Exercise sheet n°2 : Basic concepts

2.1 Theoretical part

Exercice 1 :

Hydrological connectivity.

(a) Prove that the hydrological connectivity of any grid cell is unique, i.e. $hc_{cm}(i,j) = e_1$ and $hc_{cm}(i,j) = e_2 \;\rightarrow\; e_1 = e_2$.

(b) Show that the path that defines the hydrological connectivity of a grid cell might not be unique.

(c) Can you find a neccessary and sufficient condition of the path that defines the hydrological connectivity for the case $\forall (i,j)\; hc_{cm}(i,j) \;=\; elevation(i,j)$?

2.2 Practical part

Exercice 1 :

The library code is available on `https://gitlab.com/globalclimateforum/diva_library`. The Julia language can be downloaded from `https://julialang.org/`. Code can be edited with usual editors, for instance Visual Studio `https://visualstudio.microsoft.com/de/` or build-in editors like vim or emacs. If you have not check out the code, check out the repository. Checkout should work as follows:

```
git clone -branch exercises https://gitlab.com/globalclimateforum/diva_library.git
```

At the location called a sub directory `diva_library` will be created with furter subdirectories `exercises` and therein `exercise02`. If you did check out the repository before you can update the code by calling `git pull`. In this exercise you are supposed with data. Exmaple data is provided on the seminar webpage `https://globalclimateforum.org/diva_modelling/`. The diva library provides (among other things) data structures to read, write and work on `geotif` data. It can be included by

```
include("../jdiva_lib.jl")
```

where `..` has to be replaced accordingly with the path to the location of your diva library. Geotiff data can be read into `SparseGeoArray` data structures.

```
julia> sga = SparseGeoArray{Float32,Int32}("luebeck_meritDEM.tif")
```

```
read: 0 10 20 30 40 50 60 70 80 90 100
708x523 SparseGeoRaster implemented as Dict{Tuple{Int32, Int32}, Float32} with undefined CRS
projref: GEOGCS["WGS 84",DATUM["WGS_1984",SPHEROID["WGS 84",6378137,298.257223563,AUTHORITY["EPSG","7030"]],AUTHORITY["EPSG","6326"]],PRIMEM["Greenwich", ...
aft: AffineMap([0.0008333333333333332 0.0; 0.0 -0.000833333333460802], [10.527916667, 54.077916667]); nodatavalue: -9999.0; stored values: 93969
```

Data access etc. works as described int the seminar session. Use the diva library to answer the following questions.

(a) UKIRL_meritDEM.tif contains the merit-DEM elevation data for UK and Ireland. According to this data, what is the highest elevation in the UK/IRL? Where is the point with the highest elevation (indices x/y and coordinates lon/lat). Check if you favourite GIS viewer if this makes sence.

(b) According to this data, what is the lowest elevation in the UK/IRL? Where is the point with the lowest elevation (indices x/y and coordinates lon/lat).

(c) UKIRL_GHS_POP_E2020_GLOBE_R2023A_4326_3ss_V1_0.tif contains the global human settlement layer polulation data for UK and Ireland. According to this data and the merit-DEM elevation data, what is the highest/loweset inhabitet elevation in the UK/IRL? Where is the point with the highest/lowest elevation (indices x/y and coordinates lon/lat). Every grid cell with a data value in the population data is seen as inhabitet (and therefore every grid cell with no data in the population data is seen uninhabitet).

(d) UKIRL_gpw_v4_population_count_rev11_2020_30_sec.tif contains the gridded population of the world polulation data for UK and Ireland. Repeat the previous analysis.

(e) UKIRL_merit_coastplain_elecz_12m.tif contains the elvation of all UK/IRL area that has an elevation of not more than 12.0m and a hydrologic connectiviy of not more than 12m. Using the global human settlement layer polulation data provide a table with population living below 0m, 0.5m, 1.0m, 1.5m, ... 11.5m, 12.0m. The values should be cumulative - population below 12m should count all population below 12.0m (including for instance the population on 5.5m etc).

(f) Repeat the previous analysis with the gridded population of the world data.

(g) Repeat the previous analysis with the accumulating the area of grid cells instead of population.

(h) For those who work on the Seychelles: repeat the analysis from the previous three exercises with the data seychelles_GHS_POP_E2020_GLOBE_R2023A_4326_3ss_V1_0.tif, seychelles_gpw_v4_population_count_rev11_2020_30_sec.tif and seychelles_meritDEM.tif.

(i) For those who work on the Lübeck: repeat the analysis from the previous exercise with the data luebeck_meritDEM.tif, luebeck_GHS_POP_E2020_GLOBE_R2023A_4326_3ss_V1_0_meritDEM.tif and luebeck_gpw_v4_population_count_rev11_2020_30_sec_meritDEM.tif.

(j) For those who work on the Lübeck: repeat the analysis from the previous exercise with the data luebeck_copernicus_v11.tif, luebeck_GHS_POP_E2020_GLOBE_R2023A_4326_3ss_V1_0_copernicus.tif and luebeck_gpw_v4_population_count_rev11_2020_30_sec_copernicus.tif. Compare the results with the meritDEM results.