Overview of Input Data and Model Outputs

Seasonal Water Yield Model

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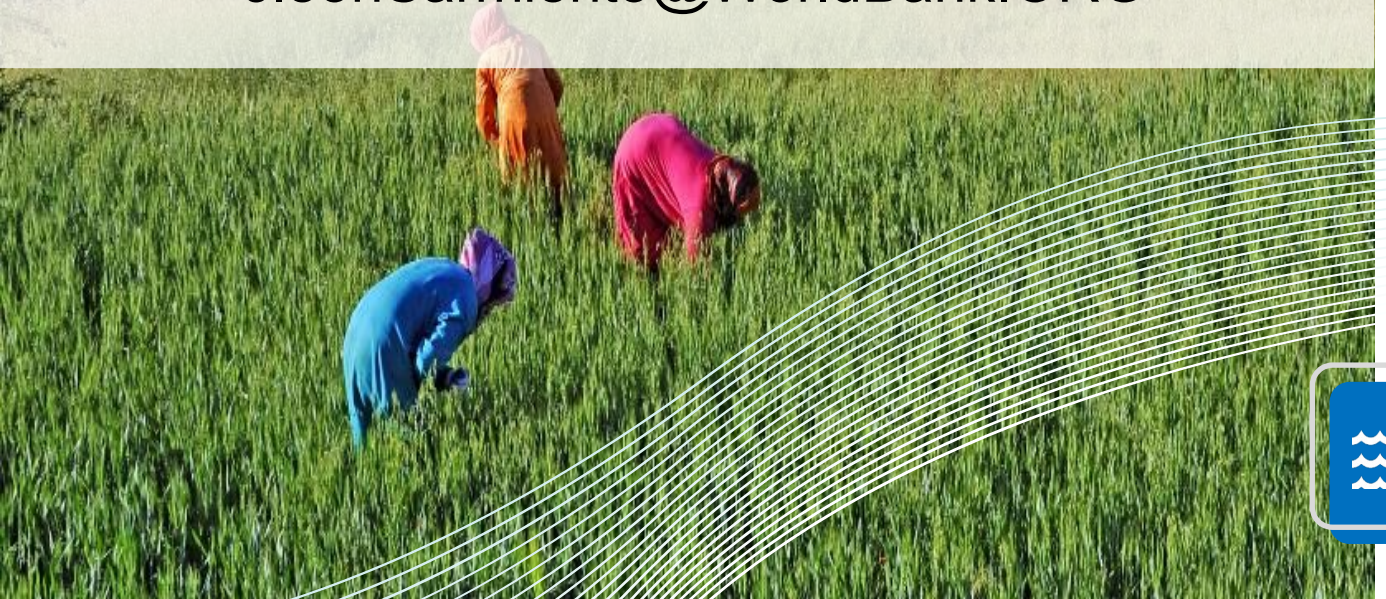
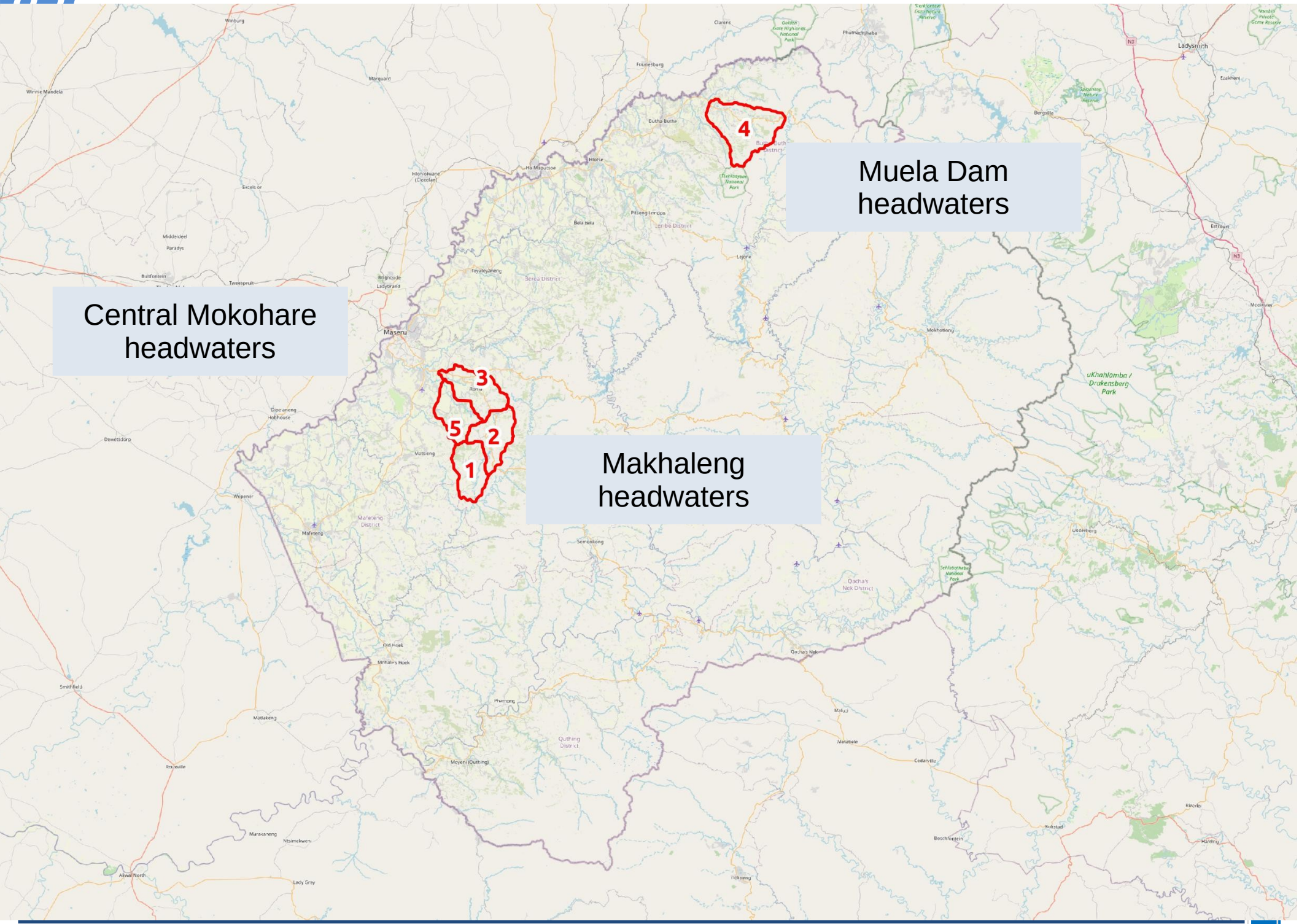
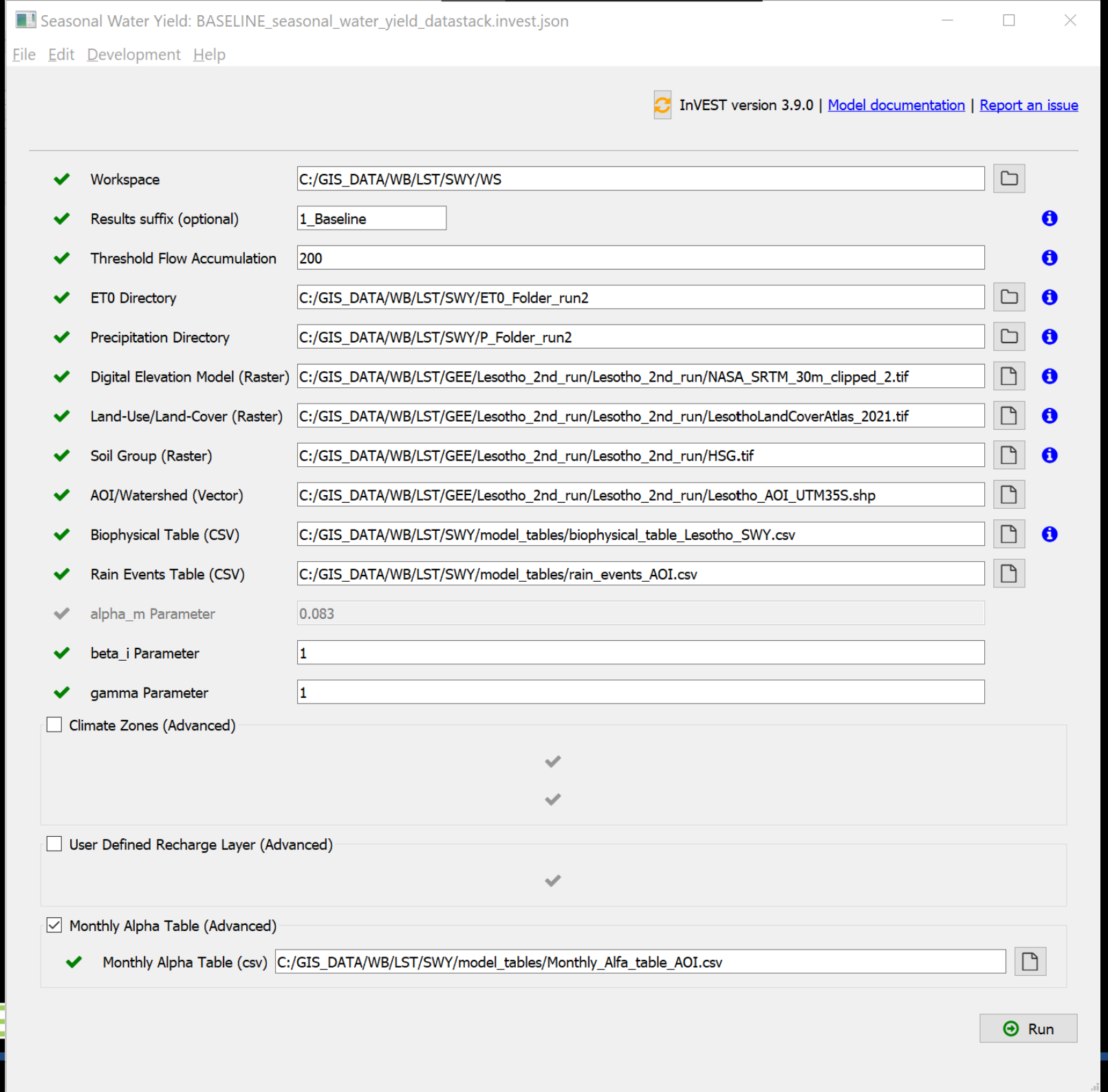


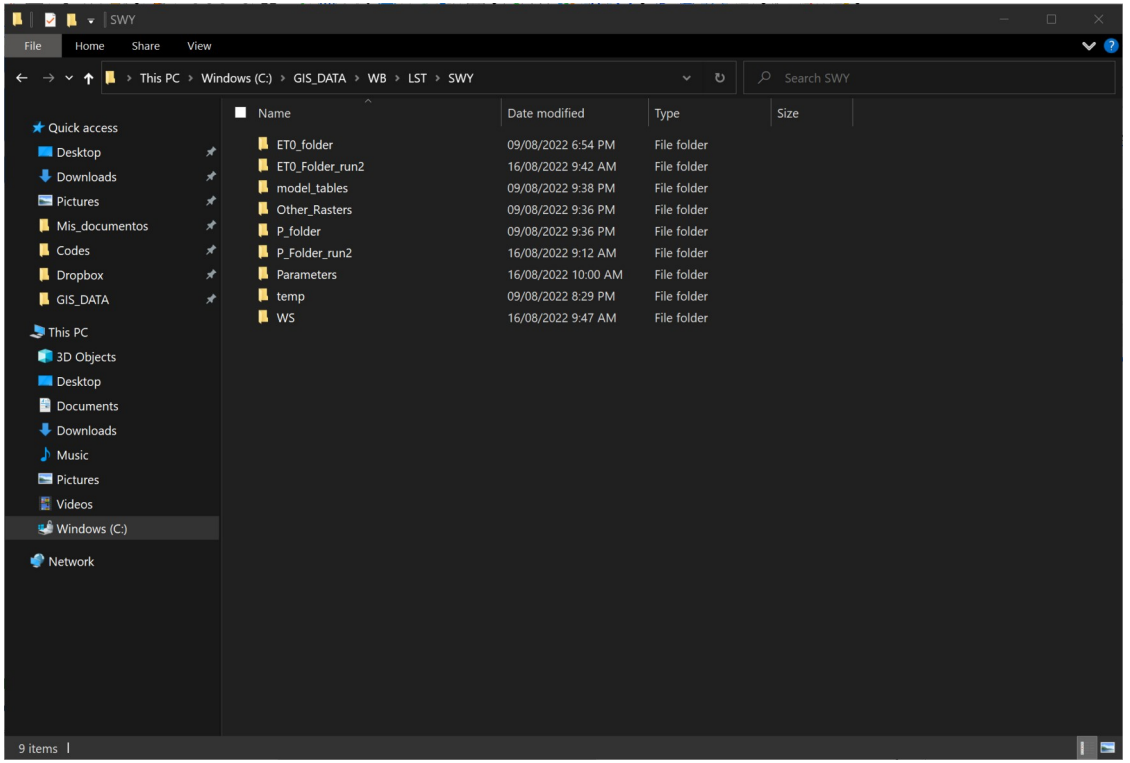

Muela Dam headwaters
Central Mokohare headwaters
Makhaleng headwaters
4
3
5
2
1


Seasonal Water Yield: BASELINE_seasonal_water_yield_datastack.invest.json
File Edit Development Help
InVEST version 3.9.0 | Model documentation | Report an issue
Workspace C:/GIS_DATA/WB/LST/SWY/WS
Results suffix (optional) 1_Baseline
Threshold Flow Accumulation 200
ET0 Directory C:/GIS_DATA/WB/LST/SWY/ET0_Folder_run2
Precipitation Directory C:/GIS_DATA/WB/LST/SWY/P_Folder_run2
Digital Elevation Model (Raster) C:/GIS_DATA/WB/LST/GEE/Lesotho_2nd_run/Lesotho_2nd_run/NASA_SRTM_30m_clipped_2.tif
Land-Use/Land-Cover (Raster) C:/GIS_DATA/WB/LST/GEE/Lesotho_2nd_run/Lesotho_2nd_run/LesothoLandCoverAtlas_2021.tif
Soil Group (Raster) C:/GIS_DATA/WB/LST/GEE/Lesotho_2nd_run/Lesotho_2nd_run/HSG.tif
AOI/Watershed (Vector) C:/GIS_DATA/WB/LST/GEE/Lesotho_2nd_run/Lesotho_2nd_run/Lesotho_AOI_UTM35S.shp
Biophysical Table (CSV) C:/GIS_DATA/WB/LST/SWY/model_tables/biophysical_table_Lesotho_SWY.csv
Rain Events Table (CSV) C:/GIS_DATA/WB/LST/SWY/model_tables/rain_events_AOI.csv
alpha_m Parameter 0.083
beta_i Parameter 1
gamma Parameter 1
Climate Zones (Advanced)
User Defined Recharge Layer (Advanced)
Monthly Alpha Table (Advanced)
Monthly Alpha Table (csv) C:/GIS_DATA/WB/LST/SWY/model_tables/Monthly_Alfa_table_AOI.csv
Run

Model Inputs and Parameters

Workspace: where the tool will save the outputs

Run name: a tag appended for results identification



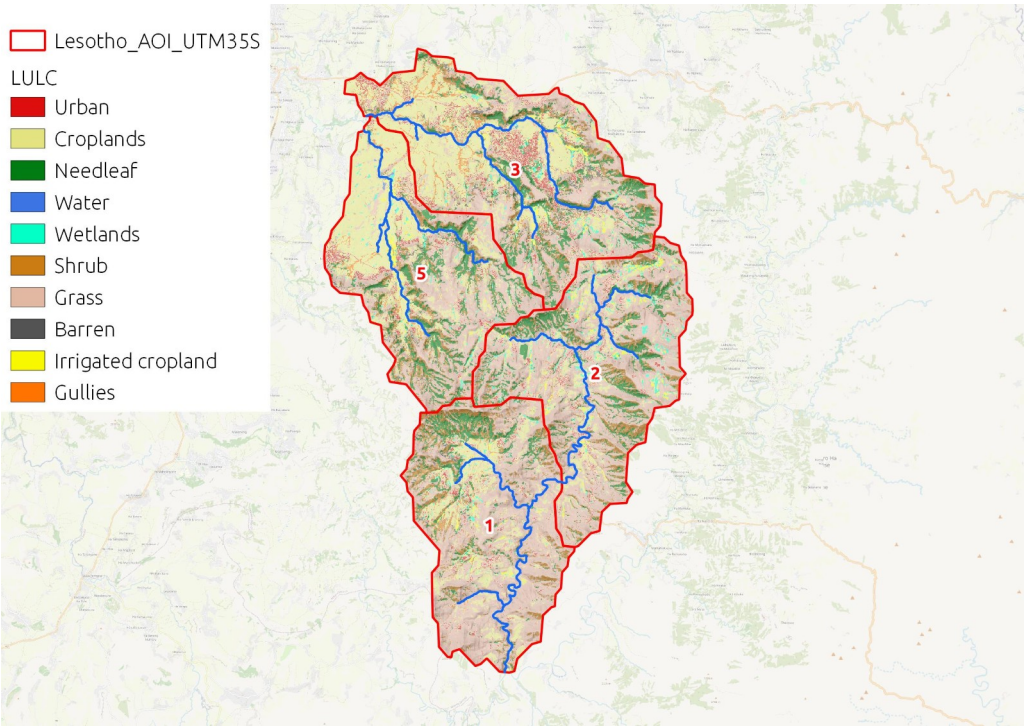
Model Inputs and Parameters

Land Use and Cover (LULC): a raster layer that represents the land covers and uses in the landscape.

It is used by the model to represent baseline or scenarios land covers. It can also be used to represent land cover condition (degraded-fair-good). Can be as detailed you need to represent your processes of interest.

Commonly obtained from imagery classification combined with field surveys, or from secondary data sources (national maps, open access maps, etc)

For this example we are using the Renoka LESOTHO LAND COVER ATLAS 2017- 2021



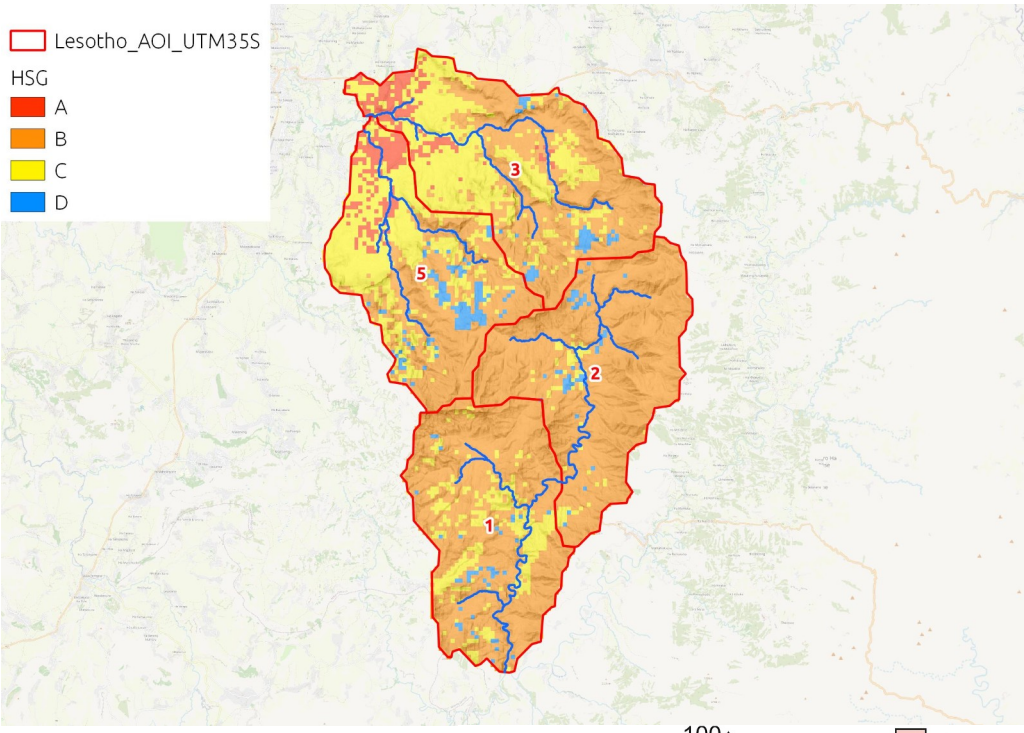
Model Inputs and Parameters

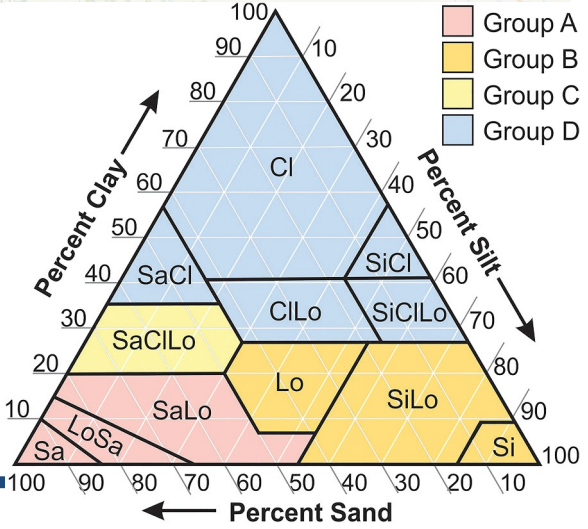
Soil Groups: a raster layer that represents the Hydrological Soil Group (A-B-C-D) of each soil class in the landscape.

It is used by the model to assign the appropriate Curve Number to each Land Cover and Use.

Commonly obtained soil surveys with a texture analysis, or from secondary data sources (national maps, open access maps, etc)

For this example we are using the OpenLandMap database 2017.





Model Inputs and Parameters

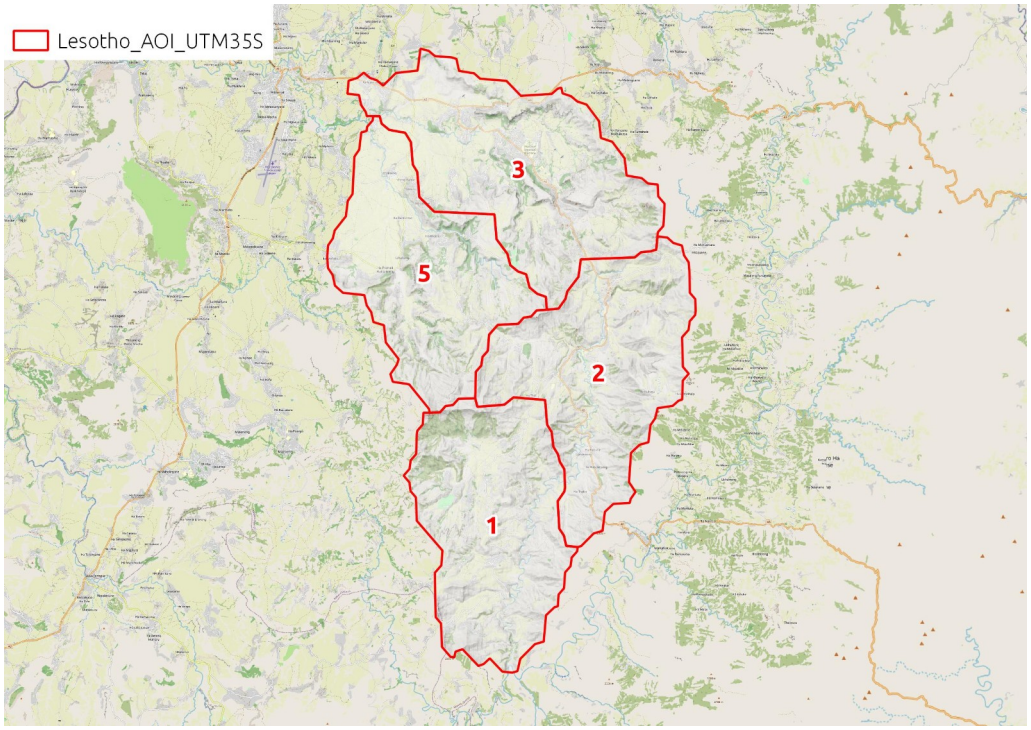
AOI Watersheds: a Shapefile layer that represents the Area of Interest or the catchments for which you want the summary of model outputs.

It is used by the model to clip results and summarize water yields.

Commonly derived from the DEM using watersheds delineation. It can be obtained using the “delineate it” tool of InVEST or similar tools.

It must contain a field “**ws_id**” with unique watershed numbering, and a field “**subws_id**” with unique subwatershed numbering.

For this example we are using WWF Hydrobasins level 12 shapefile for Central Mokohare headwaters (5 & 3), Makhaleng headwaters (1 & 2) and Muela Dam headwaters (4)



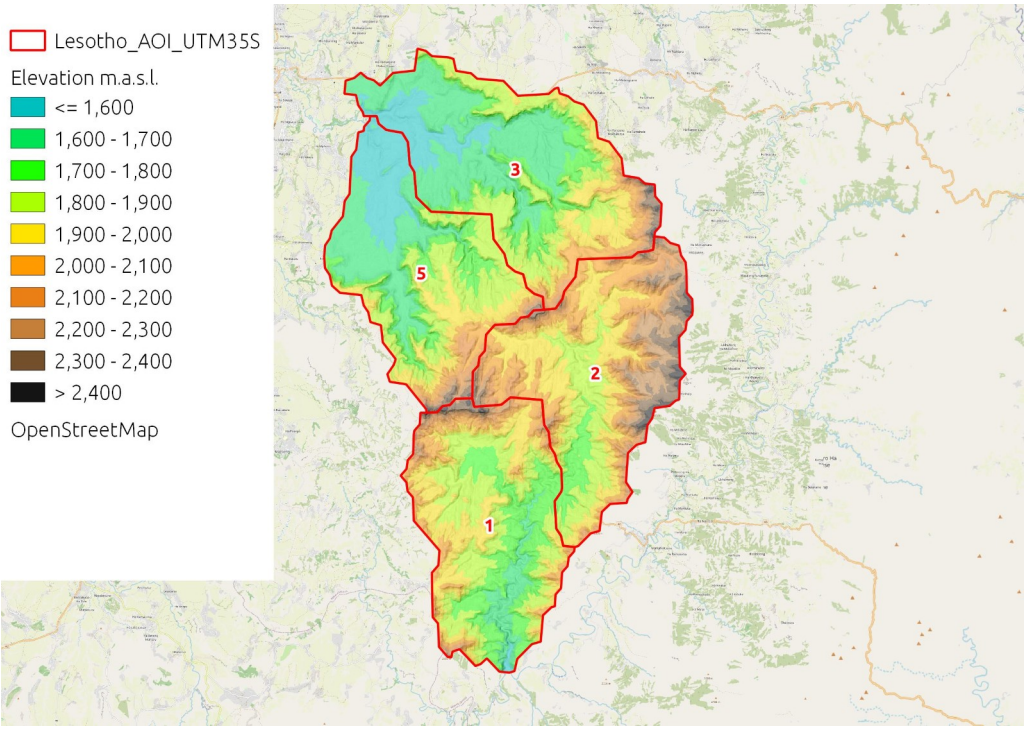
Model Inputs and Parameters

Digital Elevation Model: a raster layer that represents the topography of the study area.

It is used by the model to en-route water flowing across landscape following due to gravity. It is also used to define the spatial resolution of the analysis.

Commonly obtained from NASA SRTM product, from ESA TerraSar-X, drone photogrammetry or field topographic surveys.

It should be hydrological corrected (no sinks, filled, drainage burned if necessary)

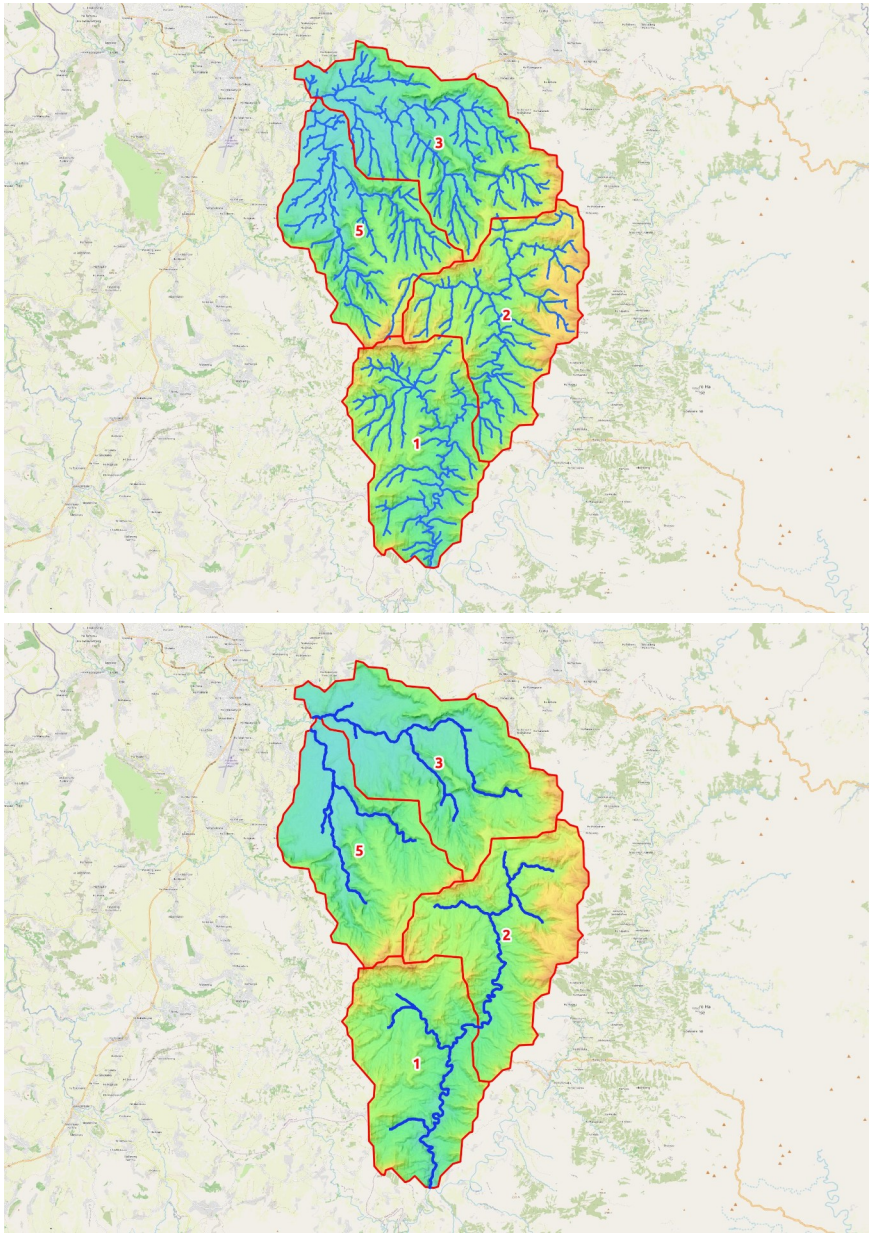


Model Inputs and Parameters

Threshold Flow Accumulation: Parameter used to delineate streams and channels.

Is used to allow the model to focus on permanent or seasonal rivers and creeks.

Depending on the scale of your analysis you can set it.



Model Inputs and Parameters

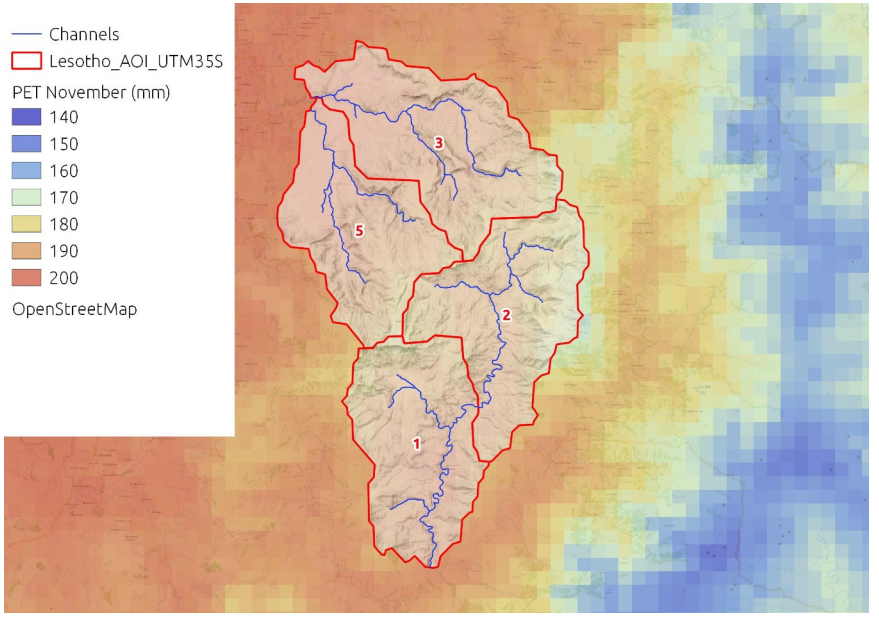
Monthly Potential Evapotranspiration (PET): This parameter is used in combination with Evapotranspiration coefficients (Kc) from vegetation to estimate water losses fro soil evaporation and plant transpiration.

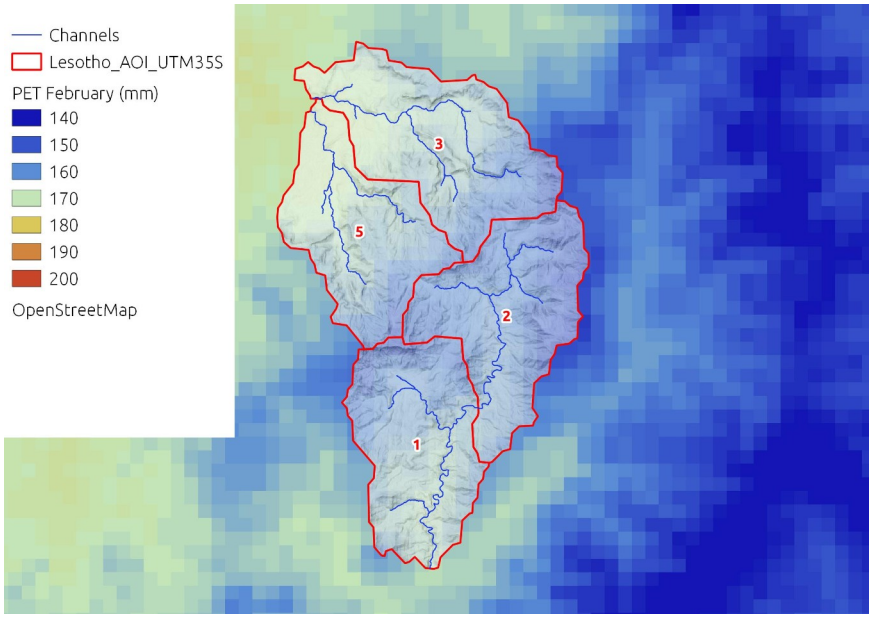
It can be obtained from meteorological data using rational equations (penman monteith, hargreaves, priestley taylor) or field measurements (lysimeter measurements)

They should be calculated from a representative period of time (min. 10 years), or from future climate (in case you are interested in future water yield modeling).

For this example we are using CGIAR Monthly PET dataset, WorldClim climatology derived.

12 raster layers (1 x each month)





Model Inputs and Parameters

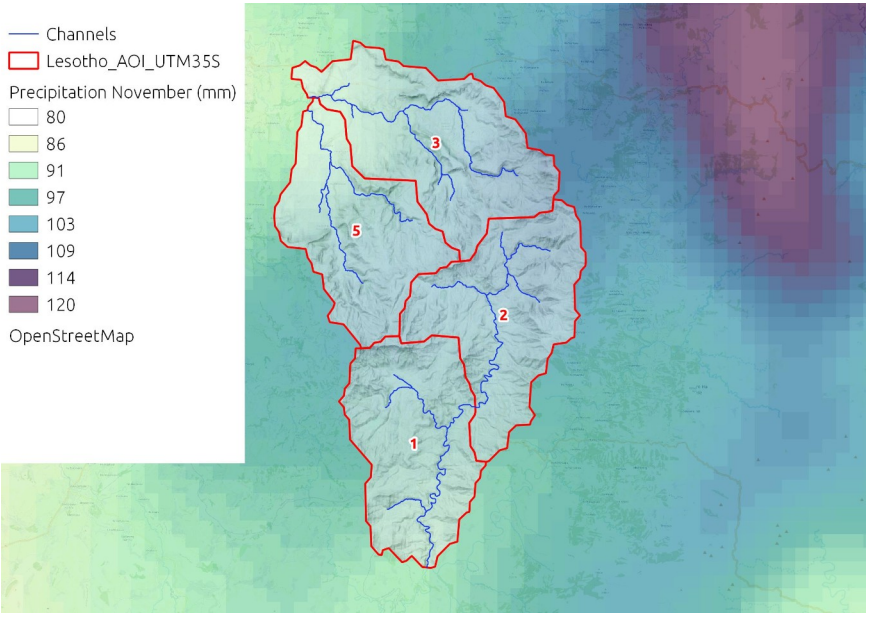
Monthly Precipiation (PET): This parameter is used to calculate water inputs from rain and snow.

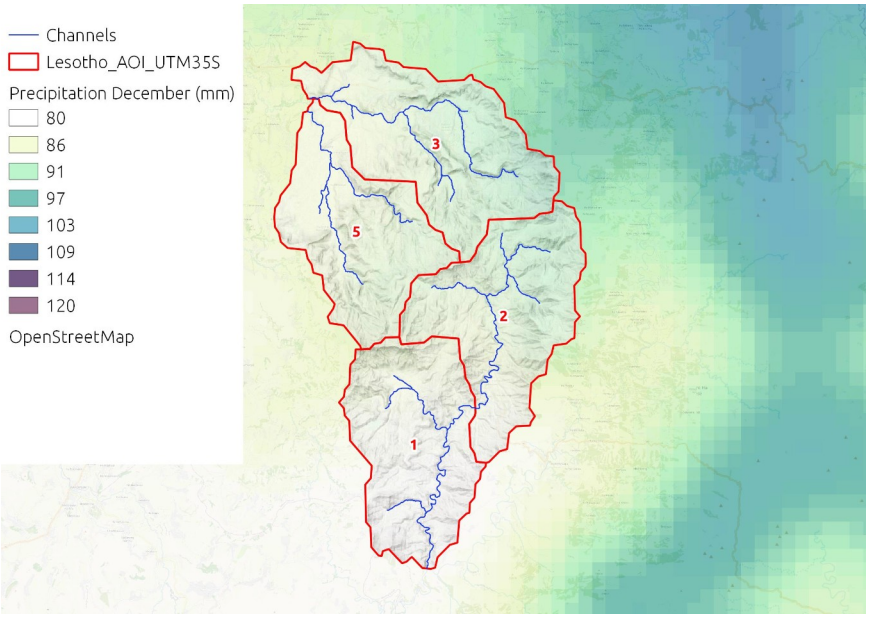
It can be obtained from meteorological data using field measurements (pluviometric data) or remote sensing data (satellite measurements GPM, TRMM, CHIRPS, etc.)

They should be calculated from a representative period of time (min. 10 years), or from future climate (in case you are interested in future water yield modeling).

For this example we are using WorldClim version 2.1 climate data for 1970-2000.

12 raster layers (1 x each month)





Model Inputs and Parameters

Biophysical table: a CSV file. A table mapping each LULC code to biophysical properties of the corresponding LULC class.

All LULC classes in the LULC raster MUST have corresponding values in this table.

Columns:

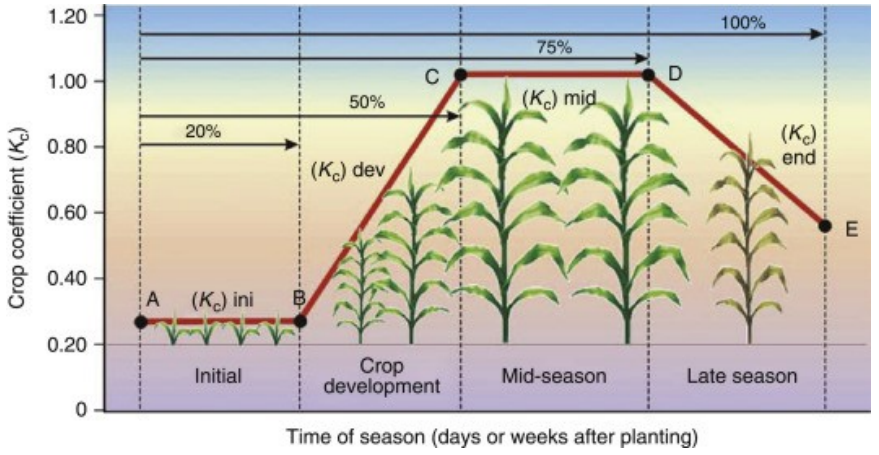
lucode (integer, required): LULC code matching those in the LULC raster.

cn_[SOIL_GROUP] (number, units: unitless, required): Curve number values for each combination of soil group and LULC class.

kc_[MONTH] (number, units: unitless, required): Crop/vegetation coefficient (Kc) values for this LULC class in each month.

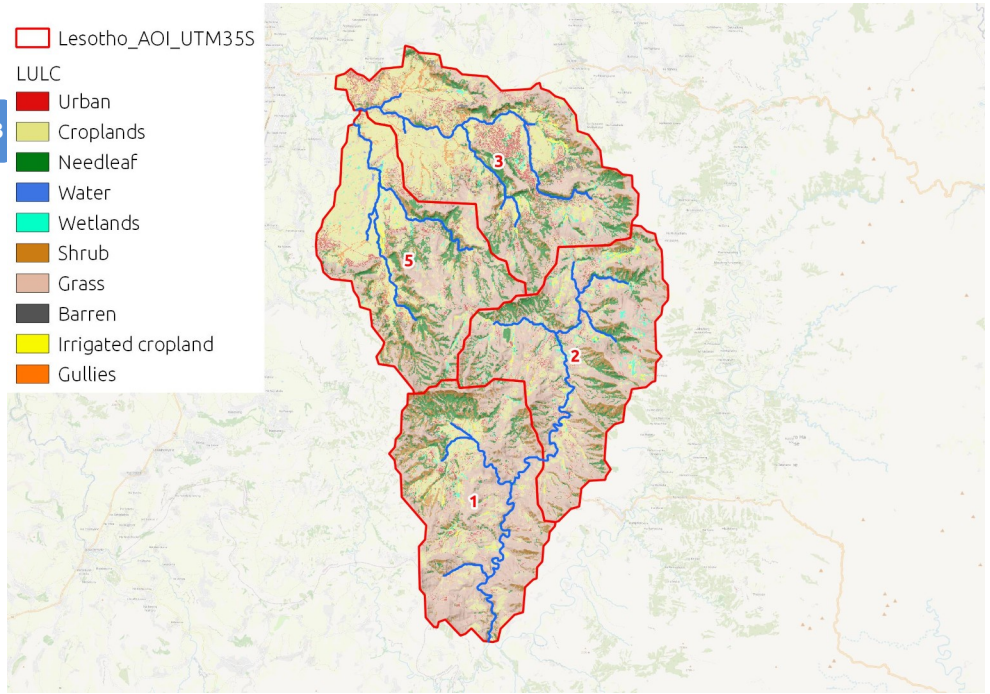
For this example we are using average coefficients from the InVEST parameters database (you can find in online) and the USDA guidance from USDA CN method (based on photos because have yet no visited the field). Kc coefs. Can be derived also from remote sensing.

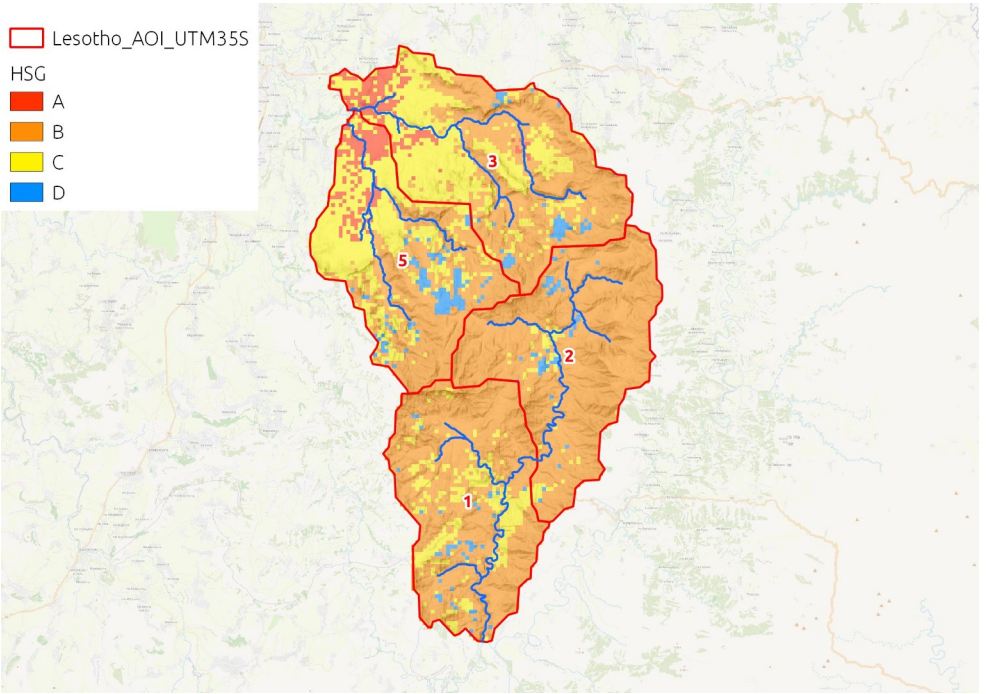
Anderson Code	Land Cover Description	Soil Class A	Soil Class B	Soil Class C	Soil Class D
0	Unclassified	54.0	70.0	80.0	85.0
100	Urban and Built-Up Land	81.0	88.0	91.0	93.0
211	Dryland Cropland and Pasture	68.0	79.0	86.0	89.0
212	Irrigated Cropland and Pasture	62.0	71.0	78.0	81.0
213	Mixed Cropland and Pasture	65.0	75.0	82.0	85.0
280	Cropland/Grassland Mosaic	65.0	75.0	82.0	85.0
290	Cropland/Woodland Mosaic	45.0	66.0	77.0	83.0
311	Grassland	54.0	70.0	80.0	85.0
321	Shrubland	45.0	66.0	77.0	83.0
330	Mixed Shrubland/Grassland	49.5	68.0	78.5	84.0
332	Savanna	57.0	73.0	82.0	86.0
411	Deciduous Broadleaf Forest	45.0	66.0	77.0	83.0
412	Deciduous Needleleaf Forest	45.0	66.0	77.0	83.0
421	Evergreen Broadleaf Forest	25.0	55.0	70.0	77.0
422	Evergreen Needleleaf Forest	25.0	55.0	70.0	77.0
430	Mixed Forest	35.0	60.5	73.5	80.0
500	Water Bodies	98.0	98.0	98.0	98.0
620	Herbaceous Wetland	30.0	58.0	71.0	78.0
610	Wooded Wetland	25.0	55.0	70.0	77.0
770	Barren or Sparsely Vegetated	68.0	79.0	86.0	89.0
820	Herbaceous Tundra	98.0	98.0	98.0	98.0
810	Wooded Tundra	98.0	98.0	98.0	98.0
850	Mixed Tundra	98.0	98.0	98.0	98.0
830	Bare Ground Tundra	98.0	98.0	98.0	98.0
900	Snow or Ice	98.0	98.0	98.0	98.0



Model Inputs and Parameters

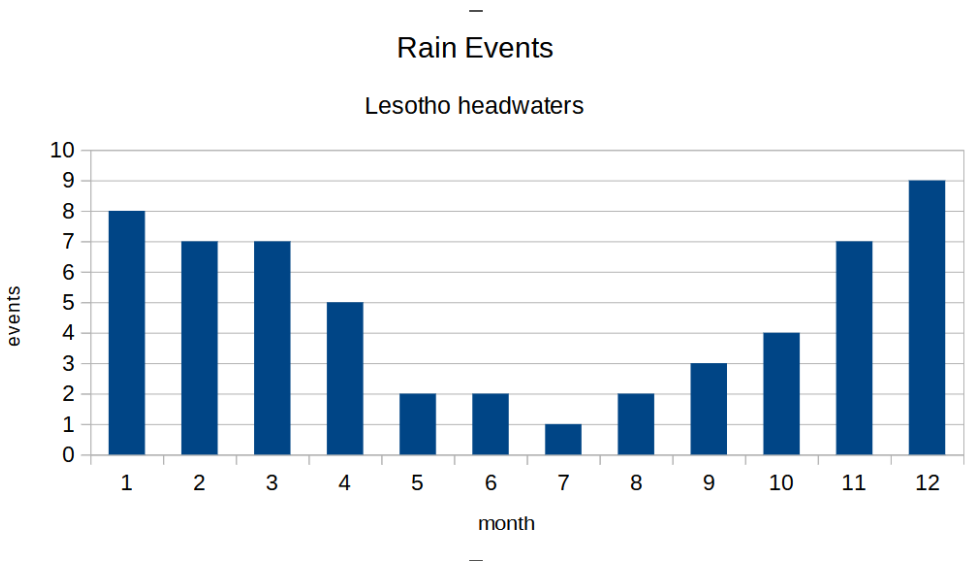
description	lucode	Kc_1	Kc_2	Kc_3	Kc_4	Kc_5	Kc_6	Kc_7	Kc_8	Kc_9	Kc_10	Kc_11	Kc_12	CN_A	CN_B	CN_C	CN_D
urban	1	0.23	0.23	0.22	0.21	0.21	0.21	0.17	0.17	0.17	0.17	0.21	0.22	76	85	89	91
croplands	2	0.50	0.50	0.46	0.40	0.28	0.15	0.15	0.15	0.15	0.15	0.15	0.26	67	77	83	87
needleleaf	4	0.60	0.60	0.60	0.50	0.50	0.25	0.25	0.25	0.25	0.25	0.50	0.5	30	46	63	66
water	6	0.63	0.58	0.53	0.48	0.43	0.38	0.33	0.38	0.43	0.48	0.53	0.58	92	92	92	92
wetlands	7	0.60	0.60	0.43	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.43	49	69	79	84
shrub	9	0.48	0.48	0.48	0.45	0.45	0.20	0.20	0.20	0.20	0.20	0.20	0.34	30	46	63	66
grass	10	0.55	0.55	0.50	0.45	0.45	0.45	0.25	0.25	0.25	0.25	0.45	0.5	31	59	72	79
barren	12	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	49	69	79	84
Irrigated Cropland	14	0.58	0.58	0.53	0.46	0.32	0.17	0.17	0.17	0.17	0.17	0.17	0.299	67	77	83	87
Gullies	15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	77	86	91	94





Model Inputs and Parameters

Rain Events table: a CSV file. A table with the average number of rain events per month in your AOI (small AOIs) or for each (sub)catchment (bigger AOIs)



Columns:

Month: 1 to 12

Events: number of rain events per month

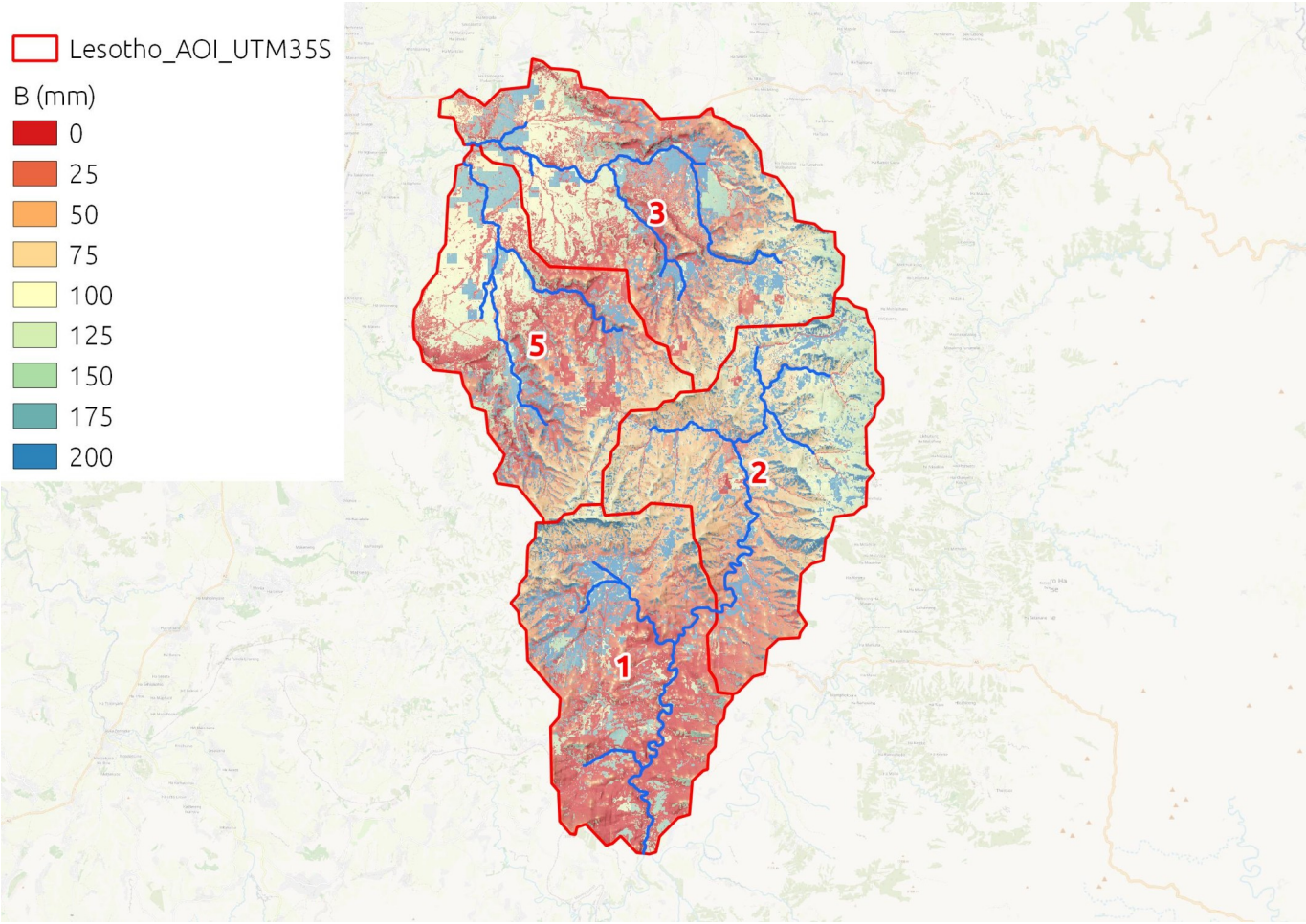
For this example we get the number of rain events per month from CHIRPS satellite rainfall measurements, for the period 2000 – 2020

Model Outputs

B surface: Map of baseflow values, the contribution of a pixel to slow release flow (which is not evapotranspired before it reaches the stream)

The baseflow index represents the contribution of a pixel to baseflow (i.e. water that reaches the stream during the dry season). If the local recharge is negative, then the pixel did not contribute to baseflow so **B** is set to zero. If the pixel contributed to groundwater recharge, then **B** is a function of the amount of flow leaving the pixel and of the relative contribution to recharge of this pixel.

Units: mm

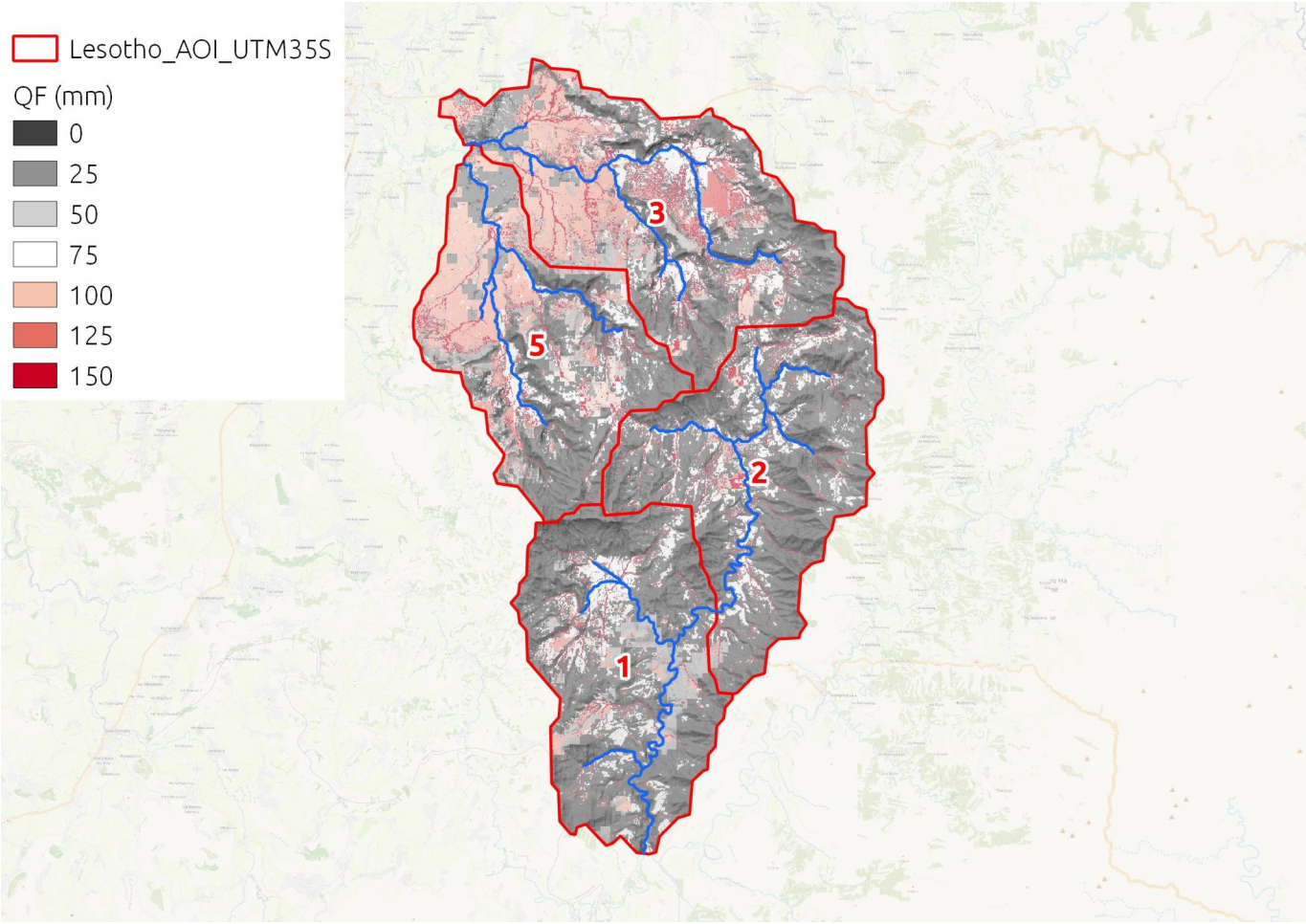


Model Outputs

QF surface: Map of quickflow (QF) values

Quickflow (**QF**) is calculated with a Curve Number (CN)-based approach. Monthly rain events cause precipitation to fall on the landscape. Soil and land cover properties determine how much of the rain runs off of the land surface quickly (producing quickflow) versus infiltrating into the soil (producing local recharge.)

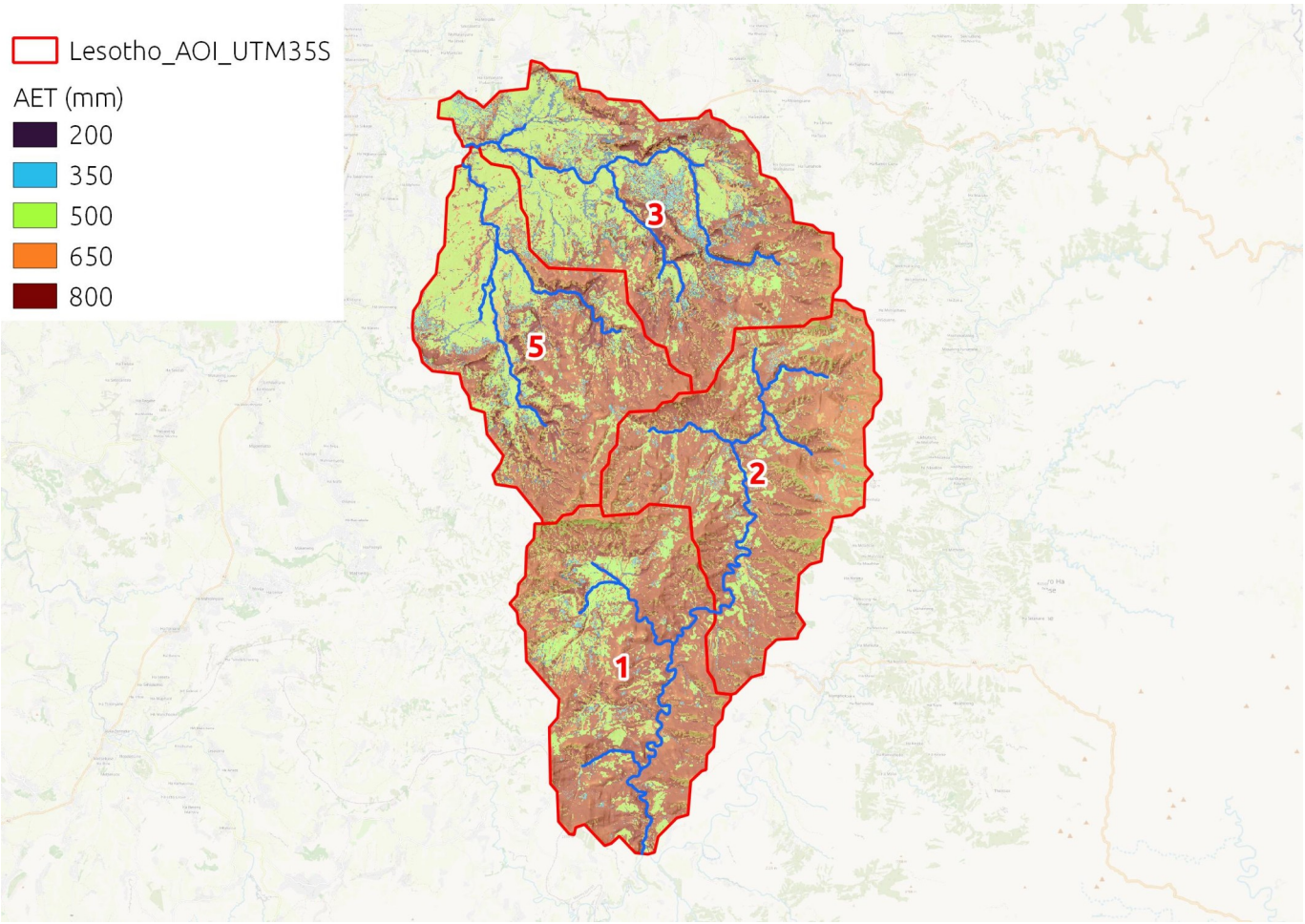
Units: mm



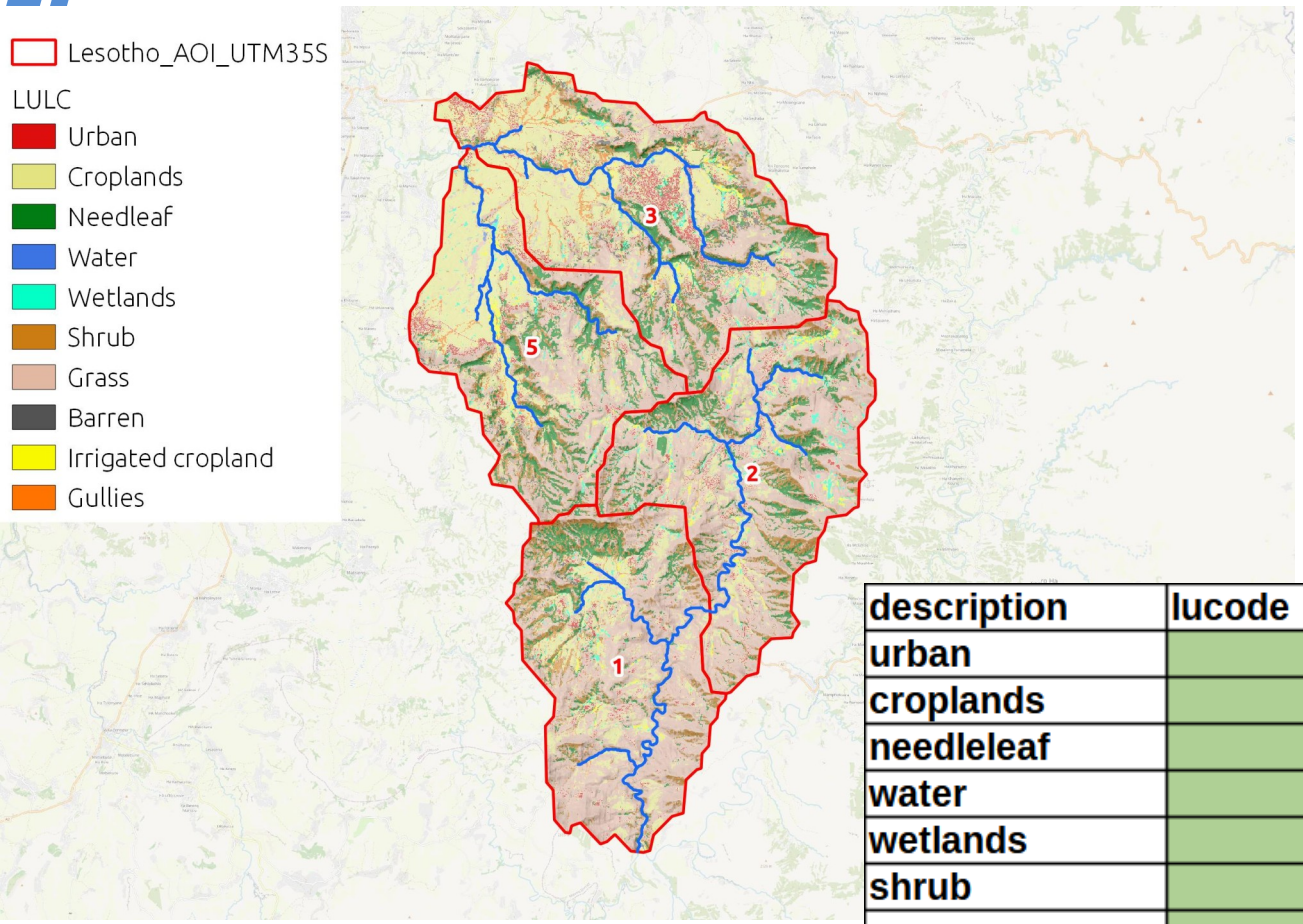
Model Outputs

AET surface: Map of actual evapotranspiration (AET)

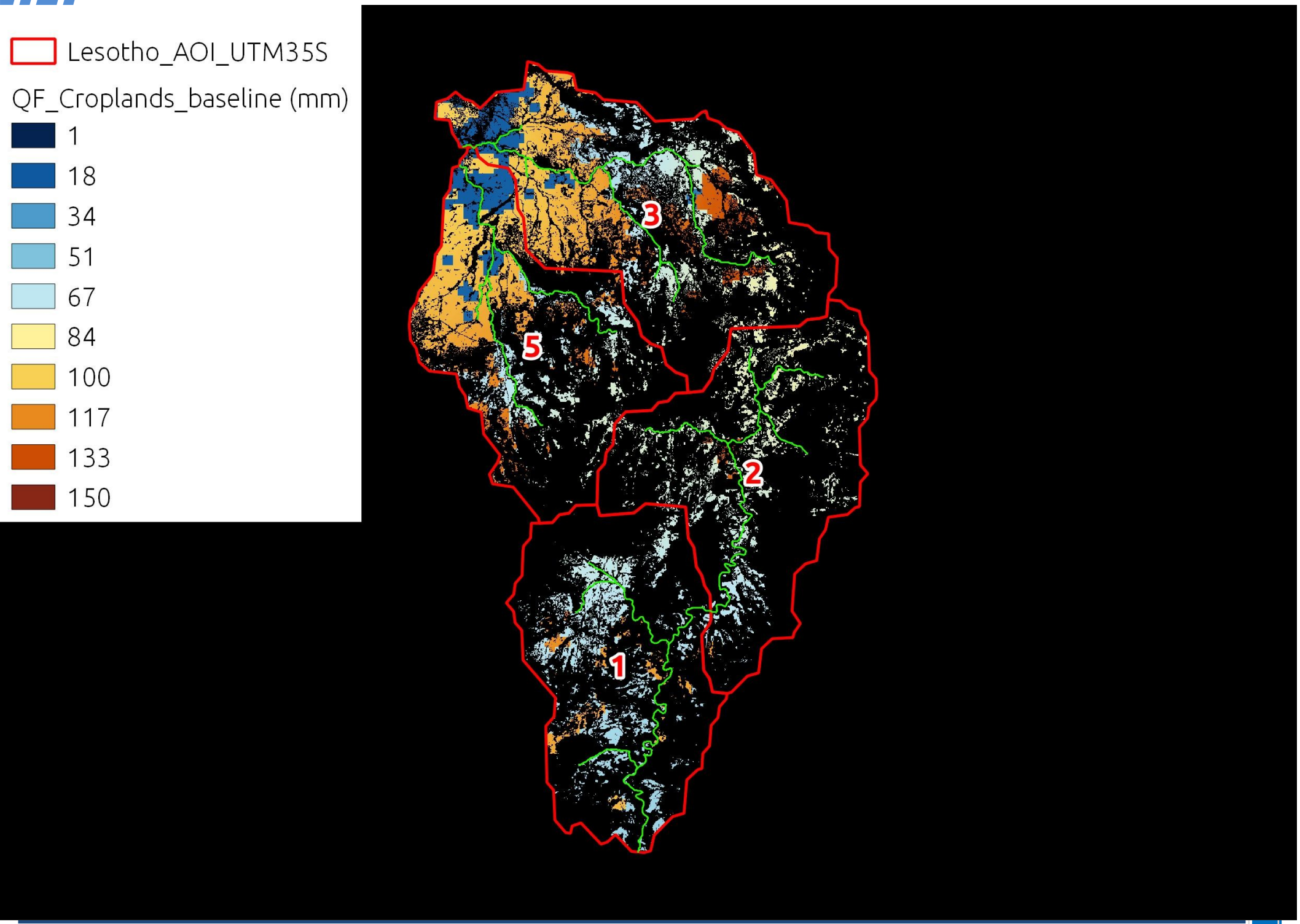
Units: mm

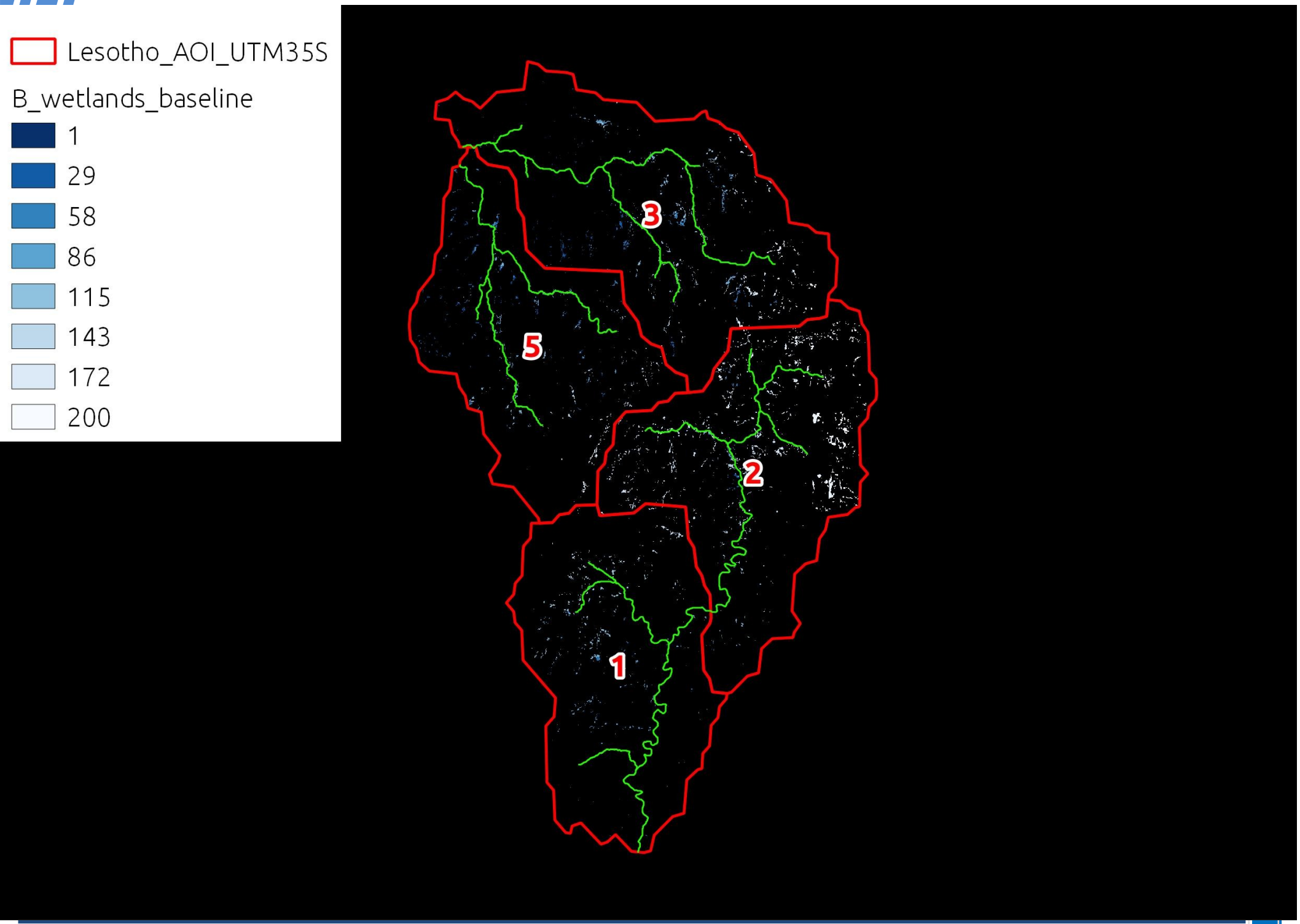


Model Outputs

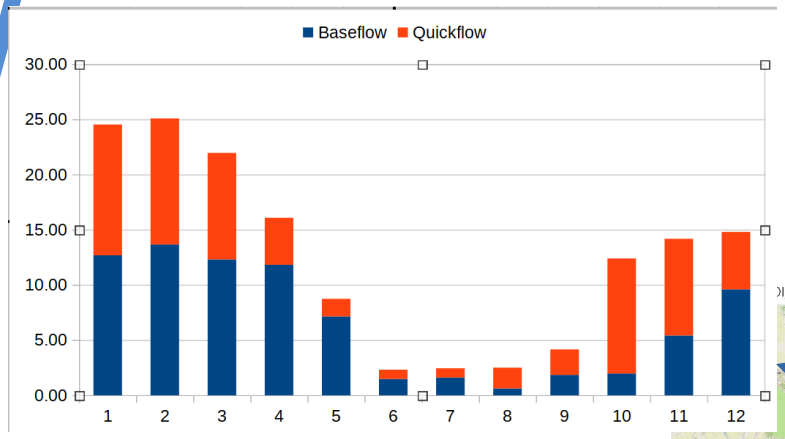


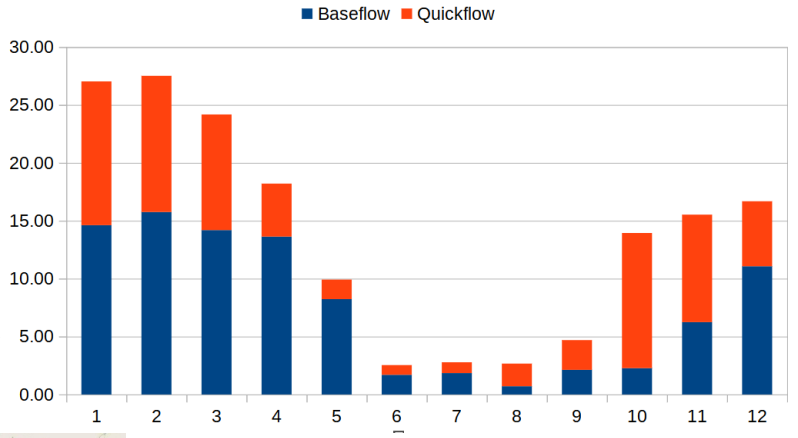
description	lucode	B (avg)	QF (avg)
urban	1	25.02	171.99
croplands	2	165.65	107.75
needleleaf	4	72.22	31.99
water	6		
wetlands	7	135.41	131.66
shrub	9	271.12	8.13
grass	10	96.15	28.96
barren	12	44.44	68.54
Irrigated Croplan	14	108.48	198.83
Gullies	15	25.57	263.59

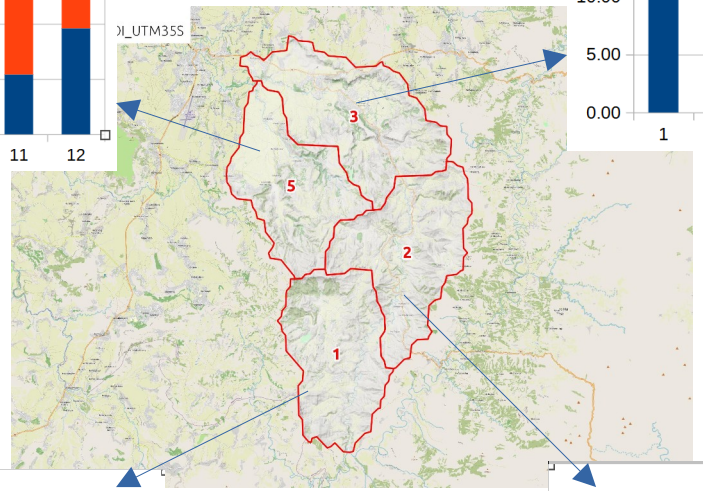

Lesotho_AOI_UTM35S
QF_Croplands_baseline (mm)
1
18
34
51
67
84
100
117
133
150
3
5
2
1

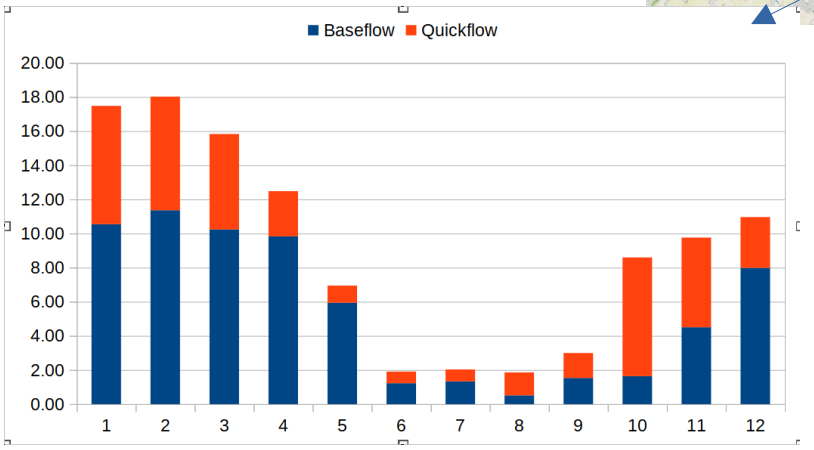

Lesotho_AOI_UTM35S
B_wetlands_baseline
1
29
58
86
115
143
172
200
3
5
2
1

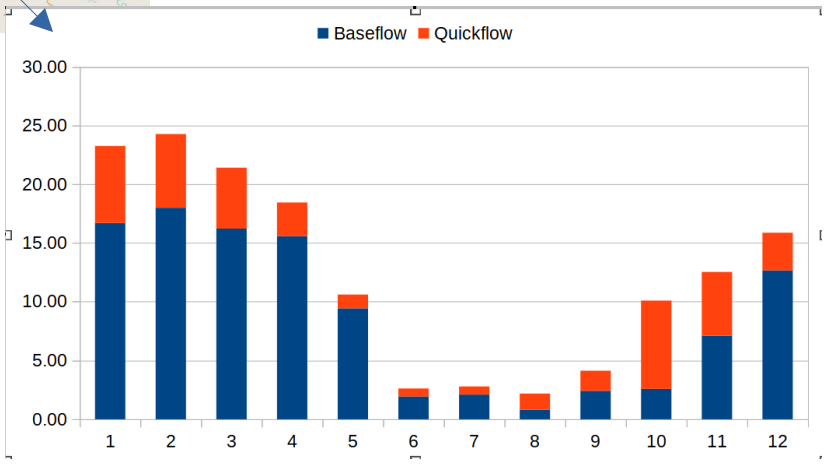
Model Outputs











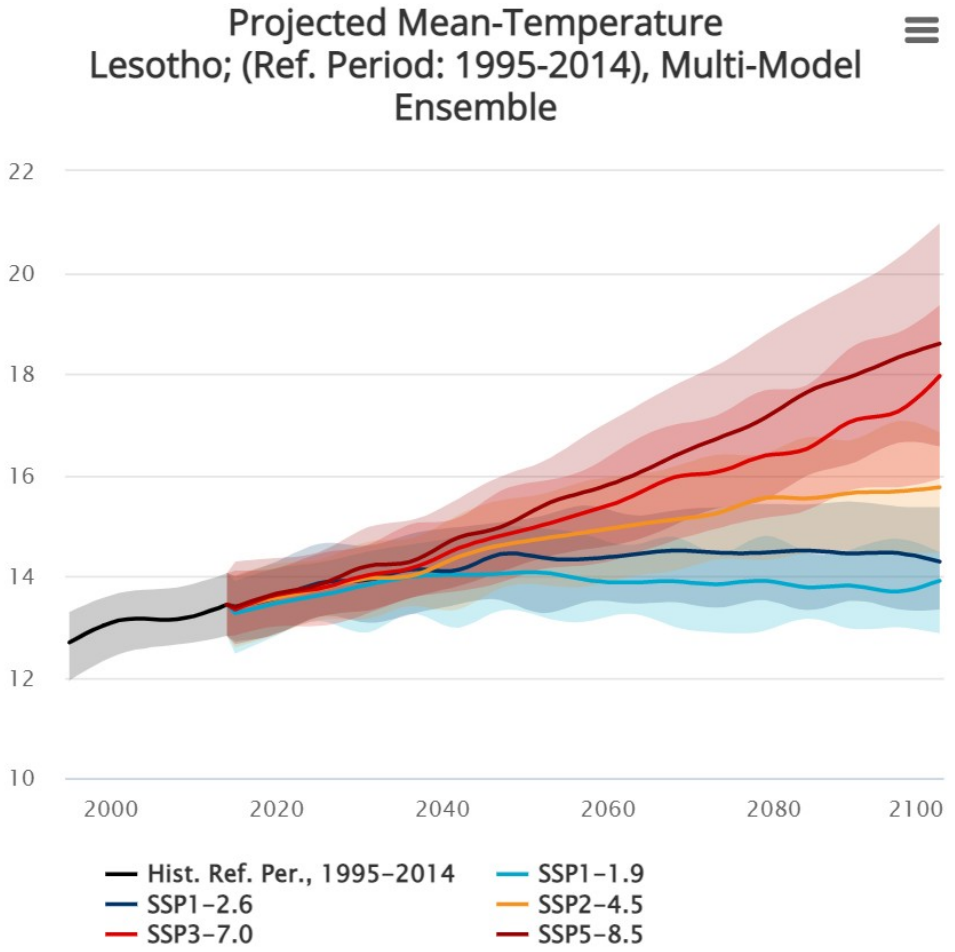
Day 2 Technical Workshop
Scenarios for Seasonal Water Yield Model

- Baseline → Scenario(s)

- To have a simple yet meaningful exercise we propose to formulate together 3 simple scenarios considering:
  - A climate change scenario
  - + a Land Degradation scenario (if we do nothing)
  - + a Land Restoration/Improv. Management scenario

Climate change scenario for Seasonal Water Yield Model

- Select 1 SSP.
- Why this SSP?
- This is introduced in the model by changing the ET and the P monthly rasters

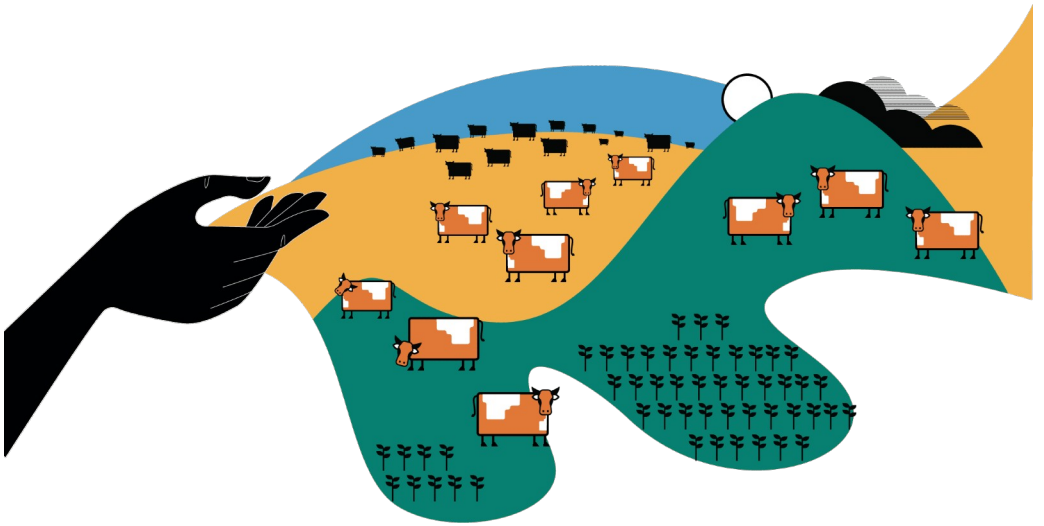


Land Degradation scenario for Seasonal Water Yield Model

- Gullies are consequence of multiple climate & human driven processes.
- Perhaps one of the most difficult cover to restore.
- This is introduced in the model by changing LULC raster.
- What do you think is the most pressing Land Use and Cover change in the watersheds?

Land Restoration RENOKA DREAM scenario for Seasonal Water Yield Model

- How does the RENOKA dream watershed looks like?
- Having seen what we saw, how do you think that vision can be translated into model inputs?

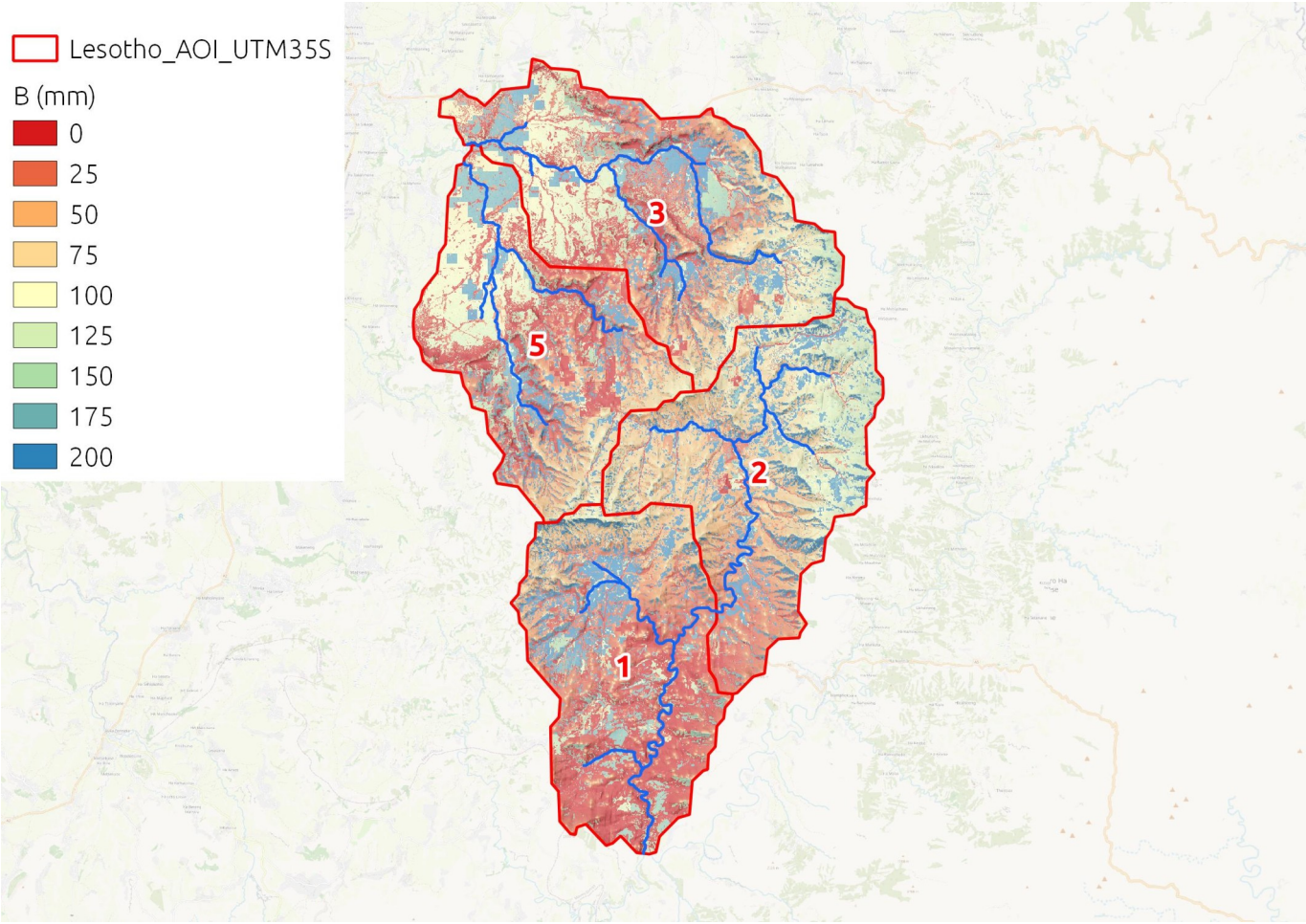


Model Outputs

B surface: Map of baseflow values, the contribution of a pixel to slow release flow (which is not evapotranspired before it reaches the stream)

The baseflow index represents the contribution of a pixel to baseflow (i.e. water that reaches the stream during the dry season). If the local recharge is negative, then the pixel did not contribute to baseflow so **B** is set to zero. If the pixel contributed to groundwater recharge, then **B** is a function of the amount of flow leaving the pixel and of the relative contribution to recharge of this pixel.

Units: mm



Overview of Input Data and Model Outputs

Seasonal Water Yield Model

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