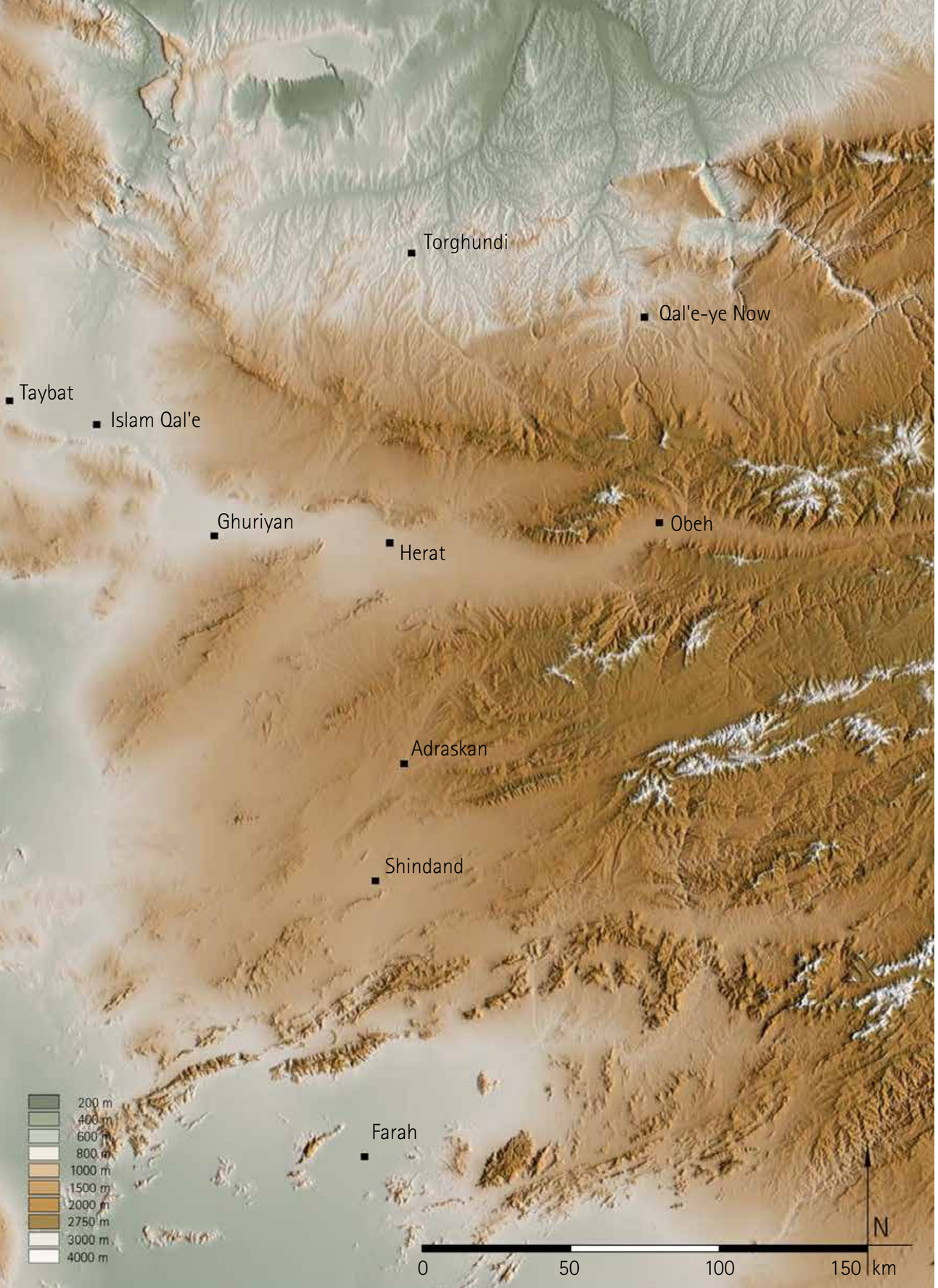

Environmental Characteristics of Herat and Its Surroundings

Daniel Knitter

The city of Herat, capital of the eponymous province in northwestern Afghanistan, is situated in the oasis of the Hari Rud River on a flood-safe terrace, approximately five kilometres north of the river.[1] The Hari Rud originates in the mountain range of the Hindukush, thence continues to flow westward, passes Herat and turns north before reaching the Afghan-Iranian border, where it finally drains in the endorheic region of the Karakum Desert or the Aral-Caspian depression.[2] Since prehistoric times the city of Herat has been a central place in the region, owing its outstanding position to its favourable location rather than to the ecological potential of the oasis.[3]

In the north, the area is lined by the foothills of the ancient Paropamisus, which is the western extension of the Hindukush with altitudes of more than 3,000 m (Title image). It connects the region with the mountain ranges of Central Iran.[4] South of this mountain range are the extensions of the Central Afghan highlands, whose diverse south and southwest stretching mountain ranges gradually slip under the plains of southern and western Afghanistan. The main geological feature of the region is a tectonic fault line, which intersects the whole region of northern Afghanistan over a length of 1,100 km, thereby separating the foothills of the ancient Paropamisus and central Afghanistan from each other. The fault starts 30 km east of the Iranian border and continues thenceforth to the east, passing the city of Herat, which lent its name to the Herat Fault, at a distance of 7 km.[5] The course of the Hari Rud traces the deep fault-line, which separates the major tectonic units of northern and southern Afghanistan. These units represent independent geological structures that, up to the Cenozoic period[6], belonged to separate palaeo-geographical spheres.[7] The elongated east-west-oriented tectonic units of the Band-e Bayan and the Herat Block separate the Variscan structural complex of structures in northern Afghanistan, part of the Turan block, from the Alpine complex in southern Afghanistan, which originated from the geosynclinical system of the Tethys Ocean.[8] The different geological development is also evident in the main orientation and rock composition of the mountainous regions: the mountain ranges south and west of Herat run northeast – southwest and consist mainly of sand- and siltstone of the Jurassic and Cretaceous periods[9] as well as of Pliocene[10] conglomerates and sandstone.[11] The mountain ranges situated north, east and southeast of Herat, in contrast, are characterised by very old metamorphic rocks of the Proterozoic[12] with west-east-orientation, consisting mainly of gneiss, slate, quarzite and marble. As a consequence of the steepness of the slopes in those mountainous regions, combined with active erosion, only soils on solid rock, so-called leptosols, litho- and regosols, could develop that are little or not suitable for agricultural utilisation.[13]

Although there is evidence for seismic activity, as i.e. in the widely known hot spring of Obeh or documented earthquakes with a magnitude of 6 on the Mercalli scale, the question whether the Herat Fault shows recent activity is still subject of scientific dispute.[14] Compared to other regions in Afghanistan the area of investigation has to be regarded as an area of little seismic activity.

As a result of geotectonic development a basin emerged south of the Herat Fault, which is today filled with sediment from the Hari Rud and the surrounding mountains. In this region, called Hari Rud Oasis, loess was deposited during the last glacial period[15], on which fertile alluvial soils developed.[16] Here the Hari Rud flows as braided river. In its floodplain of sometimes several kilometres breadth, characterised by sand and gravel

1 Grötzbach 1990, 321.
2 Wolfart/Wittekindt 1980, 2.
3 Grötzbach 1990, 318.
4 Wolfart/Wittekindt 1980, 1–2.
5 Wellmann 1966, 724.
6 Cenozoic Era, beginning at the end of the Cretaceous 65 million years ago and still continuing today.
7 Wolfart/Wittekindt 1980, 10.
8 Wolfart/Wittekindt 1980, 22; 323.
9 Eras of the Mesozoic: Jurassic c. 200–150 million years ago; Cretaceous c. 150–65 million years ago.
10 Epoch of the Neogene that lasted approx. 5.3–2.6 million years and is followed by the Pleistocene, the epoch of the glacial periods.
11 Doebrich/Wahl 2006.
12 Geological eon of the beginnings of earth history, extending from c. 2,500 to 540 million years ago.
13 Wolfart/Wittekindt 1980, 312.
14 Wheeler et al. 2005, 9.
15 Approx. 115,000 – 10,000 years ago, corresponding to the geological epoch of the Pleistocene, followed by the Holocene.
16 Wolfart/Wittekindt 1980, 312.

◀ *Isometric map of the surroundings of Herat (spatial reference system: WGS 84, UTM grid zone 41); database: A. Jarvis, H. I. Reuter, A. Nelson, E. Guevara, Hole-Filled Seamless SRTM Data V4, International Centre for Tropical Agriculture (CIAT), 2008. URL http://srtm.csi.cgiar.org. Processing and addings: Th. Urban*

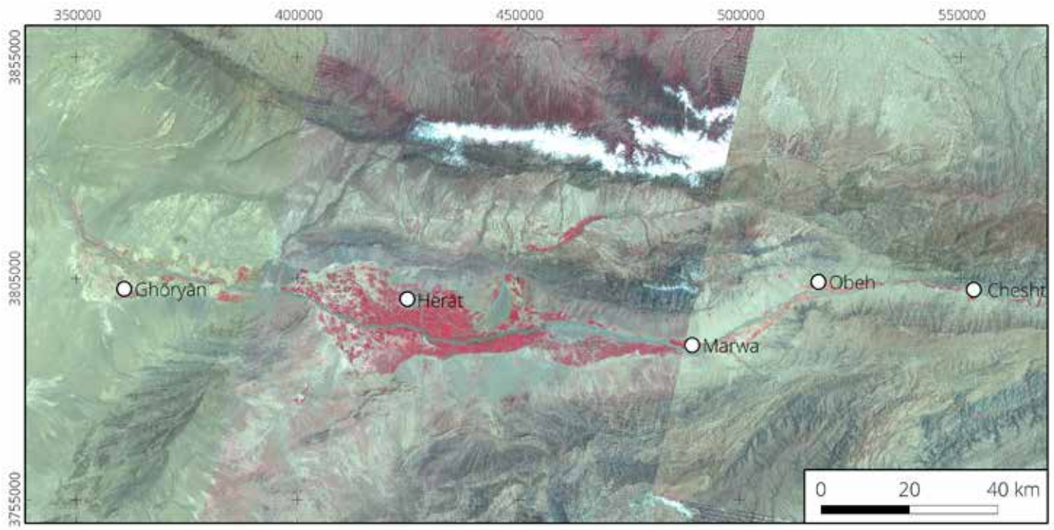

Fig. 12 Overview of the Hari Rud Oasis. Vegetation is marked in red. The agricultural favourability of the river's vicinity is evident. Furthermore, in the adjacent northern and southern areas sporadic patches of vegetation can be detected, indicating smaller favourable areas of settlement; further information in the text (spatial reference system: WGS 84, UTM zone 41); sources: Landsat ETM satellite data of the years: 2000, 2001 and 2005; bands 4-3-2 correspond to R-G-B; retrieved from: Global Land Cover Facility (http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp), last access: December 30, 2012

islands, the Hari Rud continually changes its approximately 20 to 70 m broad bed. With a depth of c. 1–1.5 m the present Hari Rud has a mean outflow of 1.2-1.3 m/s.[17]

The Hari Rud Oasis stretches from Chesht-e-Sharif in the east to the northwest of Ghuriyan (Fig. 12) and has always been an important passage between the regions east and west of the Hindukush. The eastern, circa 80 kilometres long section is a five kilometres broad oasis situated in the valley, extending from Chesht-e-Sharif to the confluence of the Kawghan River near Marwah. Downstream of Marwah the valley widens to the 115 km long and 25 km broad oasis of Herat. West of this landscape with extensive livestock farming and high population density, on both sides of the river, wide Dasht plains (Dasht-e-Randan in the south; Dasht-e-Hamdamab in the north) serve nomads in winter as pastures.

Weathered rocks of the mountains surrounding the valley are transported by tributaries of the Hari Rud and deposited in large alluvial fans at the edges of the basin. The transition between mountains and fans is in some areas cliff-like with drop heights of up to 200 m.[18] The thickness of sediment deposits varies according to the sizes of drainage basins of the mountain rivers. Particularly remarkable is the alluvial fan of the Karukh River (Fig. 12). But the entire course of the Hari Rud west of Obeh is characterised by alluvial fans at the foot of the mountains.

17 East View Cartographic 2003, 173.

18 Grötzbach 1990, 321–328.

Apart from geological preconditions, climate is a decisive factor of landscape formation. There are little meteorological records or other sources of climatic development in the area of investigation. From the regional perspective it can be stated for western Afghanistan and Iran that the climatic characteristics of the last 6,000 years can be compared with those of the present day. Short phases of humid or dry conditions as could be proven for other Middle Eastern regions, might be assumed, but cannot definitely be deduced from the available data.[19] Therefore, the following description is based on the present climatic conditions, distinctly showing the region's marginal characteristics. In the area of investigation there is a typical continental, cold arid steppe climate – BSk according to the climatic classification by Köppen-Geiger – as a result of the long distance to the sea as well as vertical structuring of the mountain ranges.[20] The main time of precipitation is in winter, when depressions

19 Kehl 2009.

20 Kottek et al. 2006, 261.

from western directions move along over Afghanistan (Fig. 13a).[21] As a consequence of their tracks and the orographic lift of the air masses at the Central Afghan Highlands, precipitation decreases in western Afghanistan from north to south and from west to east (Fig. 13b).[22]

Precipitation shows high intra- and inter-annual variability and occurs very often as torrential precipitation.[23] For this reason irrigation farming using water from the river is very common, even if there is sufficient precipitation (more than 250 mm annually). The irrigated area from 1966 to 1968 comprised 73,000 ha.[24]

Due to the annual distribution of precipitation the rivers have their highest runoff in the winter (rainy season) and spring months (snowmelt), while they have little water in the summer time, or – when much water is extracted for irrigation – no water at all.[25] Areas that use river water for irrigation suffer from drought and water shortage from June or July on. Therefore, from that time onwards the fields lie fallow – a situation that becomes increasingly serious the farther downstream one goes.[26] Thus, apart from irrigation with river water, spring water is used as well as until recently, *qanat* technology to ensure an all-season water supply. Thereby, c. 5,600 ha of irrigated land are made available for agriculture.[27]

However, in the course of the year evaporation is higher than precipitation and therefore the regions east of Herat without continuous water inflow are characterised by vast salt pans.[28]

21 Wolfart/Wittekindt 1980, 2–3.

22 Other authors give annual totals of 242 mm (Grötzbach 1990, 317) or 222 mm (Wolfart/Wittekindt 1980, 5).

23 Wolfart/Wittekindt 1980, 7.

24 Grötzbach 1990, 325–326. See also p. 13.

25 Cf. Wolfart/Wittekindt 1980, 7, among others.

26 Grötzbach 1990, 325–326. - Reindke 1976, 129–132 mentions 60,000 ha of intensly irrigated land.

27 The most important *qanat* irrigation area is situated east of Herat, in the alluvial fan of the Karukh River; the most extensive area irrigated by spring water is located southeast of the alluvial fan of the Karukh, beyond the Hari Rud (Grötzbach 1990, 325–326).

28 Cf. Wolfart/Wittekindt 1980, 7, among others.

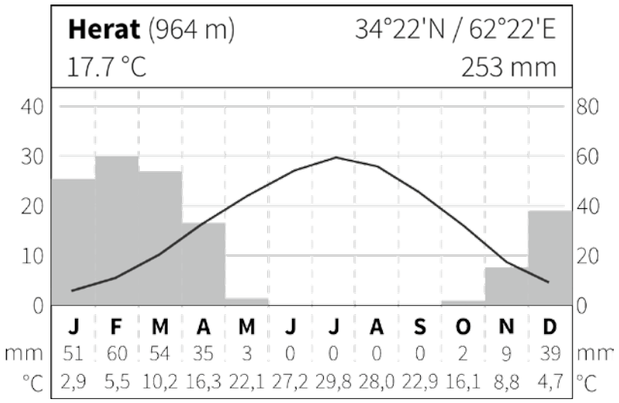

Fig. 13a Climate diagram of Herat for the period 1961–1990. Source: Food and Agriculture Organization of the United Nations (FAO) (2012): Climate, Energy and Tenure Division (NRC), FAOClim-NET, http://geonetwork3.fao.org/climpag/agroclimdb_en.php, last access: December 27, 2012

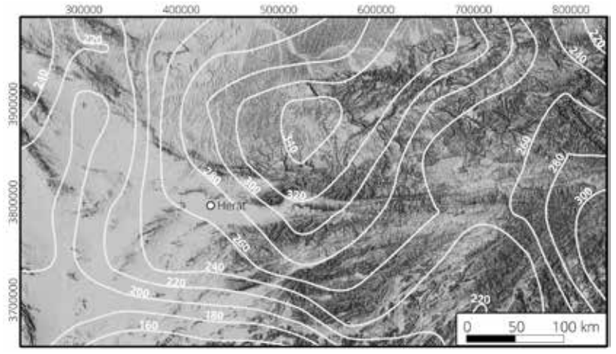

Fig. 13b: Isohyetal map for the surroundings of Herat. The orographic lift at the mountains as well as decrease of precipitation from north to south are clearly visible (spatial reference system: WGS 84, UTM zone 41; Isohyetal based on: Food and Agriculture Organization of the United Nations (FAO) (2012): Climate, Energy and Tenure Division (NRC), FAOClim-NET, http://geonetwork3.fao.org/climpag/agroclimdb_en.php, last access: December 27, 2012; relief: Aster DEM

There is also a particular climatic phenomenon that is triggered by high pressure differences between Central and South Asia: a wind occurring during the summer months, called 'the wind of 120 days', blowing from Gulran to Sistan from the north, often causing heavy dust and sandstorms.[29]

29 Grötzbach 1990, 317.