The evolution of salinity and groundwater chemistry in an irrigated semi-desert environment, Faryab, northern Afghanistan

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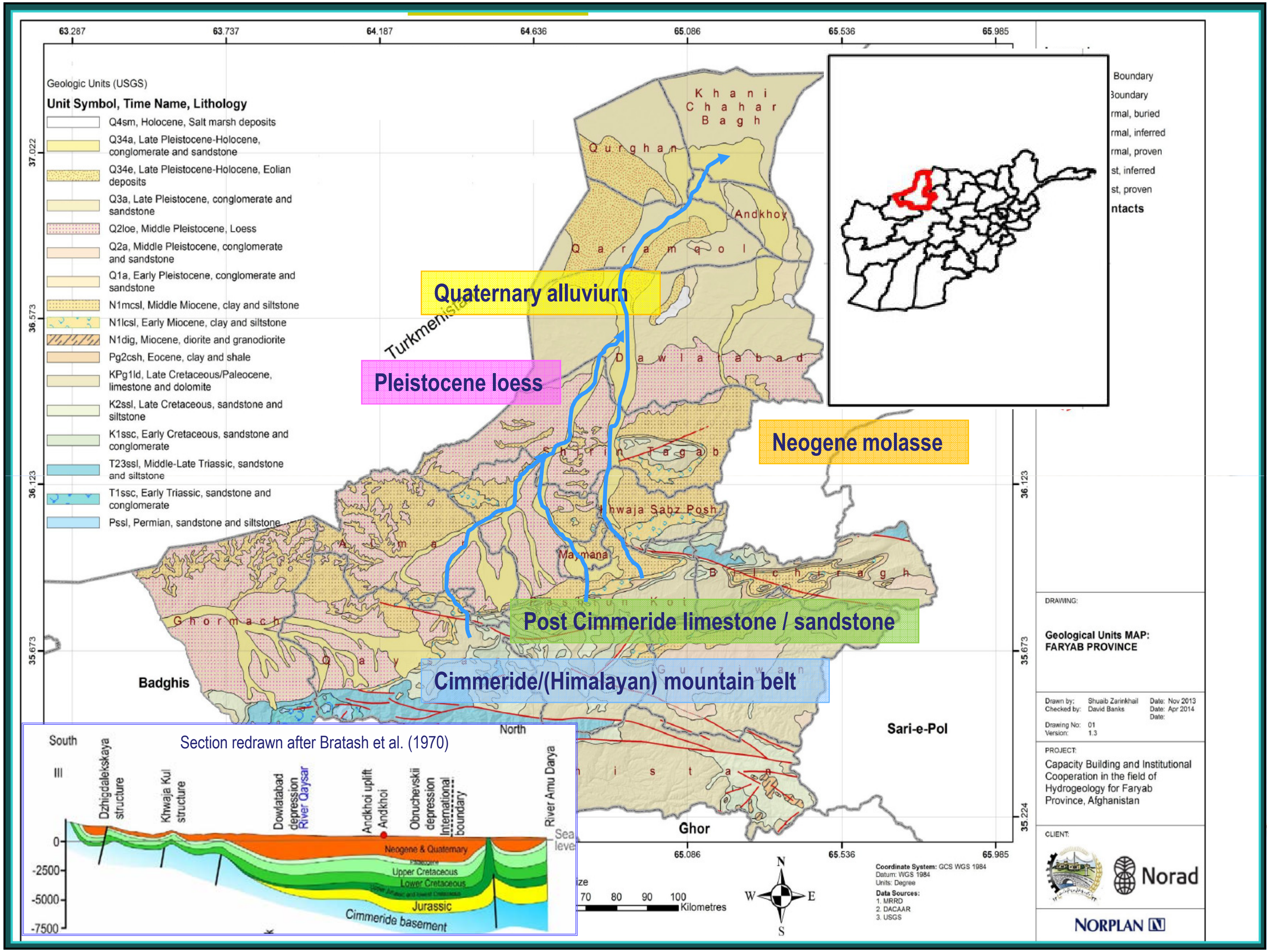
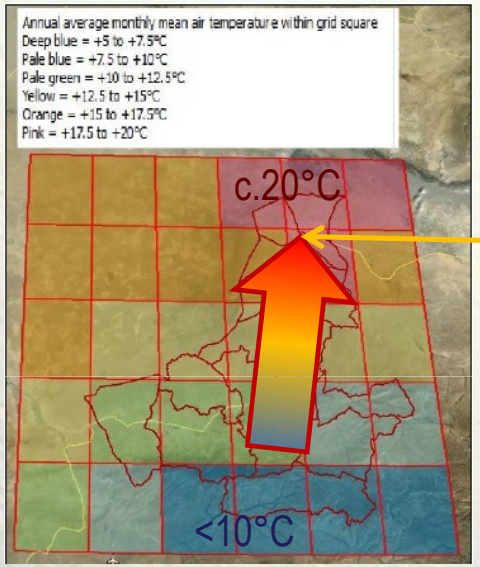
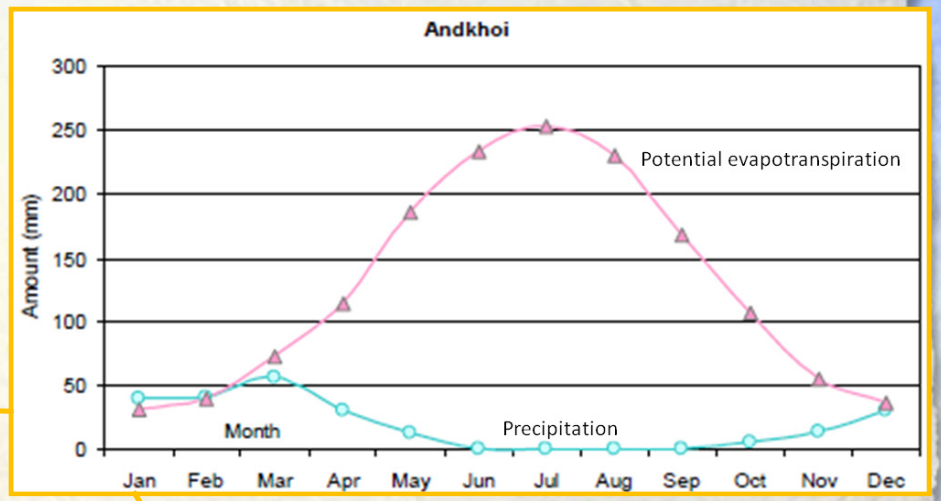
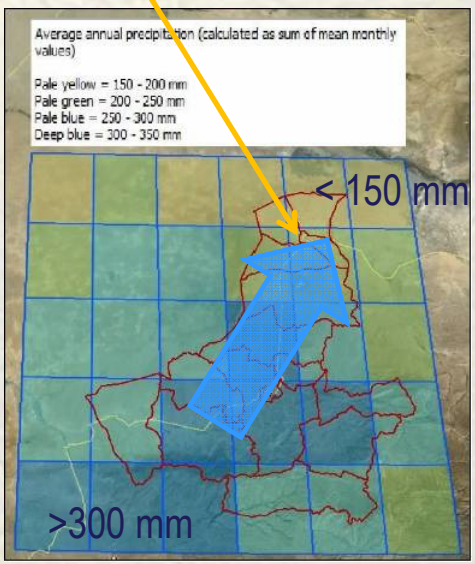

Geologic Units (USGS)
Unit Symbol, Time Name, Lithology
Q4sm, Holocene, Salt marsh deposits
Q34a, Late Pleistocene-Holocene, conglomerate and sandstone
Q34e, Late Pleistocene-Holocene, Eolian deposits
Q3a, Late Pleistocene, conglomerate and sandstone
Q2loe, Middle Pleistocene, Loess
Q2a, Middle Pleistocene, conglomerate and sandstone
Q1a, Early Pleistocene, conglomerate and sandstone
N1mcsl, Middle Miocene, clay and siltstone
N1lcsl, Early Miocene, clay and siltstone
N1dig, Miocene, diorite and granodiorite
Pg2csh, Eocene, clay and shale
KPg1ld, Late Cretaceous/Paleocene, limestone and dolomite
K2ssl, Late Cretaceous, sandstone and siltstone
K1ssc, Early Cretaceous, sandstone and conglomerate
T23ssl, Middle-Late Triassic, sandstone and siltstone
T1ssc, Early Triassic, sandstone and conglomerate
Pssl, Permian, sandstone and siltstone
Quaternary alluvium
Pleistocene loess
Neogene molasse
Post Cimmeride limestone / sandstone
Cimmeride/(Himalayan) mountain belt
Turkmenistan
Khani Chahar Bagh
Qurghan
Andkhoy
Qaramqol
Dawlatabad
Shirin Tagab
Khwaja Sabz Posh
Maymana
Almar
Bilchiragh
Pashtun Kot
Ghormach
Qaisar
Gurziwan
Badghis
Sari-e-Pol
Ghor
Section redrawn after Bratash et al. (1970)
South
North
Dzhigdalekskaya structure
Khwaja Kul structure
Dowlatabad depression
River Qaysar
Andkhoi uplift
Andkhoi
Obruchevskii depression
International boundary
River Amu Darya
Sea level
Neogene & Quaternary
Upper Cretaceous
Lower Cretaceous
Jurassic
Cimmeride basement
0
-2500
-5000
-7500
DRAWING:
Geological Units MAP: FARYAB PROVINCE
Drawn by: Shuaib Zarinkhail Date: Nov 2013
Checked by: David Banks Date: Apr 2014
Drawing No: 01
Version: 1.3
PROJECT:
Capacity Building and Institutional Cooperation in the field of Hydrogeology for Faryab Province, Afghanistan
CLIENT:
Norad
NORPLAN
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Data Sources:
1. MRRD
2. DACAAR
3. USGS
Kilometres
63.287
63.737
64.187
64.636
65.086
65.536
65.985
37.022
36.573
36.123
35.673
35.224

It's a region of strong topographic and climatic gradients from S to N



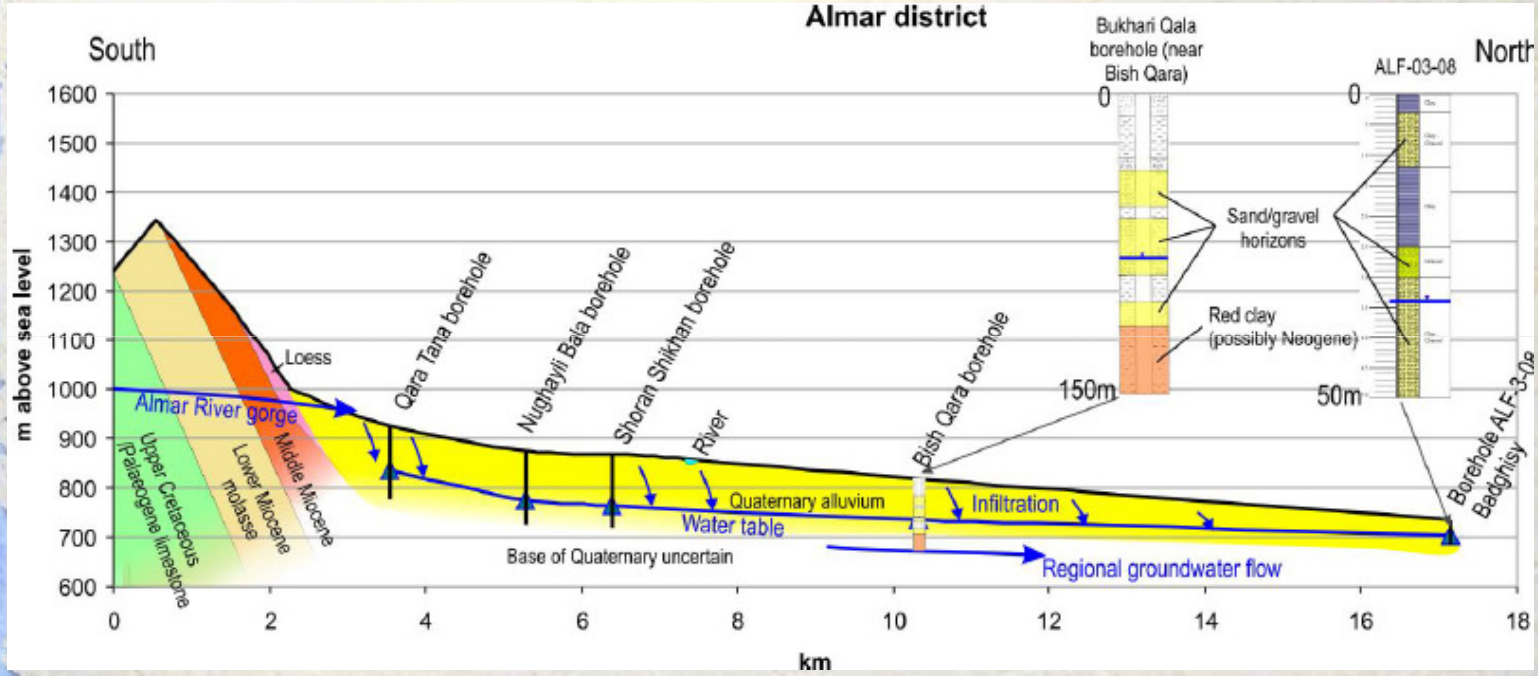
Annual average air temperature





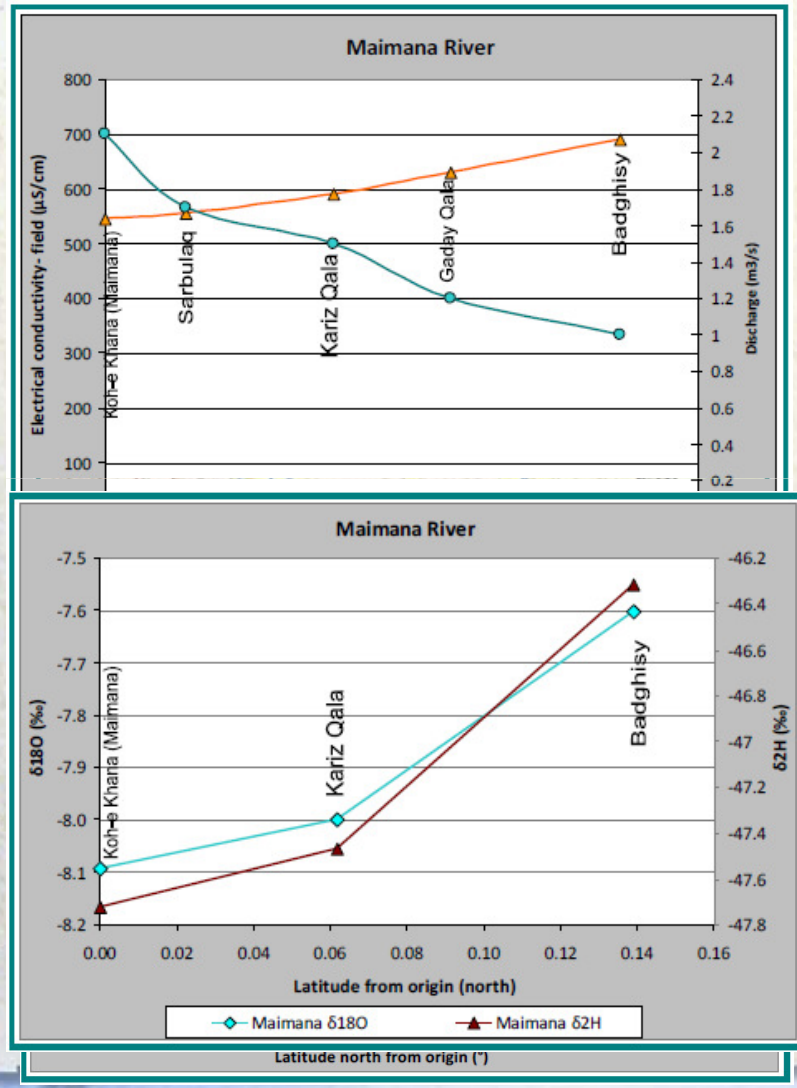
Annual precipitation

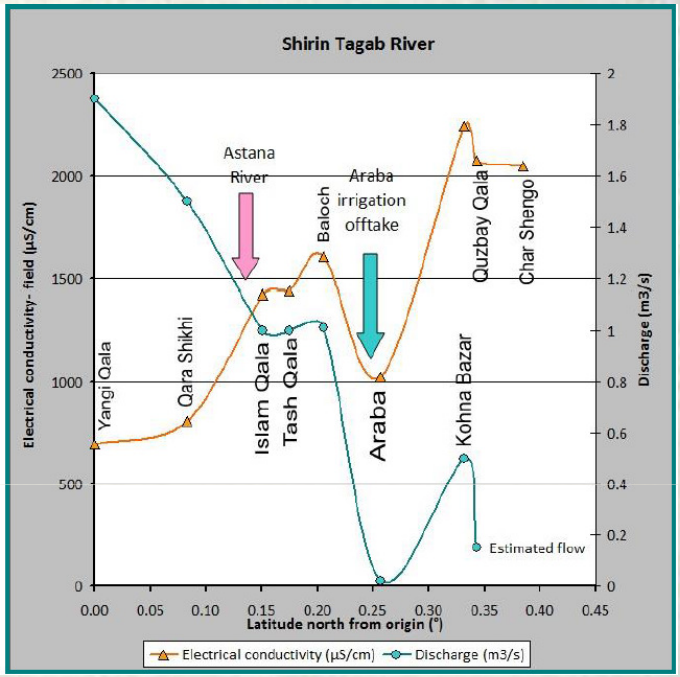
As rivers emerge from mountain areas.....



.....they start to infiltrate into alluvial fan and valley deposits.....

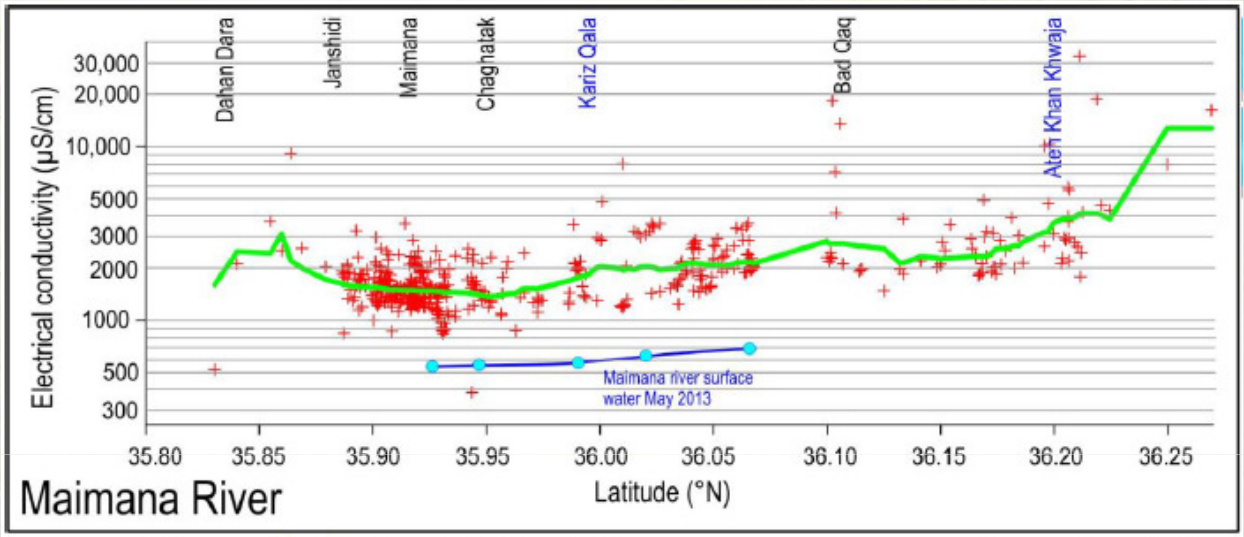
Chemistry and isotopic composition of river flows

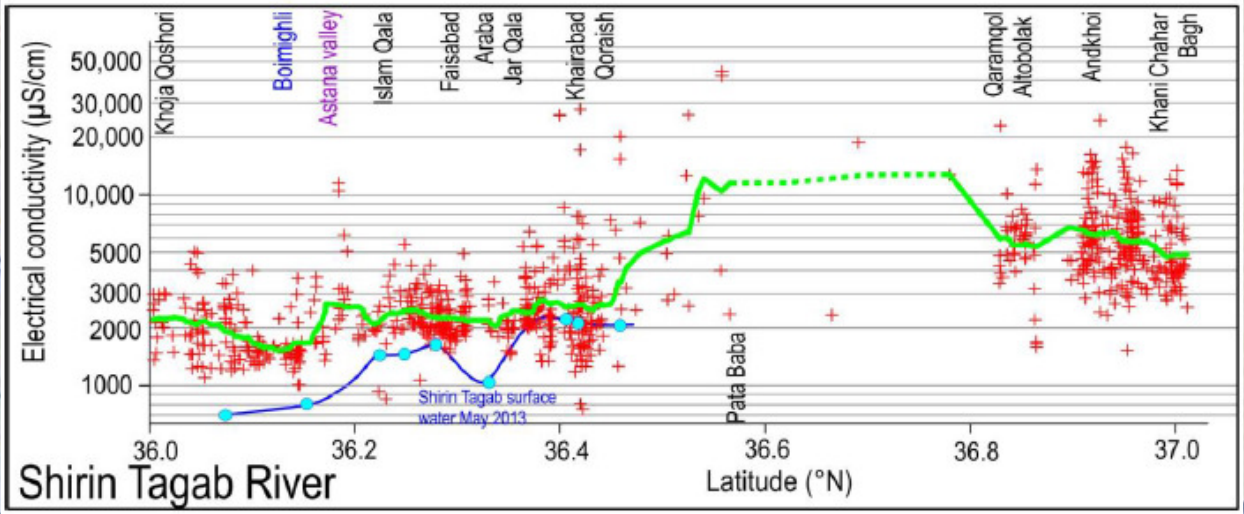




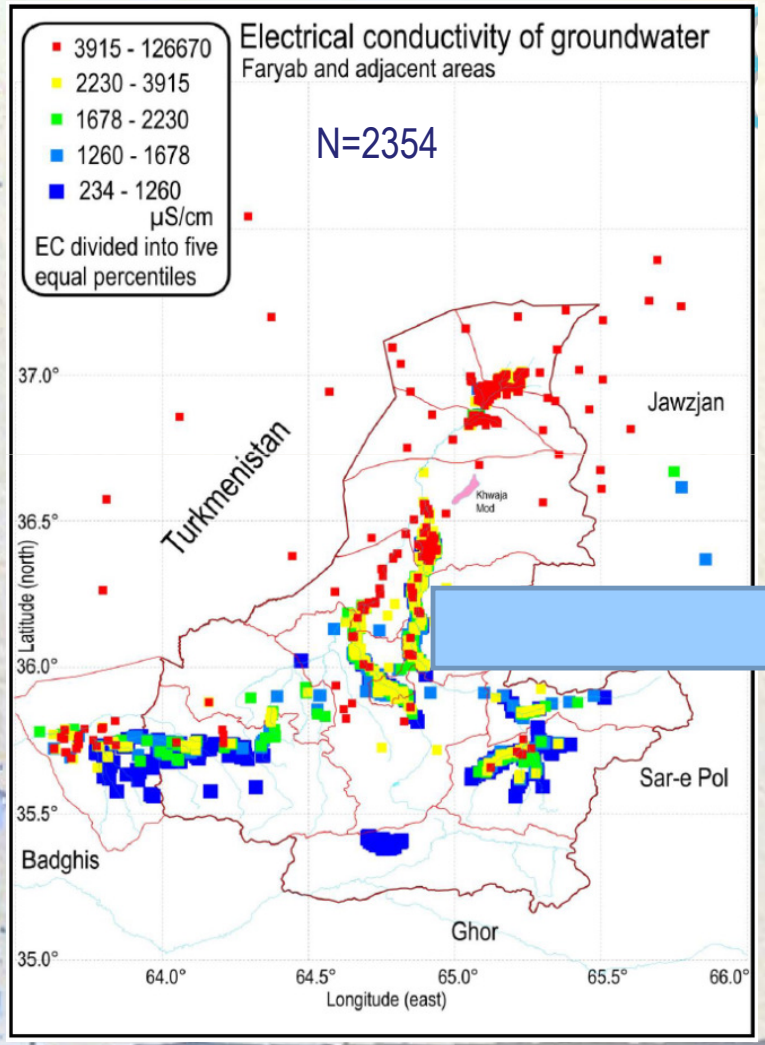
...indicates evapotranspiration is a strong driver of salinity (direct and in irrigated lands)

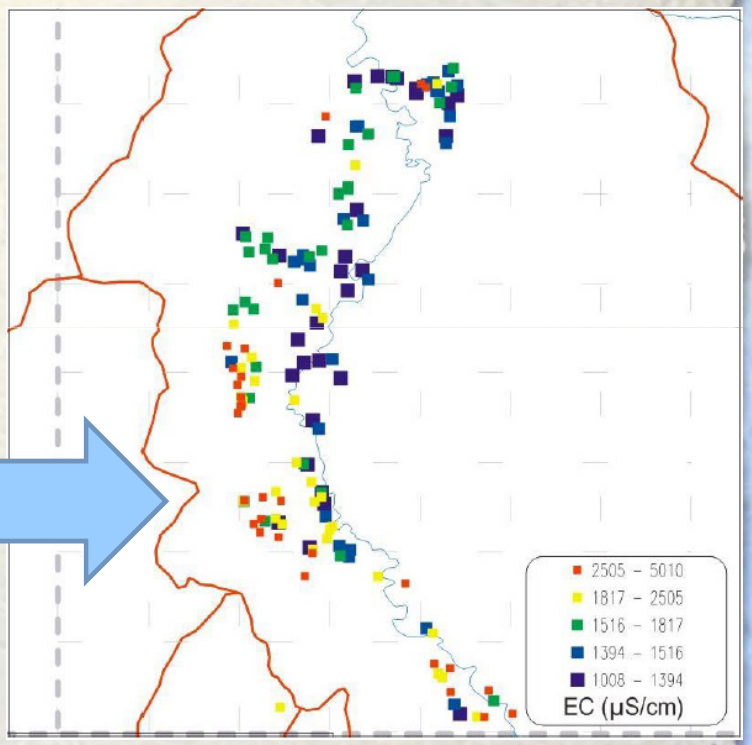
Salinity


Dahan Dara
Janshidi
Maimana
Chaghatak
Kariz Qala
Bad Qaq
Ateh Khan Khwaja
Electrical conductivity (µS/cm)
30,000
20,000
10,000
5000
3000
2000
1000
500
300
Maimana river surface water May 2013
35.80
35.85
35.90
35.95
36.00
36.05
36.10
36.15
36.20
36.25
Latitude (°N)
Maimana River


Khoja Qoshori
Boimighli
Astana valley
Islam Qala
Faisabad
Araba
Jar Qala
Khairabad
Qoraish
Qaramqol
Altobolak
Andkhoi
Khani Chahar Bagh
Pata Baba
Electrical conductivity (µS/cm)
50,000
30,000
20,000
10,000
5000
3000
2000
1000
Shirin Tagab surface water May 2013
36.0
36.2
36.4
36.6
36.8
37.0
Latitude (°N)
Shirin Tagab River

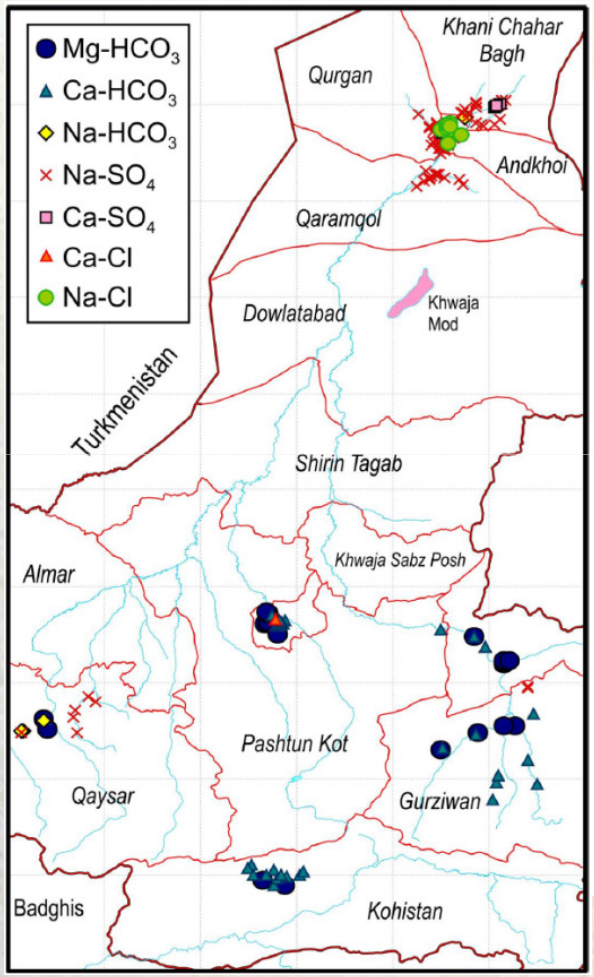
Salinity

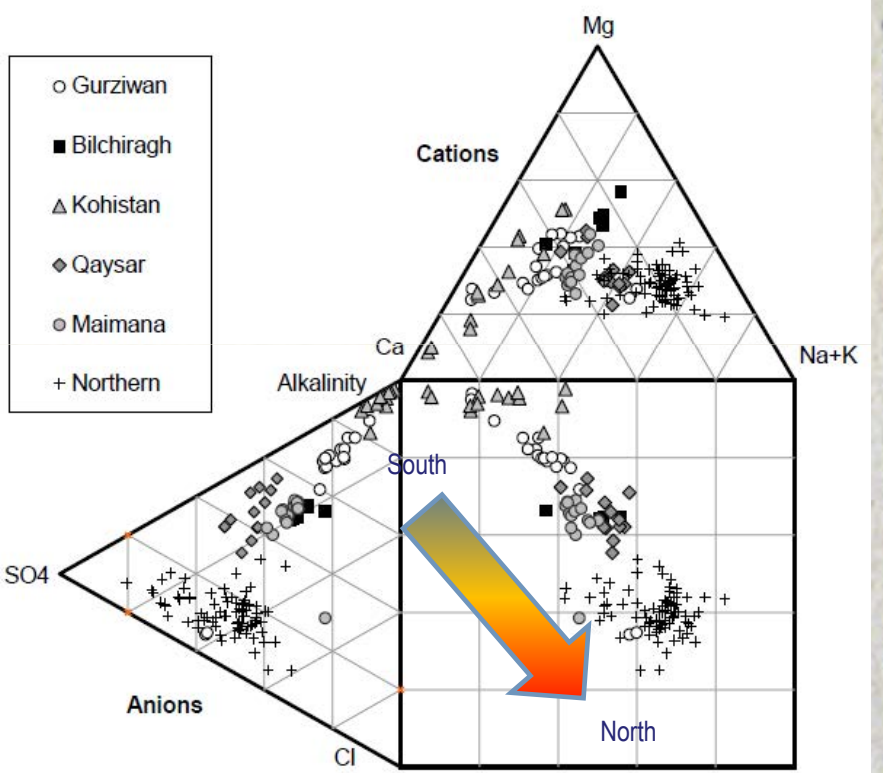




Islam Qala, Shirin Tagab

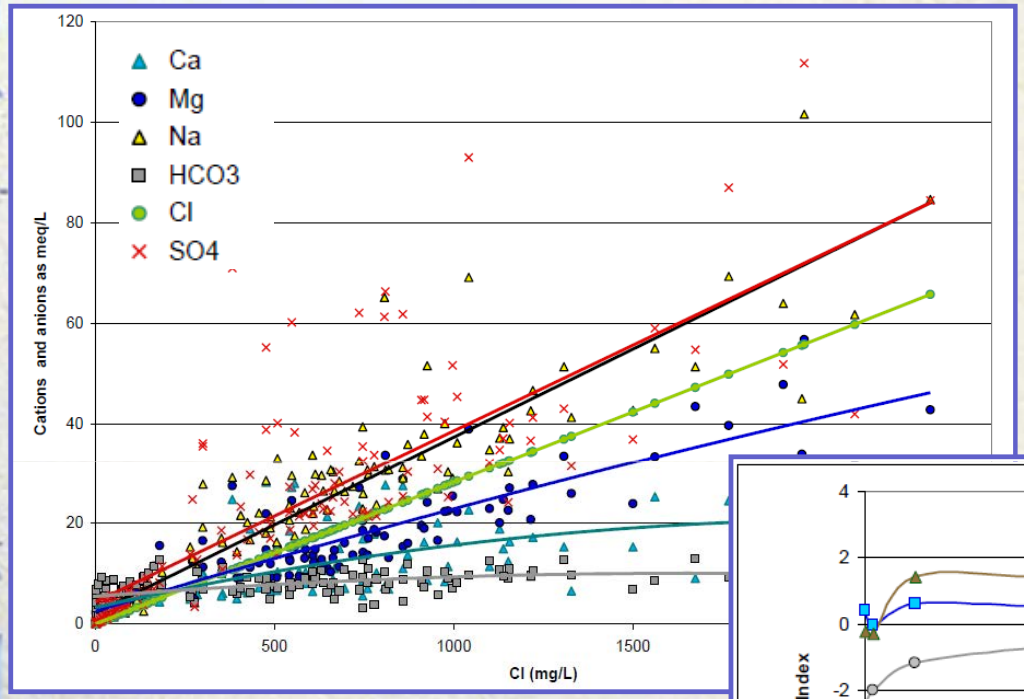
Groundwater chemistry





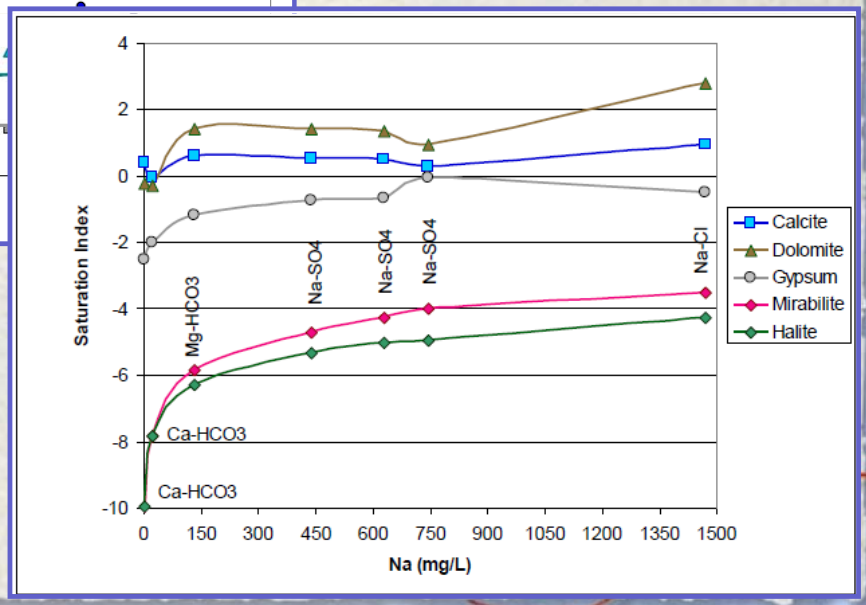
Major ion chemistry (N=148)

Groundwater evolution



Progressive ceilings for

Ca, alkalinity
Mg

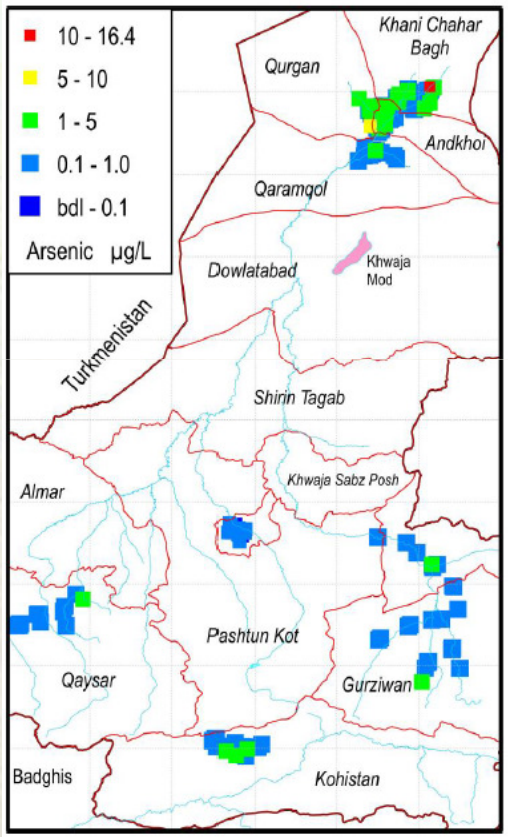


Progressive saturation with respect to

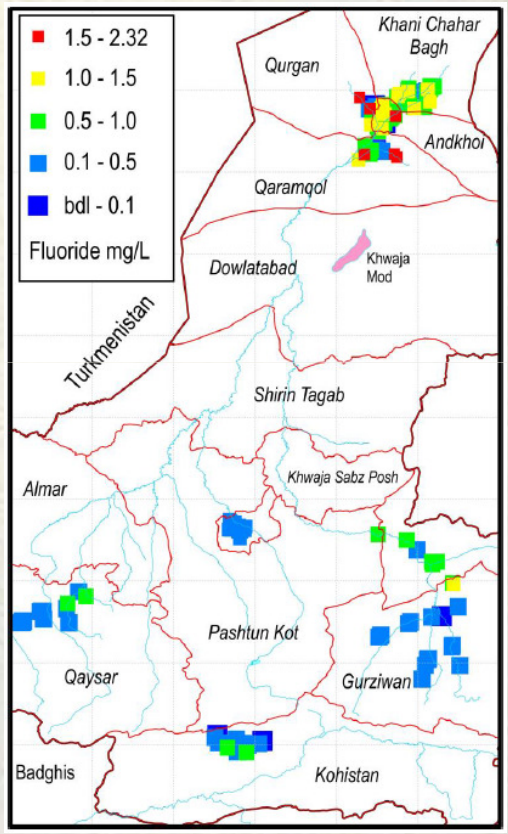
Calcite
Mg minerals (dolomite)
Gypsum

Groundwater chemistry

(N=148)



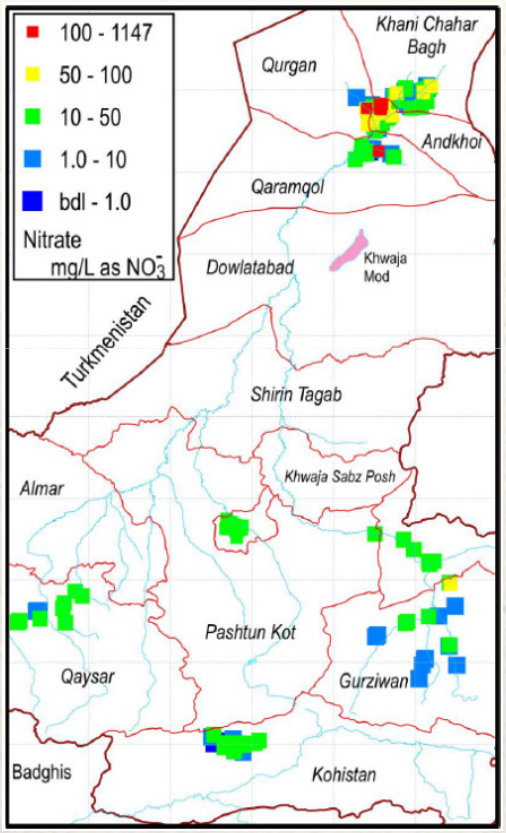
Arsenic
(should be <10 µg/L)



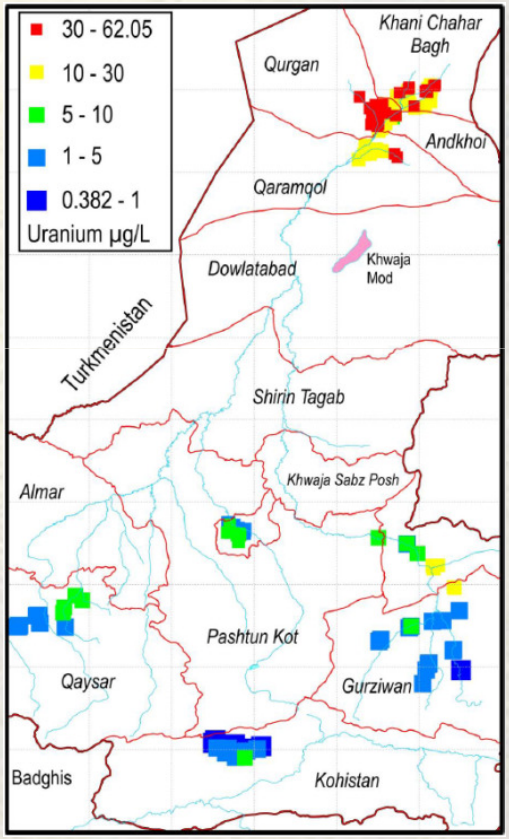
Fluoride
(should be <1.5 mg/L)

Groundwater chemistry

(N=148)



Nitrate
(should be < 50 mg/L)



Uranium
(should be < 30 µg/L)

Stable isotopes

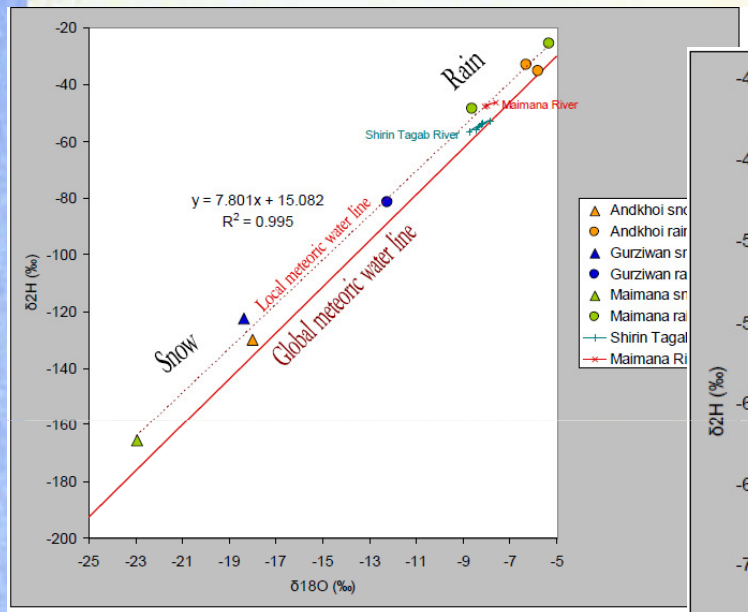


Figure 11.2. Stable isotope diagram comparing the isotopic composition of precipitation samples (from Figure 2.8) with river water samples from May 2013, described in Chapter 3. The GMWL is taken as $\delta^2H = (8.13 \times \delta^{18}O) + 10.8$ (Clark & Fritz 1997). The local meteoric water line is the linear best fit through all precipitation points and is defined by equation (11.2)

Evapotranspiration is a powerful driving factor for groundwater chemistry

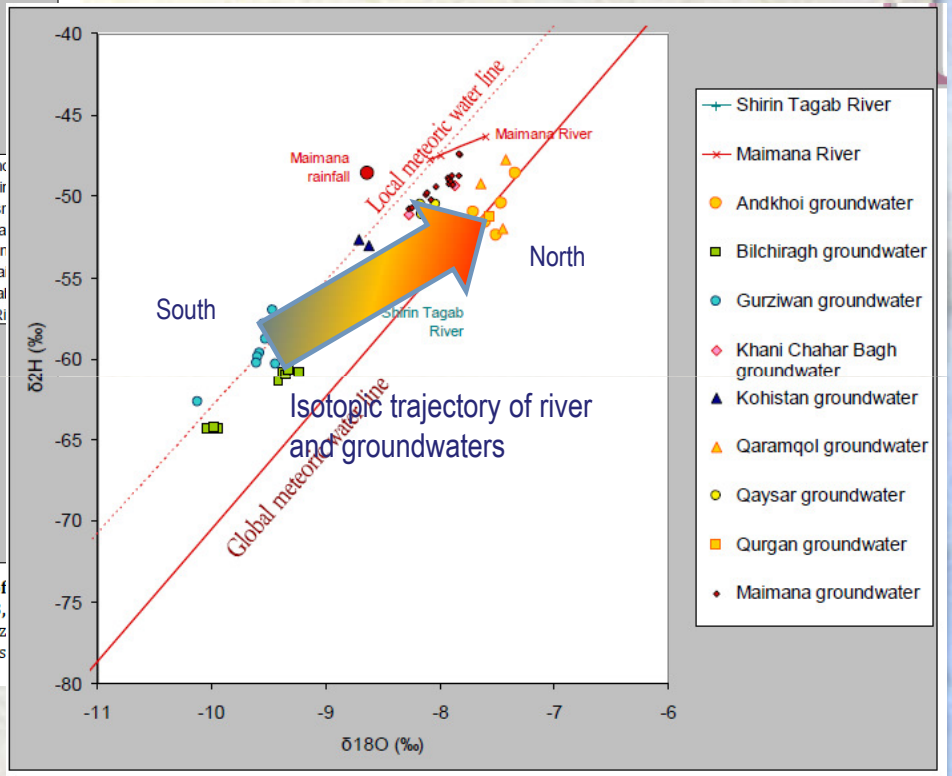
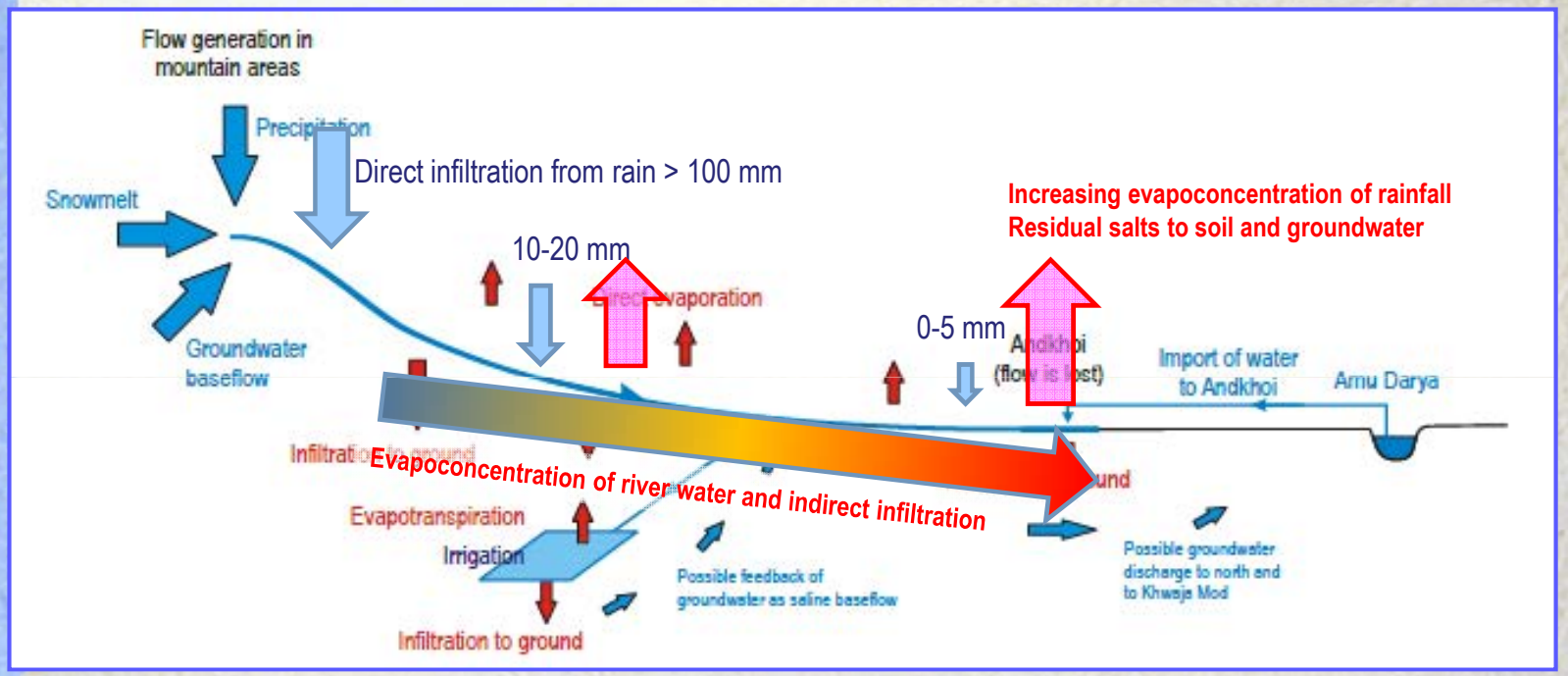


Figure 11.4. Stable isotope diagram comparing the isotopic composition of groundwater samples with river water samples from May 2013 and Maimana rainfall. The GMWL is taken as $\delta^2H = (8.13 \times \delta^{18}O) + 10.8$ (Clark & Fritz 1997). The local meteoric water line is taken from Figure 11.1 and equation 11.2.

Water balance



Direct recharge of precipitation:

Almost 0 mm in northern districts

Around 10-20 mm per year in Maimana / Gurziwan

Maybe > 100-200 mm in Kohistan (mountains in south)