REPORT ON KABUL RIVER BASIN PROJECT

High-resolution data and groundwater modeling

ABSTRACT

This report is about the high-resolution data for the geo-portal and groundwater modeling of the Kabul River Basin. The collected high-resolution data was processed in terms of the river basin boundaries and used to simulate groundwater levels.

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1 High resolution data

Different types of data were retrieved for the Kabul River Basin project's geo-portal, so that data can be shared and visualized. The description of data types and sources are presented in the following sections.

1.1 Raster and projection parameters

1.1.1 Resolution

The resolution of the raster datasets is 1x1 km (30 arcsec).

1.1.2 Coordinate reference system

Coordinate reference system (crs) is EPSG 4326 (WGS84 geographic coordinate system).

In pretty wkt format:

```
GEOGCS["WGS 84",
  DATUM["WGS_1984",
    SPHEROID["WGS 84",6378137,298.257223563,
      AUTHORITY["EPSG","7030"]],
    AUTHORITY["EPSG","6326"]],
  PRIMEM["Greenwich",0,
    AUTHORITY["EPSG","8901"]],
  UNIT["degree",0.0174532925199433,
    AUTHORITY["EPSG","9122"]],
  AUTHORITY["EPSG","4326"]]
```

In proj4 format: ***"+proj=longlat +datum=WGS84 +no_defs"***

1.1.3 River basin boundaries

All the datasets are clipped using Kabul River Basin shapefile.

1.1.4 GIS data processing and visualization

GIS data manipulations such as reading, slicing, reprojection and plotting are done using the open-source tool called geohdf (Zhiyenbek, 2019).

1.2 Elevation, slope and land use data

Elevation data is based on SRTM 30+ and ETOPO DEM at 1/120 arc-degrees (Figure 1). The slope data is derived using the DEMSRE3 (Figure 2). Land cover data classes based on the MERIS FR images (**Error! Reference source not found.**).

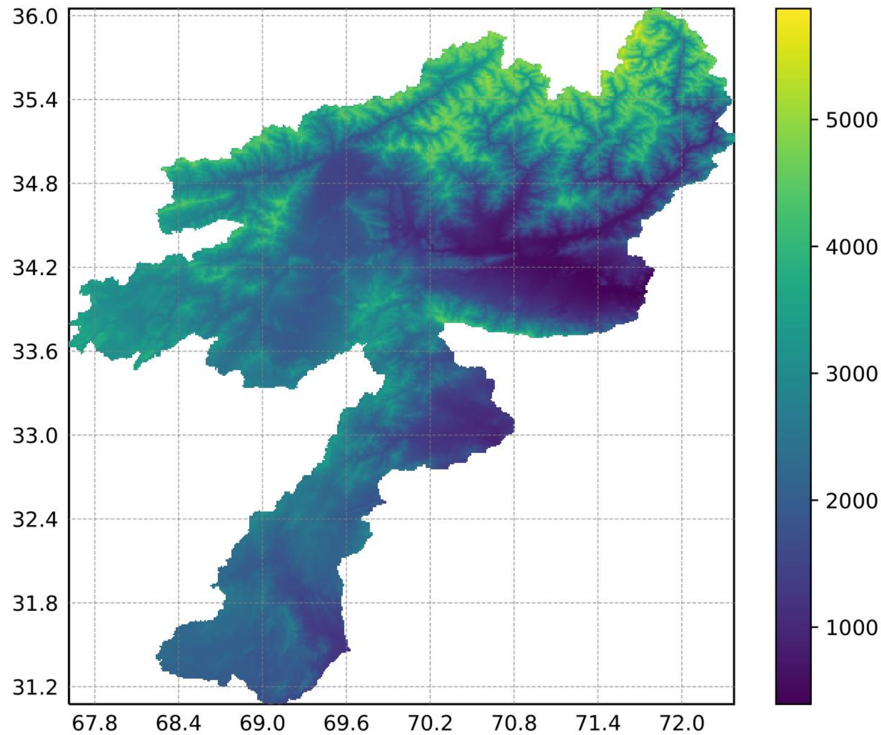

Figure 1 Elevation [meters]

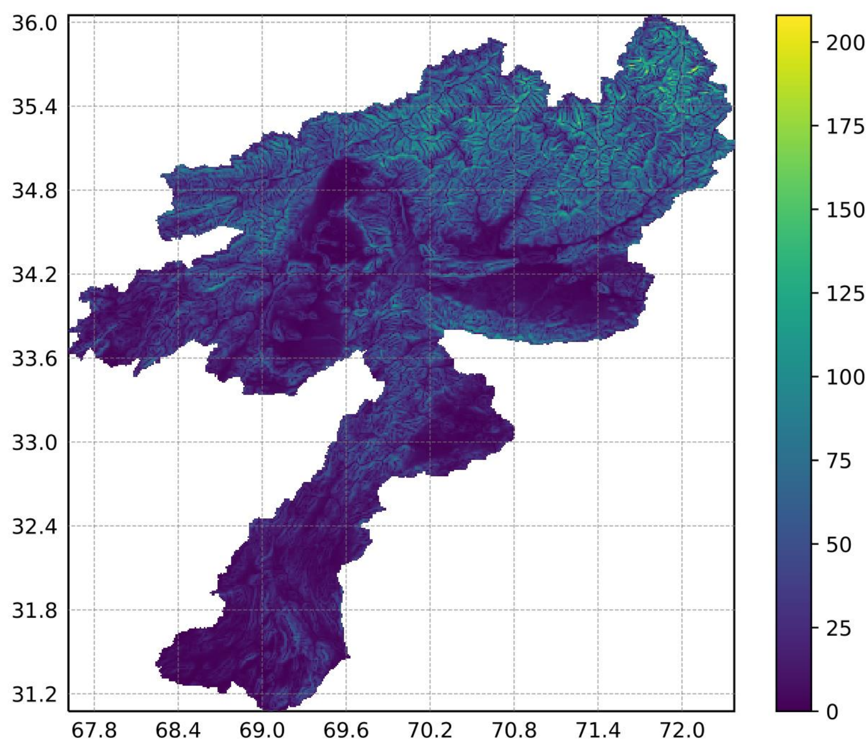

Figure 2 Slope [%]

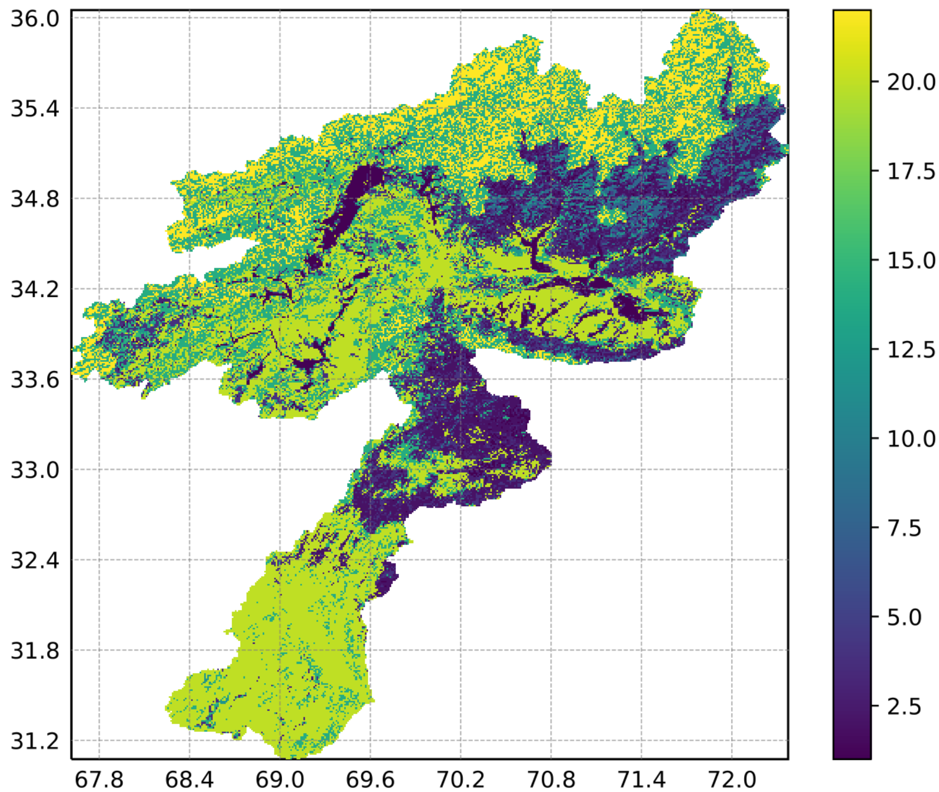

Figure 3 Land cover classes [-]

1.3 Soil data

The soil data was retrieved from the SoilGrids project. The SoilGrids project uses the machine learning tools to generate gridded data with high resolutions ((Hengl, Mendes de Jesus, Heuvelink, Ruiperez Gonzalez, & Kilibarda, 2017)). The native resolution of the SoilGrids project is 250x250 meter. However, for the Kabul River basin, to be consistent with other data, 1x1 km resolution data was retrieved and clipped by the river basin boundary.

For hydrological modeling purposes, the texture of the soil is very important. Soil texture raster files were produced with 1x1 km resolution for seven layers ranging from 0 to 200 cm (Figure 4 and Figure 5).

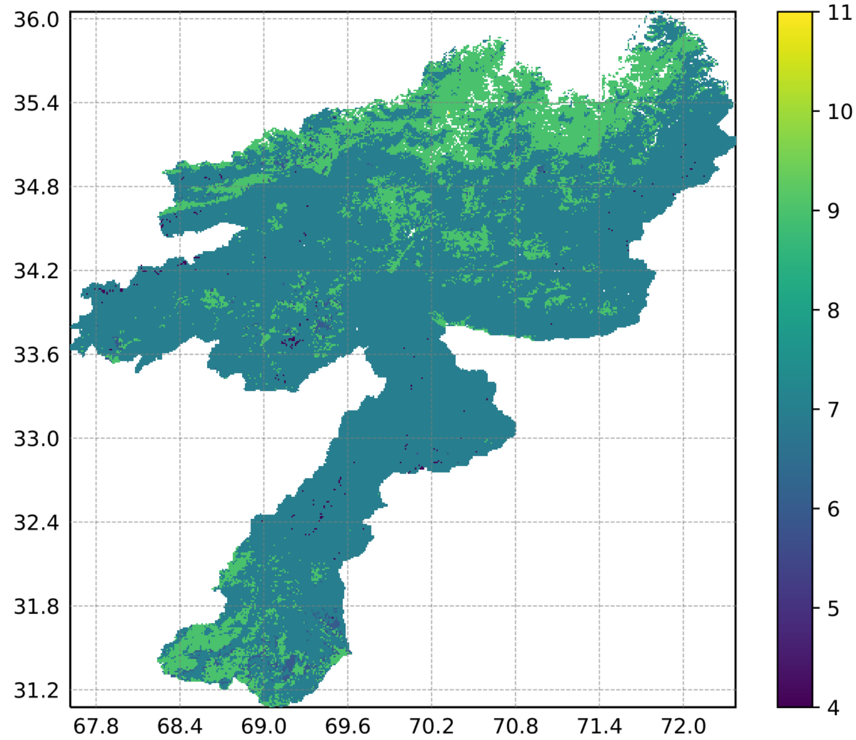

Figure 4 Soil texture (1st layer = 0 cm)

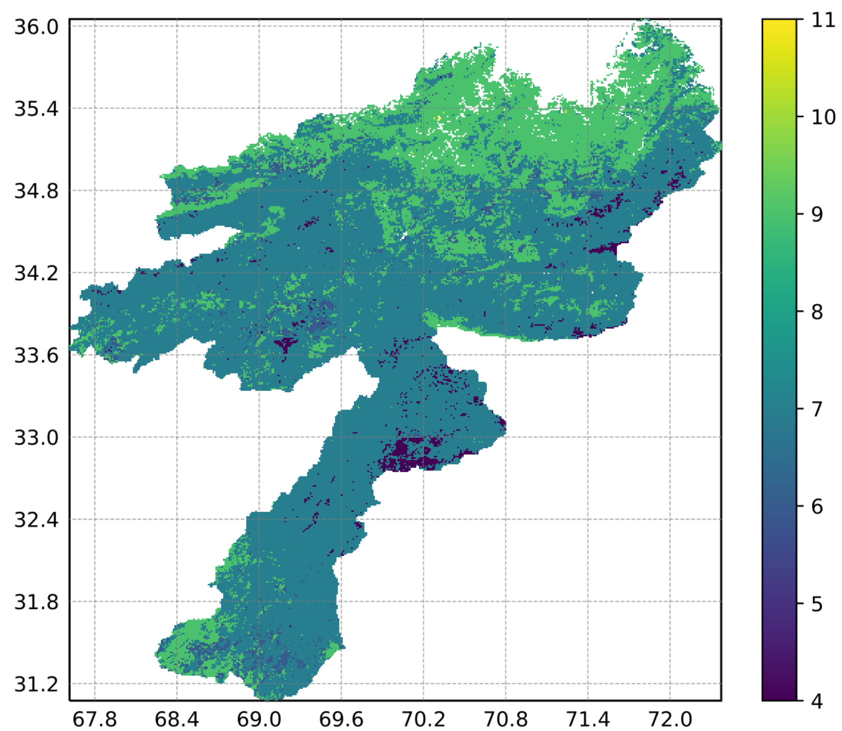

Figure 5 Soil texture (7th layer = 200 cm)

1.4 Climate data

The latest climate data was retrieved from the Chelsa (Climatologies at high resolution for the earth's land surface areas) project (Karger et al., 2019). Using Era Interim model results, they downscaled data into 1x1 km resolution. Downscaling algorithms are based on elevation and wind vectors and can be found in the documentation of the Chelsa project. The monthly datasets are the long term average values from 1979 to 2013.

In the following sections, some examples of the climate data are illustrated (from Figure 6 to Figure 9).

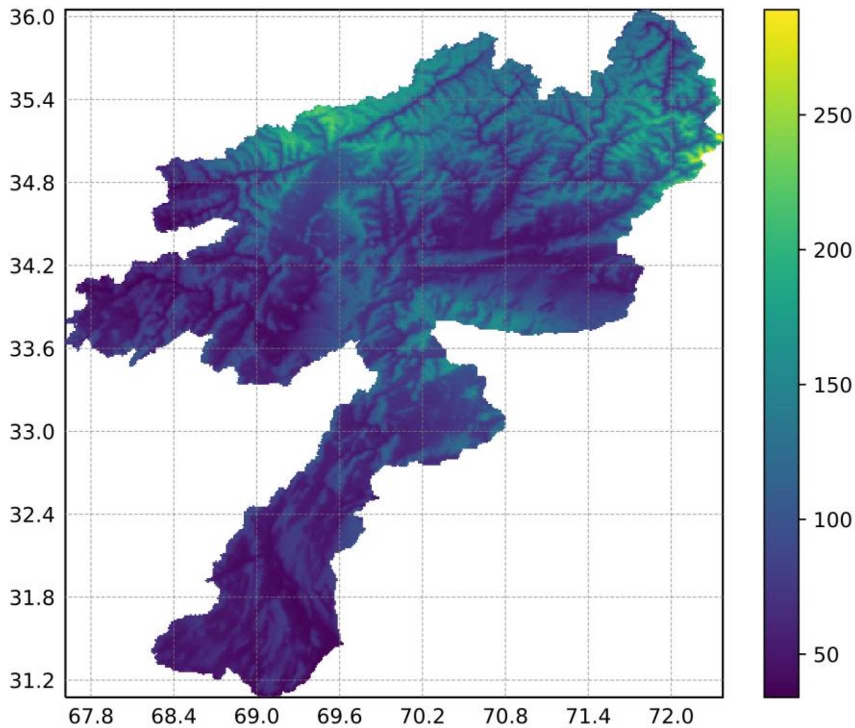

Figure 6 Precipitation in March [mm/day]

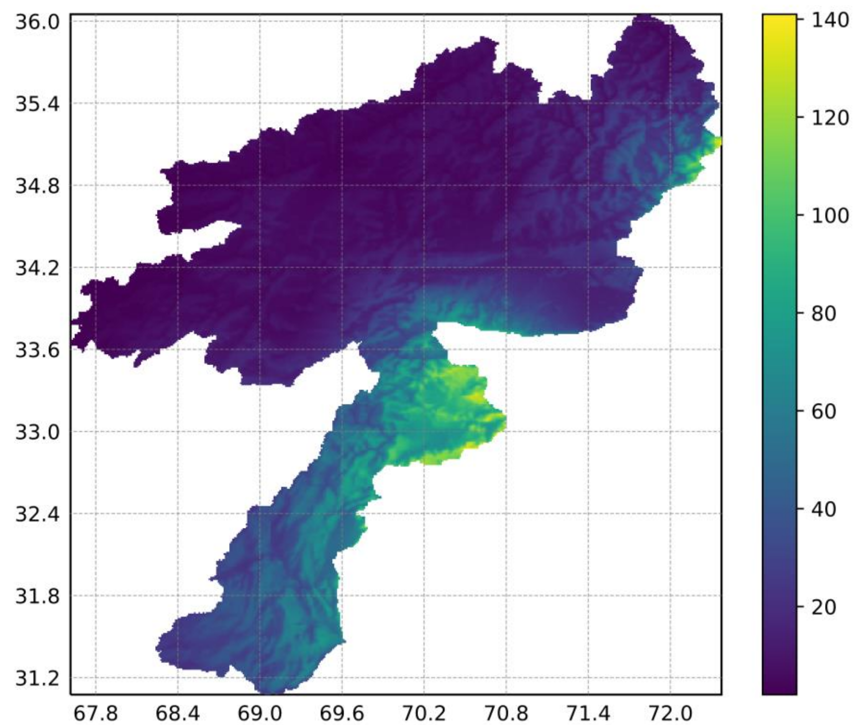

Figure 7 Precipitation in July [mm/day]

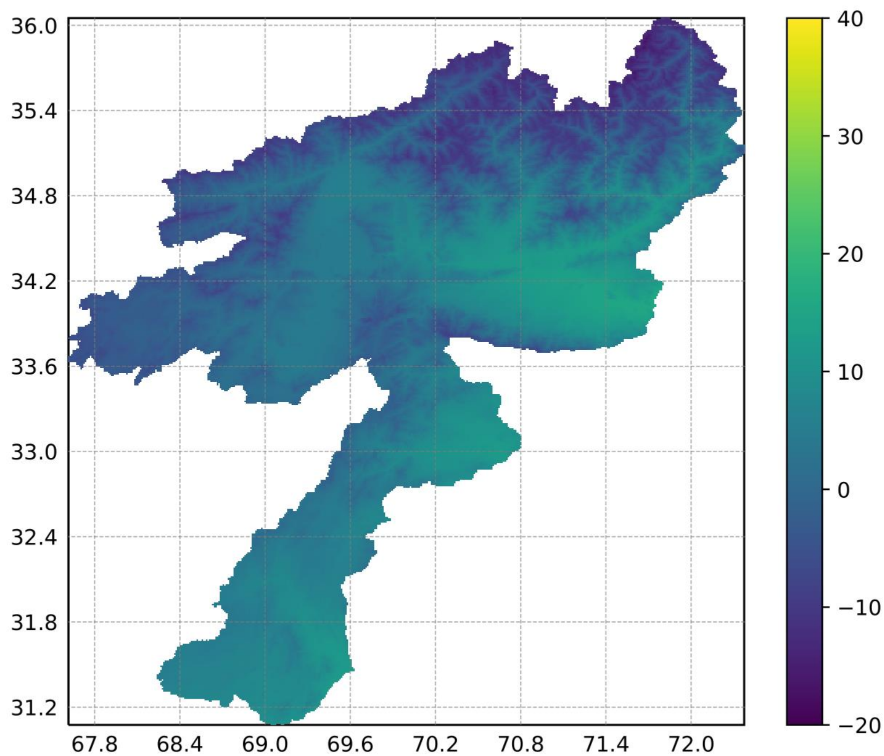

Figure 8 Maximum temperature in January [C]

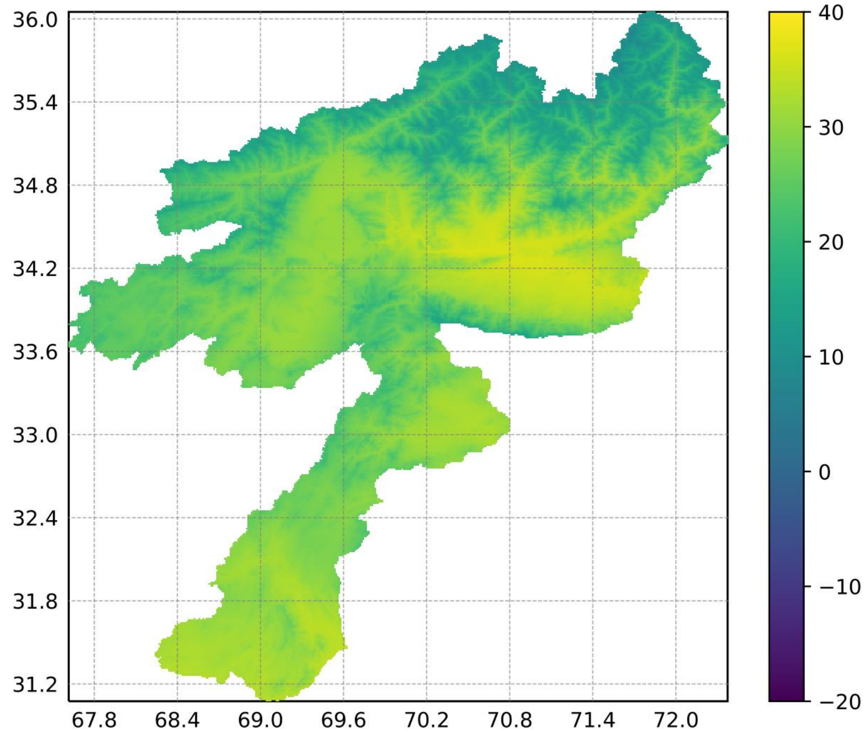

Figure 9 Maximum temperature in July [C]

2 Groundwater modeling

Using the high-resolution climate data from Chelsa project, the latest version of groundwater model was run. Different scenarios were considered in terms of time horizon (for how many years should be forecasted?) and irrigation percent from the groundwater sources etc. As an example crop type for this section, maize was selected. Detailed descriptions are demonstrated in the following sections.

2.1 30-year time horizon

When 20% of irrigation is taken from the groundwater sources to grow maize, the model shows that there will not be negative effects within next 30 years (Figure 10). Only some minor areas where land cover is impervious, the drawdown is very high, up to -12 meters decrease in water level. However, in general around 20 to 30% percent groundwater use for irrigation seems to be safe.

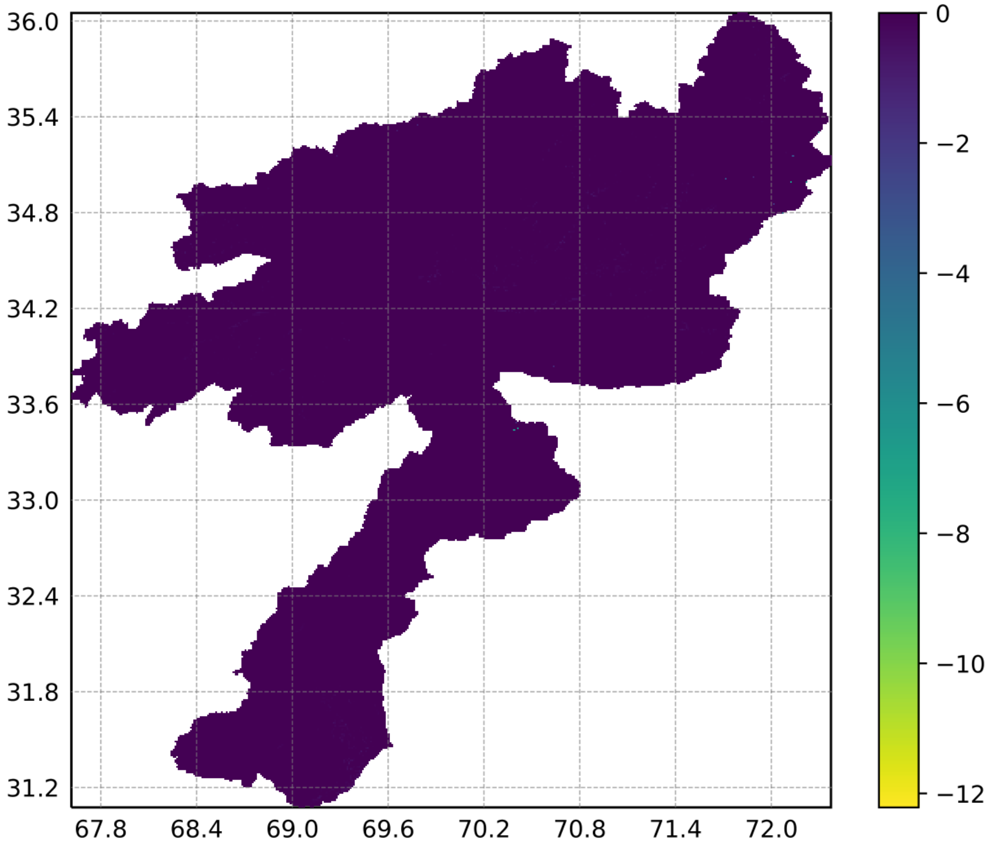

Figure 10 Groundwater drawdown when 20% irrigation from groundwater [meters]

On the other hand, when the groundwater consumption for irrigation goes 50 or 80%, the water level goes down drastically (Figure 11 and Figure 12). The groundwater level decreases up to 80 meters. This situation can create local environmental issues and difficulties to access groundwater without high energy expenses.

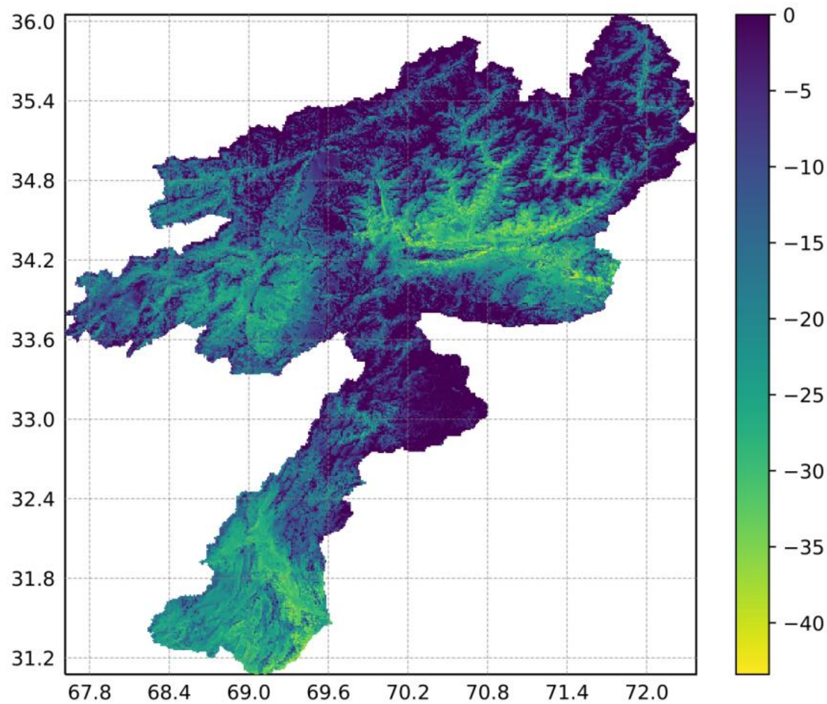

Figure 11 Groundwater drawdown when 50% irrigation from groundwater [meters]

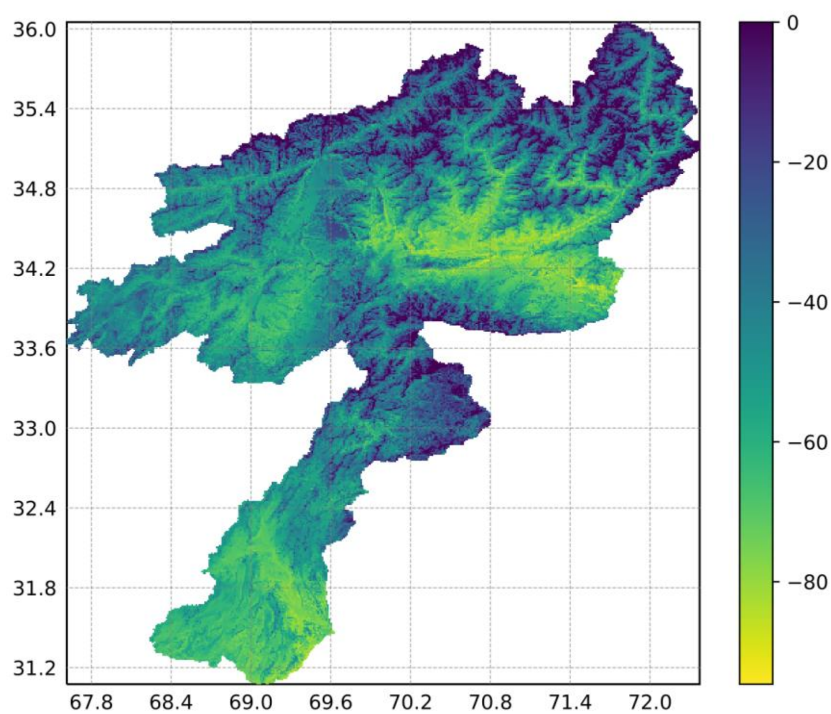

Figure 12 Groundwater drawdown when 80% irrigation from groundwater [meters]

2.2 50-year time horizon

In this part, the model was run for next 50 years. The results of using 20% groundwater for irrigation to grow maize shows similar results as above. It also indicates that within next 50 years, if 20% consumption, there will not be significant effects on water level (Figure 13)

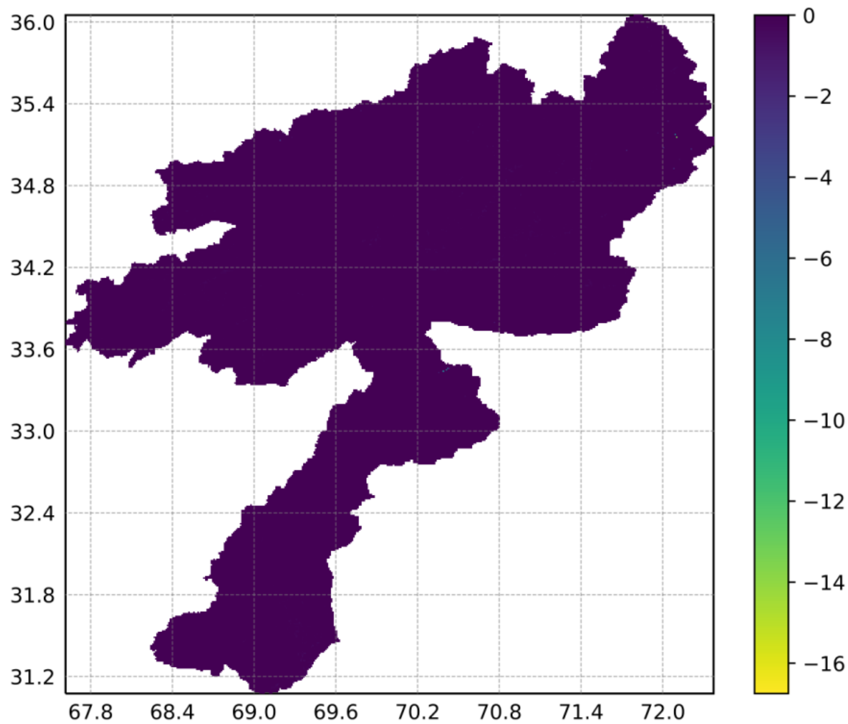

Figure 13 Groundwater drawdown when 20% irrigation from groundwater [meters]

However, higher water consumption such as 50 or 80% for next 50 years show significant drawdown (Figure 14 and Figure 15). Using 80% of groundwater for producing maize for next 50 years, can decrease groundwater level up to -150 meters.

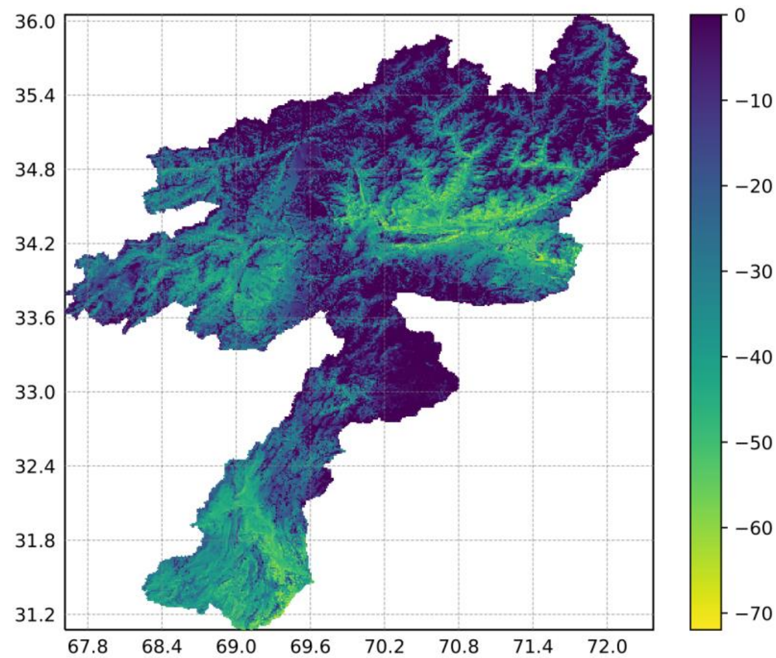

Figure 14 Groundwater drawdown when 50% irrigation from groundwater [meters]

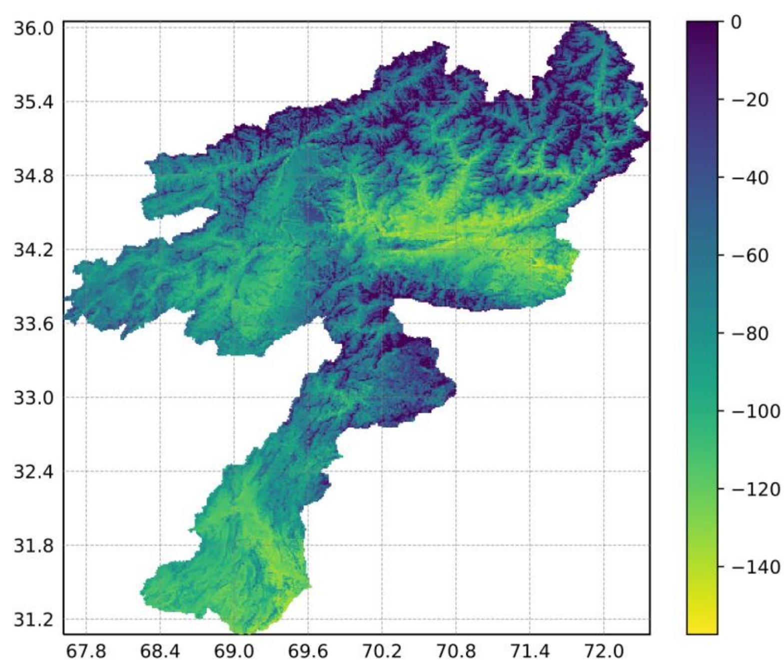

Figure 15 Groundwater drawdown when 80% irrigation from groundwater [meters]

3 Link to download high resolution datasets

All the data files in geotiff format and uploaded to this cloud directory:

https://drive.google.com/drive/folders/1czaVNAUUijSf1a2KCJzCOmxZ0ap9SUh_?usp=sharing

4 References

Hengl, T., Mendes de Jesus, J., Heuvelink, G. B., Ruiperez Gonzalez, M., & Kilibarda, M. (2017). SoilGrids250m: Global gridded soil information based on machine learning. *PLoS ONE*.

Karger et al. (2019). *CHELSA – Free climate data at high resolution*. Retrieved from http://chelsa-climate.org/

Zhiyenbek, A. (2019). *GeoHDF - Geospatial extension to Hierarchical Data Format*. Retrieved from https://github.com/abdikaiym/geohdf