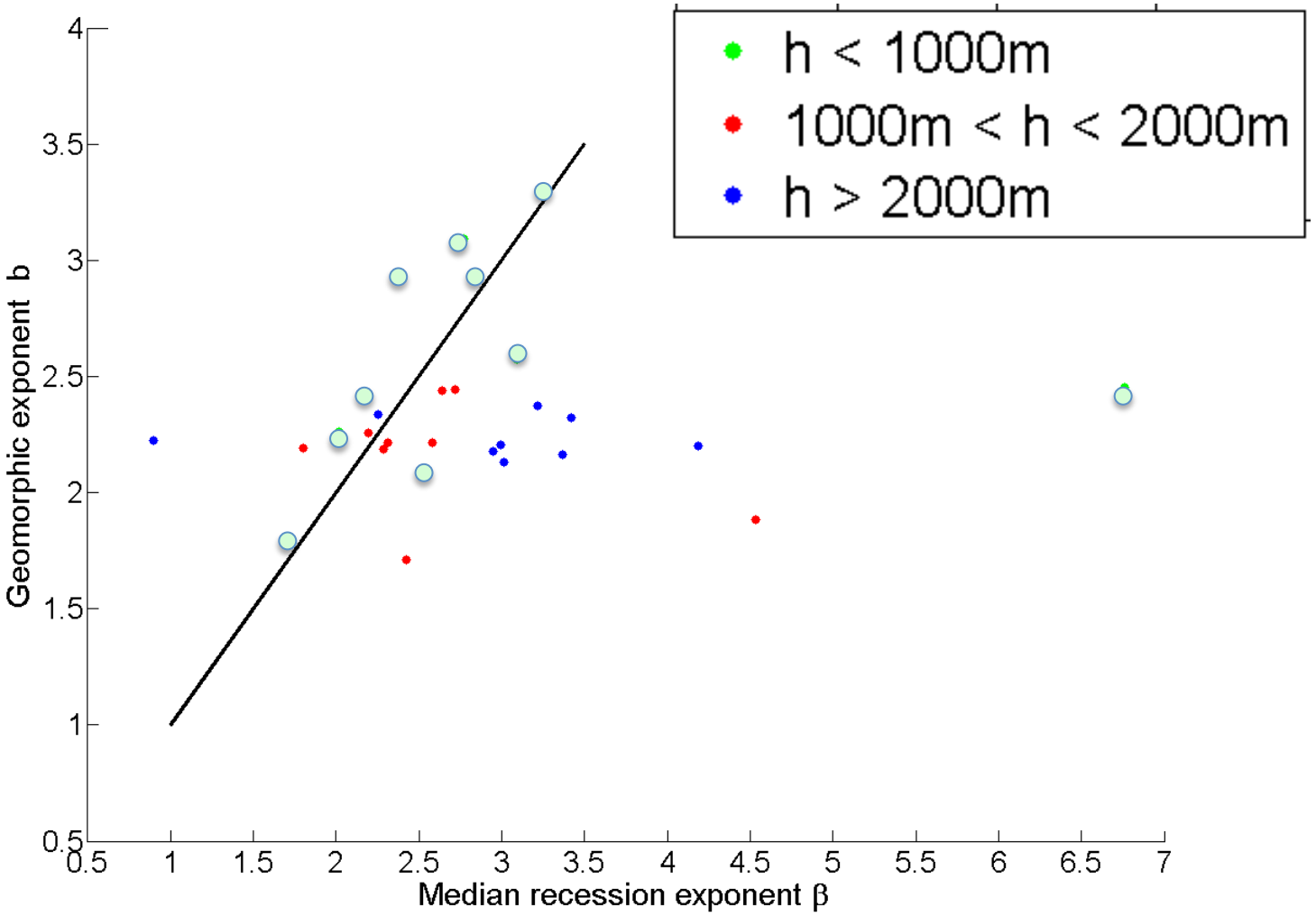
Biswal & Marani, *GRL*, 2011


21
17
1
4
15
6
7
3
8
9
14
24
23
5
26
25
16
13
11
12
10
2
19
18
22

excluded: i) daily discharges corresponding to rainy days; ii) discharge data for which dQ/dt ≥ 0

considered: iii) recessions with Q max > Q mean of the stream; iv) periods with ≥ 6 days of consecutive data

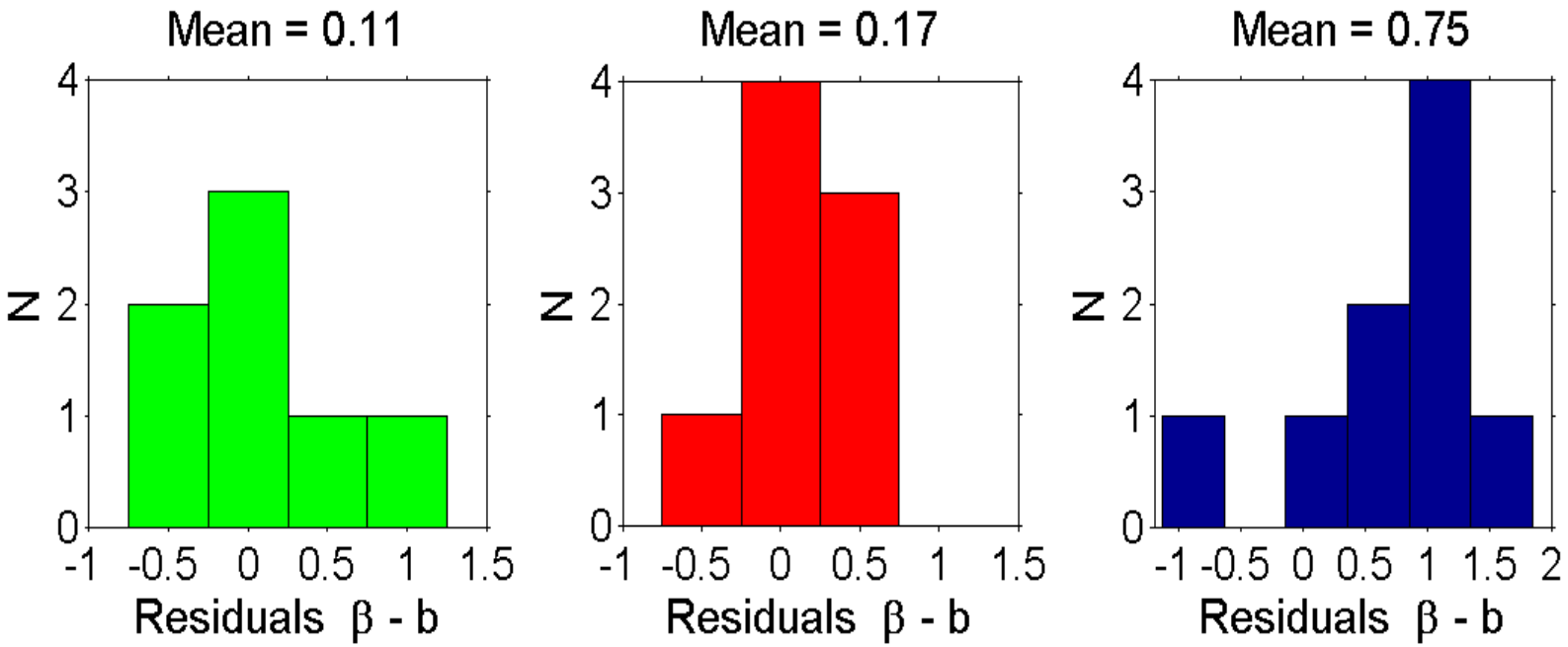




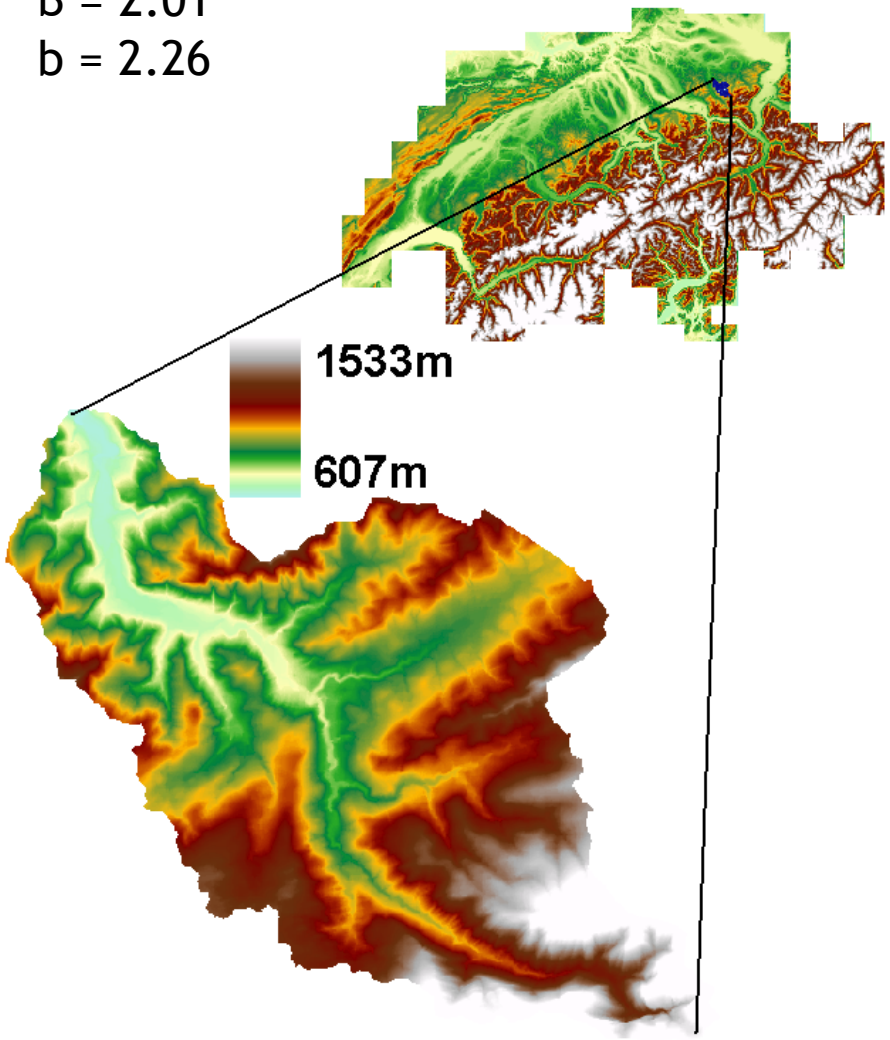
$$b \approx \beta$$

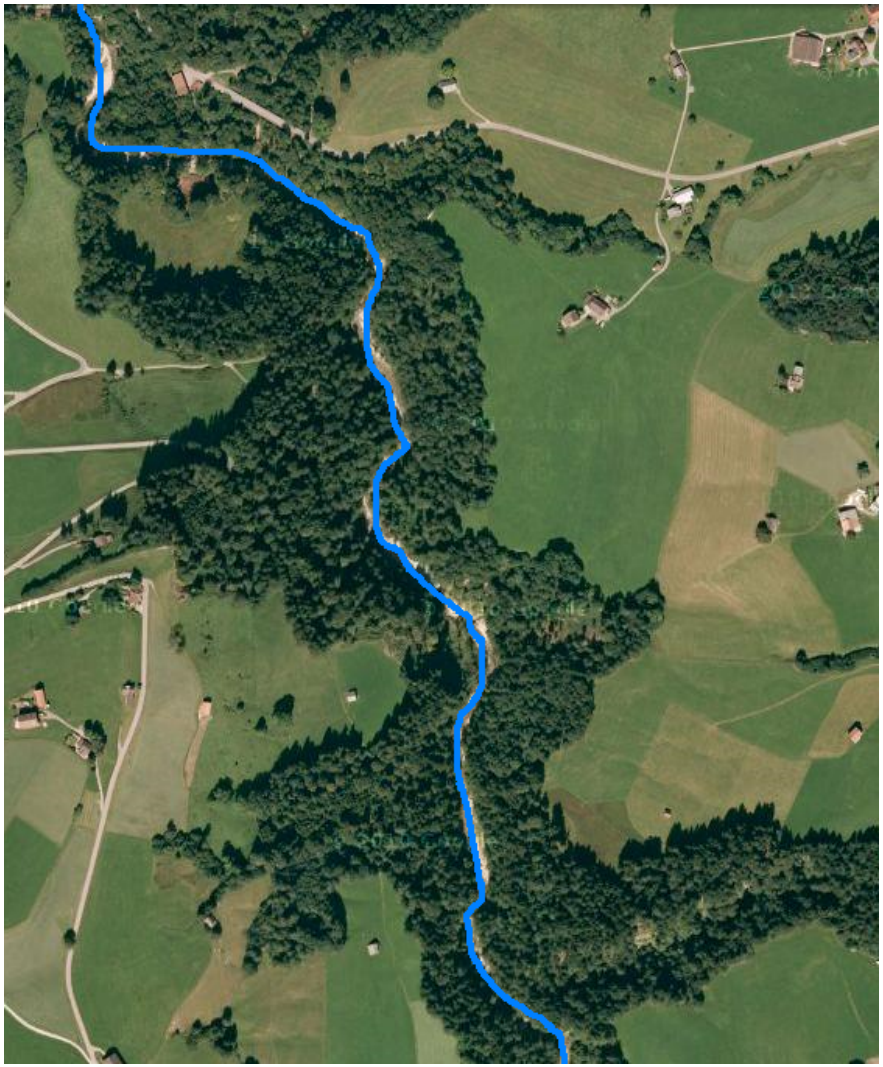
Tomasic, MSEE EPFL, 2011

frequency distribution of residuals β - b



Necker, 88km^2
β = 2.01
b = 2.26





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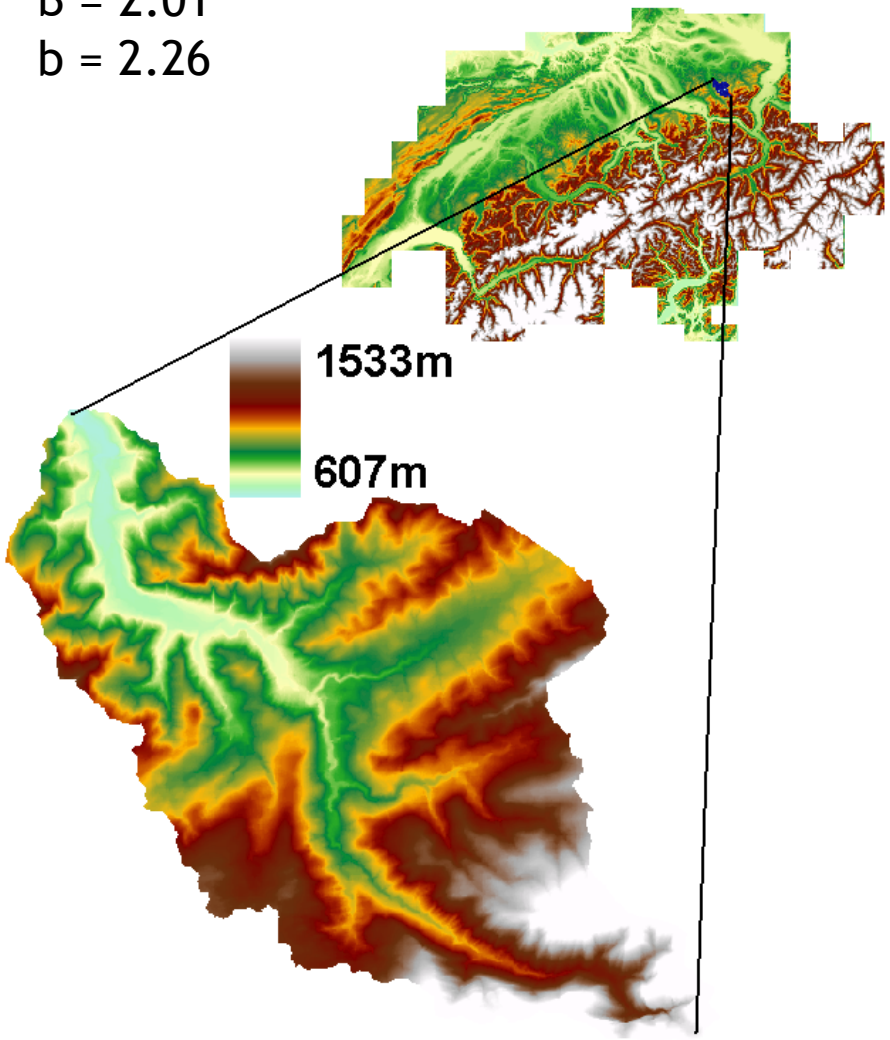
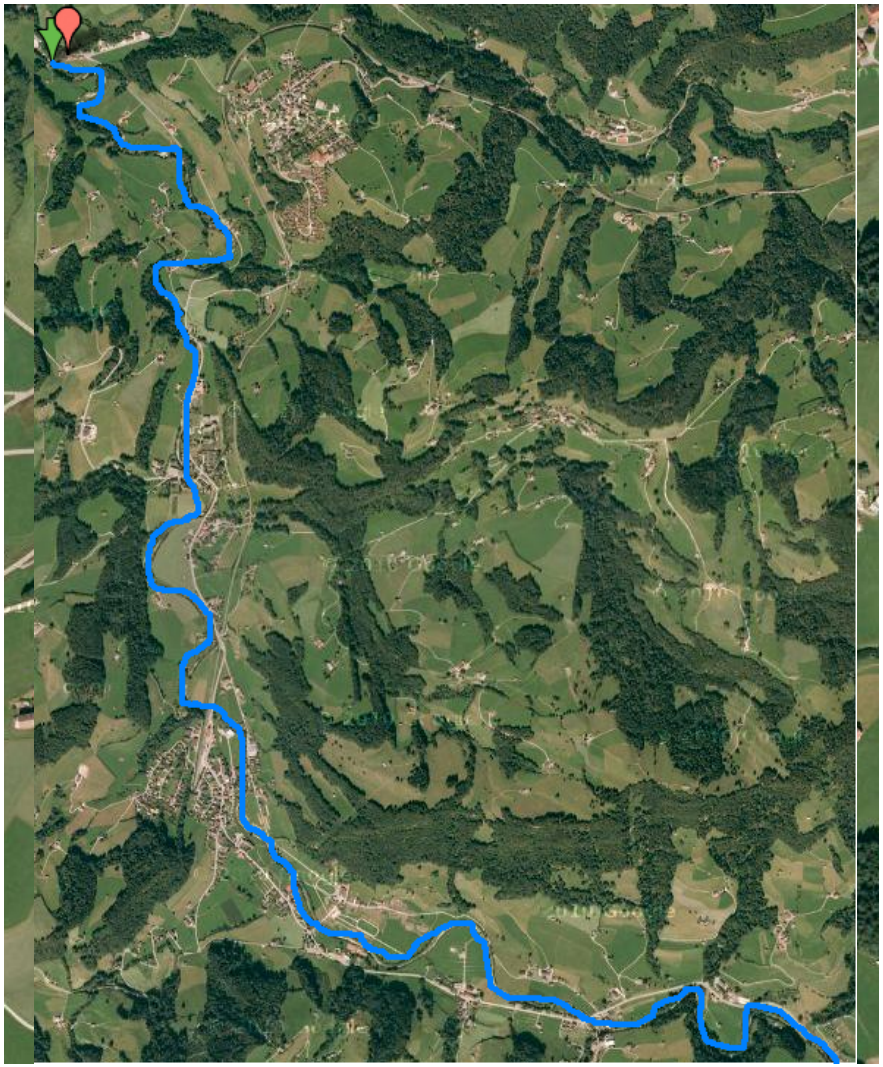
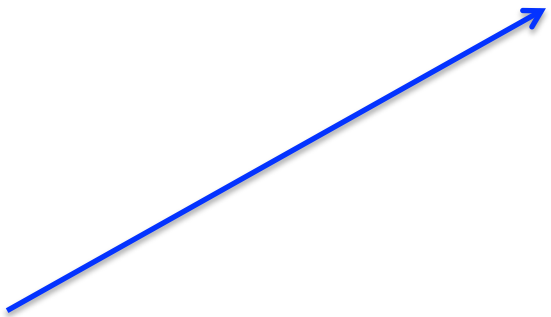




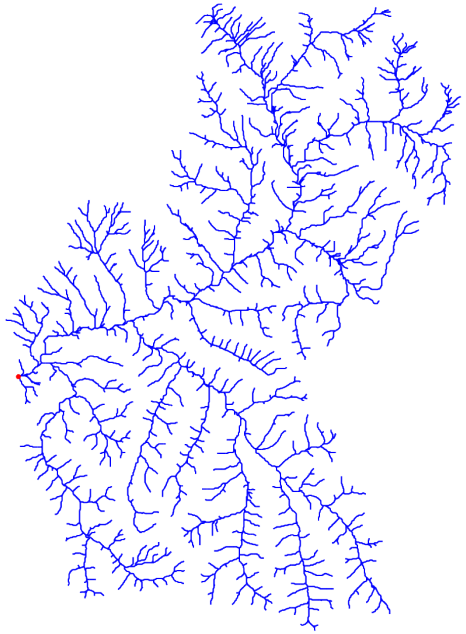
$$q \neq \text{const} = q(\ell)$$

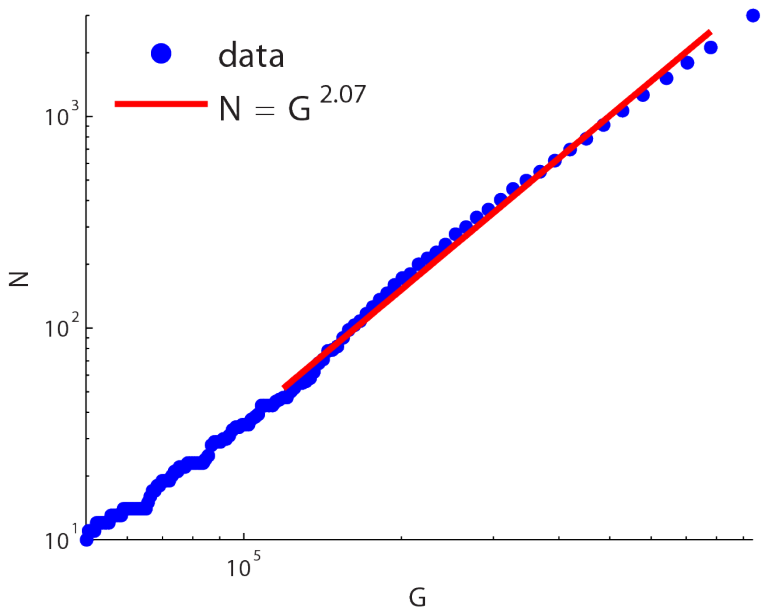
$$q(\ell) \propto \left.\frac{dA}{d\ell}\right|_{\ell}$$

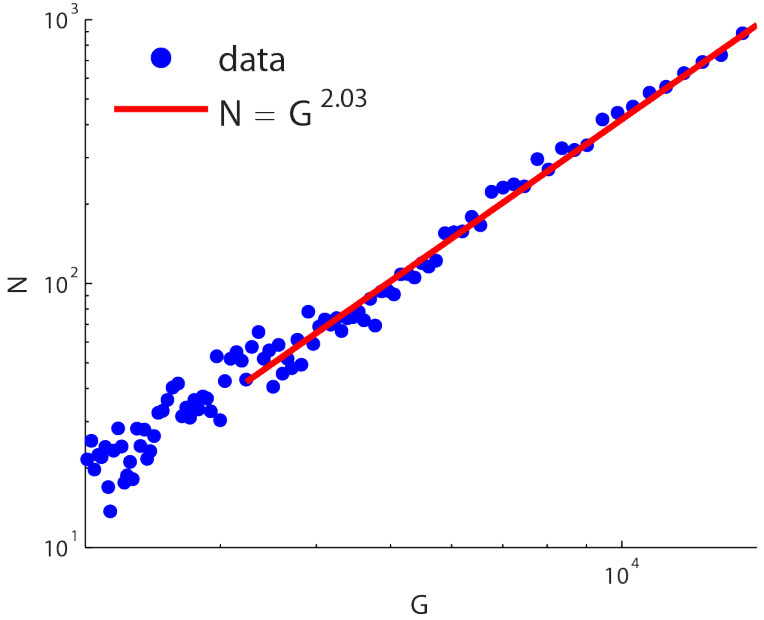


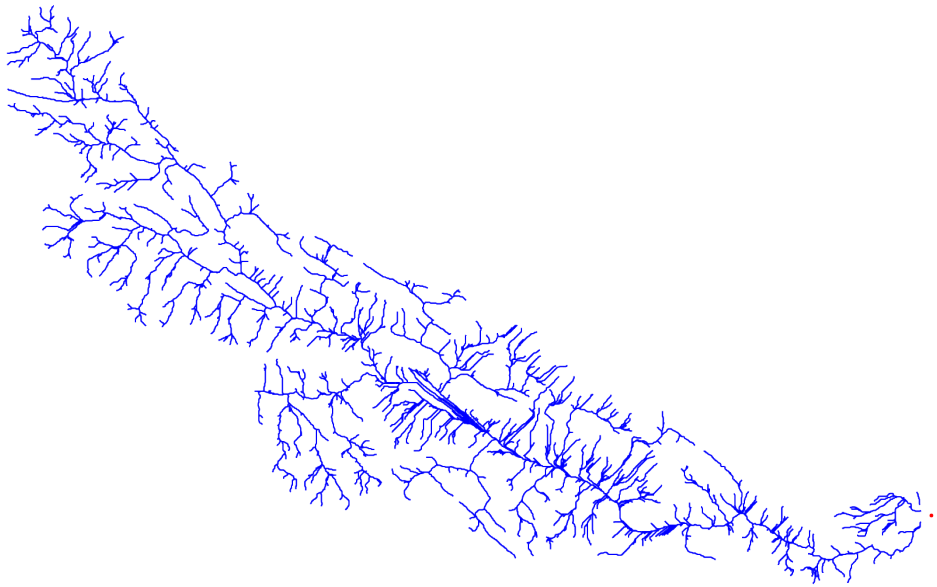
‘proper’ local
drainage density

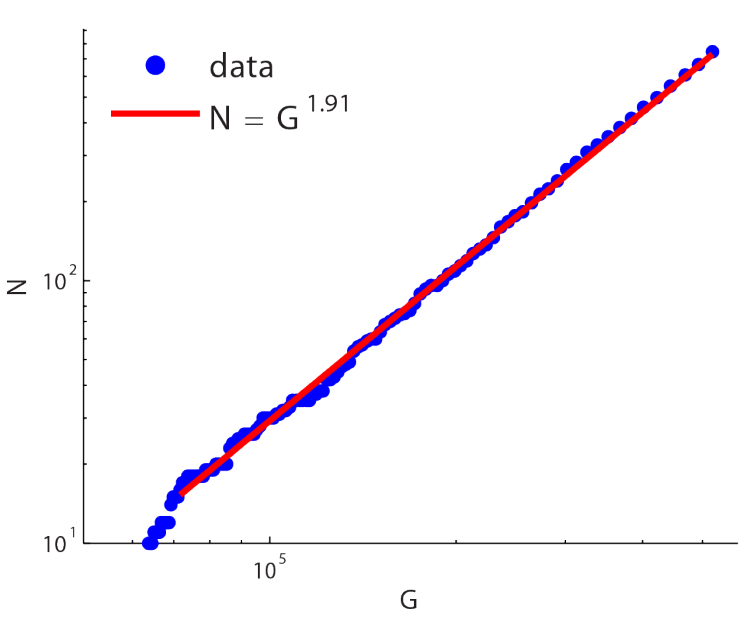
a novel approach

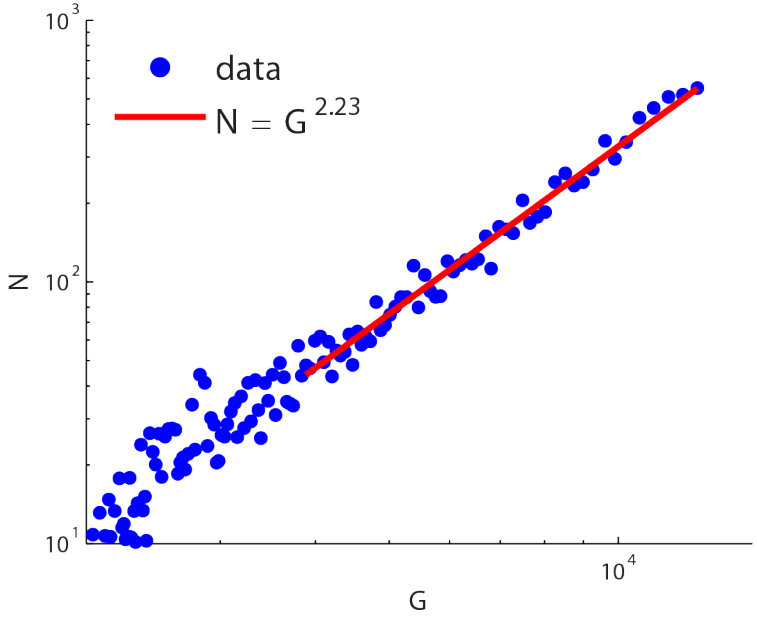


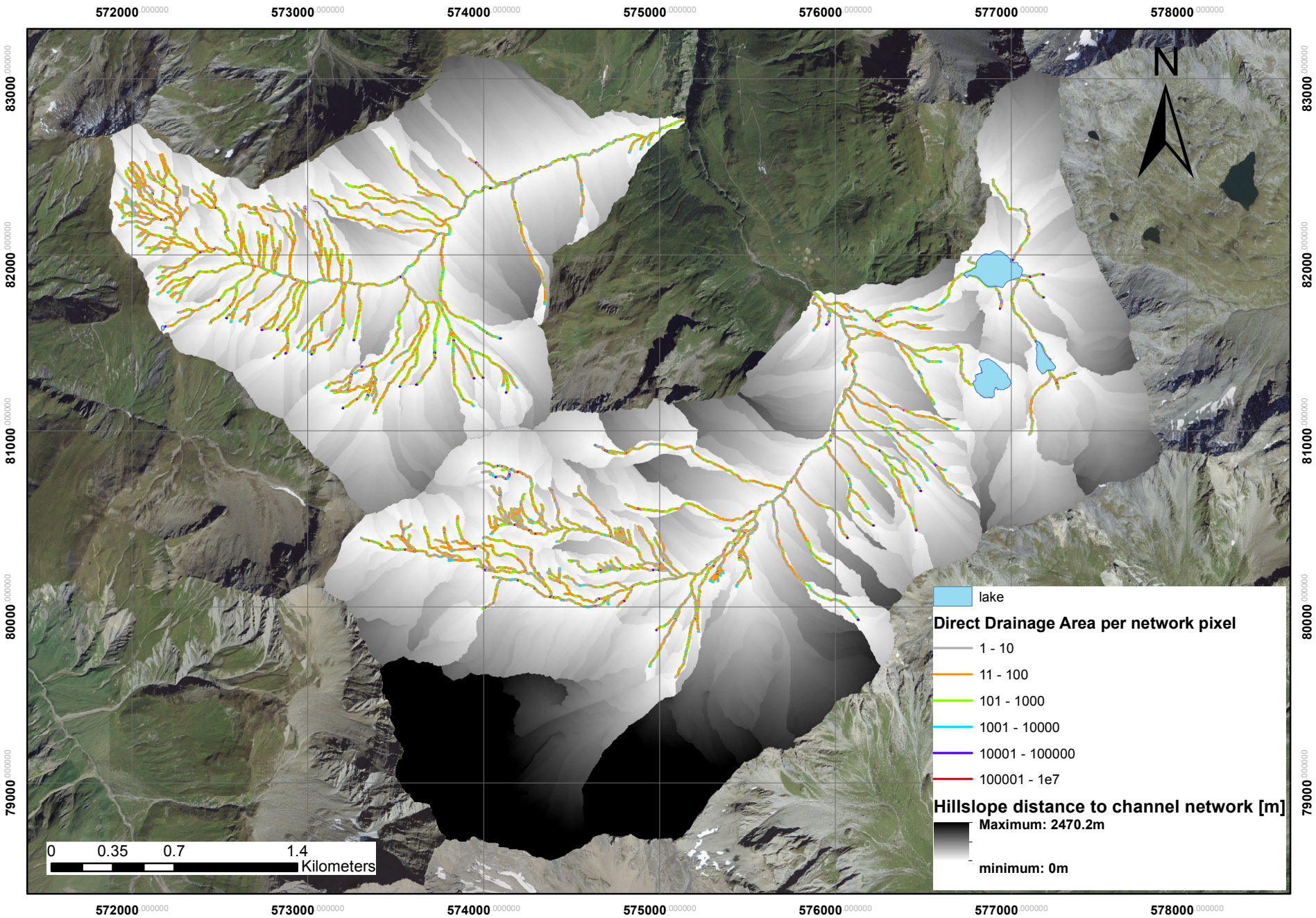

data
N = G 2.07
N
G
10^1
10^2
10^3
10^5


data
N = G 2.03
N
G
10^1
10^2
10^3
10^4

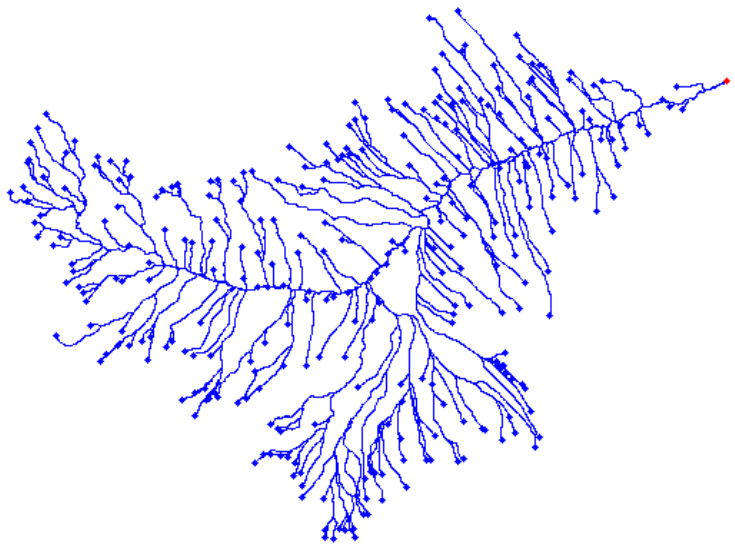


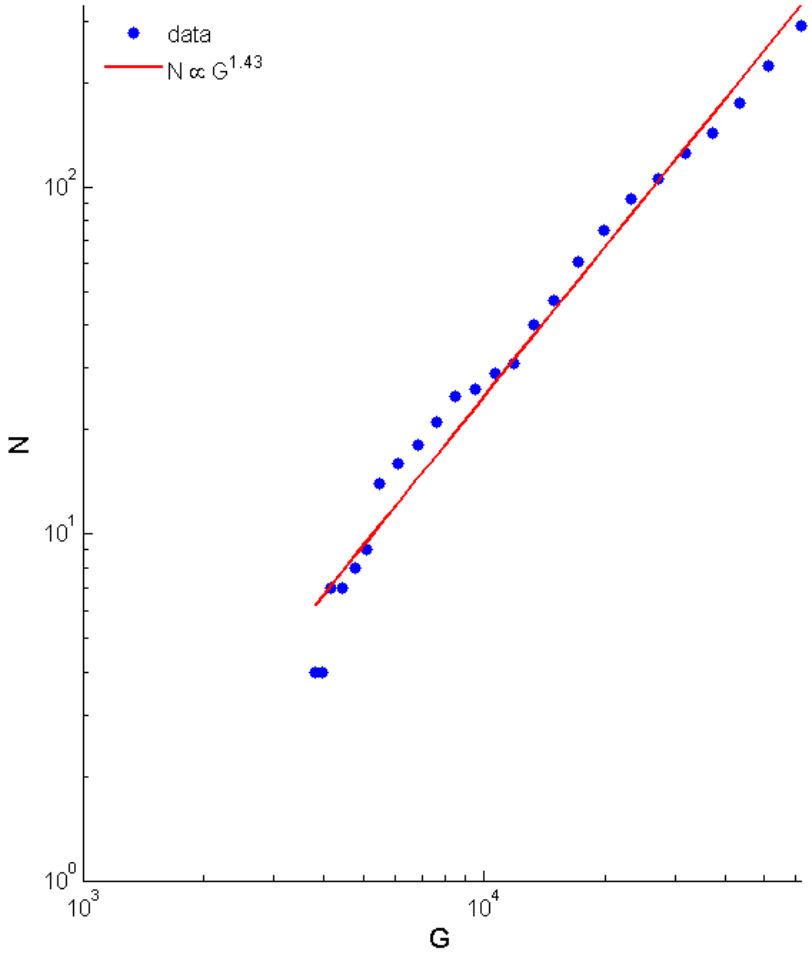

data
N = G 1.91
N
G
10^1
10^2
10^5


data
N = G 2.23
N
G
10^1
10^2
10^3
10^4



Mutzner et al, to be submitted for the WRR special issue, 2012





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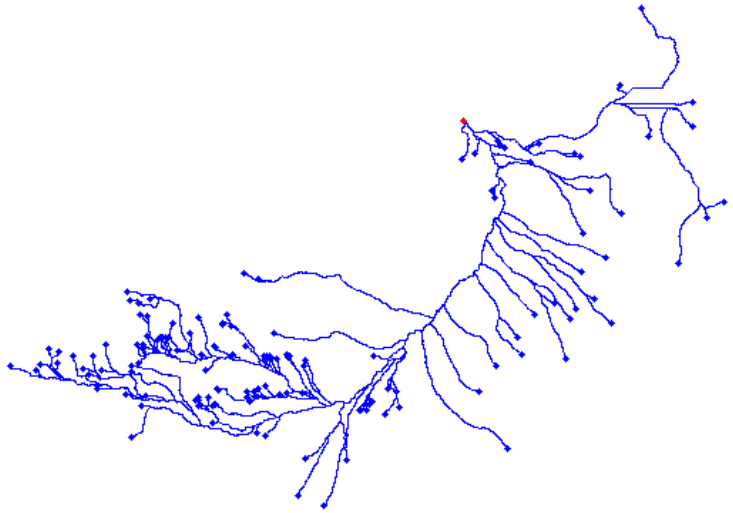

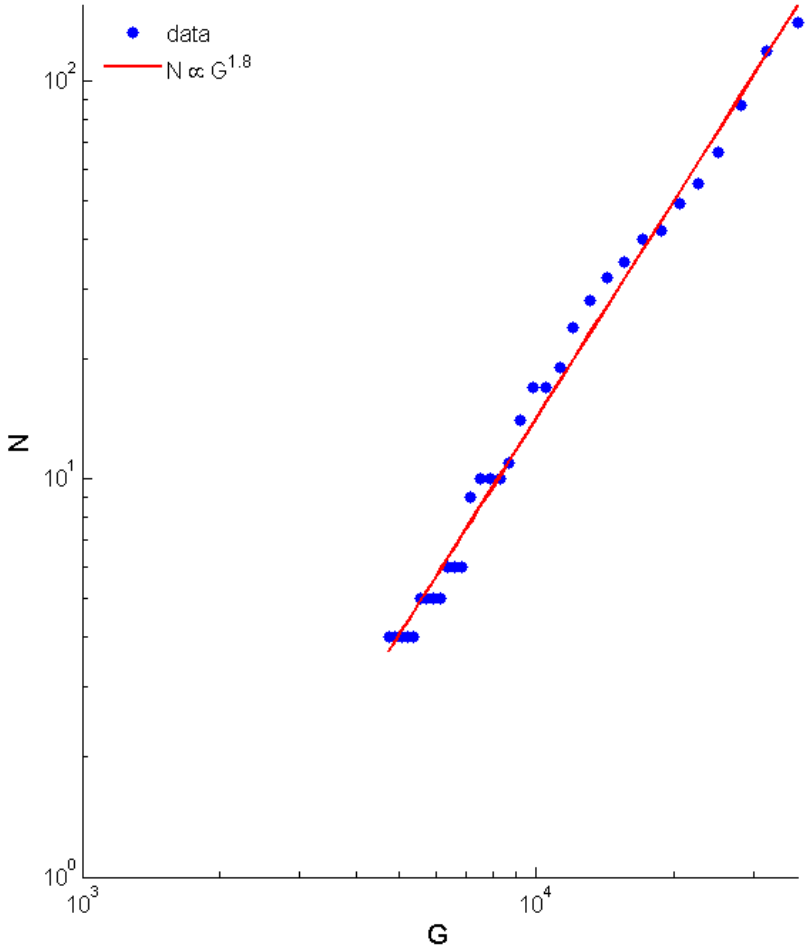

Mutzner et al, to be submitted for the WRR special issue, 2012

CONCLUSIONS

geomorphological origins of large-scale recession curves (nearly complete)

key to the linkage is drainage density – properly defined

though much remains to be done (data!)
a clear case of hydrologic discovery through physical analysis directly linked to the legacy of Wilfried and Jean-Yves