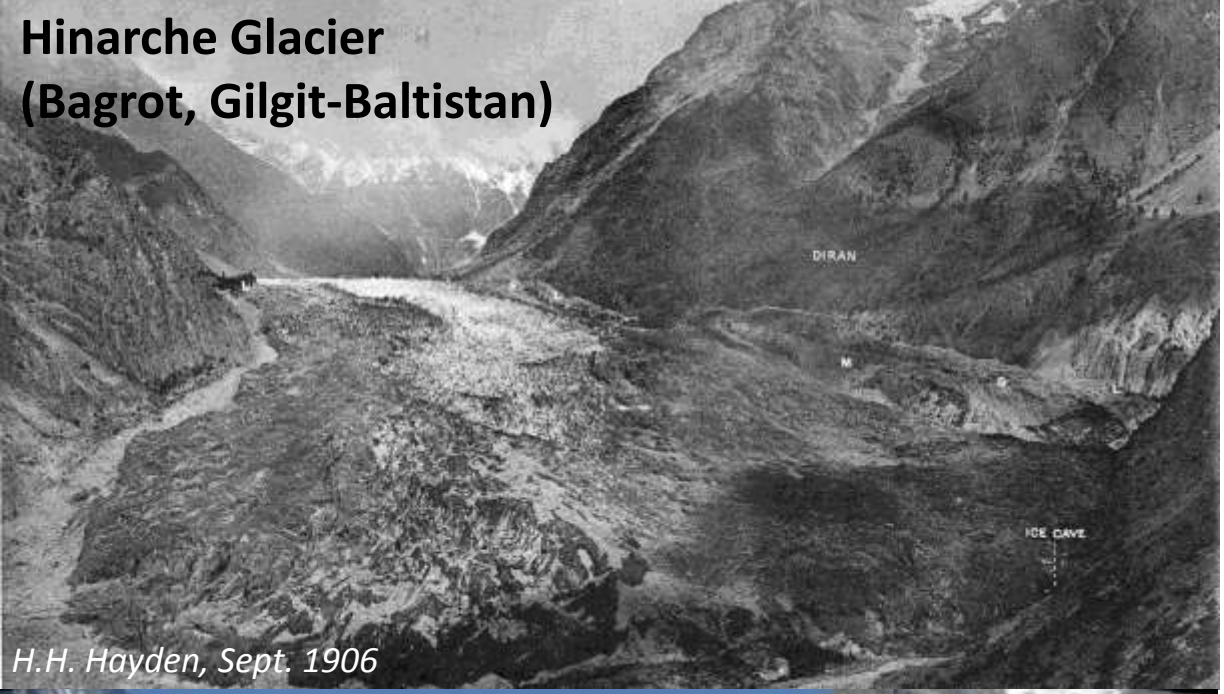
The „Karakoram Anomaly“: Indications based on observations, field data, models in Upper Hunza

Matthias WINIGER & Uwe BOERST
University of Bonn, Germany

The Italian science and cooperation at the shadow of K2
Scientific Conference: Sept. 10, 2013, Islamabad
„Karakoram Resources and Climate Change:
Glacier, Water and Ecosystem“

Retreating vs. Surging Glaciers



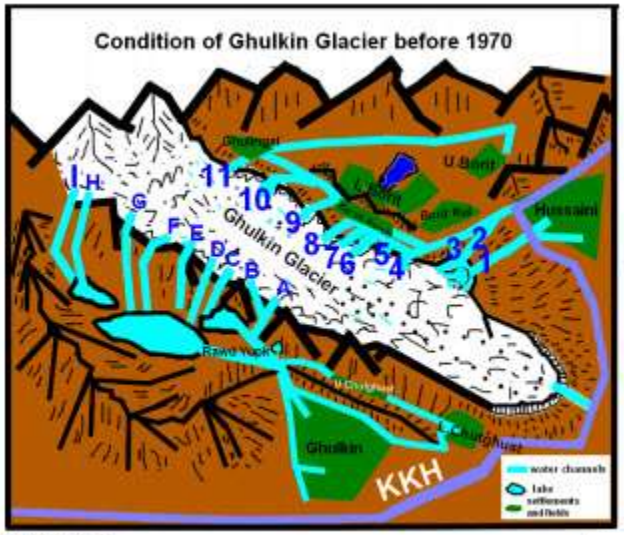
Hinarche Glacier (Bagrot, Gilgit-Baltistan)

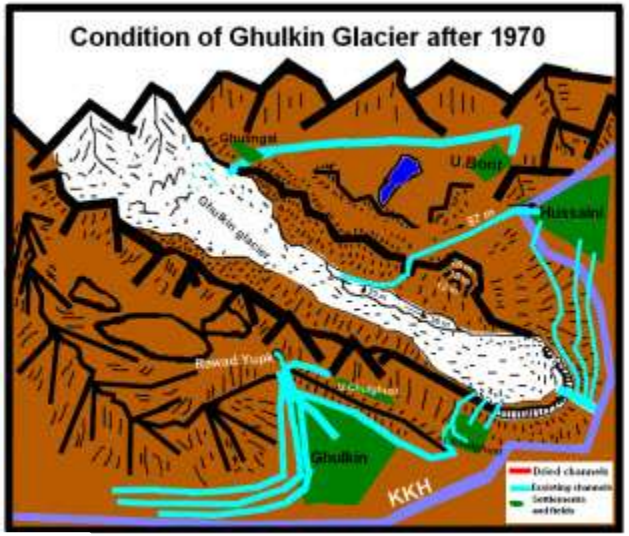
H.H. Hayden, Sept. 1906

M. Winiger, June 2011

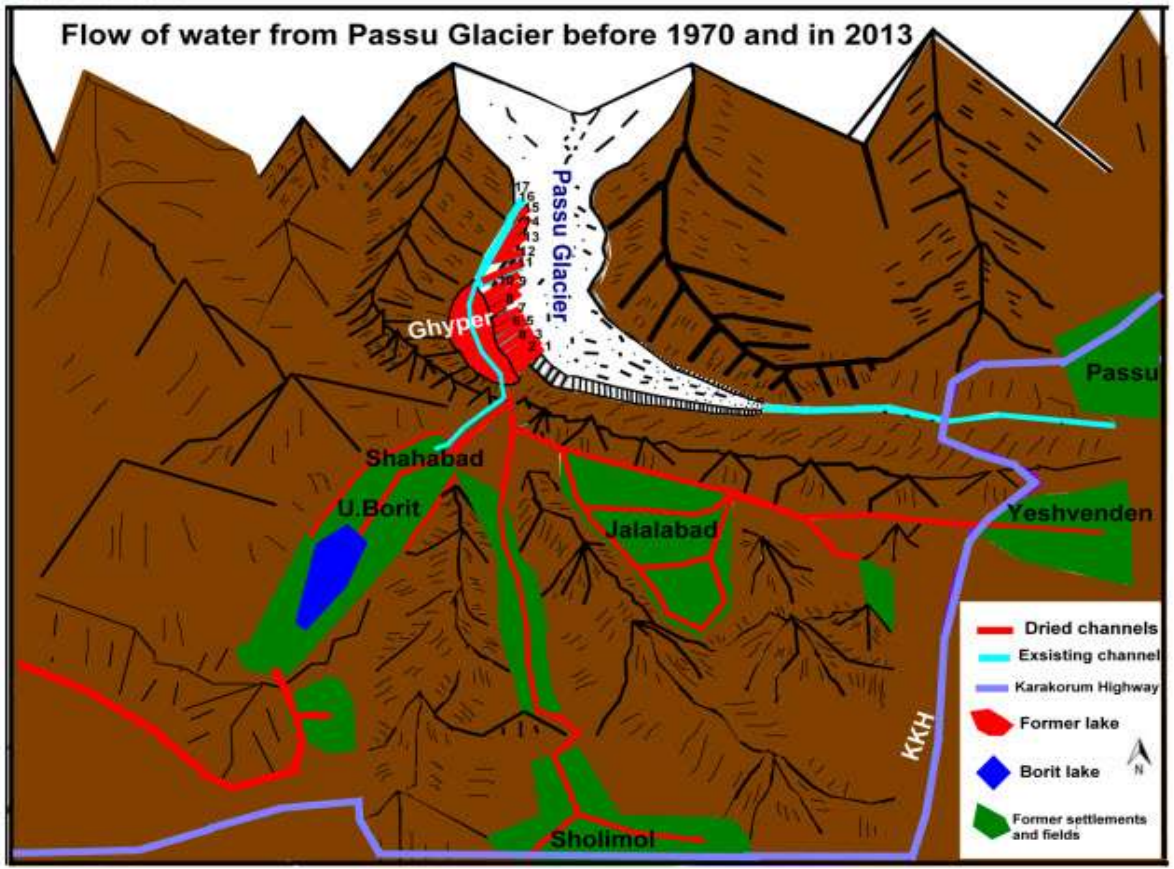
Khurdopin (Shimshal)

(Google Earth; Scene 2009)





Passu Glacier



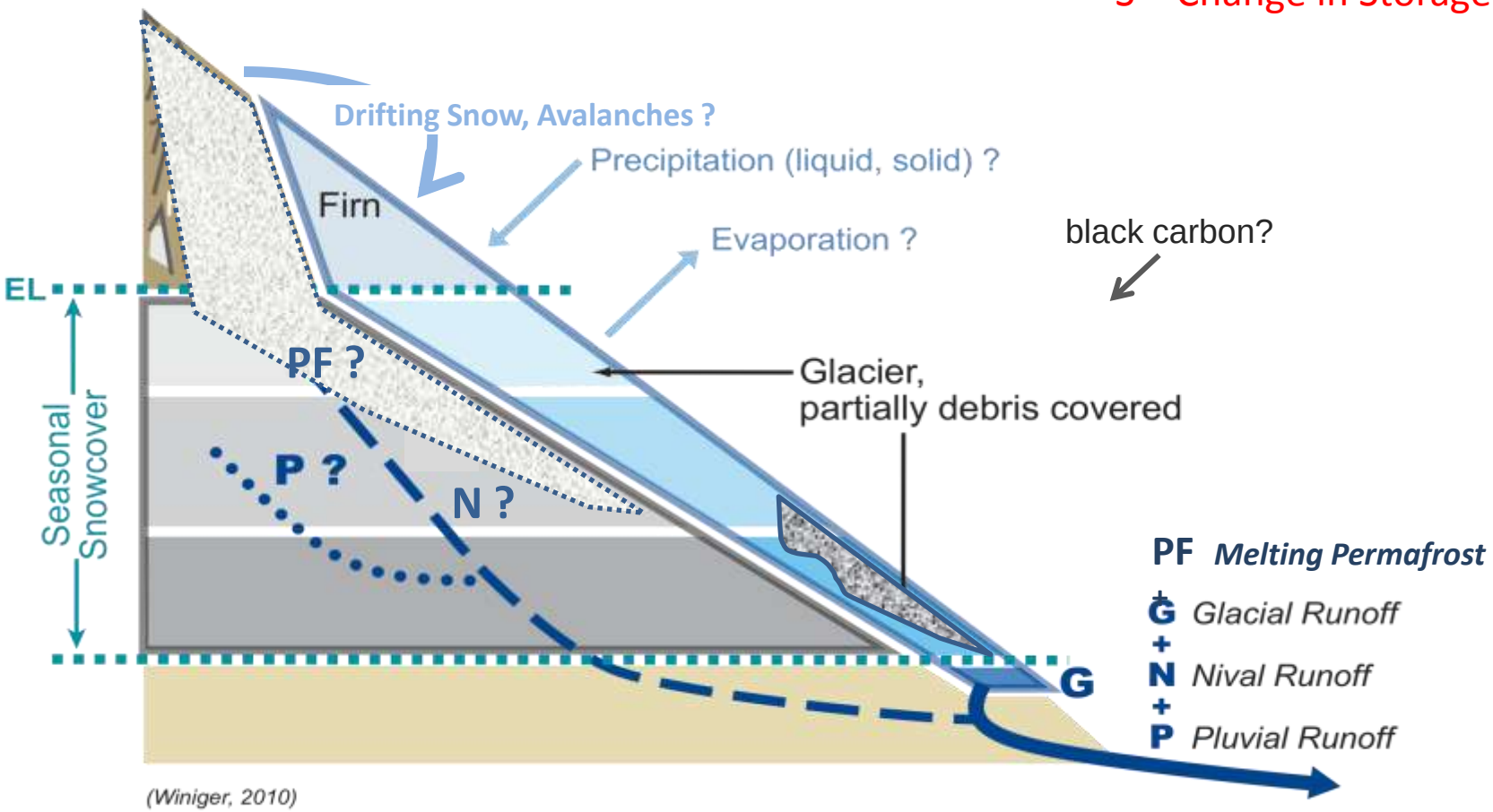
Recent downmelting of glaciers and consequencies on irrigation potential in Upper Hunza

(Field studies and draft: Sitara Parveen, 2013)

Water Balance of Mountain System (simplified)

$$P = Q + E + \Delta S$$

P = Precepitation
Q = Runoff
E = Evaporation
Δ S = Change in Storage



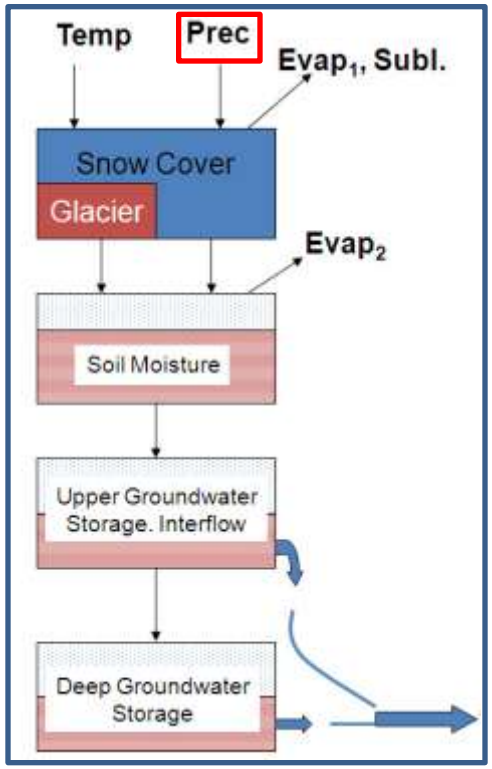
(Winiger, 2010)

Meteorological Model Inputs
Example: Comparison of areal rainfall totals (mm/y)

Perimeter: 35°-37° N / 72°-75°30‘ E (~ map perimeter of Weiers, 1995)
Different length of observation periods

1.	Weiers, 1995:	790 mm
2.	GPCC, 2010:	350 mm
3.	Pak.Met.Dpt, 1985:	440 mm
4.	Pak.Met.Dpt, 2010:	367 mm
5.	Reanalyse Data Mid troposphere, 2009:	235 mm
6.	Ragetti et al. 2012:	~ 650 mm

?

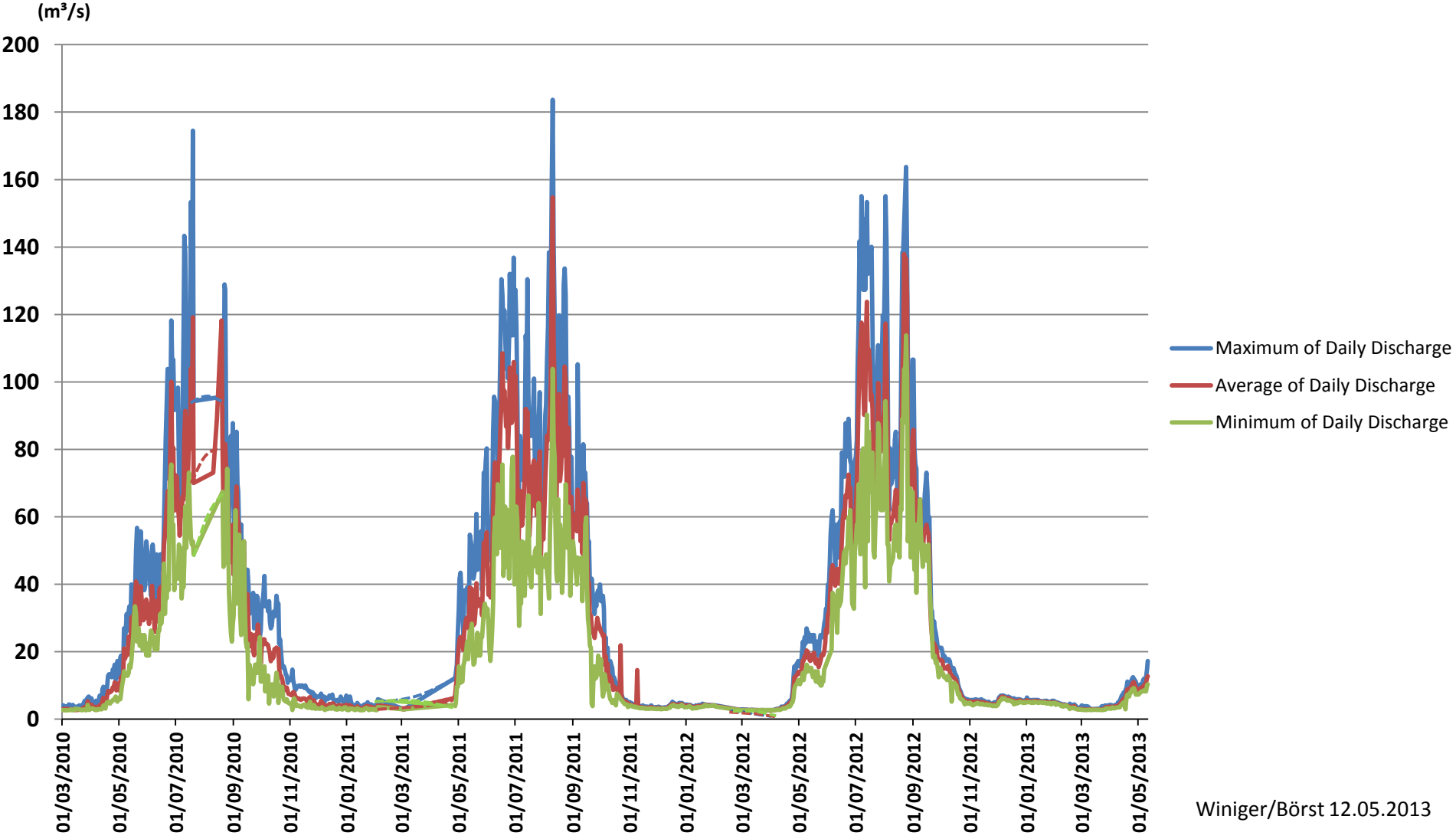


HBV3-ETH9

Total Runoff

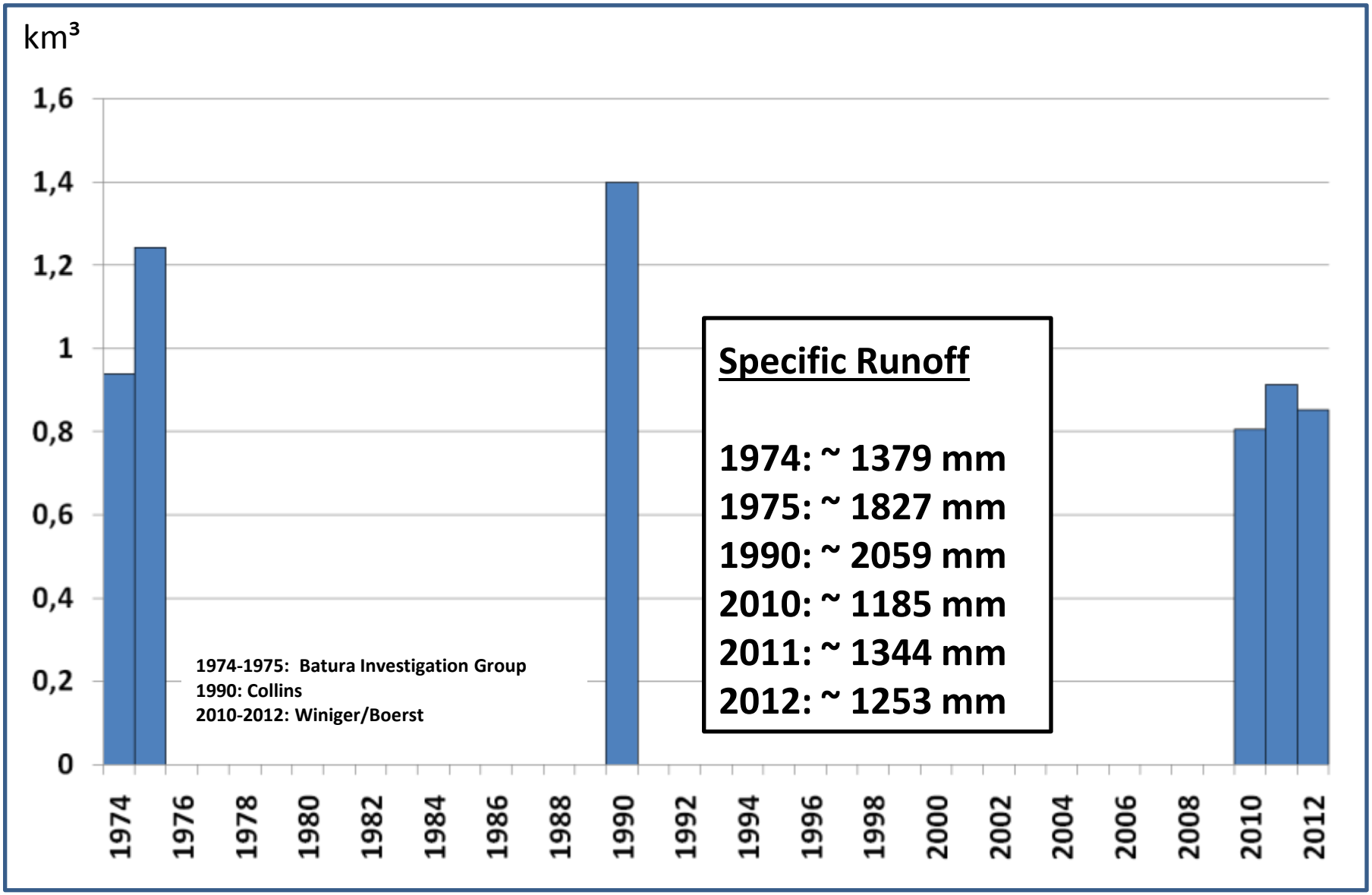
(Compiled by Winiger & Boerst, 2012)

Daily Discharge of Batura-River calculated with combined Measurement Methods
01.03.2010 - 11.05.2013



Winiger/Börst 12.05.2013

Runoff Batura River 1974 - 2012



(Draft: Boerst & Winiger, 2012)

Water Balance of Batura Valley in 2011

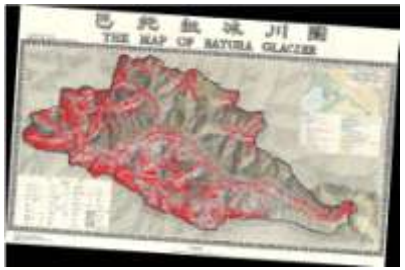
1544 mm = 1344 mm + 200 mm + 0 mm

$$P = Q + E + \Delta S$$

P = Precipitation
Q = Runoff
E = Evaporation
ΔS = Change in Storage

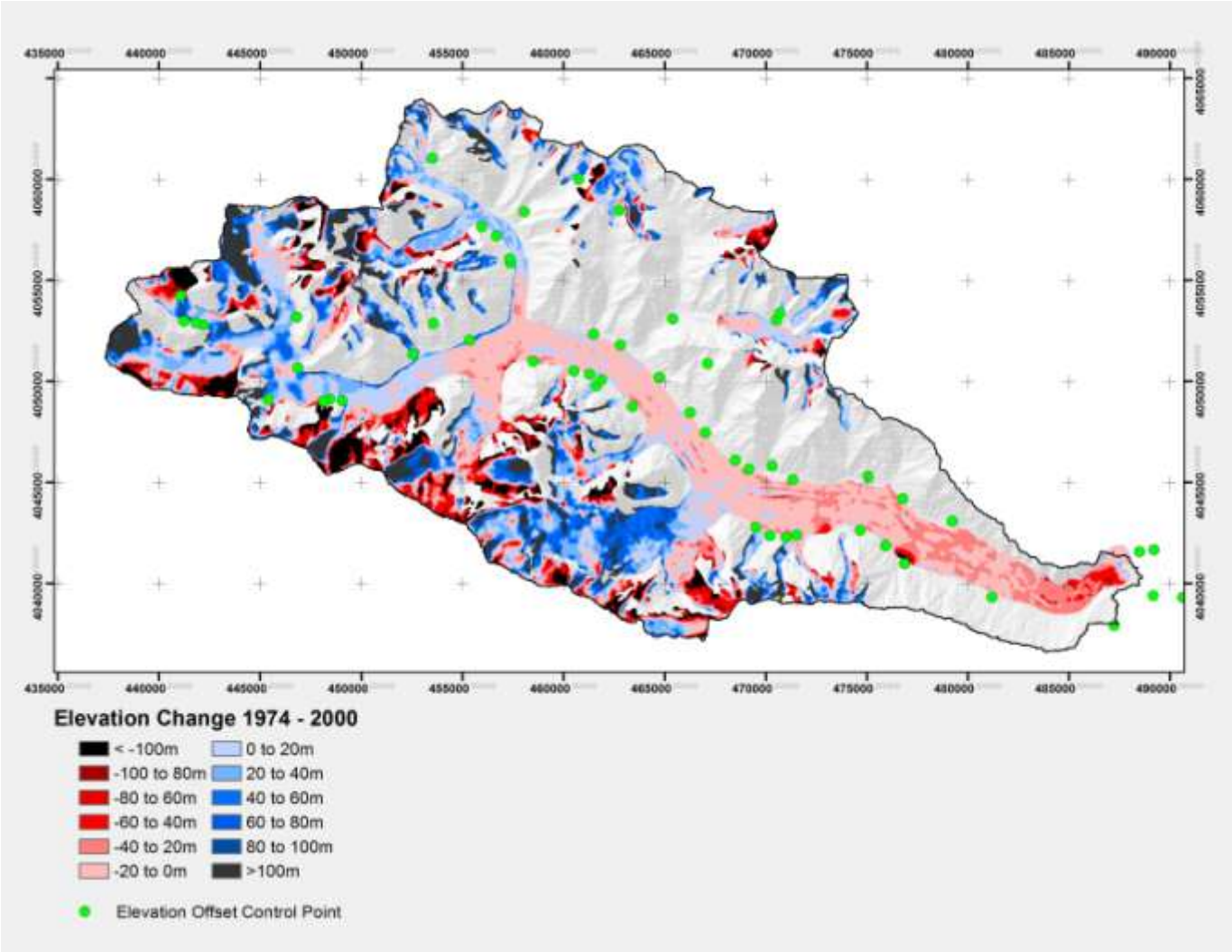
Batura Glacier Elevation Change 1974 - 2000

Map from Batura 1974
(Batura Investigation Group)

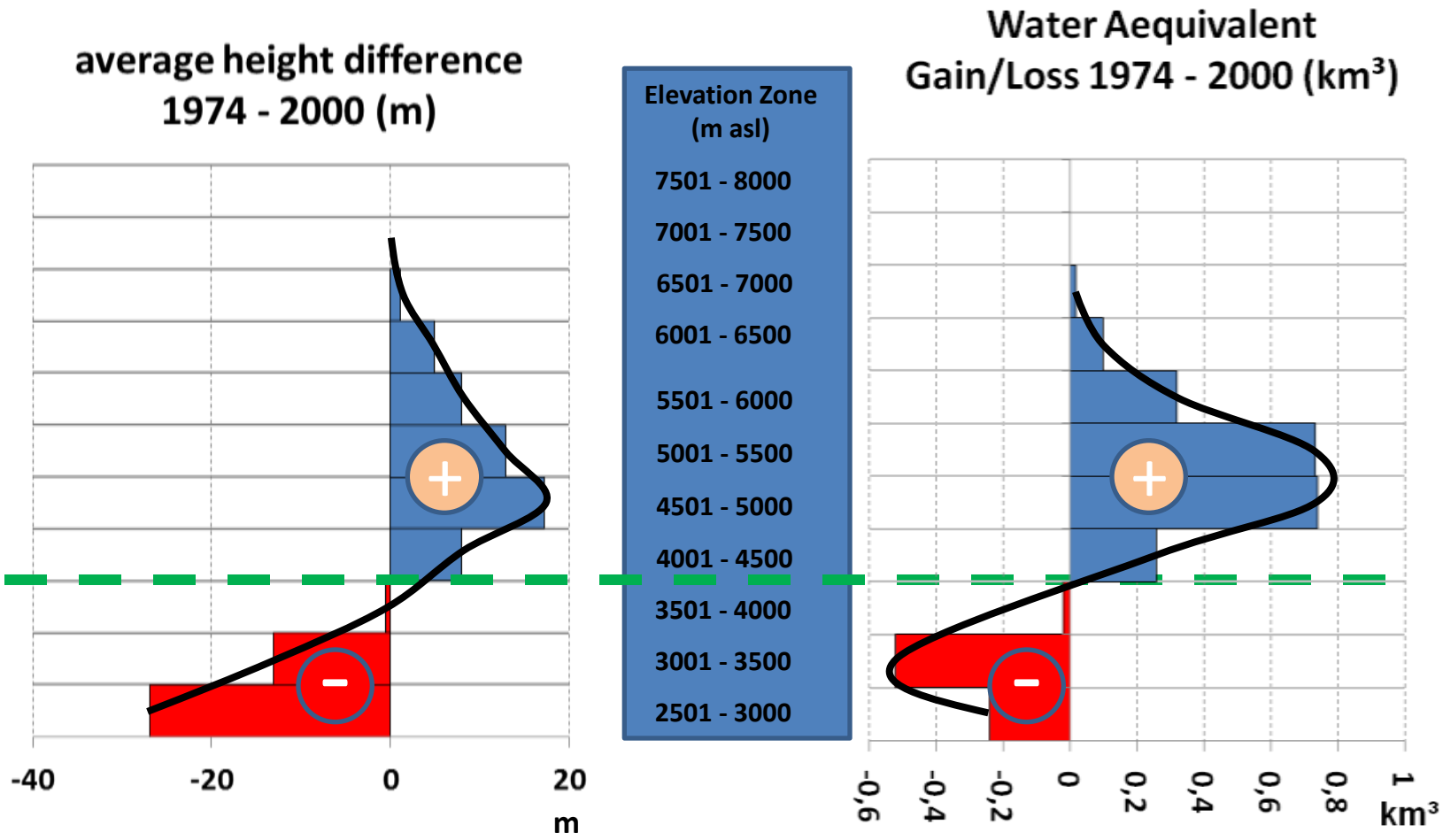


+ →

Processed SRTM
Data Version 4.1
CIAT



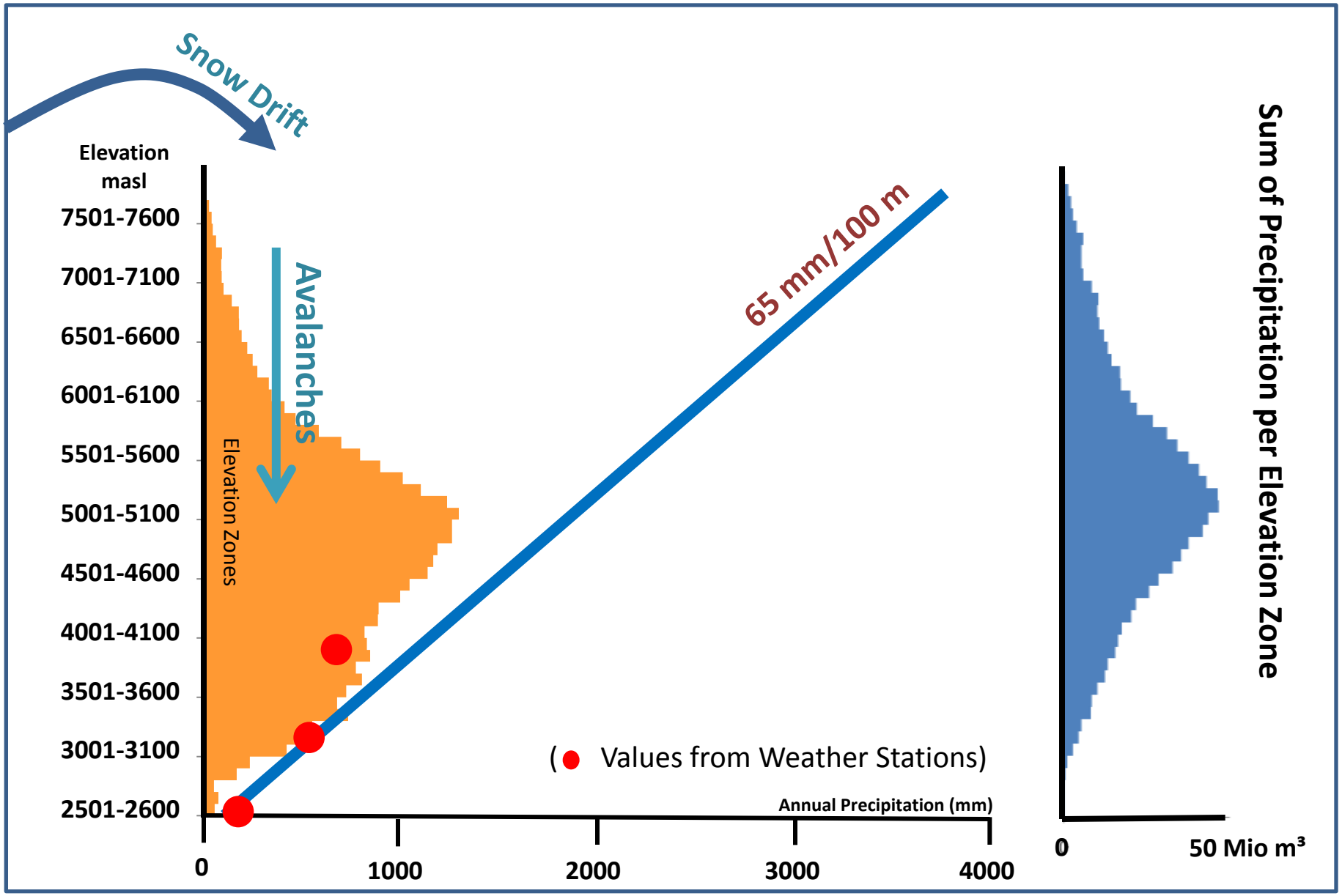
(Evaluation and draft: U. Boerst, 2012)



Gain of Ice from 1974 – 2000: ~ 1,7 km³ = 1,5 km³ Water
=> 87 mm Precipitation/Year

(U. Börst & M. Winiger, 2012)

Vertical Mean Precipitation Lapse Rate



(Evaluation and draft: Boerst, 2012)

Cryosphere : Models - Data/Field Evidence - Scales

Global to Regional Scales

General Glacier Model

Continental Topographic control

Satellite Data (Atmospheric and Surface Parameters)

General Atmospheric Model-Input Data

Regional/Local Topographic control

Data quality

Local Glacier Model

Regional/Local Meteorological Data

Data quality

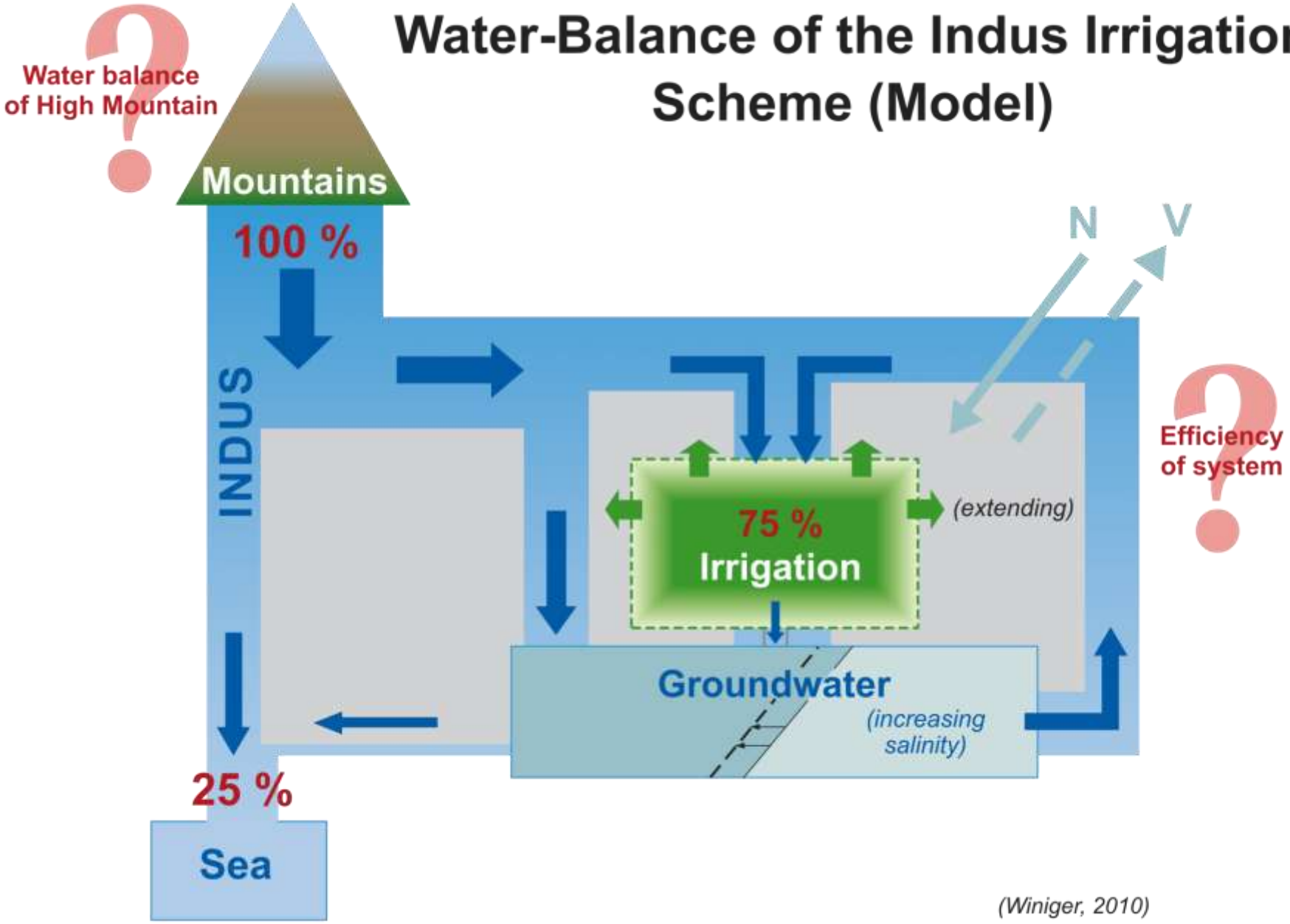
Proxy-Data

Regional to Local Scales

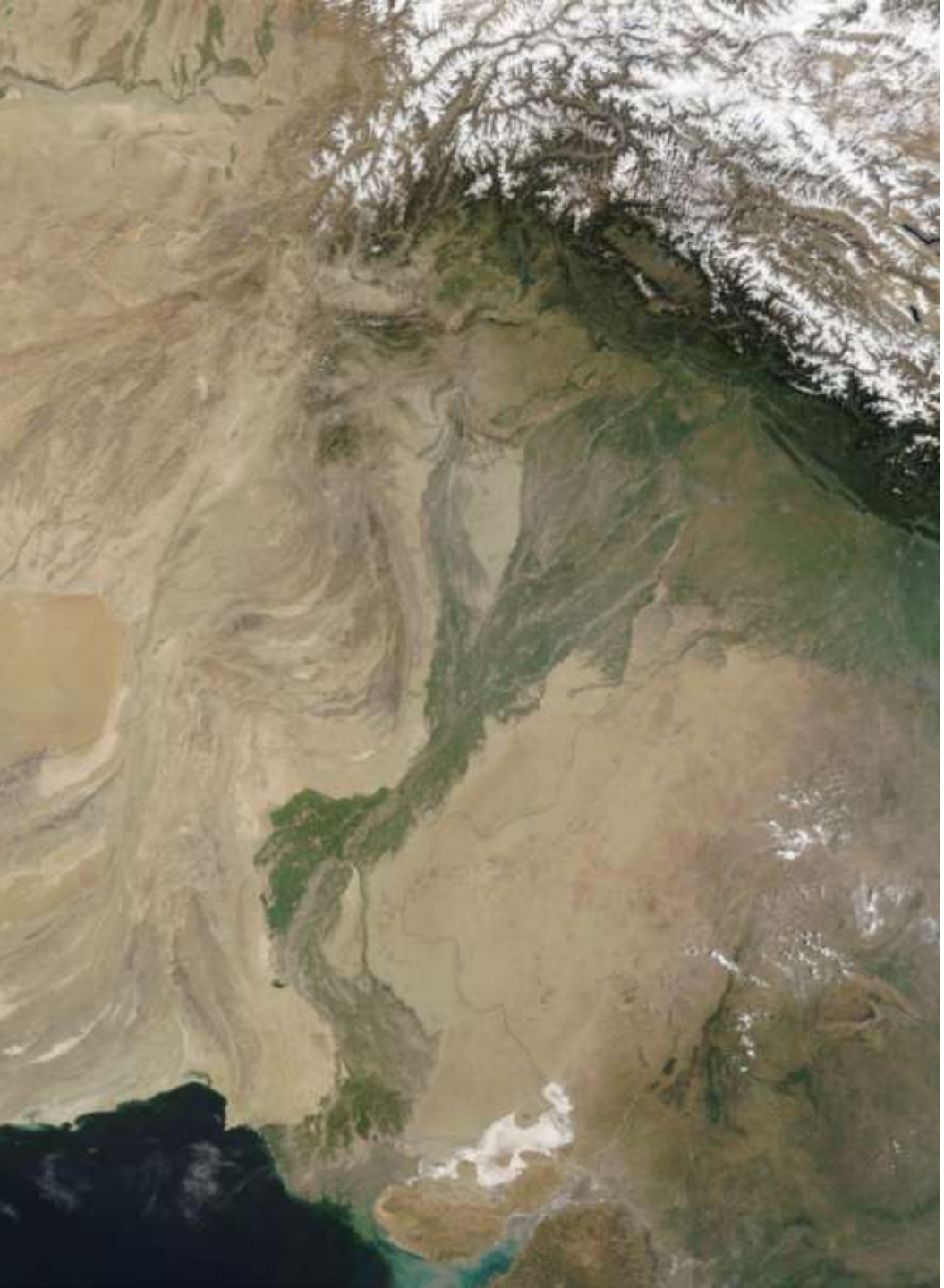
→**Vertical gradients/processes**

(Draft: Winiger, 2011)

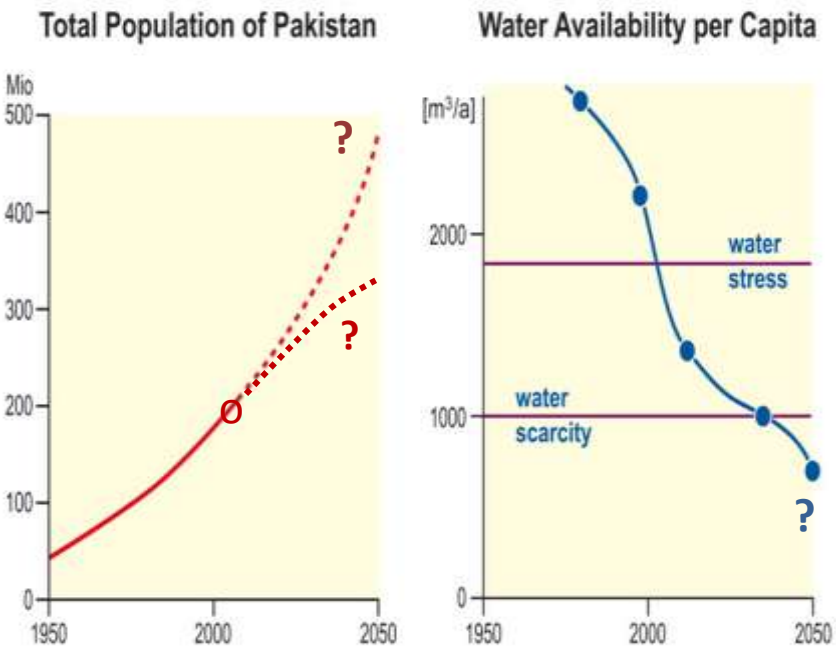
Water-Balance of the Indus Irrigation Scheme (Model)



(Winiger, 2010)



Indus River Basin:
Water scarcity: a frightening perspective



(Winiger, 2010
Data: J. Briscoe, U. Qamar, 2006)