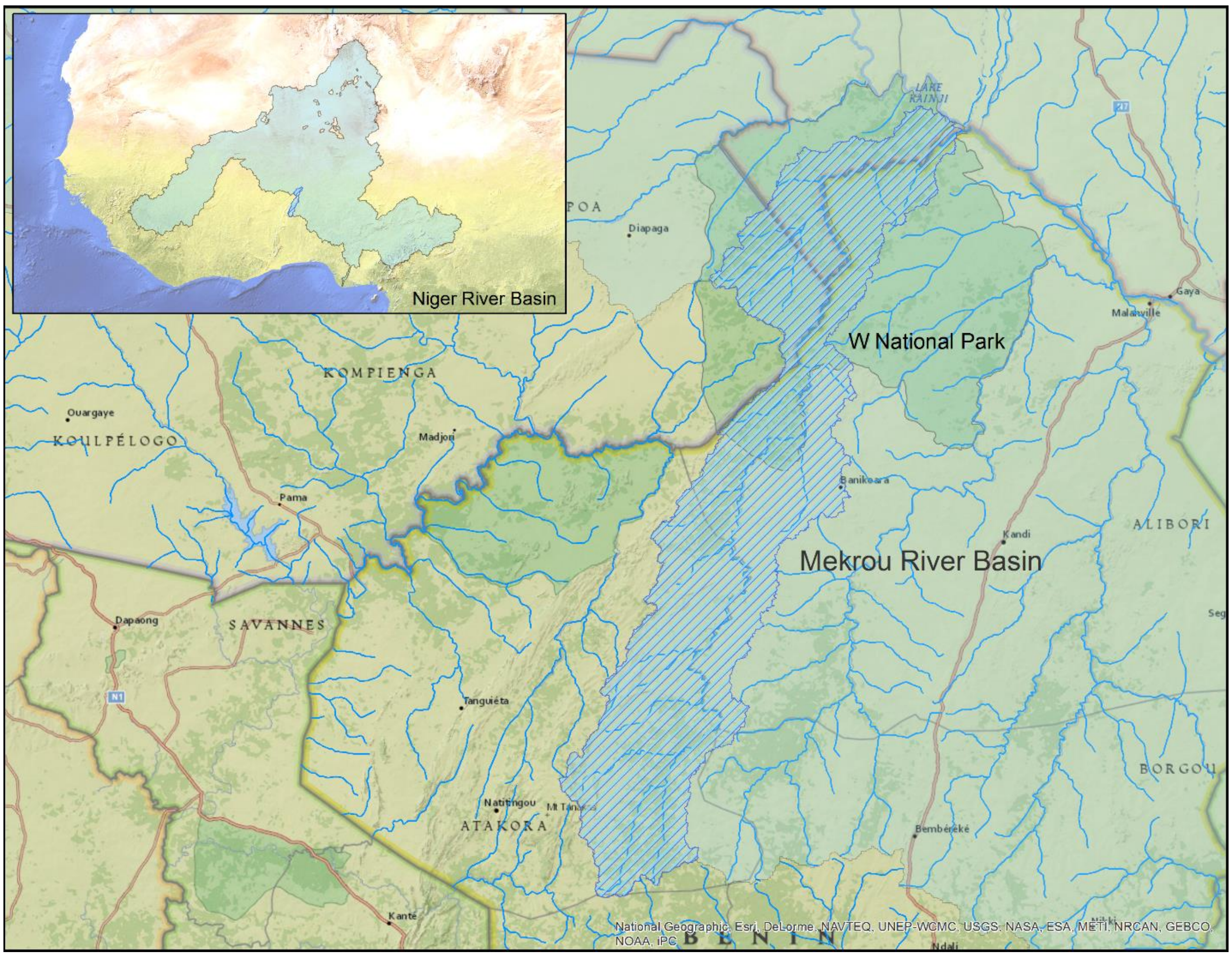
Bassin versant de la Mekrou

ATLAS OF THEMATIC MAPS

Integration for Baseline Report

DRAFT

Dropbox Link



JRC

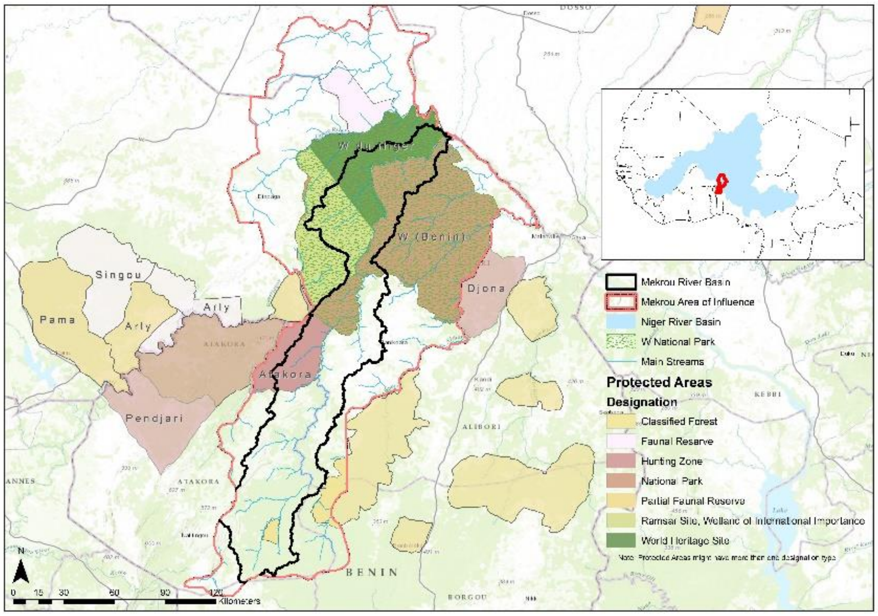
2015

Contents

1 Management

1.1 Boundaries

TITLE: Boundaries (Mekrou Area of Interest, Area of Influence and Protected zones)



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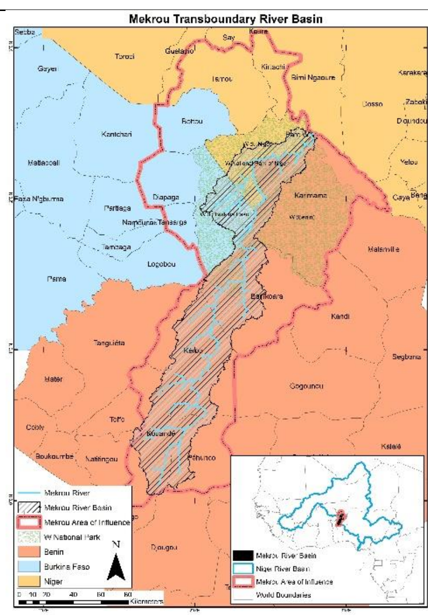
TITLE: Administrative Boundaries



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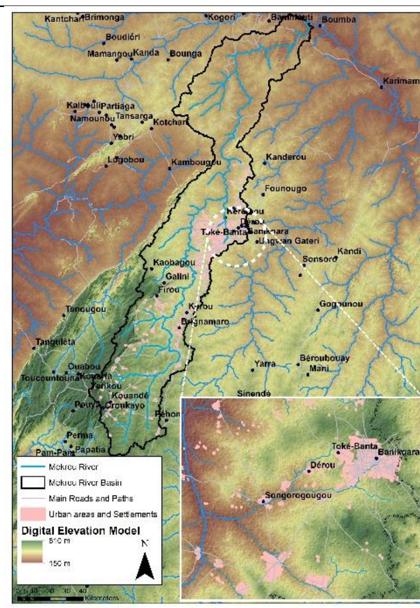
TITLE: Settlements, Roads and River Network



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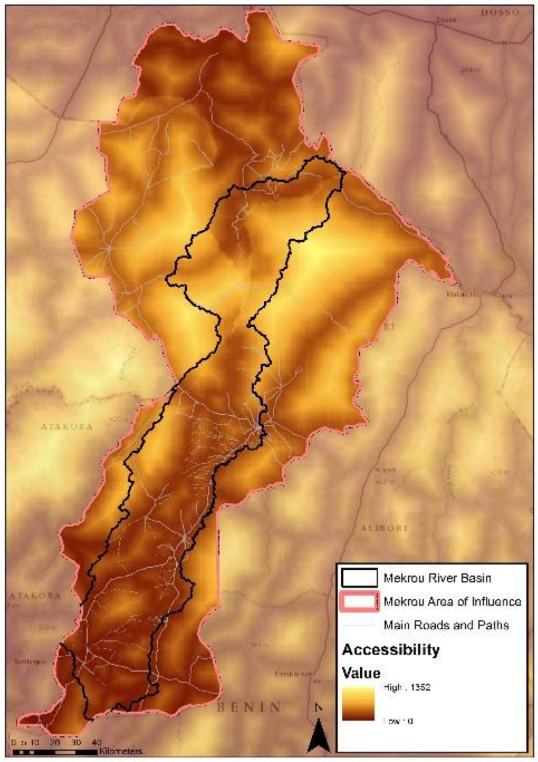
1.2 Infrastructures

1.2.1 Accesibility

TITLE: Accesibility map



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1.2.2 Irrigation

The map shows the amount of area equipped for irrigation around the year 2005 in percentage of the total area on a raster with a resolution of 5 minutes.

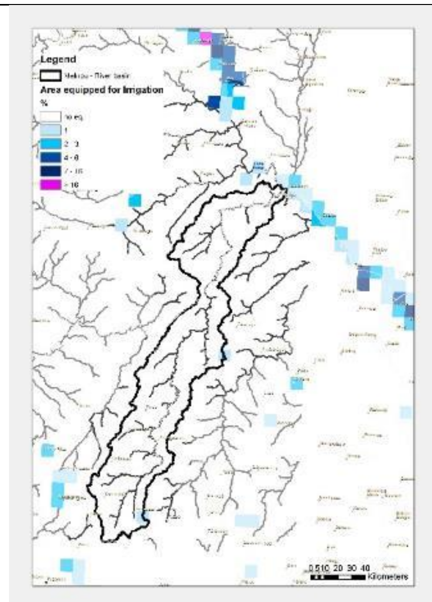
Additional available map layers refer to the percentage of the area equipped for irrigation that was actually used for irrigation and the percentages of the area equipped for irrigation that was irrigated with groundwater, surface water or non-conventional sources of water.

Map original reference: Stefan Siebert, Verena Henrich, Karen Frenken and Jacob Burke (2013). *Global Map of Irrigation Areas version 5.* Rheinische Friedrich-Wilhelms-University, Bonn, Germany / Food and Agriculture Organization of the United Nations, Rome, Italy.

Available Online: http://www.fao.org/nr/water/aquastat/irrigationmap/

According to FAO data no area is currently equipped for irrigation except the northern area around the Niger River.

TITLE: Area equipped for Irrigation



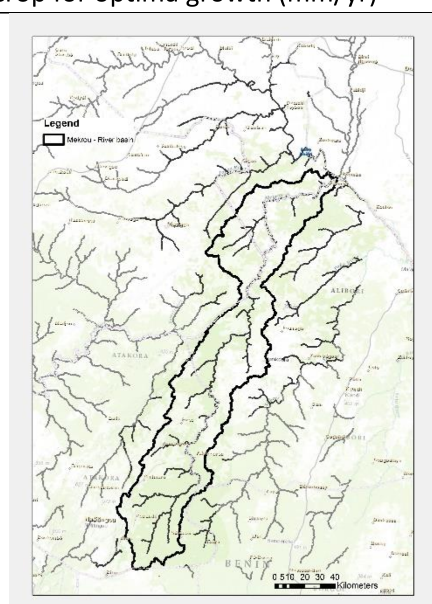
[Download High Resolution Map]

1.2.2.1 Irrigation potential requirements

Irrigation water volume required under a potential optimal growing scenario for different crops.

Here Map for Sorghum is reported (other layers and crops availible in the Geodb).

TITLE: Volume of water required by crop for optima growth (mm/yr)



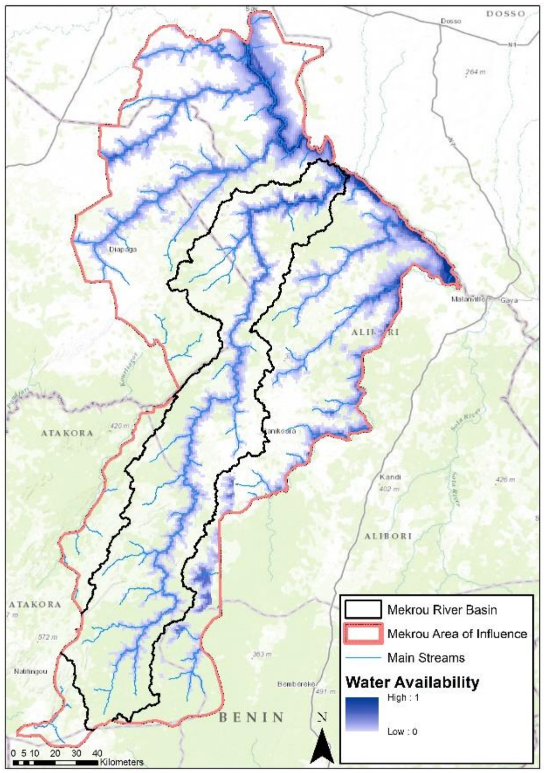
[Download High Resolution Map]

1.3 Water

1.3.1 Water Availability Index

A multicriteria indicator of topographic and hydrological water availability was calculated based on distance from nearest river stream (also differentiated with average discharge); elevation above nearest stream (as an indicator of need to pump water if needed).

TITLE: Water availibility Indicator



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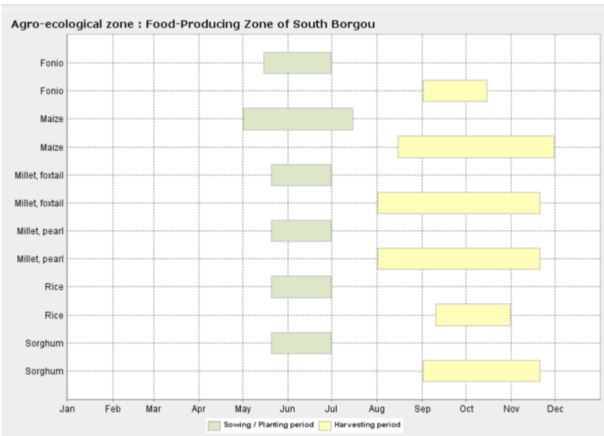
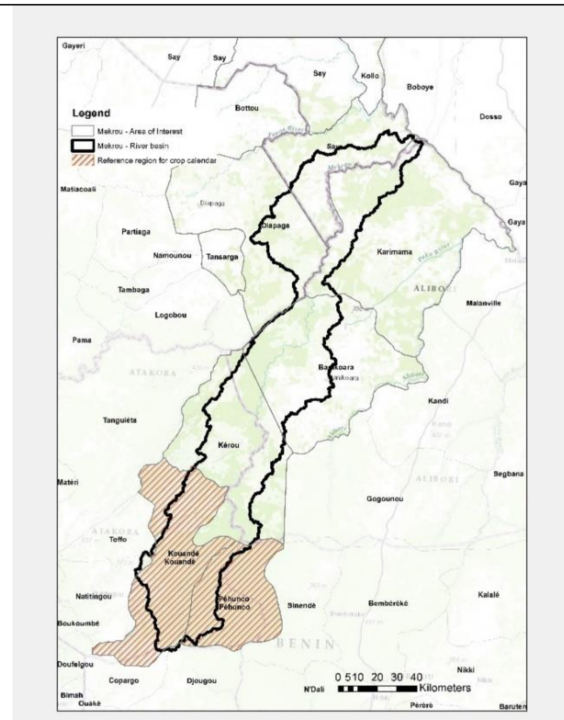
1.4 Agriculture

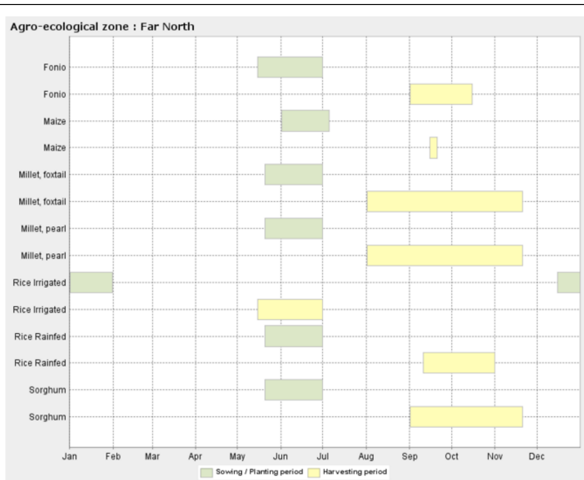
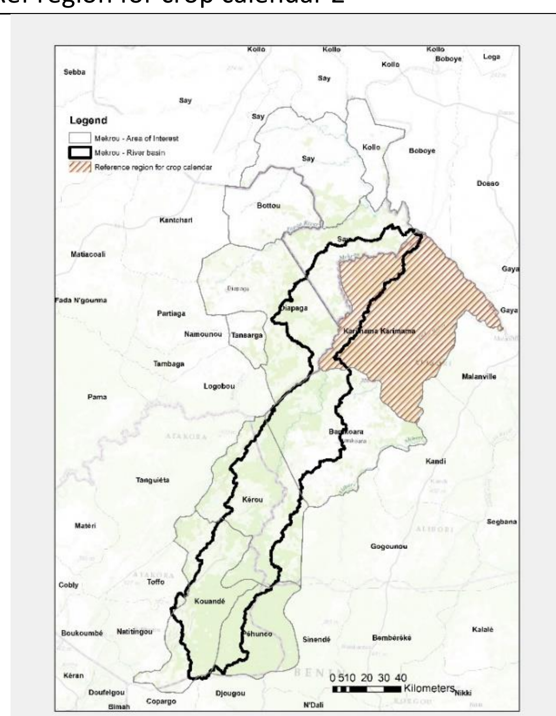
1.4.1 Crop management

Crop management is one of the most important sets of input required. It consists of detailed schedules and characteristics of the most common crop operations including sowing, harvesting, tillage, fertilisation, and irrigation, for each of the crop used in the region.

1.4.1.1 Crop Calendars examples

Here is an example crop calendar (extracted from http://www.fao.org/agriculture/seed/cropcalendar/)for Benin agro-ecological zone of South Borgou for some cereals crop. Maps of different regions with specific crop calendars (locally defined) would be need.

<table>
<tr><td>Ref. crop calendar 1 for cereals</td><td>Ref region for crop calendar 1</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Download High Resolution Graph</td><td>Download High Resolution Map</td></tr>
</table>

<table>
<tr><td>Ref. crop calendar 2 for cereals</td><td>Ref region for crop calendar 2</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

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1.4.2 Crop / Pasture land

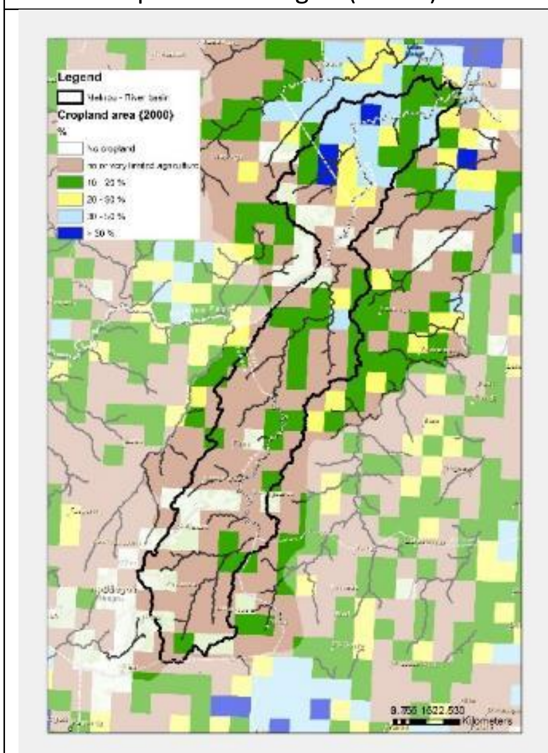
The map shows the current cropland and pasture share in the region. Map is derived by data from a global dataset for year 2000 at a spatial resolution of about 10 km (5 min).

Agricultural inventory data and satellite-derived land cover data. were used to train a land cover classification data set obtained by merging two different satellite-derived products (Boston University's MODIS-derived land cover product and the GLC2000 data set).

According to this data about 135000 ha of the river basin are classified as cropland, that means only about 13% of the river basin is currently used as cultivated land.

65100 ha area classified as pasture area corresponding about 6% of total river basin area.

TITLE: Crop Land share grid (5' res.)



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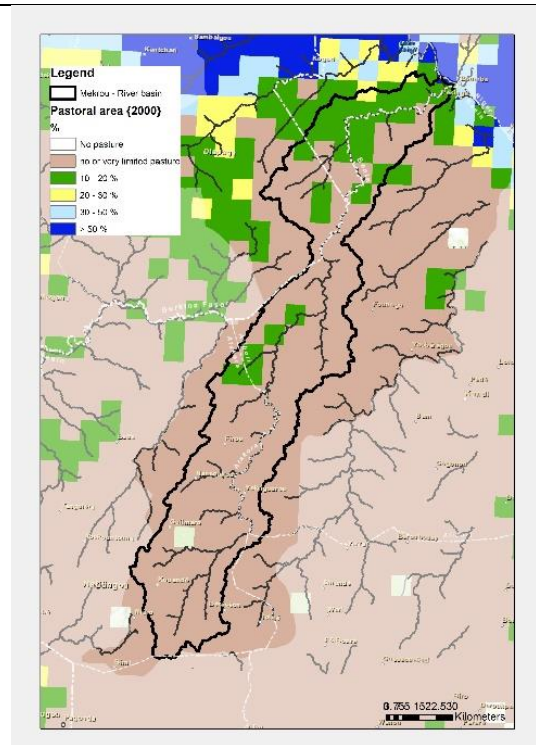
TITLE: PastrureLand share grid (5' res.)



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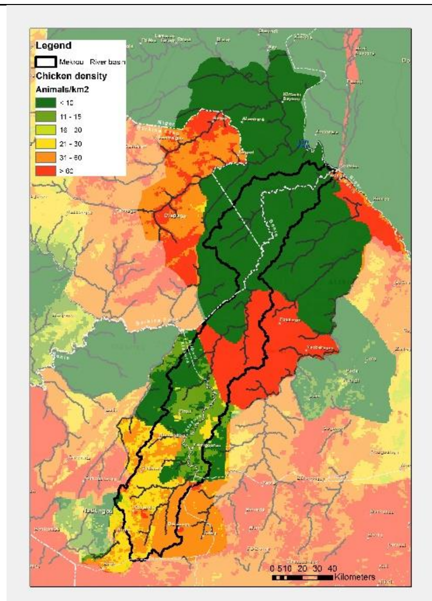
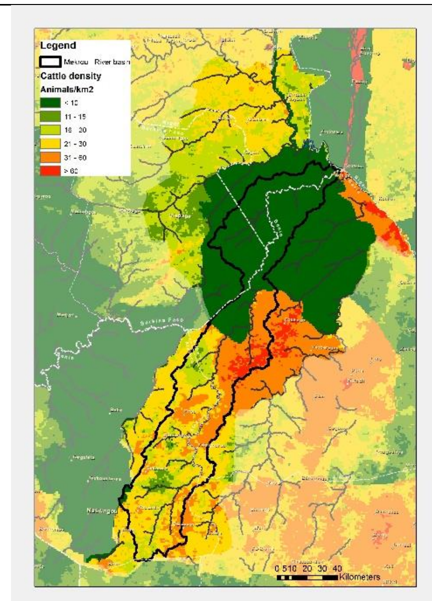
1.5 Livestock

TITLE: Chickens desnity	TITLE: Cattle density
	
Download High Resolution Map	Download High Resolution Map

Statistics by Administrative Communes

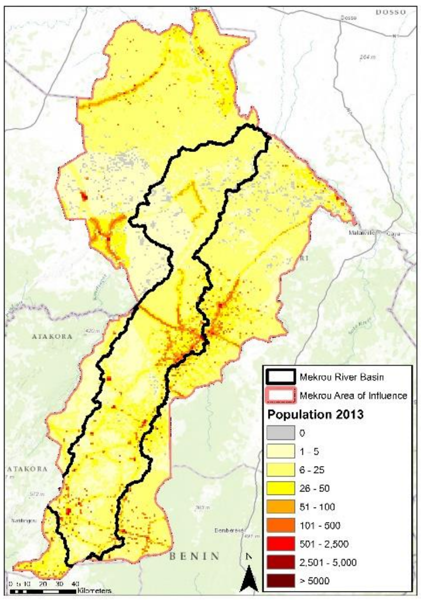
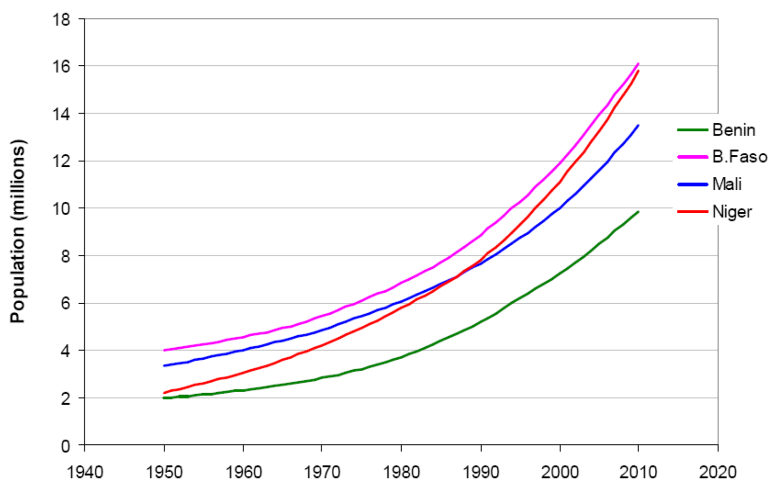
ISO	COUNTRY	NAME_1	NAME_2	NAME_3	OBJECTID_1	AVG Cattle density	Area km2	Tot Cattle	Avg Chicken density	Tot chickens
BEN	Benin	Atakora	Kérou	Kérou	1	25.2	3857.0	97197	13.5	52070
BEN	Benin	Atakora	Kouandé	Kouandé	2	22.2	3238.0	71883	28.8	93254
BEN	Benin	Atakora	Péhunco	Péhunco	3	28.2	2081.5	58699	42.6	88673
BEN	Benin	Alibori	Karimama	Karimam	4	7.2	5920.7	42629	16.1	95324
BEN	Benin	Alibori	Banikoara	Banikoar	5	41.3	4379.8	180886	107.2	469514
BFA	Burkina Faso	Tapoa	Bottou	Bottou	6	18.5	1873.3	34655	60.0	112395
BFA	Burkina Faso	Tapoa	Diapaga	Diapaga	7	6	3984.3	23906	21.2	84467
BFA	Burkina Faso	Tapoa	Tansarga	Tansarga	8	18.4	579.7	10667	79.6	46146
NER	Niger	Tillabéry	Kollo	Kirtachi	9	16.3	1026.3	16728	0.6	616
NER	Niger	Tillabéry	Say	Tamou	10	22.8	2792.5	63668	1.1	3072
NER	Niger	Tillabéry	Say	Parc W	11	0.7	2341.2	1639	0.1	234

Table 1. Livestock statistic data derived by modelled livestock density Maps.

1.6 Others

2 Socio-Economic

2.1 Demography

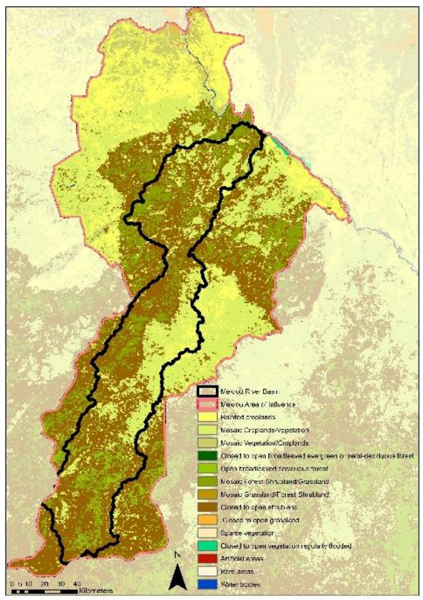
<table>
<tr><td>TITLE: Population</td><td>TITLE: Population Stimates/projections for the middle Niger basin countries (1950-2010)</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>[Download High Resolution Map]</td><td></td></tr>
</table>

2.2 Surveys

3 Biophysical

3.1 Landcover/Landuse

TITLE: Land Cover/Land Use



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3.2 Soils

The Harmonized World Soil Database (Fao et al., 2012) with a resolution of about 1 km was used to characterize soils in the Region.

Different soil data are available for each soil mapping unit and soil typology and for 2 soil layers. Data are stored in a Geodb (ex: data: texture, drainage, AWC, soil depth, organic carbon, gravel, bulk density, $CaCO_3$, TSB, etc).

Data at 6 reference depths (2.5,10,22.5,45,80,150 cm) are also available as 1km raster grid (Hengl T. et al. 2014) containing spatial modelled data for a selection of soil properties soil organic carbon (g kg^{-1}), soil pH, sand, silt and clay fractions (%), bulk density (kg m^{-3}), cation-exchange capacity (cmol+/kg), coarse fragments (%), soil organic carbon stock (t ha^{-1}), depth to bedrock (cm), World Reference Base soil groups, and USDA Soil Taxonomy suborders.

3.2.1 Soil Type

A total of 16 different soil mapping units corresponding to 6 different soil types are available in the region of interest.

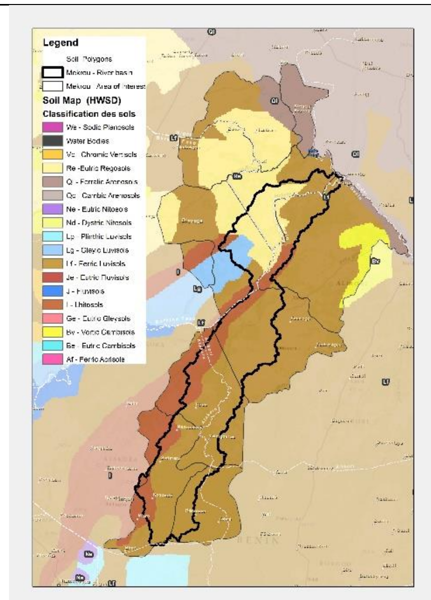
Dominant soil in the area are classified as Ferric Luvisols (58% of the area). The Reference Soil Group of the Luvisols holds soils whose dominant characteristic is a marked textural differentiation within the soil profile, with the surface horizon being depleted of clay and accumulation of clay in a subsurface 'argic' horizon.

Other dominat soil types are Eutric Regosols (17%) and Lihtosols (12%).

Regosols are very weakly developed mineral soils in unconsolidated materials that have only an ochric surface horizon and that are not very shallow. Regosols are extensive in eroding lands, in particular in arid and semi-arid areas and in mountain regions.

Lihtosols may be described as soils which are shallow or stony: usually there is a limiting horizon of consolidate rock or massive material.

TITLE: Soil Types



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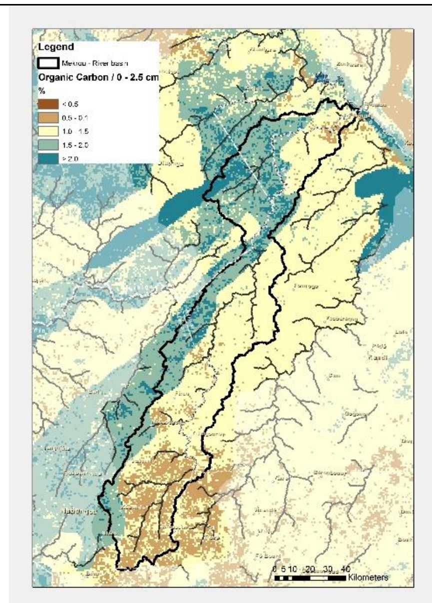
3.2.2 Soil Top Layer organic carbon content

Organic carbon content ranges between very low values (about 0.3 %) to moderate values (1 – 1.4%).

Average organic carbon content in the area is about 0.8 % which is a quite limited value to support a high productive agriculture (above all on the long term).

Anyway this data are derived from a limited number of survey and maybe more local data would show a better discretization of soil and would allow to identify regions more rich in organic carbon and potentially more productive. The most rich soils for the organic carbon content are the Lithosols and are located in the western part of the River basin.

TITLE: Soil Top layer Organic Carbon content

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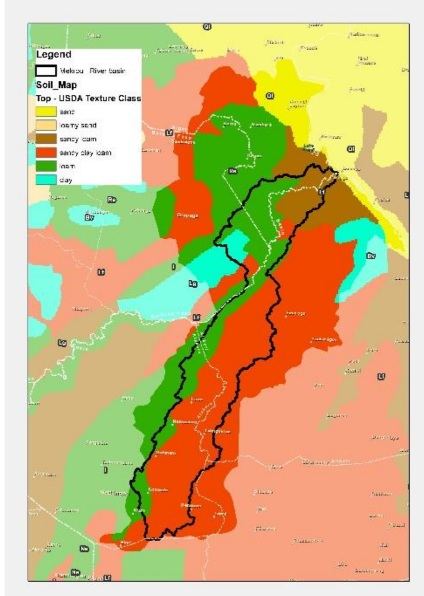
3.2.3 Soil Top Layer Texture class

Soil texture is a qualitative classification tool used in both the field and laboratory to determine classes for agricultural soils based on their physical texture. The class is then used to determine crop suitability and to approximate the soils responses to environmental and management conditions such as drought.

In the area the dominants texture classes are the sandy-clay-loam and loam which corresponds to intermediate classes. In general high content of sand (>85%) limits agricultural suitability: also high content of clay (>50%) and Lime(>60%) may limit soil suitability for crop production. In the basin soil with the highest content of sand are mainly located in the Northern eastern part, while in the central and in the south the sand content is quite moderate (See Sand Content Map).

TITLE: Soil Top layer Texture Class (for dominat soils)

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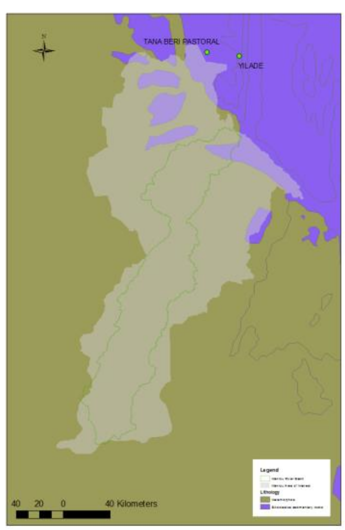
3.3 Geology

3.3.1 Lithology

The GLiM database is the one with the highest detail on lithological information in the region. According to the information therein, metamorphic rocks cover the largest part of the area of interest, while in the northern and north-eastern part there are also some siliciclastic sedimentary formations.

TITLE: Lithology


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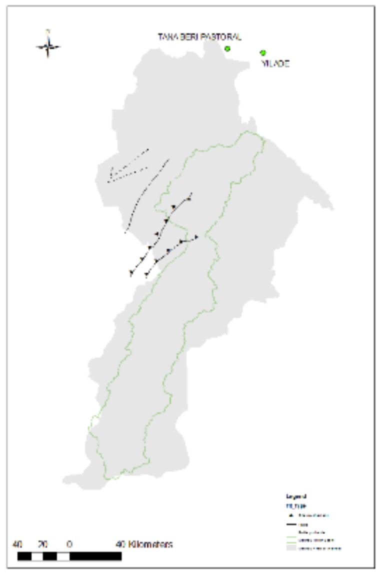
3.3.2 Lineaments (faults, cracks, folds)

Information regarding lineaments is available so far, only for the Burkina Faso part of the catchment, digitised from the 1976 Geological map, published by the Directorate of Geology and Mines. According to that map, there are two thrust faults in the area, one fault and three probable faults.

TITLE: Lineaments (faults, cracks, folds)



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3.4 Hydrogeology

3.4.1 Groundwater distribution

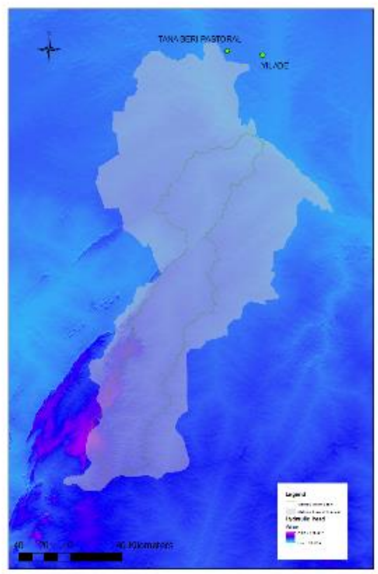
From the results of the global model that has been developed (Fan et al., 2013), a map of the region can be obtained showing the simulated groundwater table depth for the whole region. Since there were no calibration points within the area of interest, it is possible that the simulation data will have discrepancies with the actual situation. Nevertheless, the simulated results can give a first educated guess of the expected situation in the field, since the model takes into account multiple parameters of the water cycle. The groundwater distribution is calculated as the difference between the land surface at each point and the respective water table depth value.

	COUNTRY	NAME	NAME	MIN [m]	MAX [m]	MEAN [m]	STD [m]	RANGE [m]
1	Niger	Tillabéry	Kollo (Kirtachi)	140.1	220.8	191.5	11.9	80.7
2	Niger	Tillabéry	Say	136.2	269.3	214.8	23.6	133.1
3	Burkina Faso	Tapoa	Bottou (Botou)	191.3	259.1	232.4	12.2	67.8
4	Burkina Faso	Tapoa	Diapaga	176.1	322.3	254.5	17.9	146.2
5	Burkina Faso	Tapoa	Tansarga	199.0	319.3	254.1	27.2	120.3
6	Benin	Alibori	Banikoara	211.3	379.5	272.7	20.8	168.2
7	Benin	Alibori	Karimama	131.0	298.2	220.6	27.9	167.2

8	Benin	Atakora	Kérou	123.1	473.8	323.4	48.0	350.8
9	Benin	Atakora	Kouandé	270.2	623.3	400.9	54.1	353.1
10	Benin	Atakora	Péhunco (Pehonko)	294.5	436.7	358.4	26.8	142.3
			Average	187.3	360.2	272.3	27.0	173.0

Table 2. Statistical analysis results of simulated water table values from (Fan et al., 2013)

TITLE: Groundwater distribution



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3.4.2 Aquifers and their potential

As of this moment, there is no specific information available, concerning the aquifers in the region and their potential.

3.4.3 Distribution of drillings with indication of their success or failure

As of this moment, there is no specific information available, concerning the distribution of drillings in the area with indication of their success or failure.

3.4.4 Depth to the water table

A direct output of the aforementioned global model (Fan et al., 2013) was the simulated depth to the water table. The data are available for download from the journal's website.

	COUNTRY	NAME	NAME	MIN [m]	MAX [m]	MEAN [m]	STD [m]
1	Niger	Tillabéry	Kollo (Kirtachi)	0	63.9	31.7	14.3
2	Niger	Tillabéry	Say (Parc W)	0	51.3	16.9	11.9
3	Niger	Tillabéry	Say (Tamou)	0	56.6	23.9	13.6
4	Burkina Faso	Tapoa	Bottou (Botou)	0	39.1	13.8	9.0
5	Burkina Faso	Tapoa	Diapaga	0	86.4	13.0	10.8
6	Burkina Faso	Tapoa	Tansarga	0	52.0	9.8	11.1
7	Benin	Alibori	Banikoara	0	86.2	12.4	10.5

8	Benin	Alibori	Karimama	0	66.2	14.2	11.2
9	Benin	Atakora	Kérou	0	119.9	13.8	14.0
10	Benin	Atakora	Kouandé	0	113.4	17.0	16.0
11	Benin	Atakora	Péhunco (Pehonko)	0	55.1	13.7	10.3
			Average	0	71.8	16.4	12.1

Table 3. Statistical analysis results of simulated water table depth values from (Fan et al., 2013)

From a statistical analysis of the simulated data for the region, the results show that the absolute largest values of water table depth are expected in the Kérou and Kouandé parts. If the mean values of simulated water table depth are taken into account though, they show that these parts of the basin do not have generally deep groundwater, since the mean values are close to those of the general average value for the whole basin. The overall average of about 16 meters shows that the water table is expected to be rather shallow in the region.

TITLE: Depth to the water table

[Download High Resolution Map]

3.4.5 Specific discharge/productivity

As of this moment, there is no specific information available, concerning specific discharge and aquifer productivity.

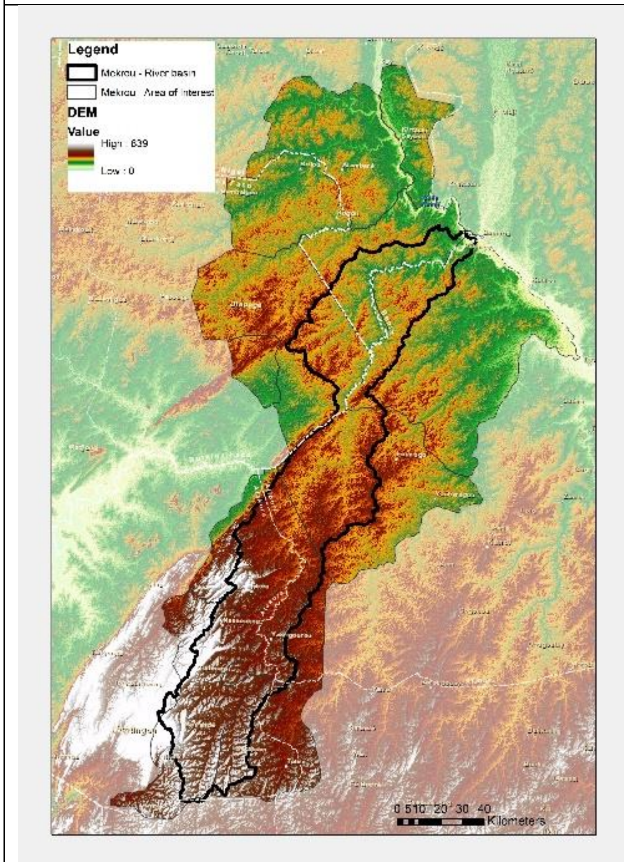
3.5 DEM / Hydrology

3.5.1 DEM

SRTM30 - Digital Elevation Model – 30m resolution. SRTM30 is a near-global digital elevation model (DEM) comprising a combination of data from the Shuttle Radar Topography Mission

Source: http://www2.jpl.nasa.gov/srtm/

TITLE: DEM



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3.5.2 Watersheds / Catchments

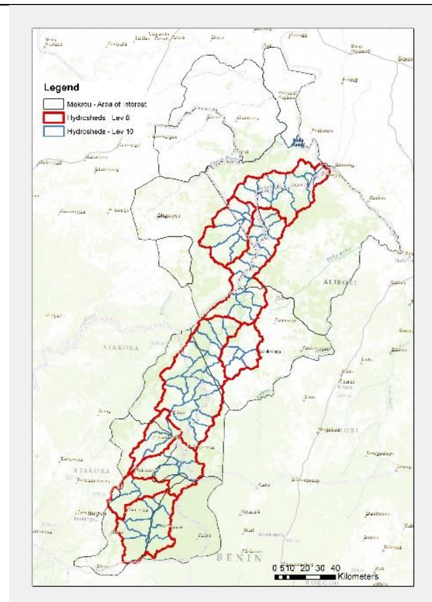
A map of catchmants was derived by HydroBASINS project data. In this dataset watershed boundaries and sub-basin delineations were derived from HydroSHEDS data at 15 second resolution.

Fort this layer 2 different levels are showed:

- level 8: nine (9) different catchments belong to Mekrou River basin with an average area of (ranging between
- level 10

Source: http://hydrosheds.cr.usgs.gov/index.php

TITLE: Catchment (Hydrosheds)



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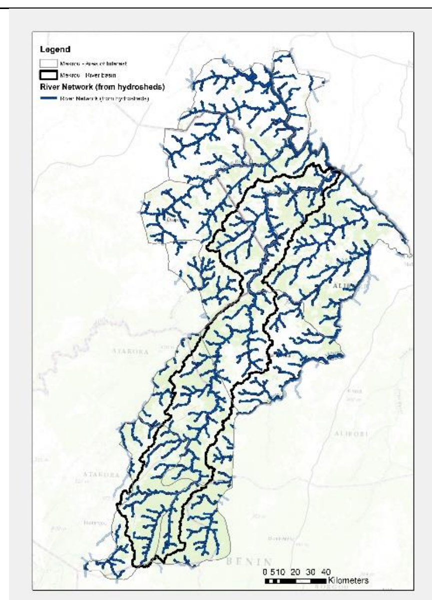
3.5.3 River Network

A Rver Network map of was derived by HydroBASINS project data.

Source: http://hydrosheds.cr.usgs.gov/index.php

TITLE: River Network



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3.5.4 Erosion Risk

Soil erosion by water is an important and globally diffused problem. The assessment and quantification of this issue it's complex and filed measurements and surveys are expensive and difficult to transfer to regional and wider scales.

The Revised Universal Soil Loss Equation (RUSLE; Renard et al., 1997) is an empirically based model, founded on the Universal Soil Loss Equation (USLE; Wischmeier and Smith, 1978).

RUSLE computes the average annual erosion expected on hillslopes by multiplying several factors together: rainfall erosivity (R), soil erodibility (K), slope length and steepness (LS), cover management (C), and support practice (P).

The average soil loss due to water erosion per unit area per year (Mg ha−1 per year) was quantified, using RUSLE (USDA-ARS, 2001; Renard et al., 1997) by the following equation: A = R × K × L × S × C × P where:

R the rainfall and runoff erosivity factor (MJ mm ha−1 h−1 per year),
K the soil erodibility factor (Mg h MJ−1 mm−1),
L the slope length (m), S the slope steepness (%),
C the cover and management practice factor,
and P the support practice. RUSLE.

3.5.4.1 R – Rainfall Erosivity

The R-factor, expressing erosive force of rainfall, is usually calculated as an average of EI values measured over 20 years to accommodate apparent cyclical rainfall patterns. Since Mekrou catchment region did not have long-term rainfall records, the R-factor was computed using the following procedure:

a) Reference literature R-values were collected over the African continent; only long term multi annual derived values were considered;
b) A linear regression was tested by considering reference data for stations: latitude, longitude, elevation, annual precipitation, and different statistics over the annual series (maximum monthly precipitation, 80^{th} percentile, etc.)
c) The optimal regression was used to spatially calculate R factor over mekrou region by considering data from locally detailed available input dataset (local precipitation data at 1km resolution, elevation from DEM at 30m resolution).

The resulting equation used to extrapolate R factor is:

$$R = \alpha + \beta * \ln(Rain_{month\_max}) + \gamma * Elev$$

Where α,β,γ are the coefficient of the regression optimized with the least squares method and are:
$\alpha = -870.9$; $\beta = 3588.401$; $\gamma = -1.65253$; $Rain_{month\_max}$= maximum monthly precipitation (over the observed period); [mm]; Elev= Station altitude in [m].
R^2 = 0.85; std = 1538

3.5.4.2 K – Soil erodibility

The K factor is an empirical measure of soil erodibility as affected by intrinsic soil properties. The main soil properties affecting K are soil texture, organic matter, structure, and permeability of the soil profile. Soil erodibility (K factor) was estimated based on the Kuery Software (see Borselli et al., 2012)

Soils in the region result in low values of erodibility (range is 0.006 to 0.025).

3.5.4.3 LS – slope length/slope steepness

The LS factor was calculate based on a simplified method, proposed by Moore and Wilson (1992) to derive a *LS* factor suitable for 3D application:

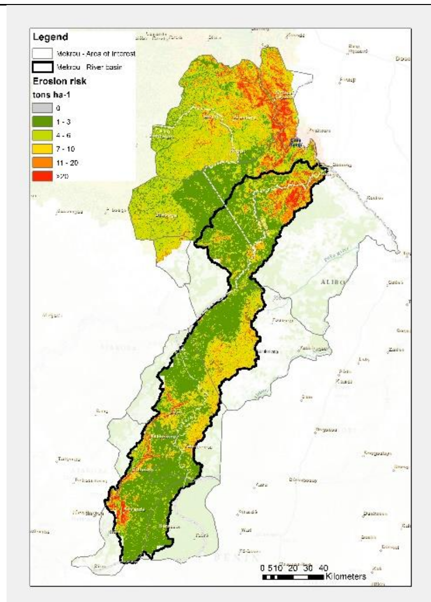
$$LS3 = \left(\frac{A_s}{22.13}\right)^m \left(\frac{\sin\theta}{0.0896}\right)^n$$

where the hillslope length is replaced by an accumulation area per contour length A_s (m^2/m); the exponent *m* may vary in the range 0.4-0.6 (0.4 for this analysis) ; and *n* varies in 1.2-1.3 (1.3 for this analysis).

3.5.4.4 C – Cover Management factor

The vegetation cover and management factor C represent the effect of cropping and management practices in agricultural management, and the effect of ground, tree, and grass covers on reducing soil loss in non-agricultural situation. For this analysis C factor was associated to each cell according to dominant land cover class.

Landuse	C
Rainfed cropland	0.3
Mosaic cropland	0.3
Vegetation (mosaic)	0.25
Opean broadleaved forest	0.01
Forest/shrubland	0.01
grassland/forest	0.01
shrubland	0.05
grassland/forest	0.01

<table>
<tr><td>Erosion Risk</td><td>Rain Erosivity</td></tr>
<tr><td>


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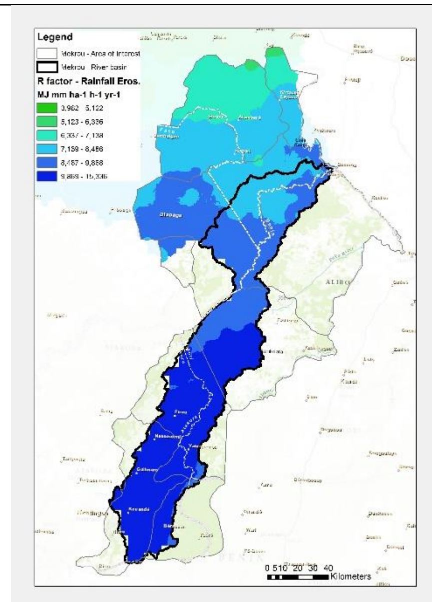
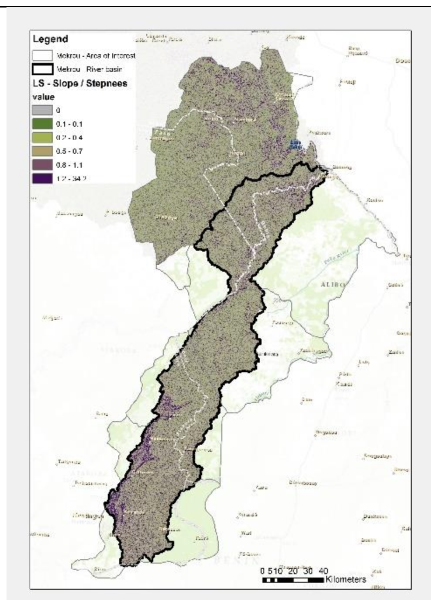


</td></tr>
<tr><td>Download High Resolution Map</td><td>Download High Resolution Map</td></tr>
<tr><td>LS – slope length/slope steepness</td><td>K – Soil erodibility</td></tr>
<tr><td>


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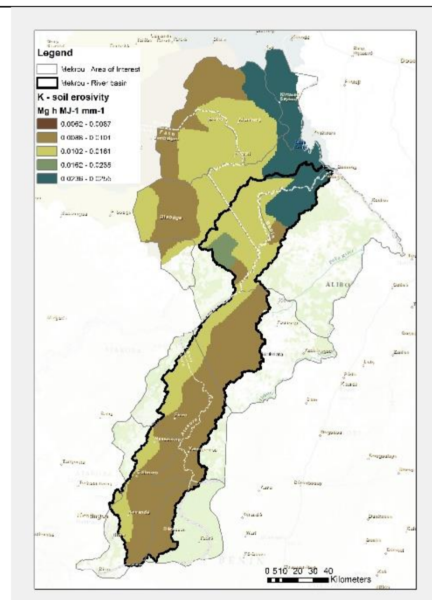
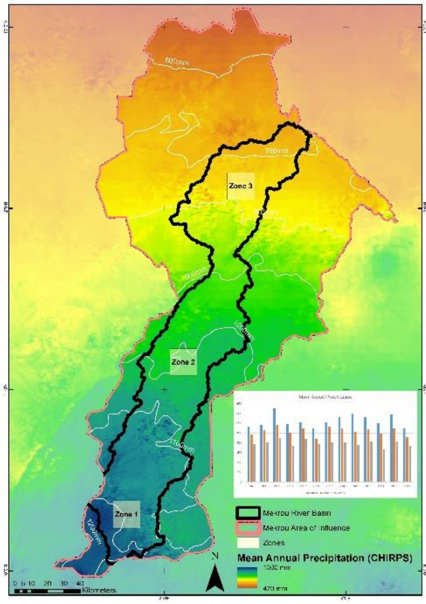
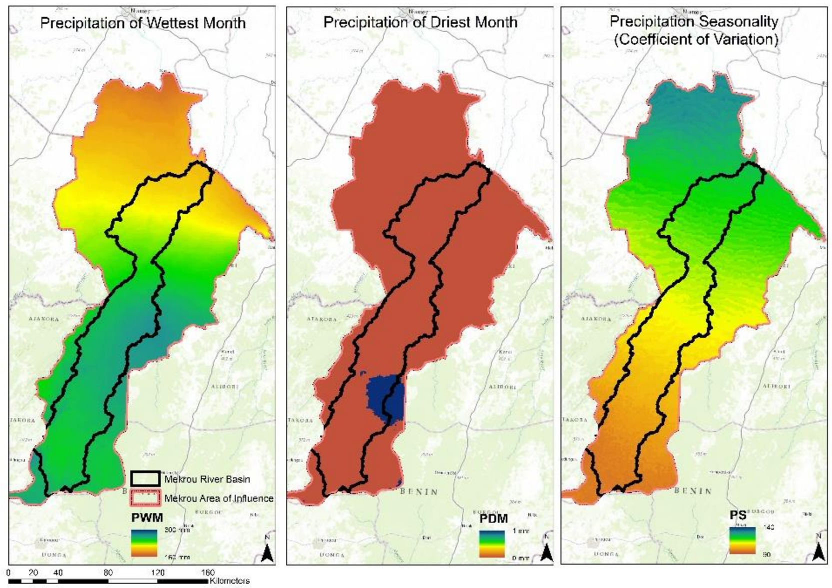


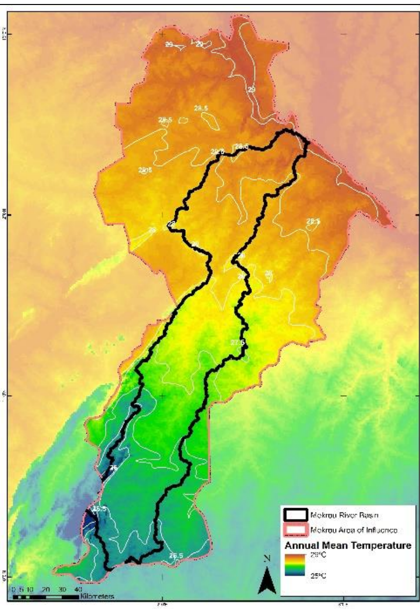
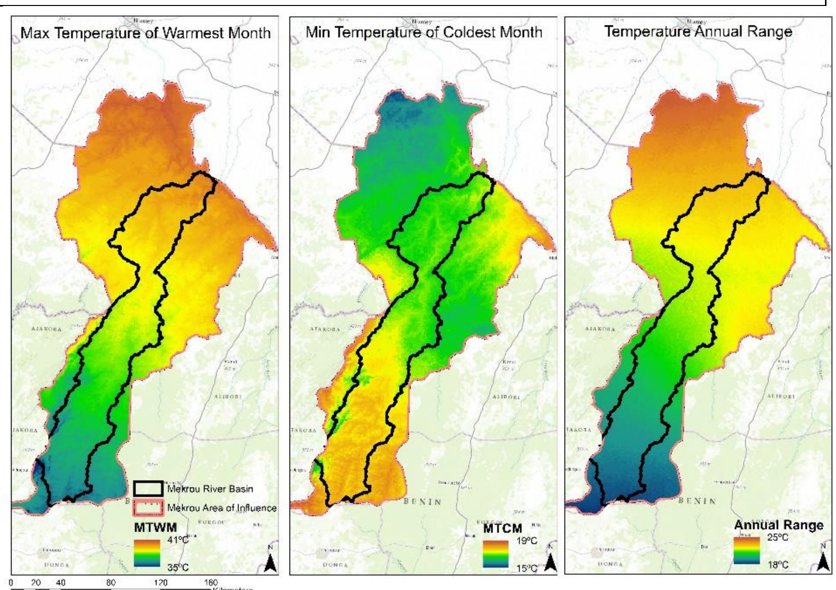
</td></tr>
<tr><td>Download High Resolution Map</td><td>Download High Resolution Map</td></tr>
</table>

3.6 Climatic variables

3.6.1 Precipitation

TITLE: Mean Annual Precipitation	TITLE: PWM, PDM, Seasonality
	
[Download High Resolution Map]()	[Download High Resolution Map]()

3.6.2 Temperature

TITLE: Annual Mean Temperature	TITLE: TWM, MTCM, Annual Range
	
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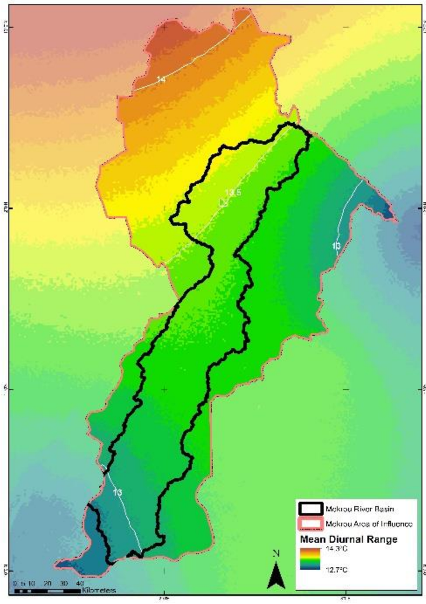
TITLE: Mean Diurnal Range



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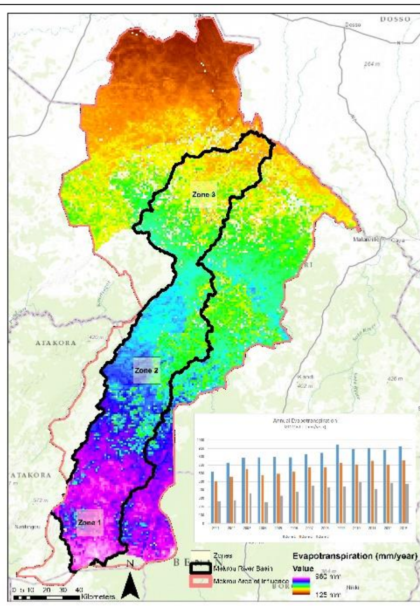
3.6.3 Evapotranspiration

TITLE: Evapotranspiration



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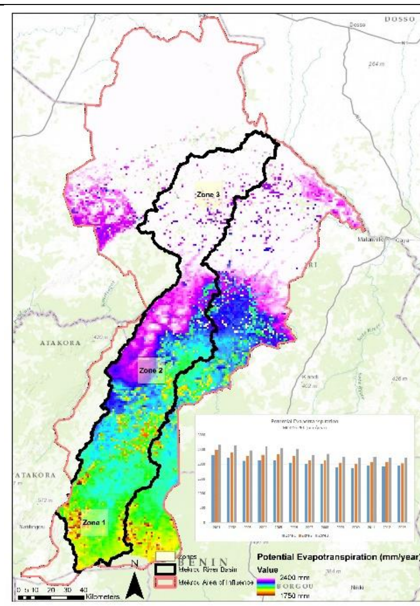
TITLE: Potential Evapotranspiration



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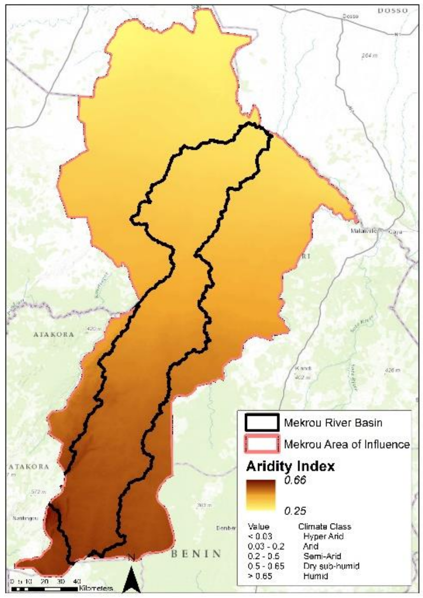
3.6.4 Aridity Index

TITLE: River Network

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