2. Faryab: Location, Topography and Climate

2.1 Location

Faryab Province lies in the north of Afghanistan, with a northern border to the former Soviet republic of Turkmenistan. Faryab is bordered in the west by Badghis Province, to the east by Jawzjan and Sar-e-Pol and to the south by the mountainous province of Ghor (Figure 1.4).

2.2 Topography

At the core of Faryab province lies the Band-e-Turkestan, an east-west ridge of mountains. This is the westernmost spur of the Hindu Kush massif, which is in turn the Afghan portion of the great Himalayan orogenic belt.

The Band-e-Turkestan range is formed by a horst-like inlier of older lithified Permian and Triassic sedimentary rocks penetrating through the surrounding Cretaceous-Palaeogene limestones and clastic sedimentary rocks. Erosion in Miocene times has restricted the elevation of the summits of the Band-e-Turkestan to 3200-3500 m asl (Encyclopaedia Iranica 2013).

The Band-e-Turkestan forms a major watershed, separating the Shirin Tagab catchment to the north from the Murghab catchment to the south.

The terrain to the south of the Band-e-Turkestan (Kohistan district, in Faryab) is largely underlain by Cretaceous-Palaeogene limestones and is relatively elevated, much of it being at an altitude in excess of 1800 m asl. The terrain is deeply incised by the River Murghab and its tributaries, which form deep ravines. Limestone-fed springs are abundant.

To the north of the Band-e-Turkestan, the land falls away to the plains of the Dasht-e Shortepe (the salty desert), which stretch between Faizabad and the Amu Darya. Cretaceous and Palaeogene sedimentary rocks predominate until an elevation below c. 1500 m, below which the topography is dominated by foothills comprised of the erosional deposits from the Himalaya / Hindu Kush mountain building episode - namely Neogene molasse and alluvial fan deposits. These are often overlain by silty Quaternary wind-blown loess and more recent aeolian deposits. The main rivers (e.g. Maimana and Shirin Tagab) have flat valley floors, infilled with recent alluvium, and it is on these that much of the irrigated agriculture takes place.

Below Faizabad (c. 500 m asl) the terrain opens out into the flat semi-desert of Dasht-e Shortepe which is formed by Quaternary alluvial and wind-blown deposits. The terrain continues to fall gently northwards past Andkhoi (c. 310 m asl) and the Turkmenistan Border at Kolodets Imam Nazar (260 m asl), towards the Zeid depression (240 m asl, now occupied by a large Turkmen reservoir) and the River Amu Darya itself at c. 245 m asl.

2.3 Climate: Temperature, Sunshine and Humidity

According to historic maps published by AIMS[1], many of which are reproduced in Favre & Kamal (2004), Faryab experiences between 2600 and 3000 sunshine hours per year, inversely depending on altitude.

[1] Afghan Information Management Services - http://www.aims.org.af/

The average temperature of the hottest month varies from >30°C in the northern semi-desert to <15°C in the Bund-e-Turkestan mountains.

The average temperature of the coldest month varies from <5°C in the northern semi-desert to below 0°C just south of Maimana and <-10°C in the Bund-e-Turkestan mountains. Figure 2.1 indicates that the average temperature in Maimana varies from around 2°C in January to over 27°C in July, with a long term average of 14.7°C (Favre & Kamal 2004 cite an annual average temperature of 14.4°C).

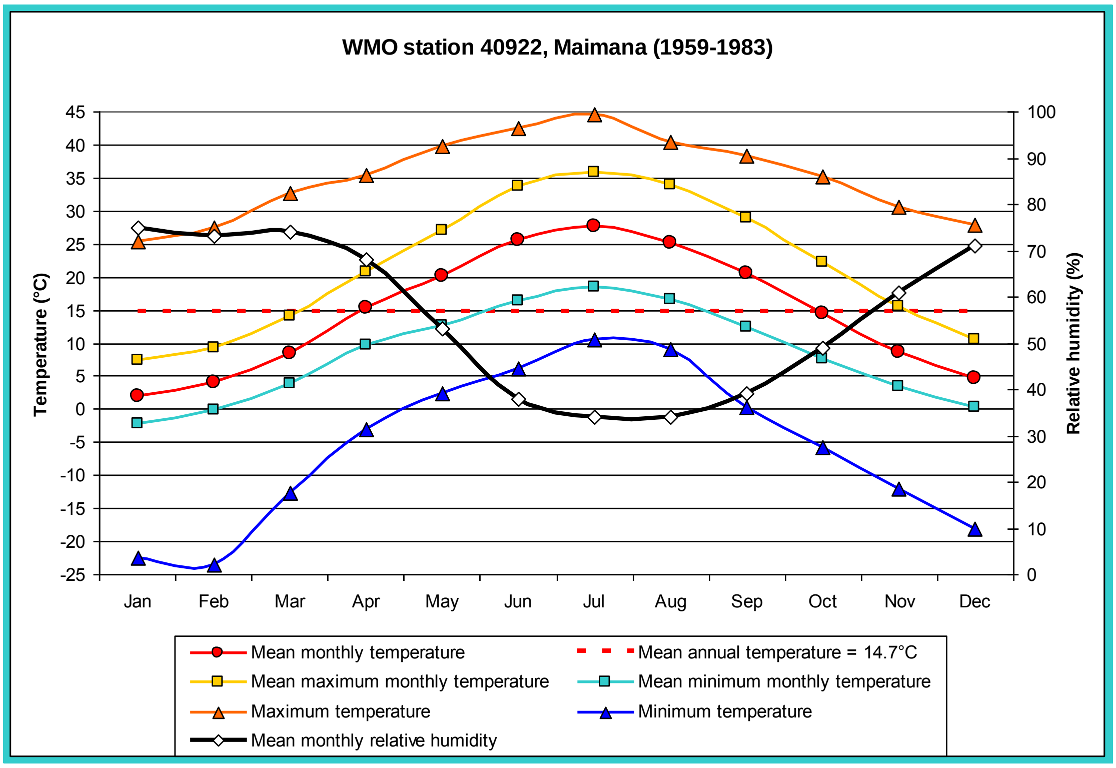


Figure 2.1. Long term dry-bulb air temperature data for WMO meteorological station Maimana (station 40922) in period 1959-83 (minimum temperature and relative humidity based on 1964-1983. Data derived from the NOAA website: ftp://ftp.atdd.noaa.gov/pub/GCOS/WMO-Normals/RA-II/AH/40922.TXT

Arguably, the best regional sources of meteorological data for temperature are found at the NOAA website http://www.esrl.noaa.gov/psd/data/gridded/data.ghcncams.html. For air temperature, the following file has been used to calculate (Figure 2.2) long-term gridded monthly means, based on data from 1981-2010, on a 0.5 degree latitude x 0.5 degree longitude global grid (360x720):

- ftp://ftp.cdc.noaa.gov/Datasets/ghcncams/Derived/air.mon.1981-2010.ltm.nc.

These data are derived from the GHCN_CAMS Gridded 2m Temperature (Land) data set (Fan & Van den Dool 2008). Figure 2.3 compares the temperatures recorded at Maimana, with those in the calculated grid squares containing Andkhoi and mountainous Kohistan regions.

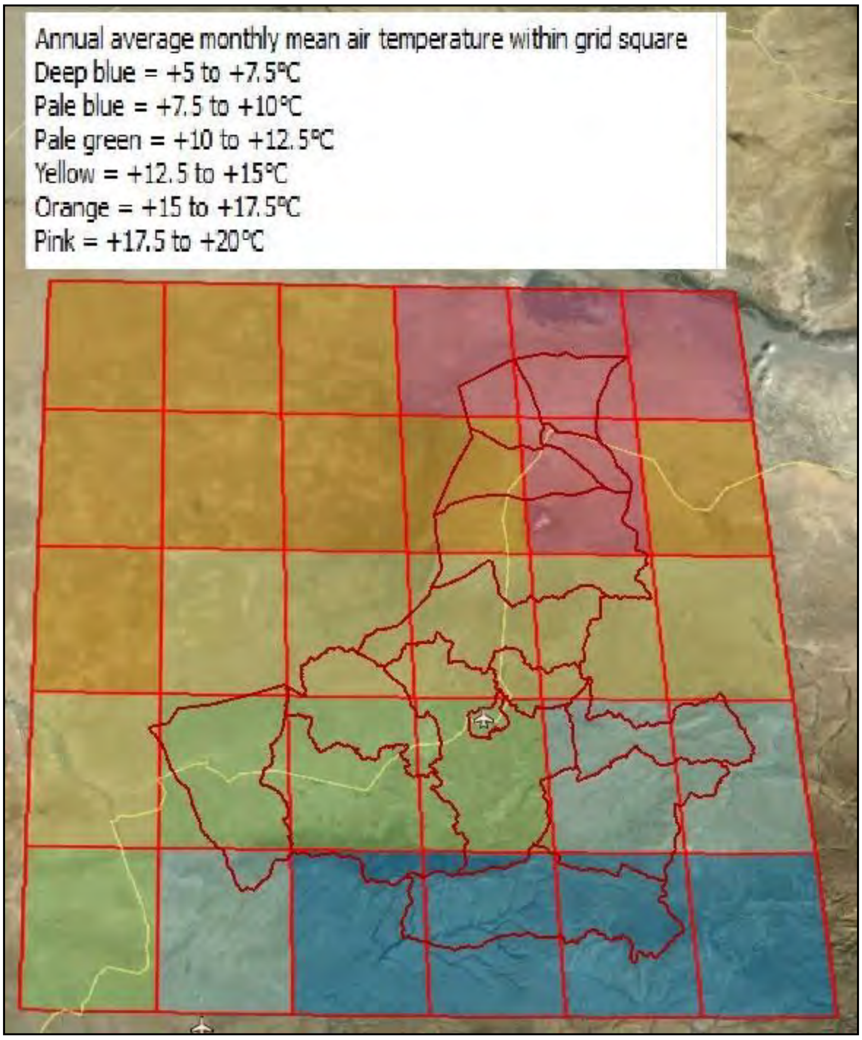


Figure 2.2. Annual average monthly mean air temperature for Faryab within 0.5° grid squares, based on 1981-2010 data, after Fan & Van den Dool (2008).

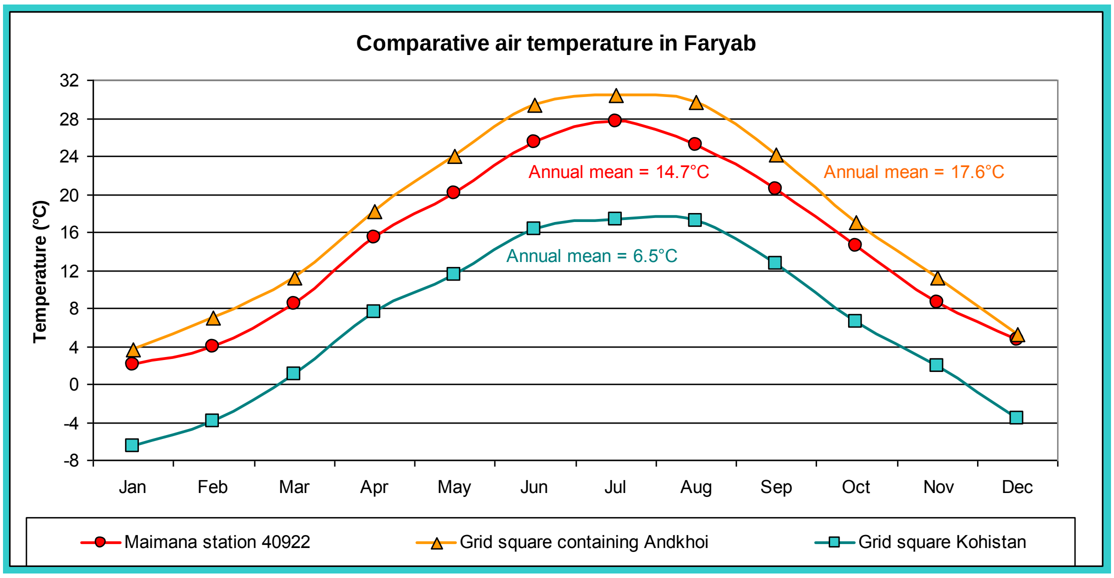


Figure 2.3. Long term annual mean air temperatures at Maimana (WMO station 40922) and in the grid squares containing Andkhoi and western Kohistan (from the NOAA dataset described in Fan & Van den Dool 2008).

2.4 Climate: Precipitation and Evaporation

According to historic maps published by AIMS, many of which are reproduced in Favre & Kamal (2004), average precipitation in Faryab ranges from 600-800 mm/a in the mountains, down to <300 mm/a in the semi-deserts of the north of the province (and even around 200 mm in the extreme north of the Province) - see also Figure 2.7.

Figure 2.4 shows that the bulk of precipitation in Faryab falls between November and May, with very little occurring between June and September.

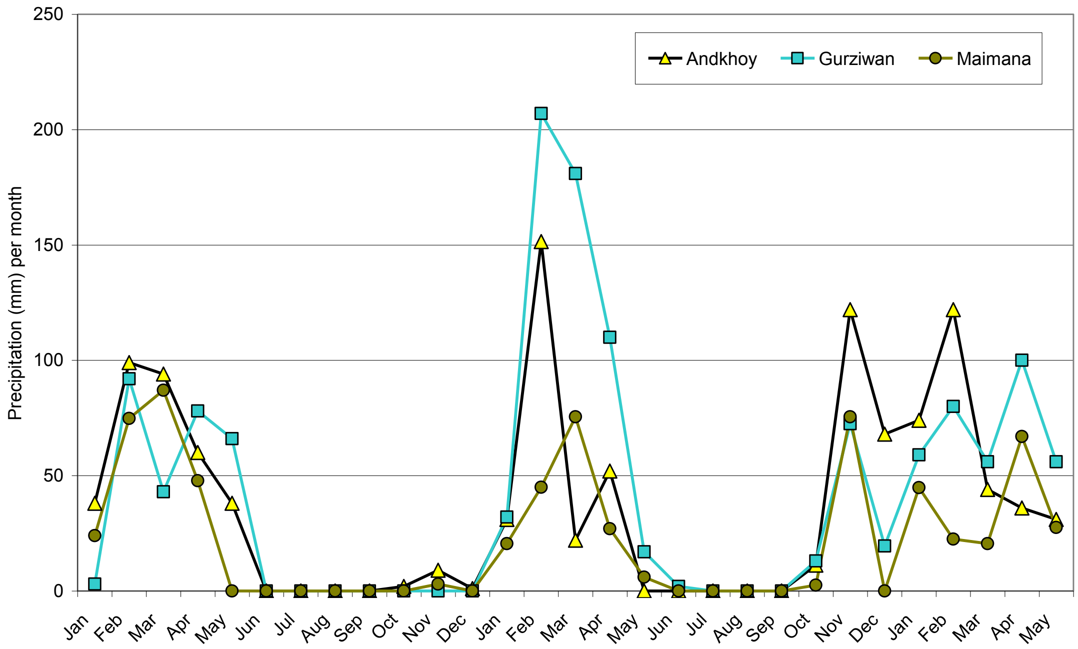


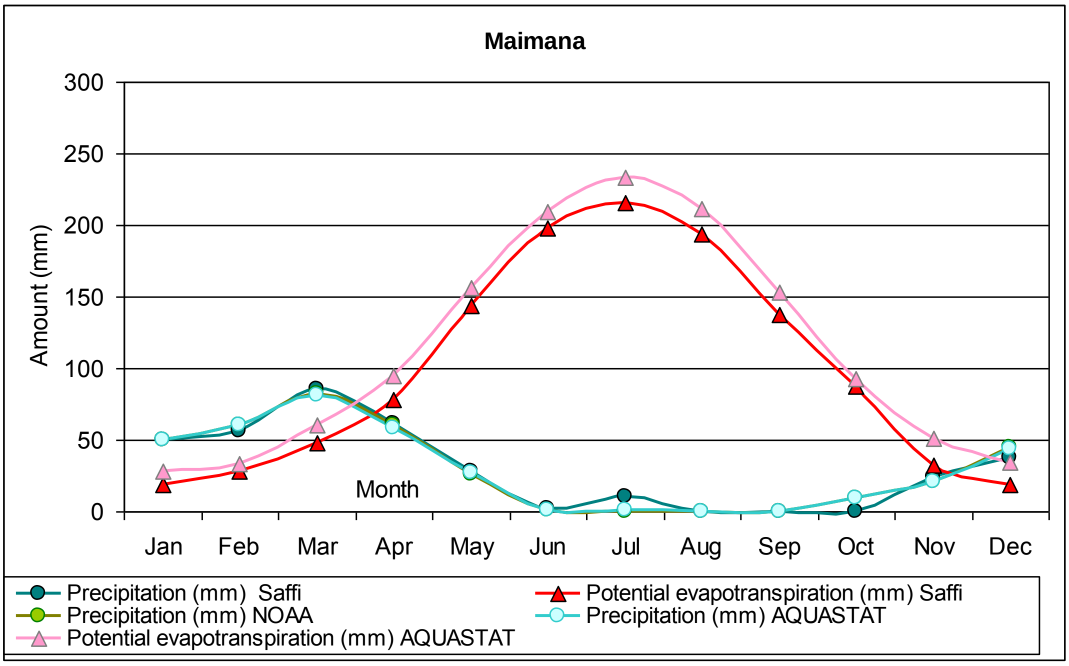
Figure 2.4. Monthly precipitation measured at Agromet stations in Maimana, Gurziwan and Andkhoi from January 2010 to May 2012, provided by the Afghan Ministry of Agriculture, Irrigation and Livestock (MAIL).

Station	Mazar-e-Sharif	Maimana	Lal-o-Sarjangal
Annual average precipitation	189 mm/a	354 mm/a	227 mm/a
Annual average potential evapotranspiration	1376 mm/a	1202 mm/a	695 mm/a
Average daily potential evapotranspiration in coolest month (December or January)	0.6 mm/d	0.6 mm/d	0.2 mm/d
Average daily potential evapotranspiration in hottest month (July)	8.5 mm/d	7.2 mm/d	4.3 mm/d

Table 2.1. Comparison of long-term precipitation and potential evapotranspiration data for Maimana with a semi-desert location (Mazar-e-Sharif) and a highland location (Lal-o-Sarjangal) - after Favre & Kamal (2004).

Figure 2.5 compares the precipitation and potential evapotranspiration in Maimana, with that at Andkhoi. It will be noted that, throughout Faryab, potential evapotranspiration greatly exceeds precipitation on an annual basis. In Maimana, precipitation typically only exceeds potential evapotranspiration in the window December to March. In Andkhoi, excess precipitation only marginally occurs in January, implying that opportunities for infiltration of excess rainfall as groundwater recharge will be very limited in the north of the Province.

The Watershed Atlas of Favre & Kamal (2004) indicates that the "normal" annual precipitation at Maimana is 354 mm, with a range from 200 mm to 582 mm. The annual average potential evapotranspiration is cited as a massive 1202 mm/a (equivalent to 3.34 mm/d), with monthly means ranging from 0.6 to 7.2 mm/d. Table 2.1 compares these data with Mazar-e-Sharif (which would not be dissimilar to Andkhoi) and Lal-o-Sarjangal in Ghor Province (not dissimilar to the mountainous portions of Faryab).



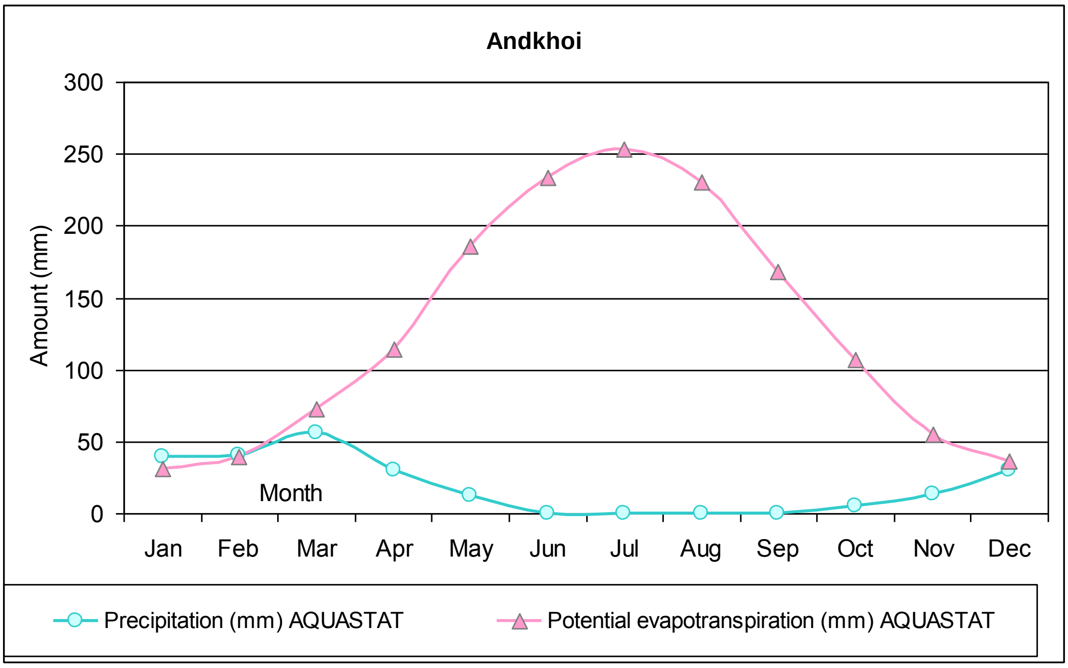


Figure 2.5. Monthly mean precipitation and evapotranspiration data for Maimana and Andkhoi. The data marked *Saffi* are long-term averages (annual mean total precipitation - 354 mm and potential evapotranspiration 1202 mm) from the Maimana meteorological station (1958-1978) cited by Hassan Saffi (2010a,b). *AQUASTAT* refers to data from the FAO Aquastat tool at http://www.fao.org/nr/water/aquastat/gis/index3.stm. *NOAA* refers to long-term averages (annual mean total precipitation - 356 mm) from the WMO station 40922 (1964-83) at Maimana, from ftp://ftp.atdd.noaa.gov/pub/GCOS/WMO-Normals/RA-II/AH/40922.TXT. The *AQUASTAT* and *NOAA* data are almost identical.

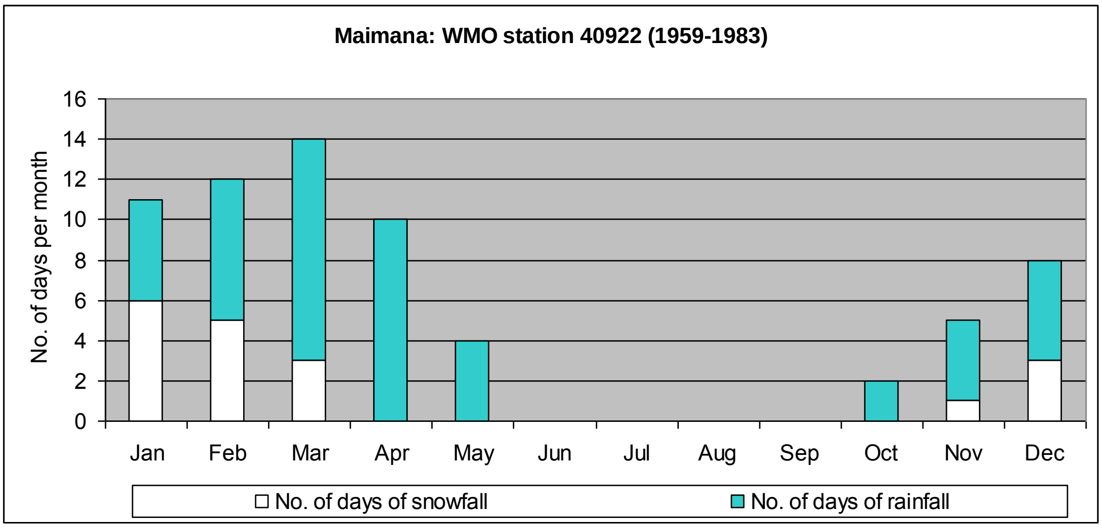


Figure 2.6. Average number of days of snowfall and rainfall recorded at WMO station 40922 Maimana for the period 1959-1983, according to data download from ftp://ftp.atdd.noaa.gov/pub/GCOS/WMO-Normals/RA-II/AH/40922.TXT

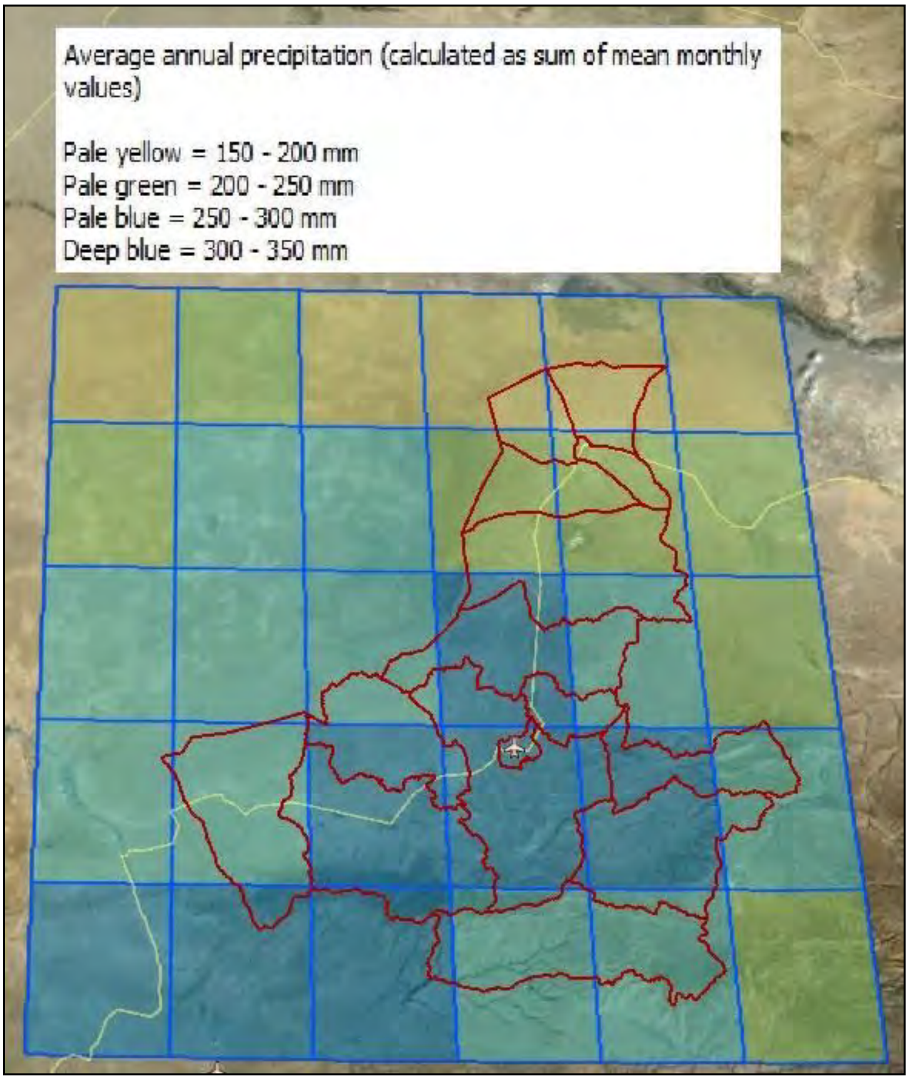


Figure 2.7. Average annual precipitation within 0.5° grid squares, based on 1981-2010 data, after Schneider et al. (2011).

Arguably, the best regional sources of meteorological data for precipitation are found at the NOAA website http://www.esrl.noaa.gov/psd/data/gridded/data.gpcc.html. For precipitation, the following file has been used to calculate long-term gridded (Figure 2.7) monthly means, based on data from 1981-2010, on a 0.5 degree latitude x 0.5 degree longitude global grid (180x720)

- ftp://ftp.cdc.noaa.gov/Datasets/gpcc/full_v6/precip.mon.1981-2010.ltm.v6.nc.

These data are derived from the GPCC Global Precipitation Climatology Centre data set (Schneider et al. 2011).

2.5 Chemical and Isotopic composition of precipitation

During winter 2012 and spring 2013, samples of rainfall and snowfall were collected at the premises of the Agricultural Departments in Maimana, Andkhoi and Gurziwan (near Jar Qala). These were couriered to the United Kingdom and analysed at the laboratories of the British Geological Survey (BGS) at Keyworth for a wide range of elements by ICP-MS techniques, anions by ion chromatography and stable O and H isotopes by mass spectrometry at the NERC isotope facility at Keyworth. The results are shown in Table 2.2.

It should be noted that, to avoid risk of contamination, the samples were *not* filtered in the field and might thus possibly contain traces of dust or other airborne materials. This effect could have resulted in elevated concentrations in, for example, the snow sample from Andkhoi.

In general, however, the samples have chloride concentrations of 1-2 mg/L at Andkhoi, 0.1 to 1.7 mg/L at Maimana and c. 0.6 mg/L at Gurziwan. The high concentrations at Andkhoi may reflect entrainment of saline windblown particles or even evapo-concentration of salts during residence in the atmosphere. Precipitation in European maritime climates (e.g. Norway and the UK) is usually dominated by marine salts (e.g. NaCl) and atmospheric industrial contaminants (sulphate, nitrate from so-called "acid rain"). The precipitation in Faryab is characterised, however, by calcium as the dominant cation. Sulphate is usually the dominant anion, followed by chloride and nitrate. Thus may reflect a greater contribution from wind-blown dust (containing calcite and gypsum, and possibly halite) than marine/anthropogenic salts. Sodium is similar to (or slightly in excess of) chloride in most of the analyses, suggesting a derivation from halite in wind-blown dust, or possibly from distal marine salts.

As regards isotopic composition, the snowfall signatures are by far the isotopically lightest, with the signatures becoming "heavier" throughout spring. The heaviest isotopic rainfall signatures typically come from Andkhoi, as one would expect, due to Andkhoi's warmer, low-elevation location, furthest from the ocean. Please refer to Chapter 11 for further discussion of stable isotopes.

Of Etymological Interest

The Faryab District of ***Kohistan*** means *mountainous land*.

Safed Koh means *White Mountains*, while ***Band-e-Turkestan*** refers to this range forming the *boundary wall to Turkestan*.

Dasht-e Shortepe: the ***dasht*** refers to a desert, while ***tepe*** probably derives from a Turkic word for hill, and ***shor*** means salty. Thus, *desert of salty hills* might be a rough translation.

Badghis means *Home of the wind.*

Table 2.2. Chemical and isotopic (VSMOW2) composition of rainfall sampled in Faryab in Winter 2012-13 and Spring 2013.

NORPLAN sample no. BGS sample number	Location Elevation	Type Date	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Sr µg/L	B µg/L	Cl^- mg/L	SO_4^{2-} mg/L	NO_3^- mg/L	$\delta^{18}O$ ‰	δ^2H ‰
Method			Inductively coupled plasma mass spectrometry						Ion chromatography			Mass spectrometry	
NOR-AND-SNW-03 13131-0003	Andkhoi c. 293 m asl	Snow 28/12/12	19.3	2.43	11.3	6.5	231	16	15.6	25.1	16.4	-18.01	-129.8
NOR-AND-RAIN-01 13131-0022	Andkhoi c. 293 m asl	Rain 15/3/13	15.0	1.38	2.5	0.62	57	12	2.0	6.9	6.8	-5.82	-35.3
NOR-AND-RAIN-02 13131-0023	Andkhoi c. 293 m asl	Rain 1/4/13	3.7	0.58	2.0	0.41	33	<10	1.4	3.9	1.0	-6.32	-32.9
NOR-GW-SNW-01 13088-0002	Gurziwan (Jar Qala) c. 1390 m asl	Snow 28/12/12	2.9	0.27	0.5	0.63	13	<10	0.60	0.75	0.38	-18.4	-122
NOR-GW-RAIN-01 13131-0001	Gurziwan (Jar Qala) c. 1390 m asl	Rain 26/2/13	5.3	0.33	0.5	0.78	19	<10	0.56	0.88	0.49	-12.24	-81.3
NOR-MAY-SNW-01 13088-0001	Maimana c. 847 m asl	Snow 28/12/12	5.2	0.14	<0.2	0.08	17	<10	0.10	0.58	0.46	-23.0	-165
NOR-MAY-RAIN-01 13131-0002	Maimana c. 847 m asl	Rain 26/2/13	2.5	0.18	0.5	0.42	13	<10	0.48	3.2	1.7	-8.64	-48.6
NOR-MAY-RAIN-02 13131-0021	Maimana c. 847 m asl	Rain 1/4/13	2.5	0.72	2.1	0.25	46	11	1.7	2.5	0.64	-5.32	-25.6

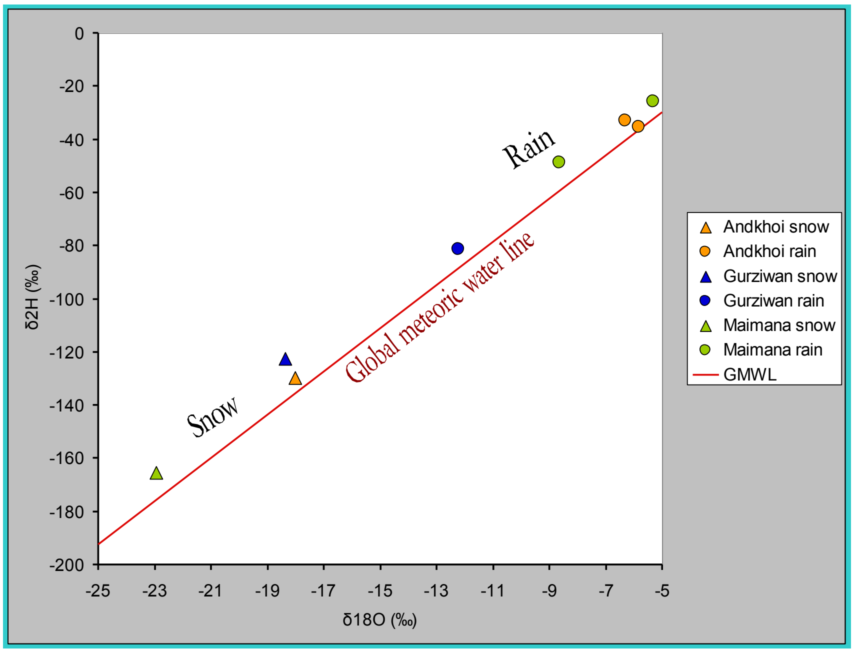


Figure 2.8. Stable isotope diagram comparing the isotopic composition of precipitation samples from Table 2.2. The Global Meteoric Water Line (GMWL) is taken as $\delta^2H = (8.13 \times \delta^{18}O) + 10.8$ (Clark & Fritz 1997).

Figure 2.9. Typical topography of the northern plains area around Andkhoi. Photo by DACAAR, 3rd April 2013.

Figure 2.10. Typical topography of the piedmont area of Qaysar district. Photo by DACAAR, 6th March 2013.

Figure 2.11. Typical topography of the mountain area of Kohistan district. Photo by DACAAR, 23rd May 2013.