The regional transport industry is therefore centred on the ports of Mombasa and Dar es Salaam: Mombasa is Kenya's only international seaport and handles cargo not only for Kenya but also for Uganda, Sudan, Rwanda, Burundi, Democratic Republic of Congo (DRC) and Northern Tanzania. The road Mombasa-Kampala-Kigali is paved. Dar-es-Salaam is the principal port of Tanzania and is a major sea outlet for Zambia, Rwanda, Burundi, Malawi, DRC and Uganda.

Despite its weaker transport infrastructure in comparison with the Northern Corridor, the Central Corridor is quite competitive and likely to become more so once the pavement is completed. Its competitiveness rests on (a) direct access to the sea (with no need to transit other countries) for six developing countries (Burundi, Democratic Republic of the Congo, Malawi, Rwanda, Uganda and Zambia); (b) shorter distances to the sea for Burundi, the Democratic Republic of the Congo and Rwanda (see table below); (c) lower transit tariffs; (d) shorter transit times; and (e) streamlined customs and administrative procedures.

The freight market is split between rail and road transport. Road is the dominant mode, with rail representing only 20% for transit containers, on the two corridors (rail on Mombasa corridor is 13%, 32% for Dar es Salaam) [PMASEA, 2005]. The following paragraphs and Map 23 describe these two corridors.

(i) Pipelines

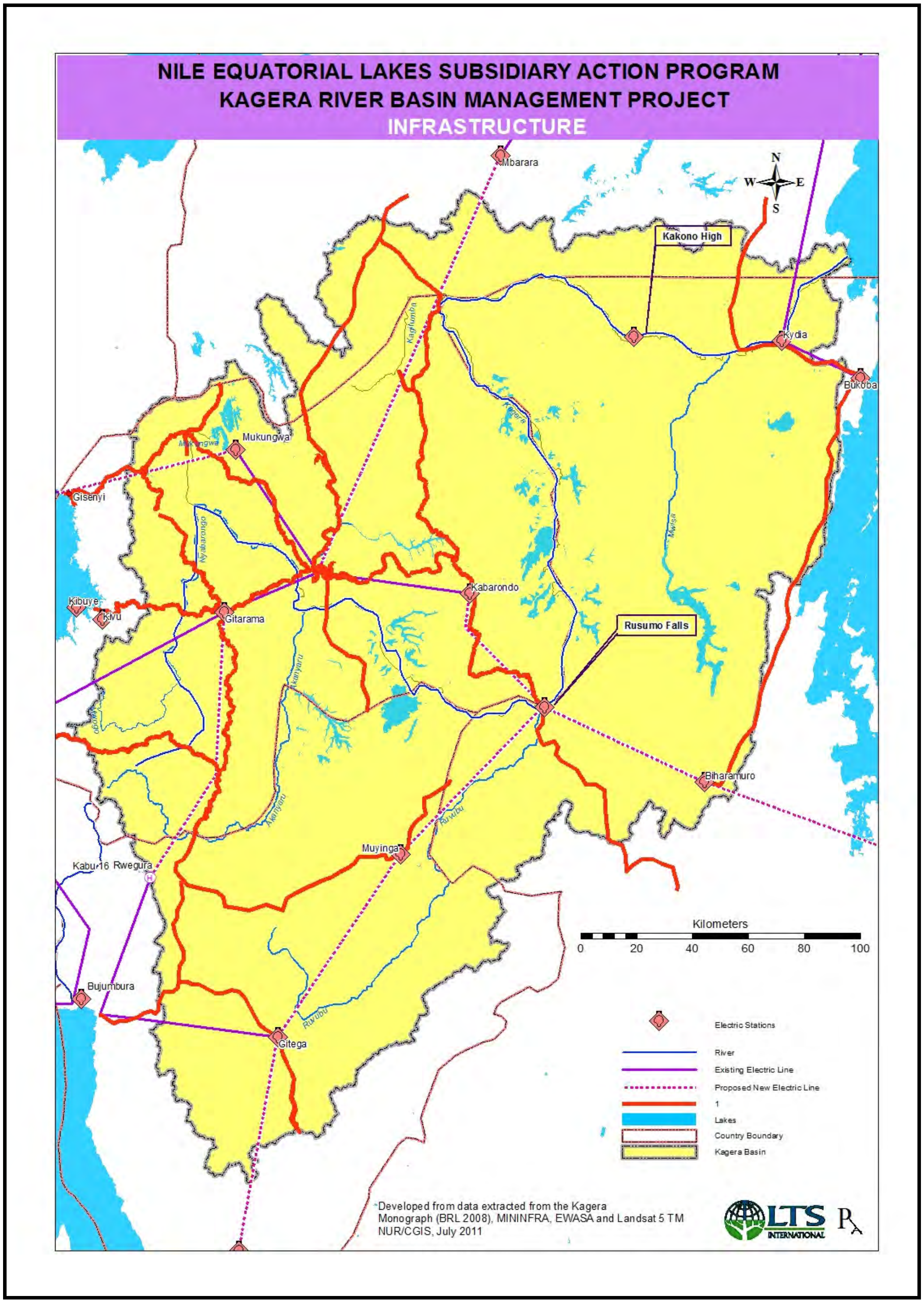
Kenya has built a pipeline from a refinery in Mombasa to the main centres of economic activity in Nairobi, Eldoret and Kisumu. The pipeline currently meets 60% of the local demand for petroleum products. An extension of the pipeline to Kampala, Uganda is under discussion with potential investors from the private sector. Another pipeline exists in the Southern Corridor but there is no link with the Kagera River basin (the 1,065 mile Tazama pipeline, jointly owned by Zambia and the United Republic of Tanzania).

(ii) Inland water transport

Inland water transport, in the Kagera River basin, is possible along the lower part of the Kagera River and through to Lake Victoria.

In the Kagera River basin, there is currently only informal navigation by small boats on the rivers and lakes giving remote areas access to markets and other services and for local fisheries. This informal navigation also contributes to a minor extent to the external trade of Rwanda, Uganda and Tanzania through their common frontiers with each Corridor offering road and intermodal transport options.

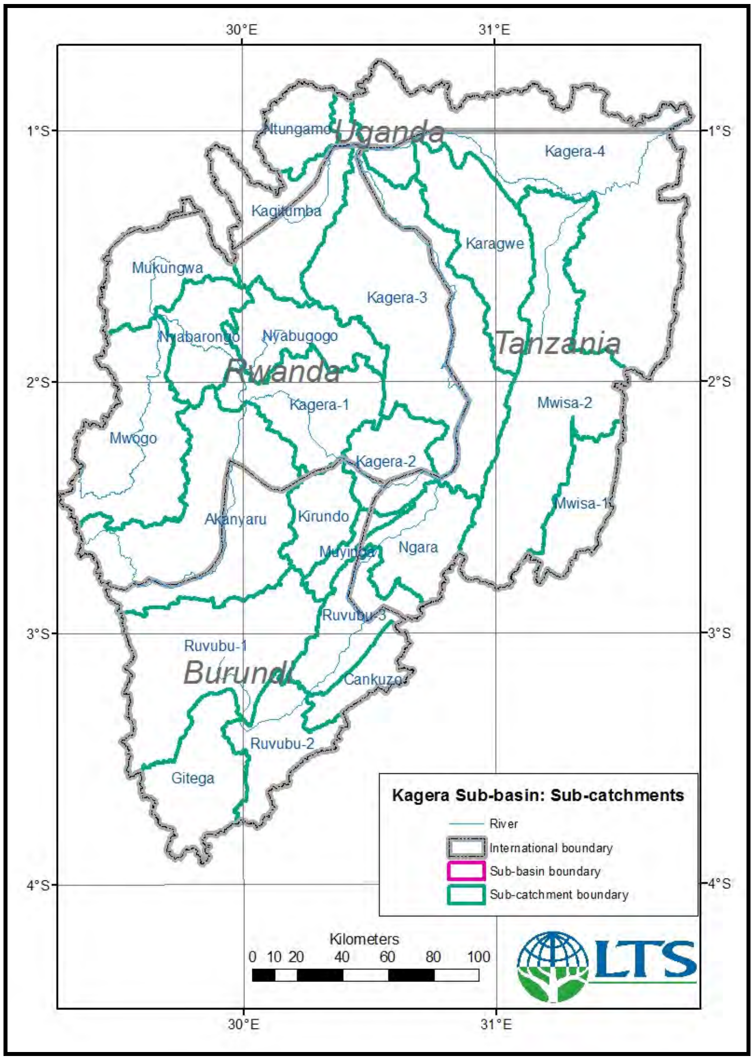
Map 23. Infrastructure



2. Sub-watershed Assessment

Within the Kagera sub-basin, 22 sub-watersheds can be delineated (Map 24). These have been taken as the basis for the characterisation of the sub-basin. The sub-watersheds were compared by overlaying the sub-watershed boundaries on specific GIS layers. This allowed the sub-watersheds to be ranked for a wide range of parameters of importance. The resulting data are used in the identification and formulation of the watershed management projects.

Map 24. Kagera sub-basin: Sub-watersheds



Two major characteristics were analysed: (i) a composite “low soil water availability” rating using rainfall-PET and percentage area under soils with low water holding capacity (Ferralsols and Lithosols), and (ii) a composite “land degradation” rating using population density and soil erosion risk.

(i) Low Soil Water Availability Rating

- Sub-watersheds were ranked based on rainfall minus potential evapo-transpiration (PET) The sub-watershed ranked 1 had the highest amount of PET exceeding rainfall and that ranked 22 exhibited the highest amount of rainfall exceeding PET. This is presented in Table 3.

- Sub-watersheds were also ranked based on percentage area with soils of low water holding capacity (i.e. Ferralsols and Lithosols). The Sub-watershed ranked 1 had the highest percentage area with Ferralsols and Lithosols and that ranked 22 had the smallest percentage area. This is also presented in Table 3.

The rankings were then added together to obtain a composite score and the sub-watersheds then ranked with the sub-watershed with the lowest score ranked first in terms of low soil water availability. This indicated those Sub-watersheds with the highest risk of crop failure due to soil moisture deficits and likely to benefit from water harvesting technologies.

Table 3. Kagera Sub-basin: Sub-watersheds ranked by Low Soil Moisture availability

Sub-Watershed	Rainfall - PET	Soil:whc	soil water availability	soil water availability
rank 1 =	Lowest	Lowest	Composite	Ranking
CANKUZO	3	1=	4	1
MUYINGA	8	1=	9	2
KAGERA 2	5	6	11	3
NGARA	1	10	11	4
RUVUBU 3	9	4=	13	5
KAGERA 1	6	9	15	6=
KIRUNDO	7	8	15	6=
KAGERA 3	2	14	16	8=
RUVUBU 2	15	1=	16	8=
NTUNGAMO	10	12	22	10
RUVUBU 1	16	7	23	11
GITEGA	20	4=	24	12=
MWISA 1	4	20=	24	12=
NYABUGOGO	13	13	26	14
AKANYARU	17	11	28	15
KAGERA 4	14	15	29	16
MWISA 2	11	19	30	17
KARAGWE	12	20=	32	18
KAGITUMBA	18	17	35	19
MWOGO	21	16	37	20=
NYABARONGO	19	18	37	20=
MUKUNGWA	22	20=	42	22

The ten Sub-watersheds with the highest rankings are indicated in map 25. These are located in the central belt of the Sub-basin, and indicate Sub-watersheds where crop and pasture production is at greatest risk because of low soil moisture.

(ii) Potential Land Degradation Rating

- An average population density (inhabitants/km^2) was estimated for each sub-watershed and these were ranked in order of density – 1 being the densest, 22 being the least dense. This is presented in Table 4.
- The average soil erosion rating (slope, rainfall and soil type) for each sub-watershed was assessed with the sub-watershed most at risk ranked 1. This is presented in Table 3.

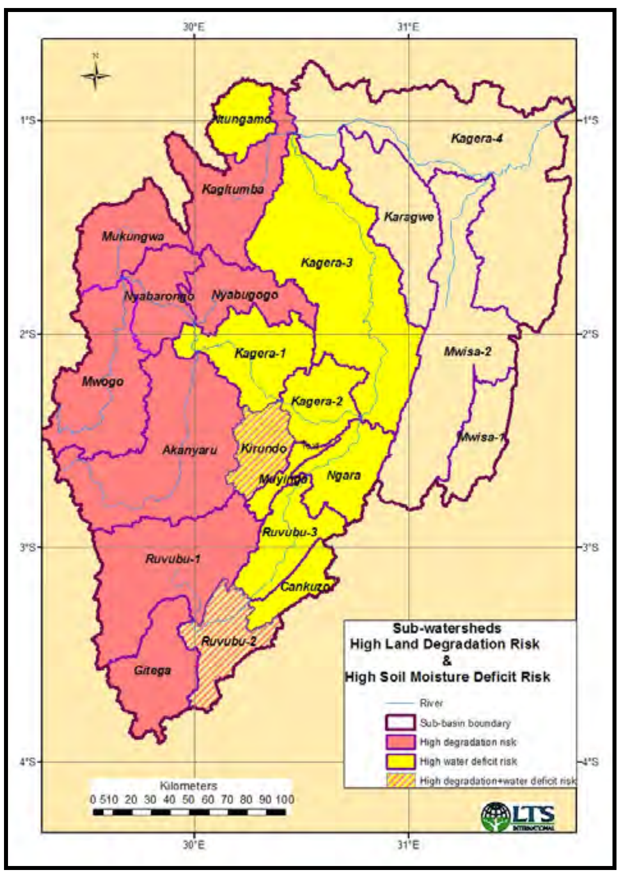
The rankings were then added together to obtain a composite score and the sub-watersheds then ranked with the sub-watershed with the lowest score ranked first in terms of low soil water availability. This indicated those Sub-watersheds with the highest risk of land degradation because of high population pressures and high soil erosion risk.

Table 4. Kagera Sub-basin: Sub-watersheds ranked by High land Degradation risk

Sub-Watershed	Population Densi	Soil Erosion	Land Degradati	Land Degradati
rank 1 =	Highest density = 1	Most at risk = 1	Composite	Ranking
NYABARONGO	2	1	3	1=
MUKUNGWA	1	2	3	1=
AKANYARU	4	4	8	3
NYABUGOGO	3	7	10	4
GITEGA	7	4	11	5
RUVUBU 1	6	6	12	6
MWOGO	10	3	13	7
KIRUNDO	5	12	17	8=
RUVUBU 2	8	9	17	8=
KAGITUMBA	9	10	19	10
RUVUBU 3	8	14	22	11
CANKUZO	15	8	23	12
MUYINGA	13	13	26	13=
KAGERA 2	12	14	26	13=
KAGERA 1	16	11	27	15
NTUNGAMO	14	14	28	16
KAGERA 4	17	16	33	17
MWISA 1	22	17	39	18
MWISA 2	18	21	39	18
KAGERA 3	21	19	40	20
NGARA	19	22	41	21
KARAGWE	22	20	42	**22**

The ten Sub-watersheds with the highest rankings are indicated in map 25. These are located in the western part of the Sub-basin characterised by steep slopes, dense cultivation and erodible soils. These Sub-watersheds are source areas of declining agricultural production, high stream sediment loads, wetland degradation and frequent flooding.

Map 25. Sub-watersheds with Highest Risk to Land Degradation and to Soil Moisture Deficits



SUB-WATERSHEDS

In this section the 22 sub watersheds are each characterised in the following order

1	Akanyaru	7	Karagwe	14	Ngara
2	Cankuzo	8	Kirundo	15	Ntungamo
3	Kagera-1	9	Mukungwa	16	Nyabarongo
4	Kagera-2	10	Muyinga	17	Nyabugogo
5	Kagera-3	11	Mwisa-1	18	Ruvubu-1
6	Kagera-4	12	Mwisa-2	19	Ruvubu-2
7	Kagitumba	13	Mwogo	20	Ruvubu-3
				21	Ruvyironza

3. Akanyaru

3.1 Key Parameters

(a) Hydrology

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
276.1	87.9	106.5	624.4	281.4	368.6
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
132.5	8.1	16.0	315.7	69.9	114.4
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
2.37	5	5.31	1.53	4	3.07
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
24.2	10.6	14.1	52.1	35.6	38.7
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
272.8	393.5	336.2	2249.6	348.1	310.7

(b) Land Use/Landcover

Akanyaru Landcover	Hectares	% of Total
Intensive agriculture	119,784	22.5
Settlements and gardens	97,666	18.3
Settlements	71,838	13.5
Intensive agriculture and bare soil	68,475	12.8
Bare Soil	65,679	12.3
Swamp and wetland	36,515	6.8
Forest plantations	26,201	4.9
Urban areas	21,439	4.0
Intensive cultivation - degraded	10,643	2.0
Grassland	6,476	1.2
Open Forest	5,151	1.0
Closed Forest	1,005	0.2
Shifting cultivation	832	0.2
Degraded Grassland	826	0.2
Lakes and rivers	607	0.1
River bed	147	0.0
TOTALS	**533,283**	**100.0**

3.2 Description of the Sub-watershed

3.2.1 Specific Nature of the Sub-watershed

The sub-watershed is located in the head-waters of the Kagera River where it starts on the Congo-Nile divide. Some 49 percent of the Sub-watershed has very steep slopes with a high to very high erosion risk, which is the 8th highest of the 22 Sub-watersheds. The Sub-watershed is ranked 16th with respect to Soil moisture deficits, but with a large coefficient of variation. Some 7 percent of the Sub-watershed is covered with wetlands, the 5th highest of the 22 Sub-watersheds. Green water is the 2nd highest with over 700mm per annum. Population density is the 4th highest in the Sub-basin.

3.2.2 Key Issues

- Acidic and infertile soils, steep slopes with high erosion risk;
- Loss of soil fertility and instability of radical terraces;
- Cultivation along river banks and lake shores contributing to sedimentation;
- High sediment loads in rivers and sedimentation in wetlands;
- Flooding along Buyongwe river;
- Livestock feed deficits;
- Agricultural encroachment of wetlands;
- Fuelwood deficits;
- Encroachment into Nyungwe National Park;
- Limited and irregular rainfall in lower Sub-watershed (Bugesera Natural Region).

3.2.3 Characteristics of the Sub-watershed

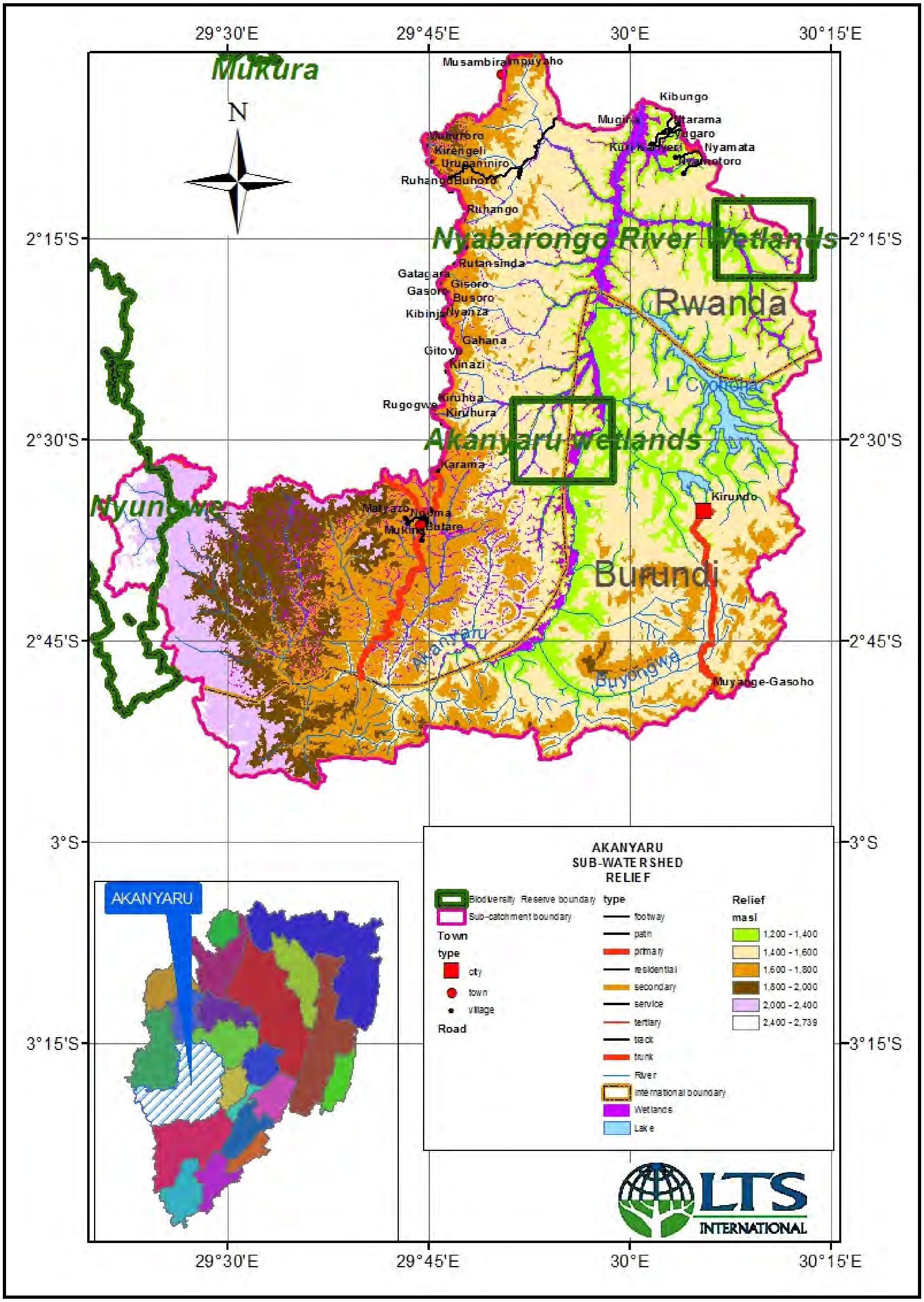
The sub-watershed is located in the central western part of the Sub-basin and covers some 533,282ha.

In the southwest the Sub-watershed is characterized with very steep slopes largely underlain by infertile and acidic ferralsols. In the east slopes are gentle with wide valley bottoms occupied with lake and wetlands. Mean annual rainfall is between 1,000 and 1,200mm/yr. Some 81 percent of the Sub-watershed has been mapped as intensive agriculture of which a third of this area has bare soil. In the steepest areas radical terraces are common. As these have been excavated into the sub-soil of acid and infertile ferralsols a significant proportion are under-utilized. Swamp and wetland cover 7 percent of the Sub-watershed.

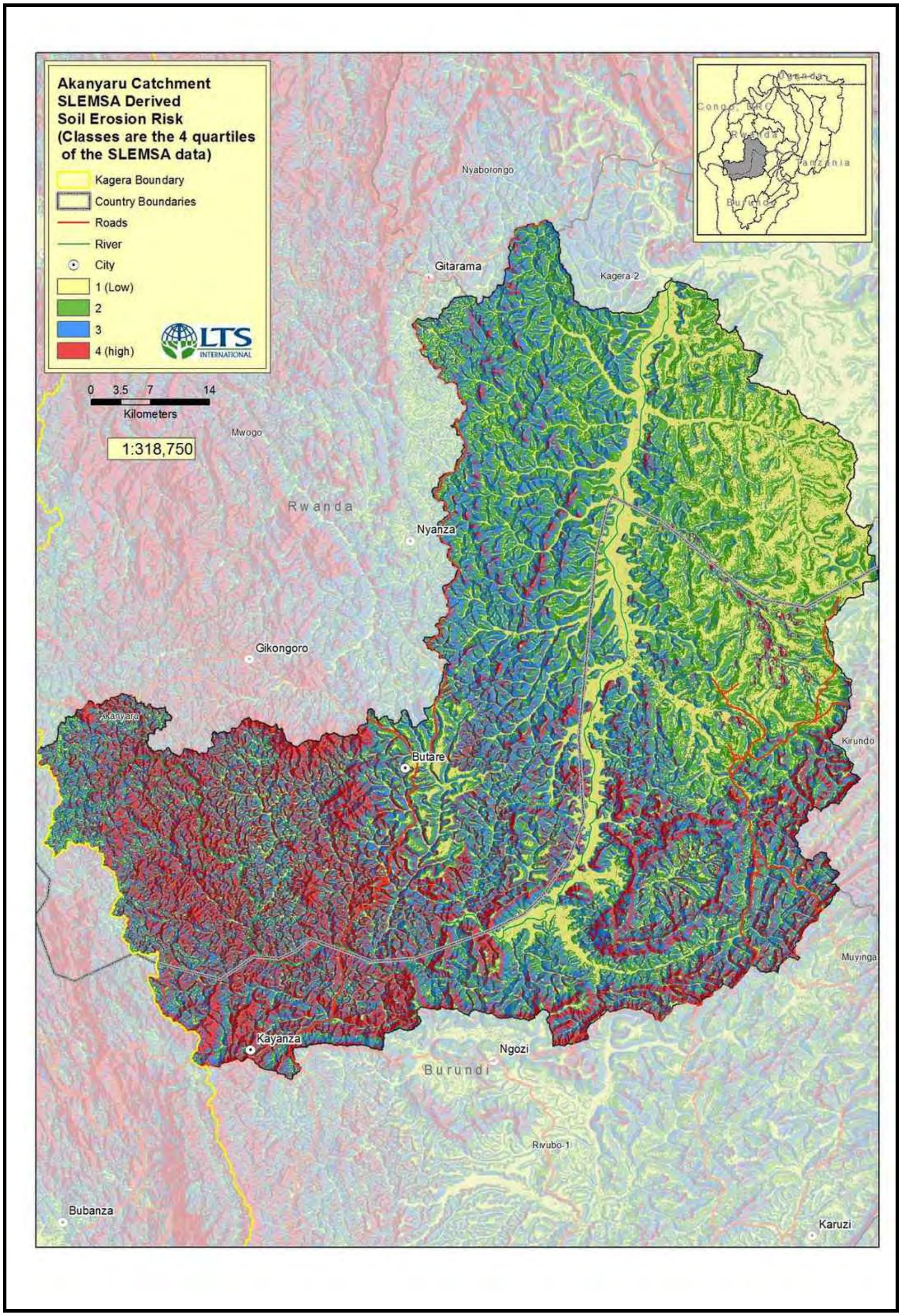
The Nile Divide Farming System is found above 1,800masl and is located in the southwest. The High Plateau Farming System is found in the remainder of the Sub-watershed low 1,800masl, in which coffee is an important cash crop. Population density is between 500 and 750 persons/km2. The main towns are Hoye and Kayanza in Rwanda and Ngozi in Burundi.

Part of the Nyungwe National Park is located in the headwaters of the Sub-basin. It is contiguous with Kibira National Park in Burundi and is one of the largest mountainous rainforests remaining in Africa. Nyungwe's biodiversity is astonishing by African standards and is one of the most endemic species-rich areas in all of Africa. However, it is experiencing agricultural encroachment.

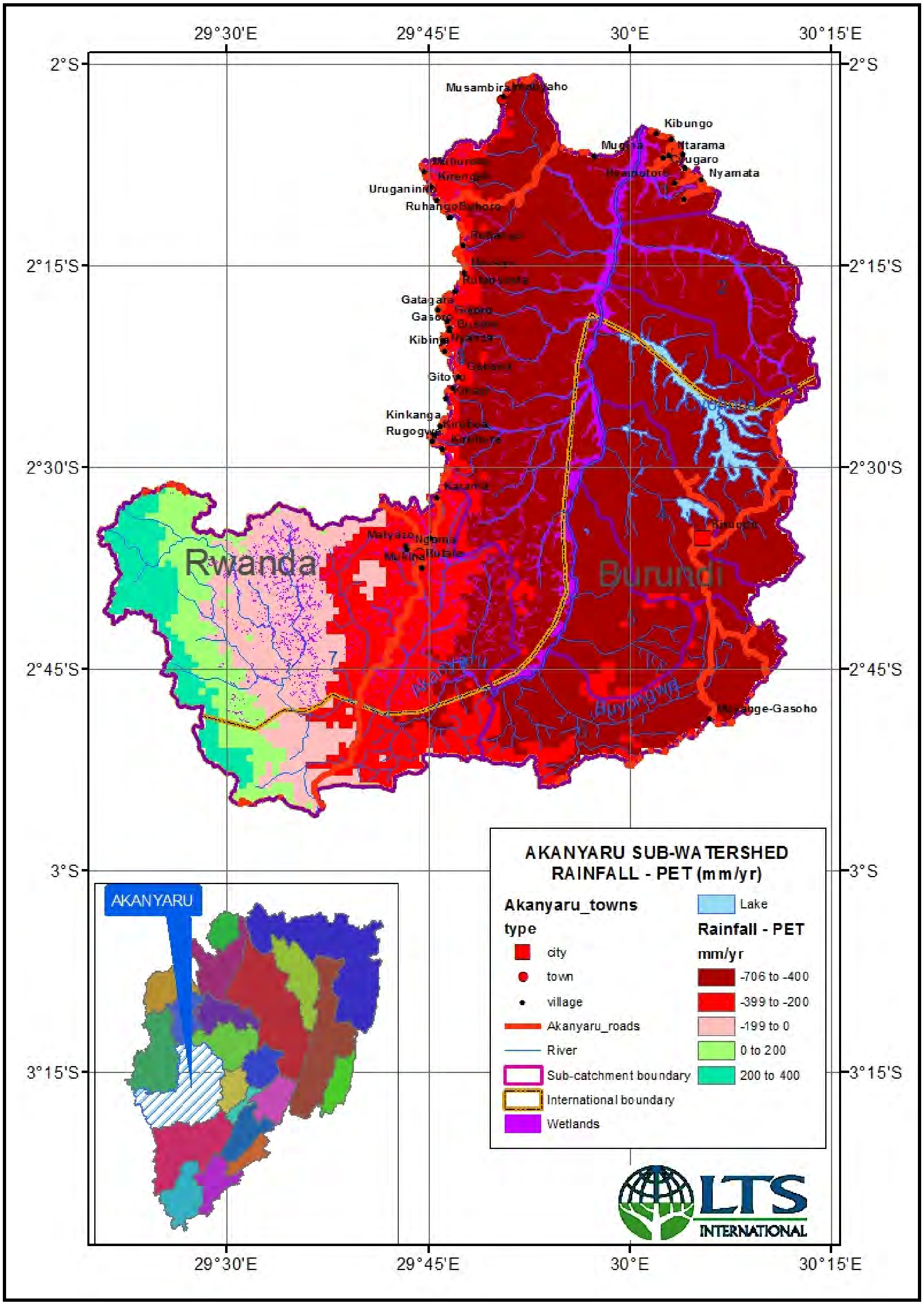
Map 26. Akanyaru Sub-watershed relief



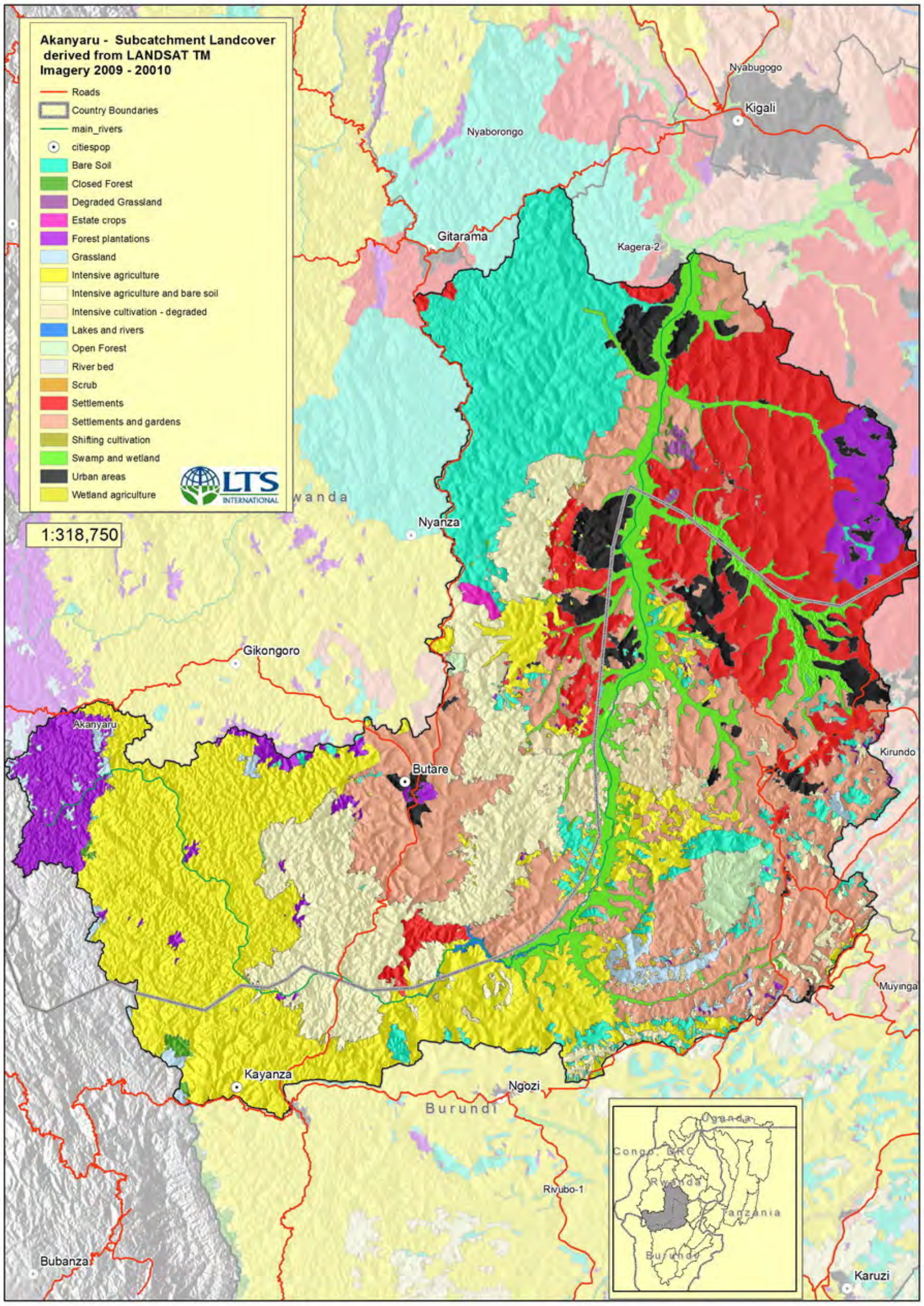
Map 27. Akanyaru Catchment Soil Erosion Risk



Map 28. Akanyaru Sub-watershed Rainfall



Map 29. Akanyaru Subcatchment Landcover



4. Cankuzo

4.1 Key parameters

(a) **Hydrology**

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
588.6	225.7	301.2	471.9	100.2	199.4
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
288.2	55.0	19.3	237.2	28.8	66.2
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
4.47	8	7.62	3.57	5	6.25
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
7.1	4.2	4.8	5.7	2.1	3.1
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
484.4	571.3	539.8	765.3	886.4	84.7

(b) Land Use/Landcover

Canzuko Landcover	Hectares	% of Total
Settlements and gardens	30,084.9	36.7
Intensive agriculture	26,836.3	32.7
Grassland	12,660.4	15.4
Bare Soil	7,917.6	9.7
Forest plantations	1,541.7	1.9
Degraded Grassland	872.3	1.1
Swamp and wetland	814.2	1.0
Settlements	542.5	0.7
Urban areas	372.7	0.5
Wetland agriculture	177.2	0.2
Intensive agriculture and bare soil	104.7	0.1
Closed Forest	65.8	0.1
Open Forest	17.9	0.0
TOTAL	**82,008.2**	**100.0**

4.2 Description of the Sub-watershed

4.2.1 Specific nature of Sub-watershed

The Kayongozi is a tributary of the Ruvubu. The sub-watershed is the third most water stressed in the Sub-basin, with an excess of PET over rainfall of 200mm/yr.

4.2.2 Key Issues

- Variable rainfall and PET exceeding rainfall leading to vulnerable crop cultivation.
- Water supply deficits for humans and livestock;
- Overgrazing and livestock feed deficits;
- Cultivation along stream banks leads to high sediment loads;
- Fuelwood deficits;

4.3 Characterization of Sub-watershed

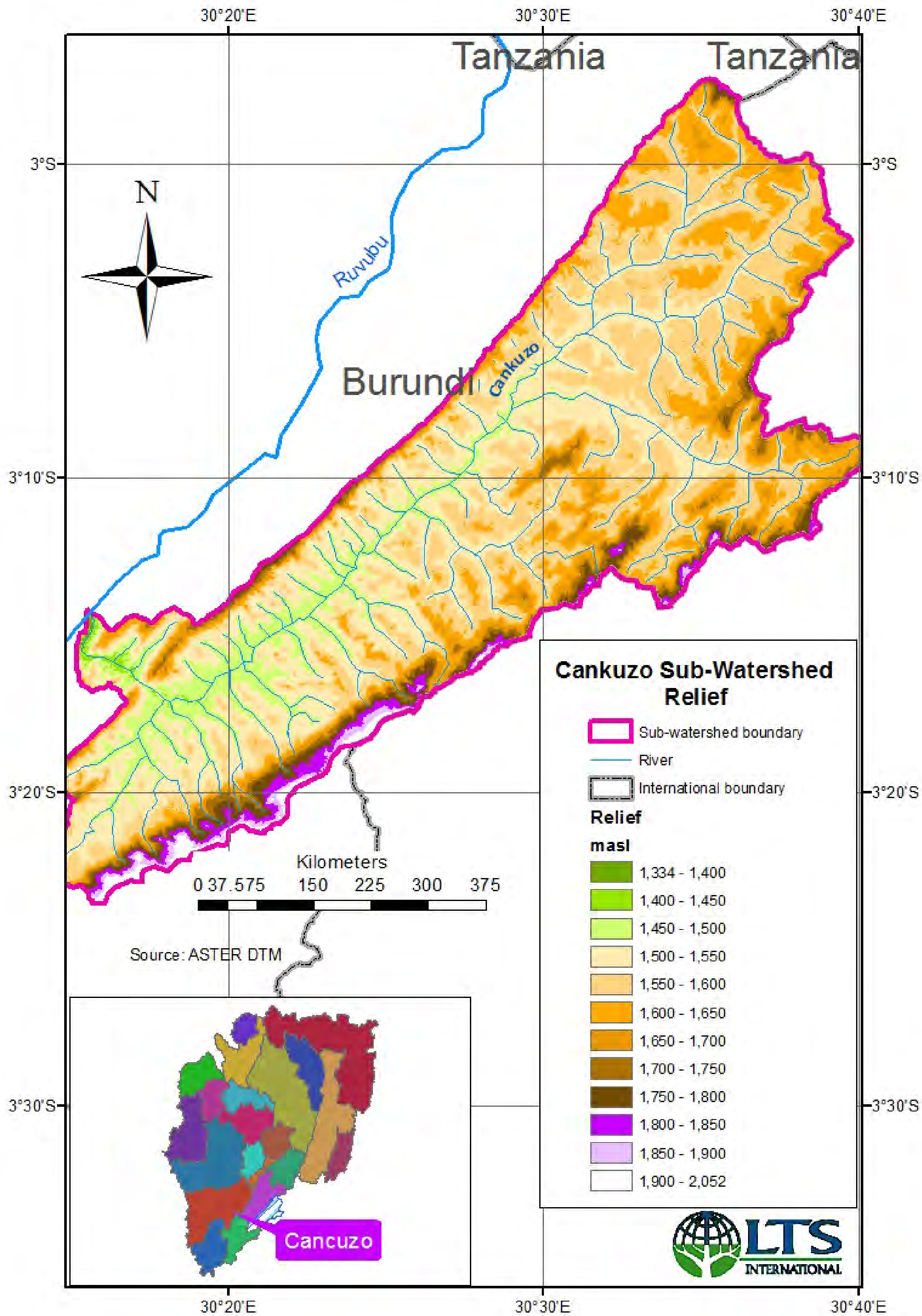
The Sub-watershed is located in the southeastern part of the Sub-basin and covers some 82,005ha.

The area lies between 1,200 and 1,700masl with a mean annual rainfall of between 900 – 1,000mm/yr. However, rainfall is extremely variable. PET exceeds rainfall by 300 to 400mm/yr and green water is only 150 to 300mm/yr. Soils are infertile and acidic ferralsols with a low moisture holding capacity. Crop production is thus risky. Although population densities are relatively moderate (125 – 500ppkm2) poor soils and risky rainfall have led to all wetlands being used for cultivation.

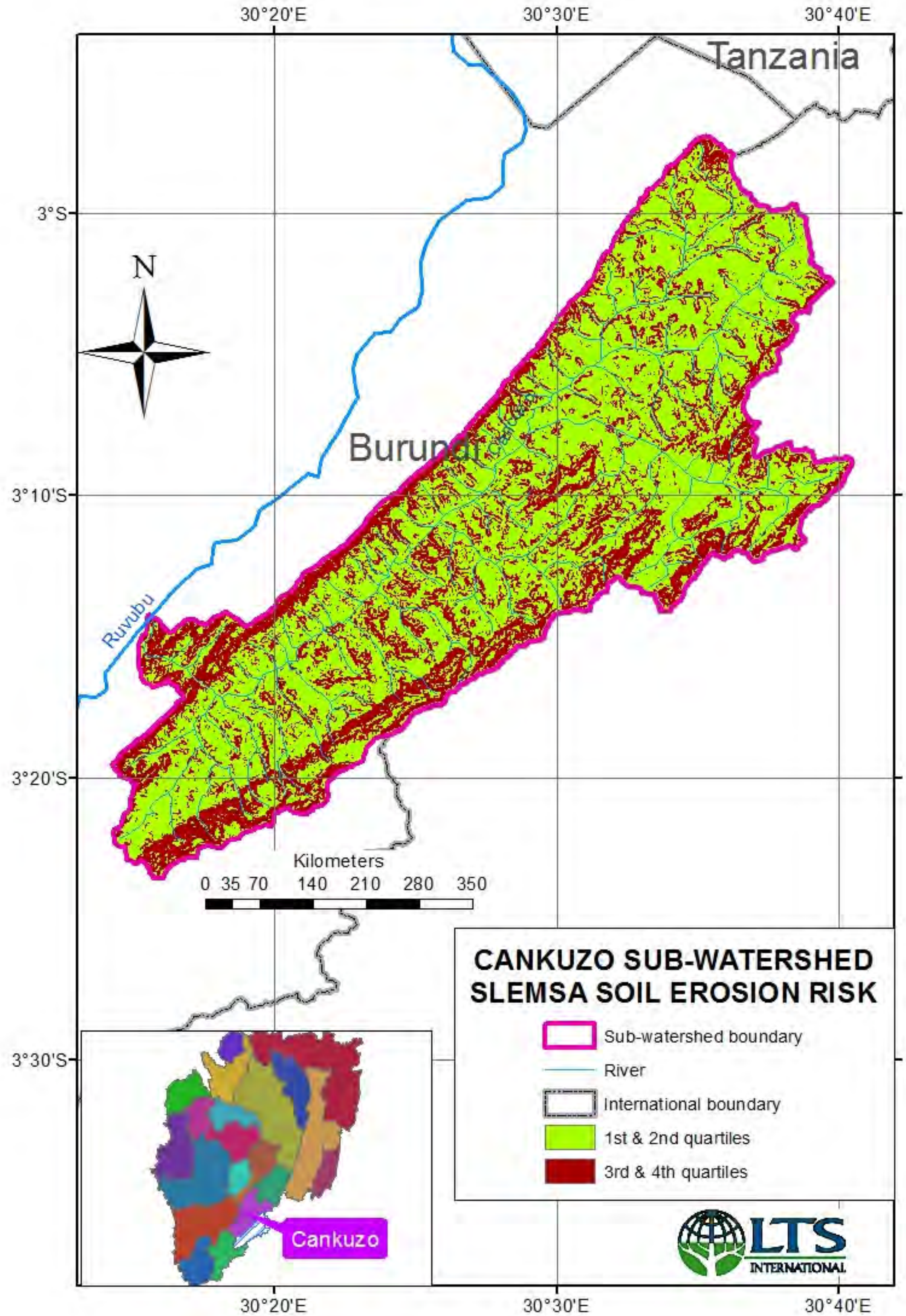
Some 70 percent of the Sub-watershed is under intensive agriculture and settlement and gardens. Bare soil covers 25 percent of the Sub-watershed. Swamp and wetlands cover nearly 7 percent and Eucalyptus plantations nearly 5 percent of the area. Although most of the Sub-watershed lies between 1,500 and 1,600masl because rainfall variability and excess of PET over rainfall the farming system is similar to the Kagera Piedmont System. Coffee can only be successfully cultivated under heavy mulch.

Some 32 percent of the area is mapped as having a high to very high soil erosion risk, which is relatively low for the Sub-basin.

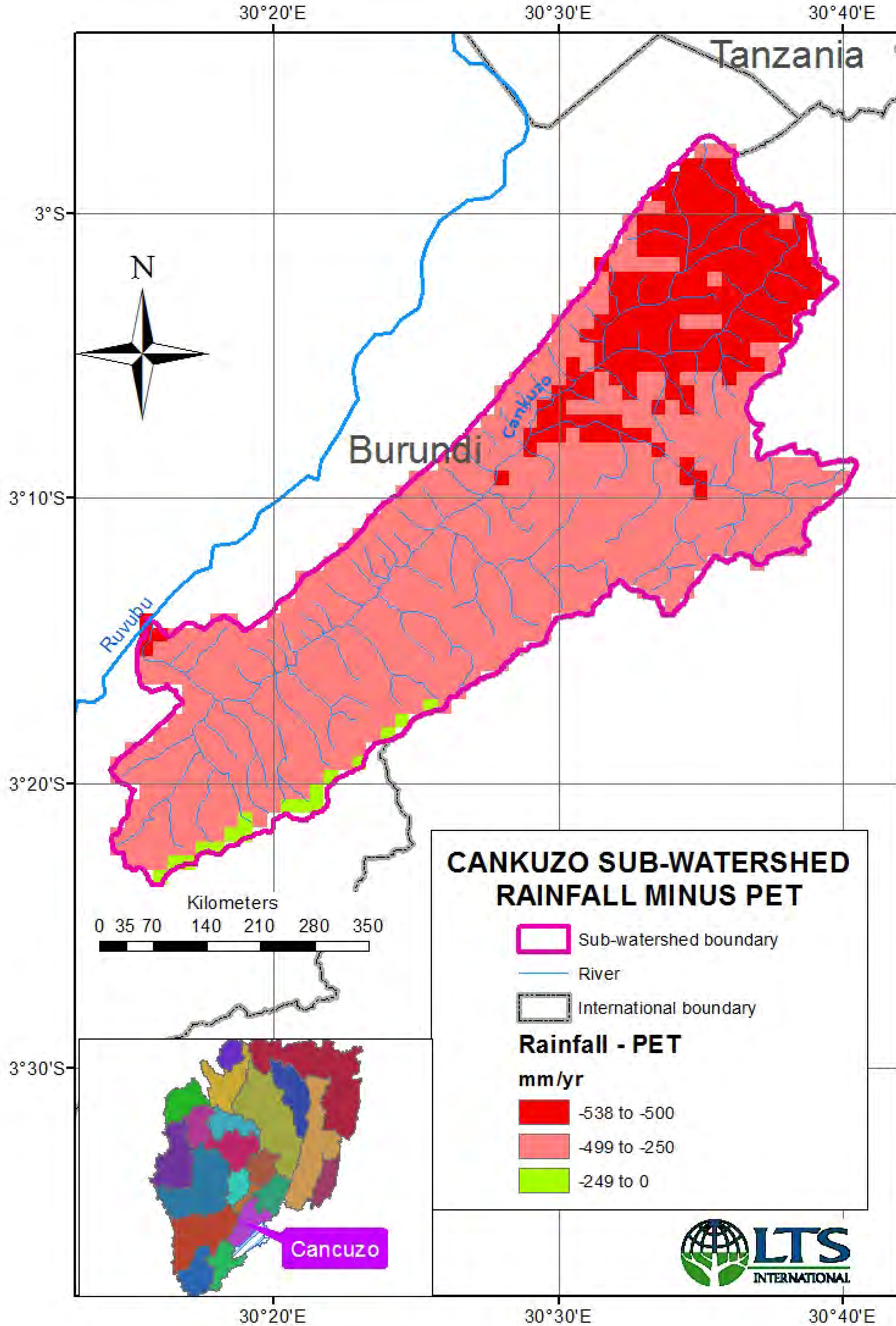
Map 30. Cankuzo Sub-Watershed Relief



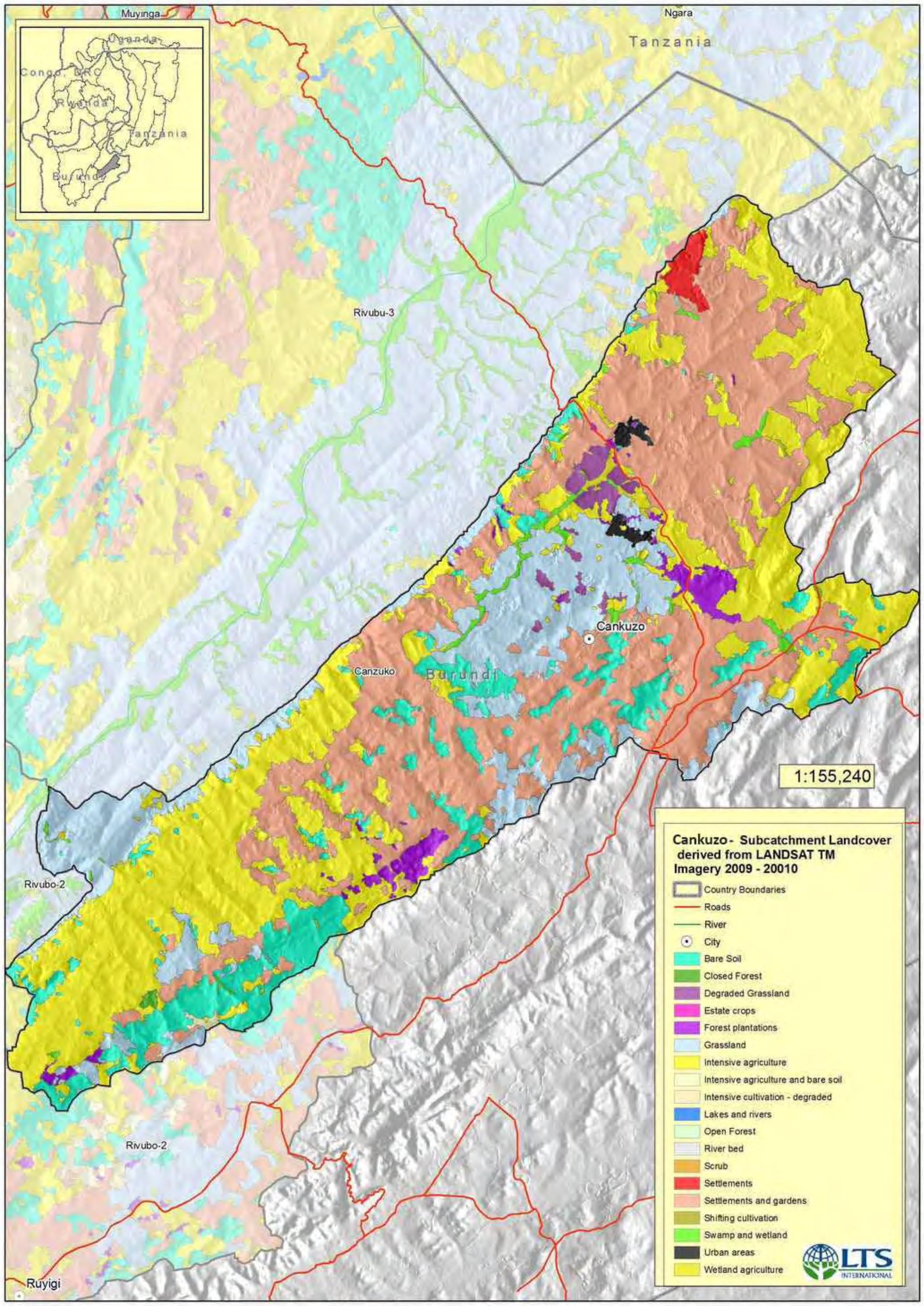
Map 31. Cankuzo Sub-Watershed Soil Erosion Risk



Map 32. Cankuzo Sub-Watershed Rainfall minus PET



Map 33. Cankuzo Sub-Catchment Landcover



5. Gitega (Ruvyironza) Sub-watershed

5.1 Key Parameters

(a) **Hydrology**

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
532.8	277	289.4	737.6	403.4	456
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
264.8	79	85.1	379.4	109.2	156.8
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
4.2	6	5.74	4.2	6	6.03
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
16.8	14	14.5	22.7	17.1	18
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
398.8	502.6	450.7	426.8	512	477.5

(b) Gitega

Gitega Landcover	Hectares	% of Total
Intensive agriculture	154,866.0	75.9
Bare Soil	25,152.6	12.3
Settlements and gardens	17,406.7	8.5
Intensive agriculture and bare soil	3,024.9	1.5
Closed Forest	1,906.2	0.9
Forest plantations	930.0	0.5
Urban areas	771.9	0.4
Totals	**204,058.3**	**100**

5.2 Description of the Sub-watershed

5.2.1 Specific nature of Sub-watershed

The sub-watershed is located in the head-waters of the Ruvubu River where it starts on the Congo-Nile divide. Some 48 percent of the Sub-watershed has steep slopes with a high to very high erosion risk, which is the 11th highest of the 22 Sub-. There are no wetlands. Green water is the 3rd highest with over 700mm per annum. Population density is the 7th highest in the Sub-basin.

5.2.2 Key Issues

- Acidic and infertile soils with aluminium toxicity
- Steep slopes with high erosion risk;
- Nutrient mining and loss of soil fertility;
- High sediment loads in rivers
- Livestock feed deficits
- Encroachment into Nyungwe National Park

5.2.3 Characterization of Sub-watershed

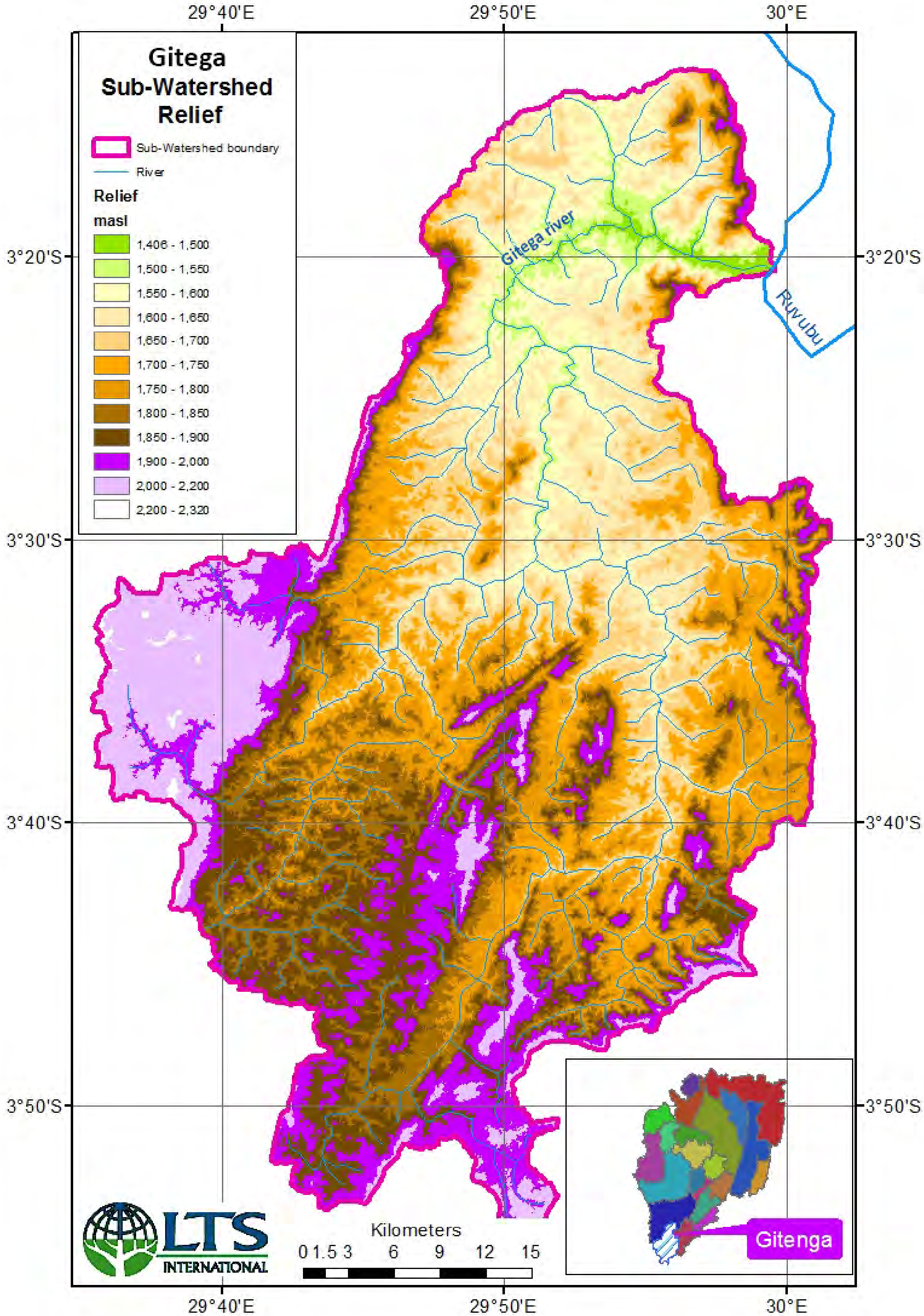
The Sub-watershed is located in the far south of the Sub-basin and covers some 204,059ha.

The Sub-watershed lies between 2,200masl in its headwaters to 1,500masl at its junction with the Ruvubu River. Steep slopes are found along its western and eastern watersheds. Mean annual rainfall is between 1,400 and 1,600mm/yr. Rainfall exceeds PET from zero to 400mm/yr. Green water is between 500 and 650mm/yr.

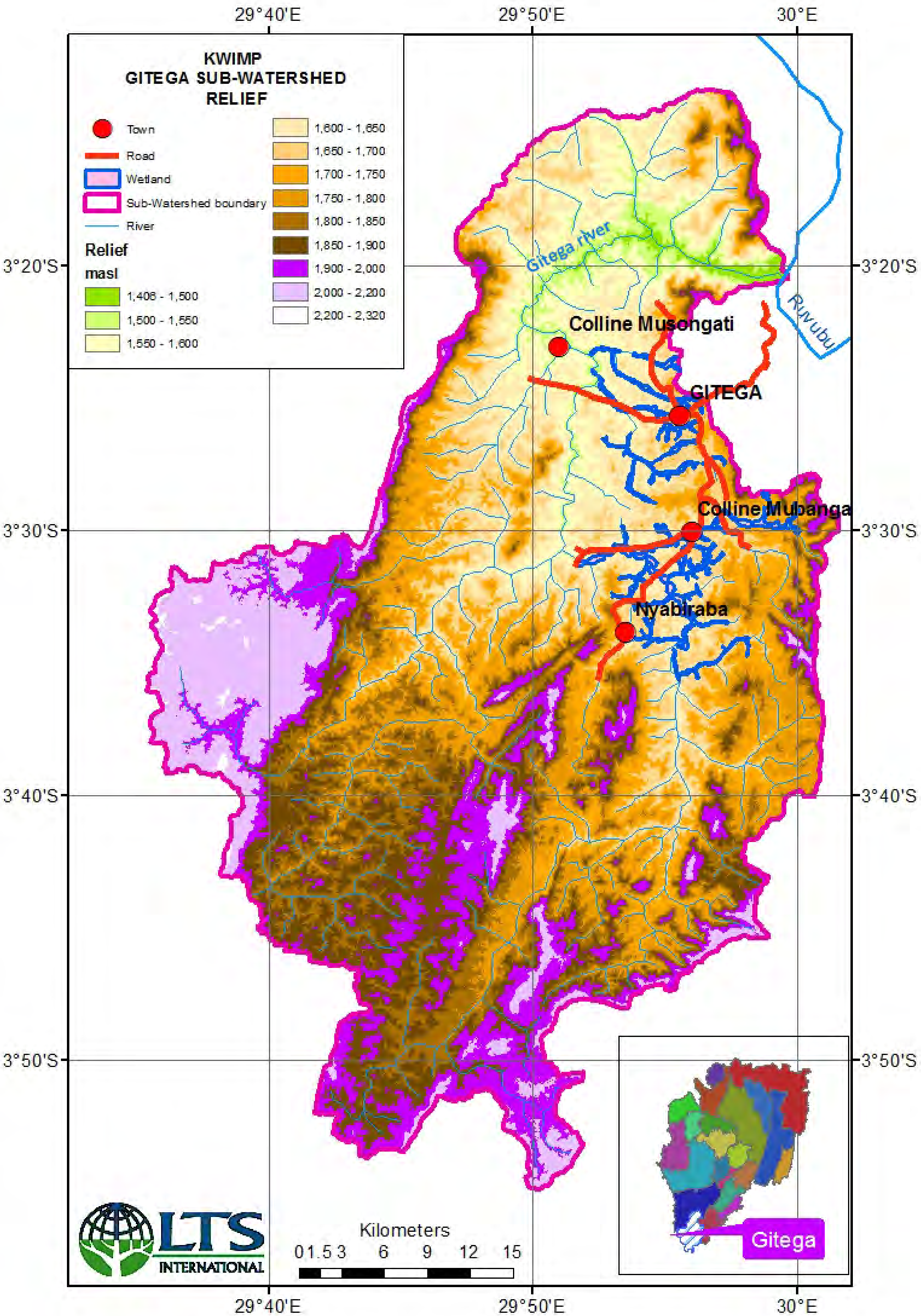
Population densities are 500 to 750 ppkm2. Some 86 percent is under intensive agriculture and settlement and gardens. The narrow bottomland wetlands are nearly always cultivated. Cultivation is carried out to the stream bank causing increased sedimentation in streams. Most radical terraces appear to be under trees and not cultivated.

The Nile Divide Farming System is found above 1,800masl in the south and southwestern part of the Sub-basin. The High Plateau Farming System is found over most of the remaining Sub-watershed.

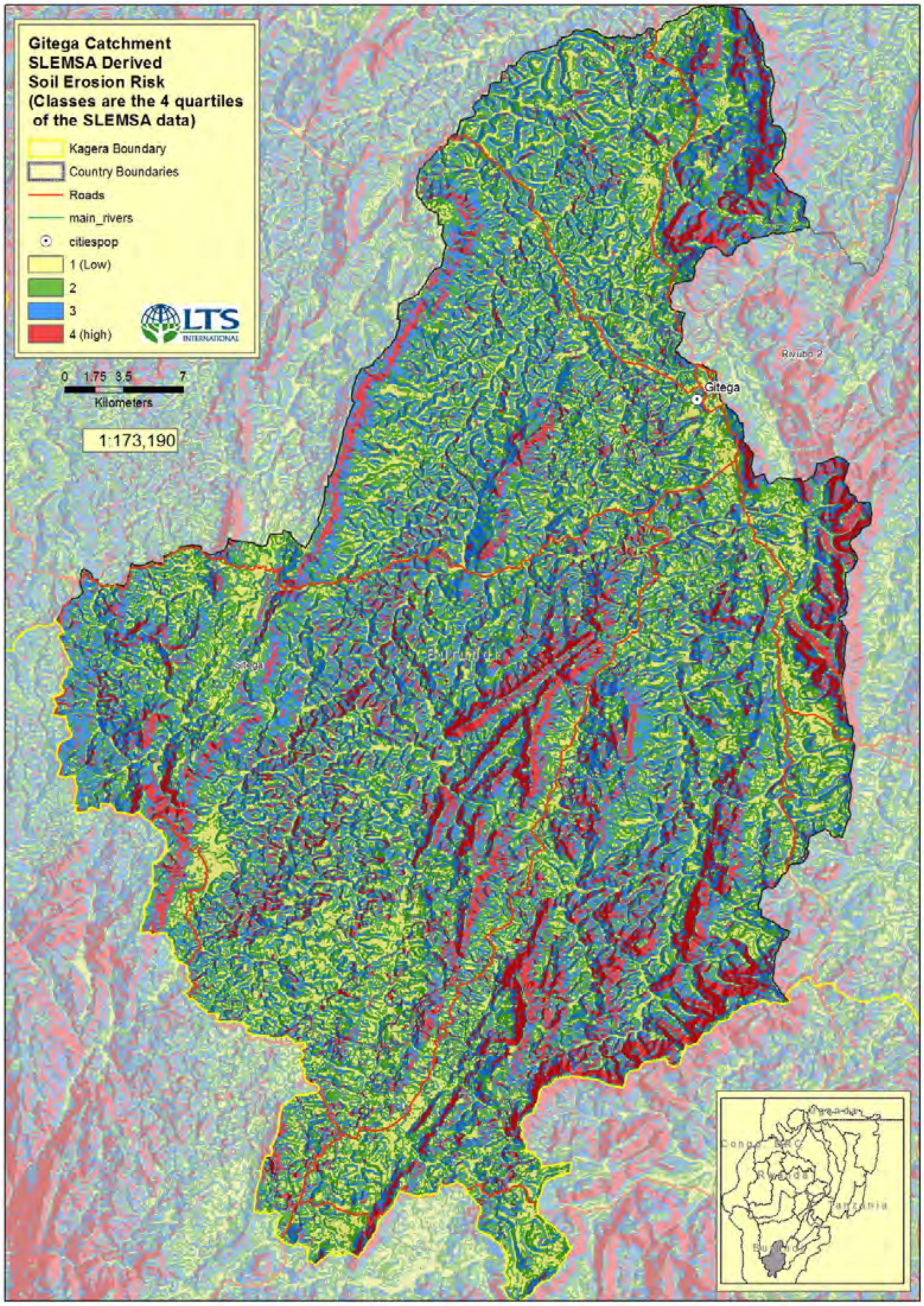
Map 34. Gitega Sub-Watershed Relief (a)



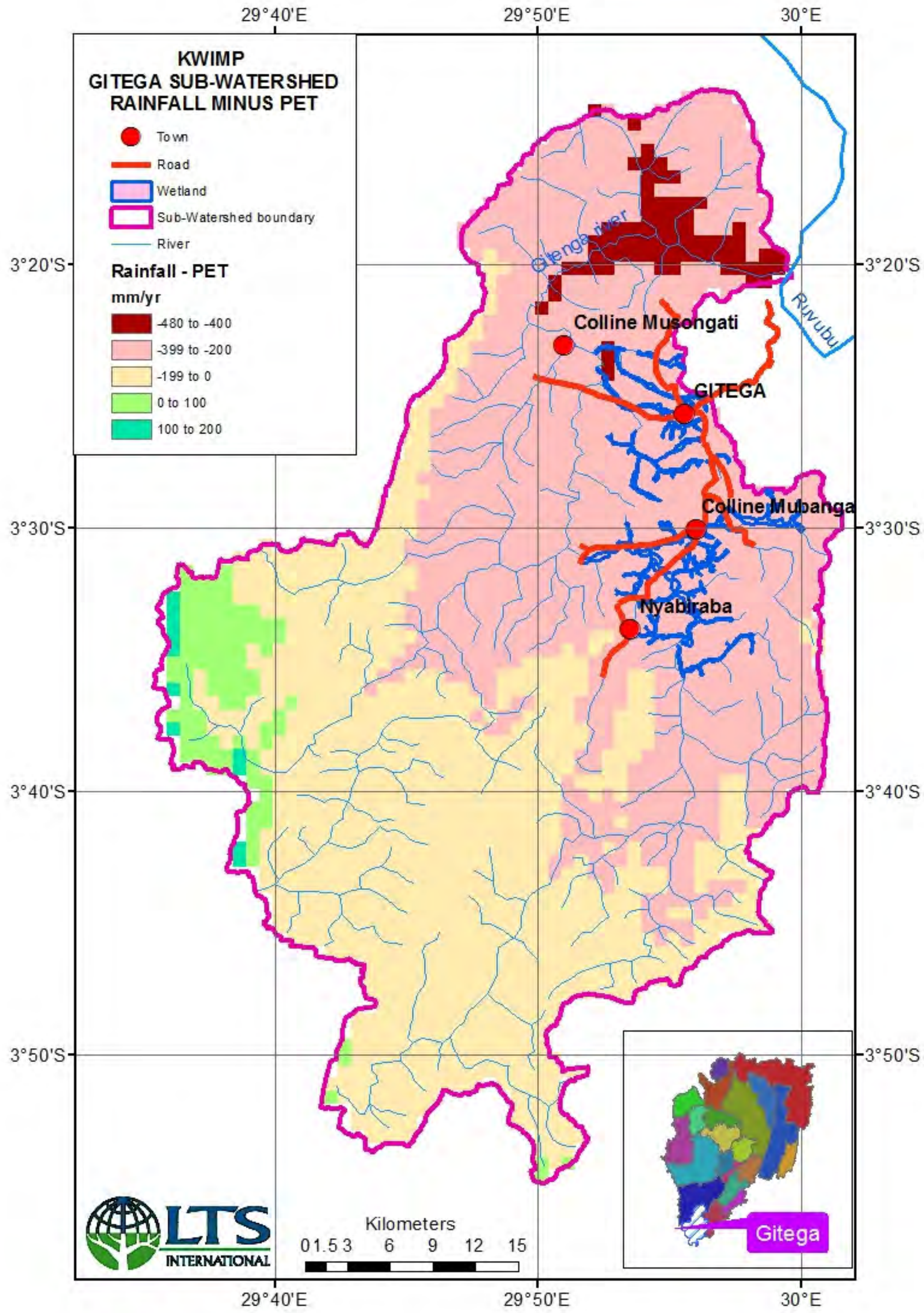
Map 35. Gitega Sub-Watershed Relief (b)



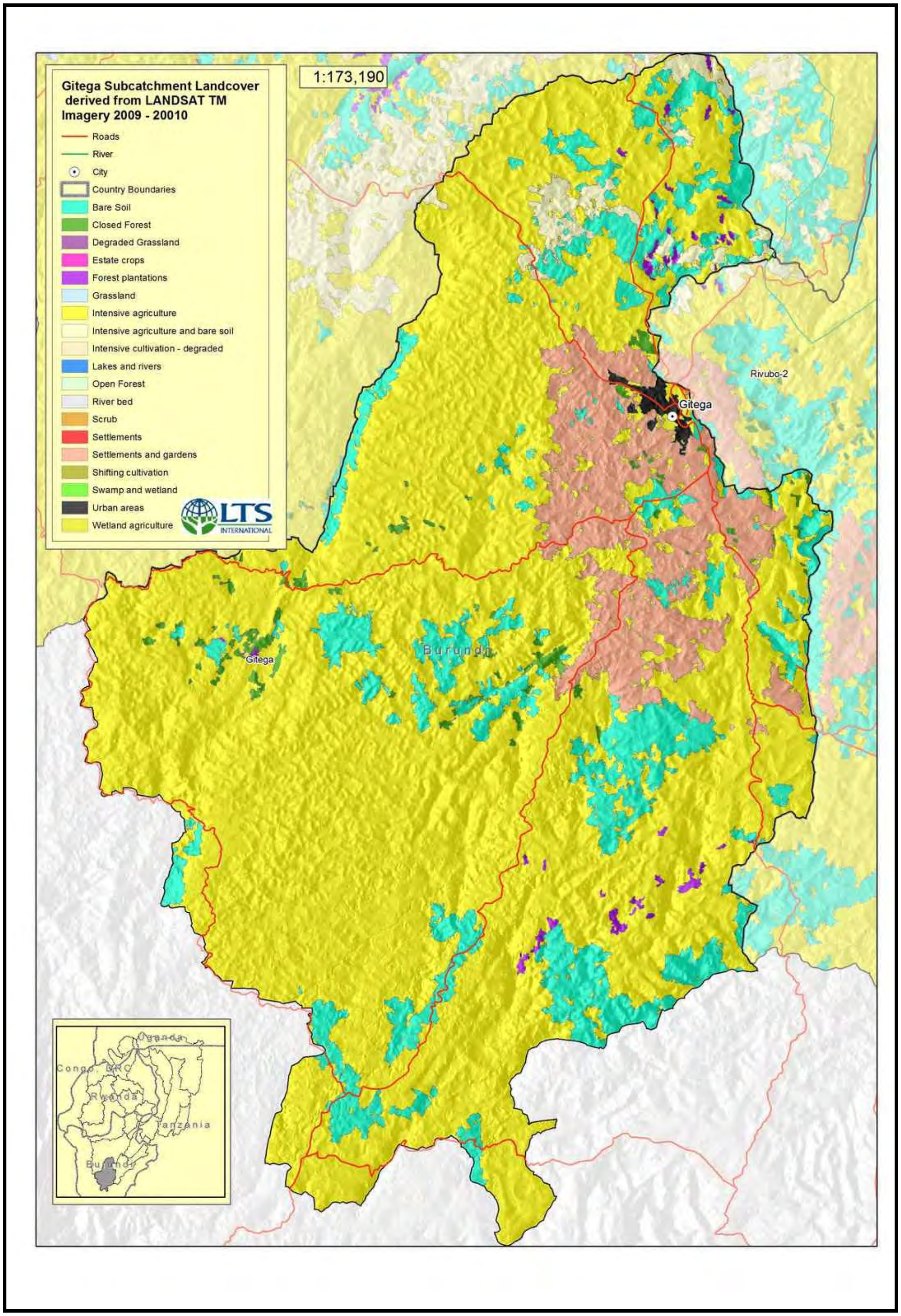
Map 36. Gitega Catchment Soil Erosion Risk



Map 37. Gitega Sub-Watershed Rainfall minus PET



Map 38. Gitega Sub-Catchment Land Cover



6. Kagera 1 Sub-watershed

6.1 Key parameters

(a) Hydrology

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
98.7	19.6	24.8	385.9	119.9	154.4
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
45.9	0.0	1.2	193.6	11.8	35.3
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
6.03	10	9.63	2.8	5	5.4
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
121.5	98.5	101	198.4	145.7	150.9
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
445.7	567.5	495.1	364.3	483.9	419.6

(a) **Land Use/Landcover**

Kagera-2 Landcover	Hectares	% of Total
Settlements	92,664	41.6
Settlements and gardens	65,968	29.6
Swamp and wetland	24,585	11.0
Lakes and rivers	10,958	4.9
Urban areas	10,370	4.7
Bare Soil	9,055	4.1
Intensive agriculture	6,938	3.1
Forest plantations	1,692	0.8
Closed Forest	209	0.1
Grassland	81	0.0
Wetland agriculture	29	0.0
Totals	**222,548**	**100**

6.2 Description of the Sub-watershed

6.2.1 Specific nature of Sub-watershed

With Kagera 1 is the driest of all the Sub-watersheds. It is ranked 21st in terms of rainfall amount and 5th in terms of PET exceeding rainfall.

6.2.2 Key Issues

- Acidic and infertile soils with aluminium toxicity
- Nutrient mining and loss of soil fertility;
- Locally steep slopes with high erosion risk;
- High sediment loads in rivers
- Livestock feed deficits

6.2.3 Characterization of Sub-watershed

The outlet of the Sub-watershed is located at the junction of the Kagera and Ruvubu rivers in the central part of the sub-basin and is some 222,554ha in extent.

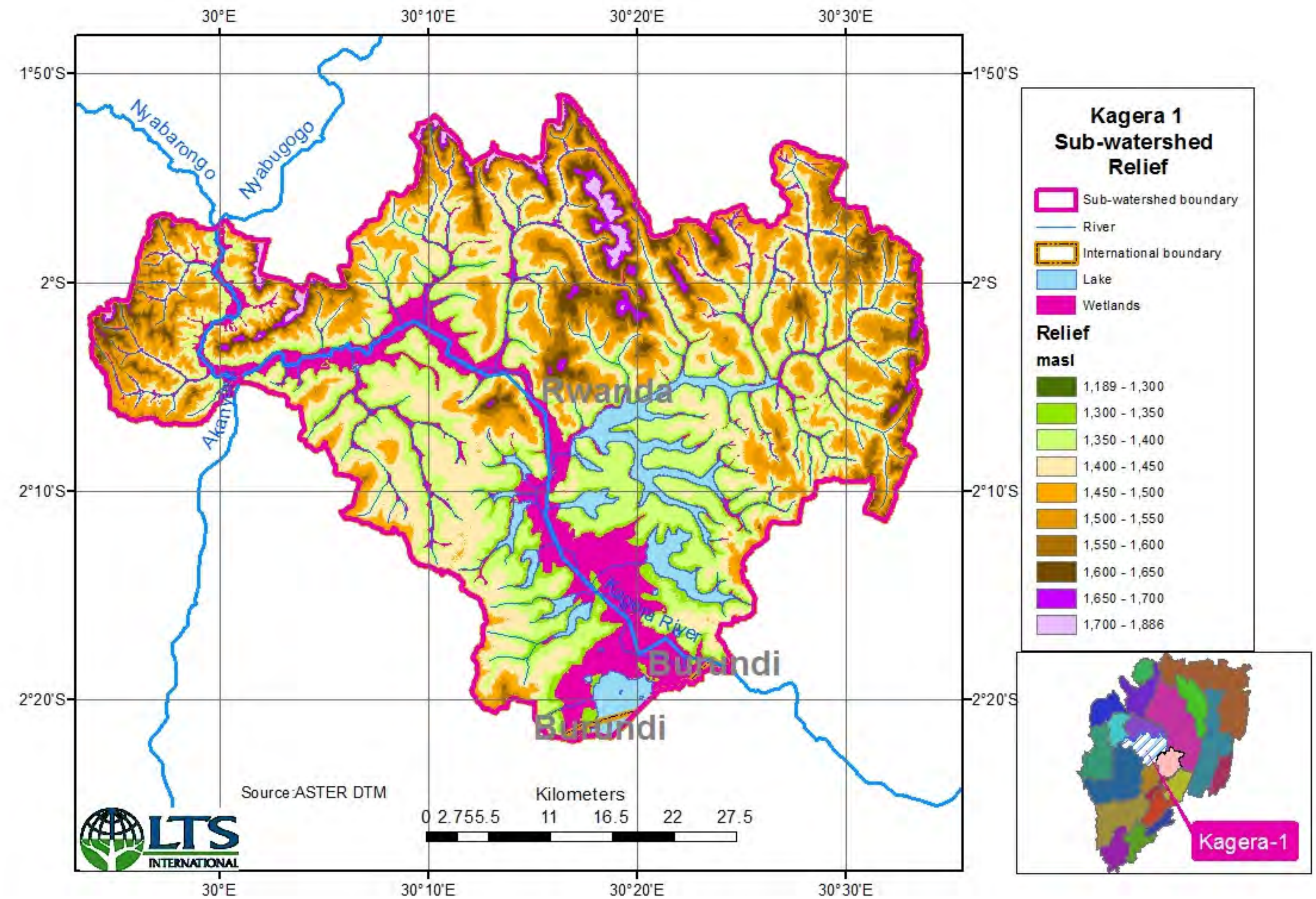
It lies between 1,250 and 1,800masl. Mean annual rainfall is 750 and 1,000mm/yr. PET exceeds rainfall by 400mm/yr and green (i.e. soil) water is only 200 to 300mm/yr. Some 71 percent of the area is covered with intensively cultivated gardens and settlement with just 3 percent of more open but intensive agriculture.

Population densities are high: 750 to 1,250ppkm2. Extensive wetlands and lakes cover some 16 percent of the area, although wetlands are not intensively cultivated.

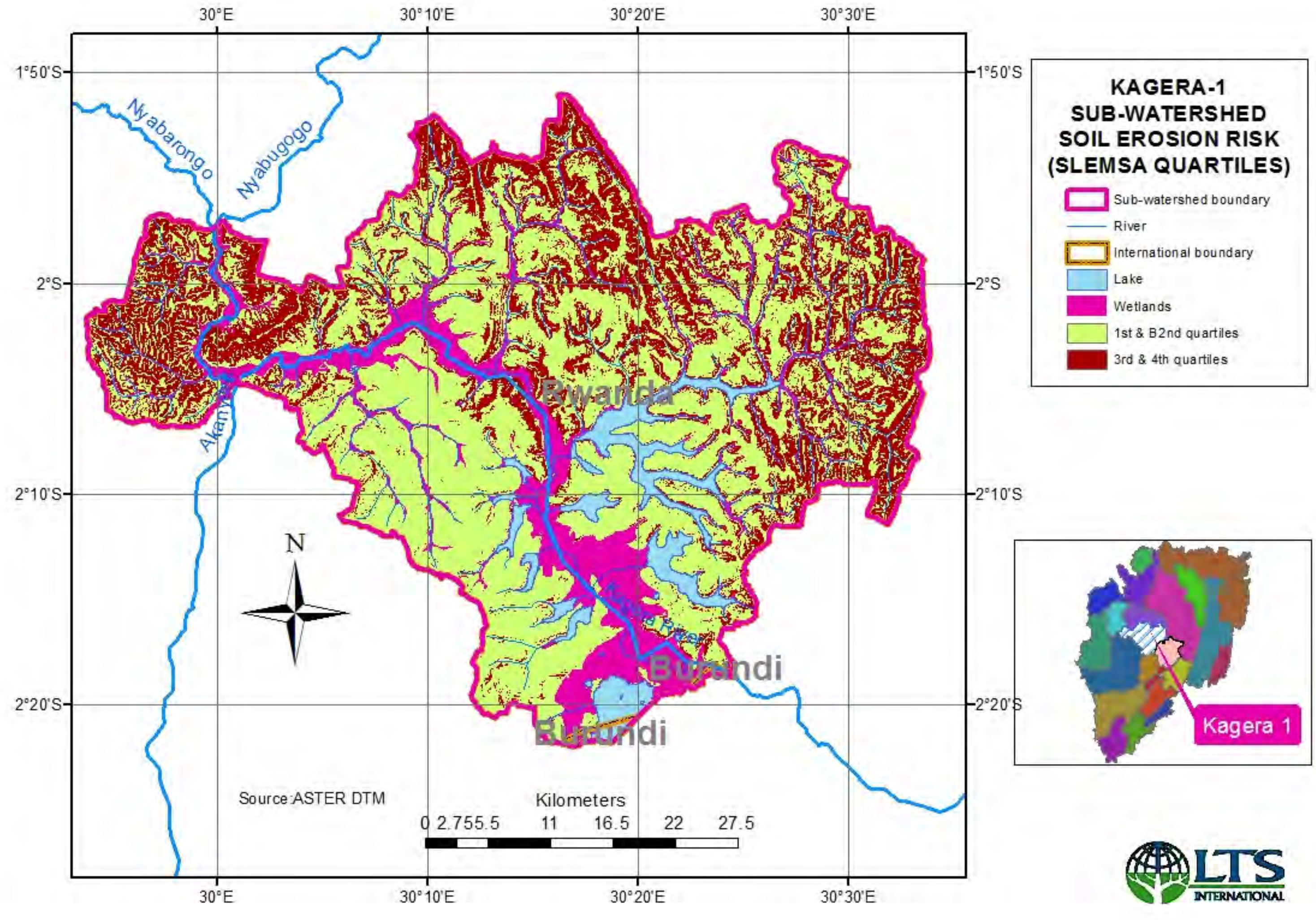
Soil erosion risk is comparatively low with only 30 percent of the land being classed as severe to very severe risk.

The High Plateau Farming System dominates the Sub-watershed with the Kagera Piedmont farming System found along the Kagera River valley.

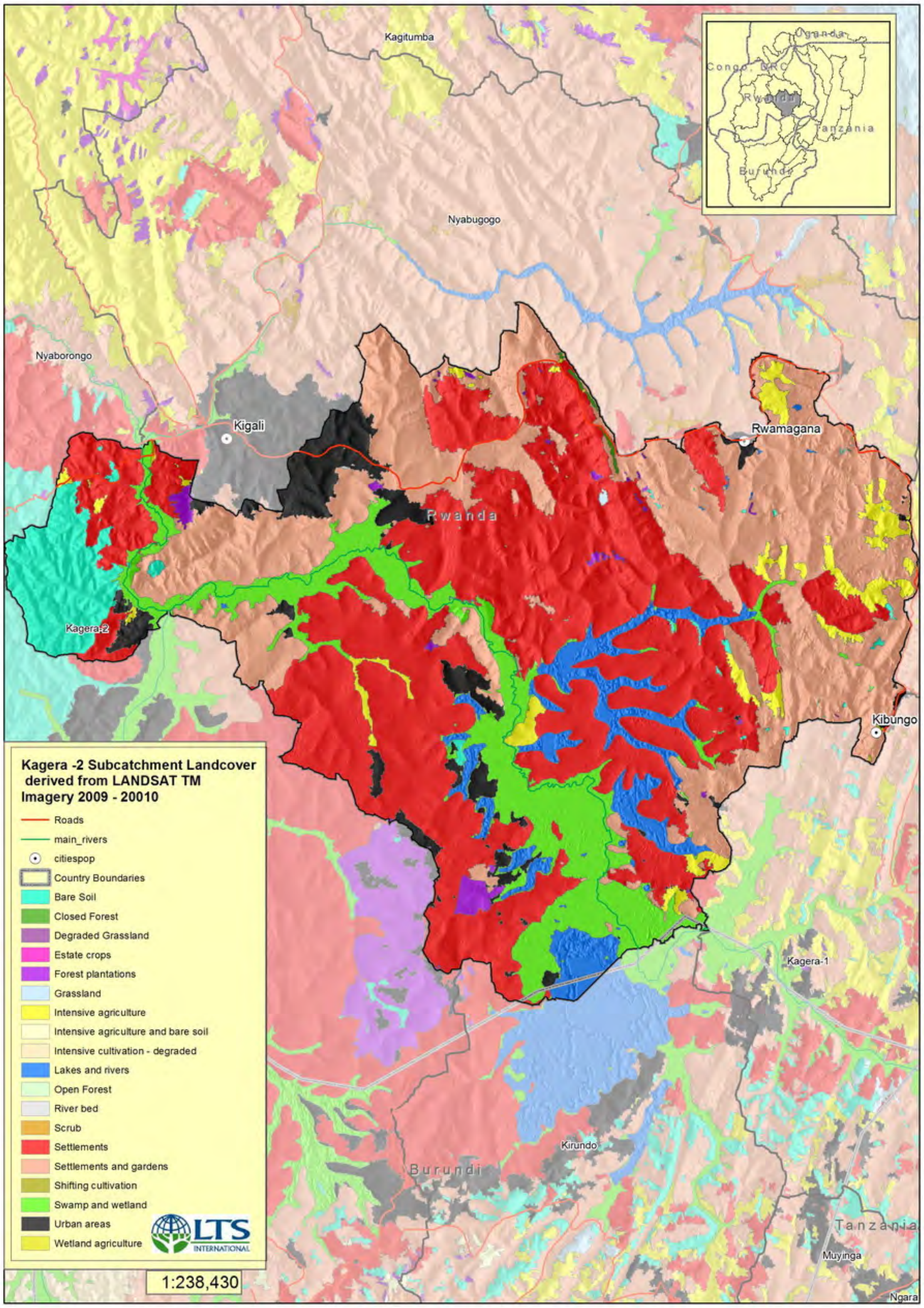
Map39. Kagera 1 Sub-Watershed Relief



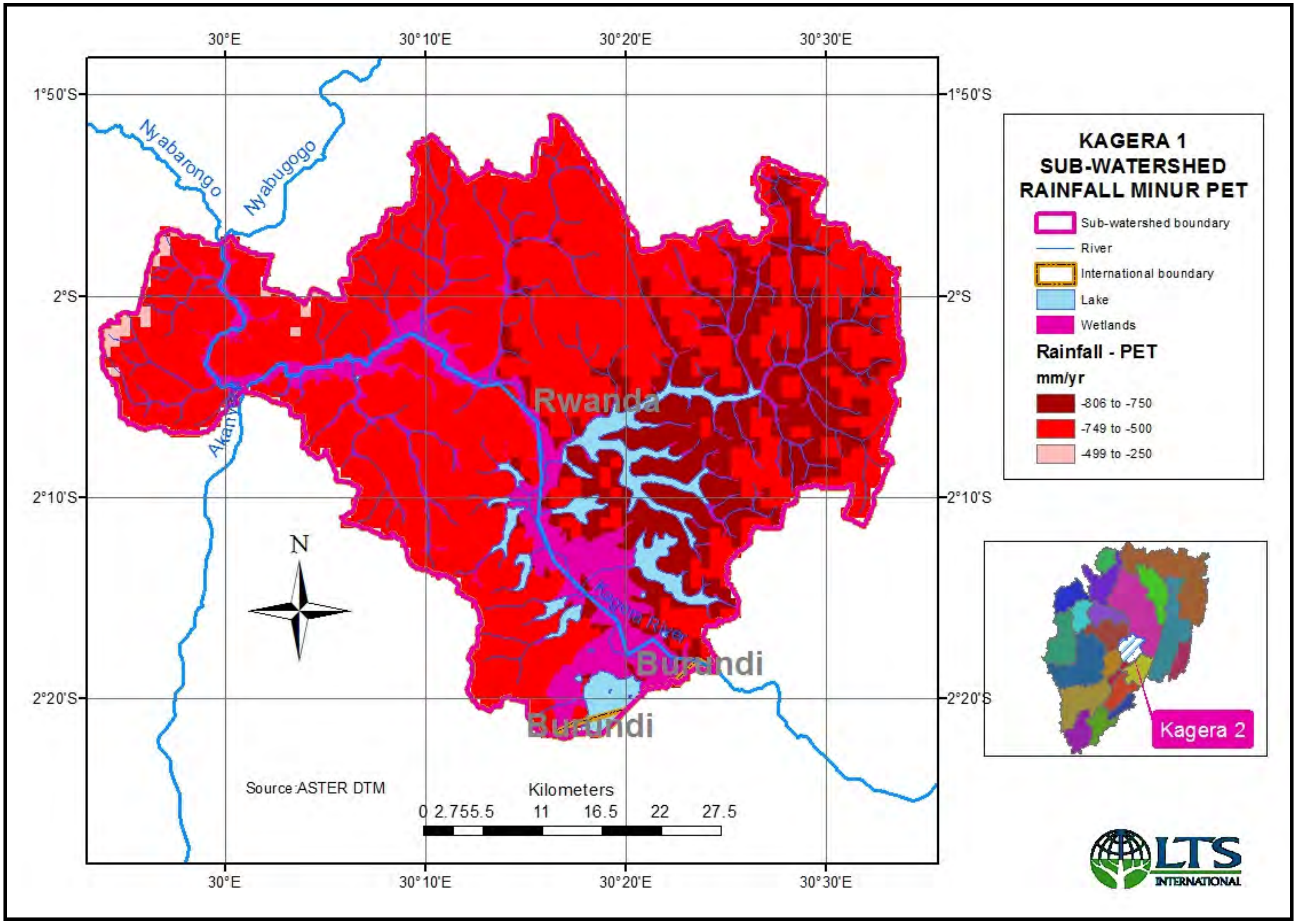
Map 40. Kagera 1 Sub-Watershed Soil Erosion Risk



Map 41. Kagera 2 Sub-Catchment Landcover



Map 42. Kagera 1 Sub-Watershed Rainfall minus PET



7. Kagera 2 Sub-watershed

7.1 Key Parameters

(b) **Hydrology**

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
478.2	241.3	275.3	541.1	260.3	313.1
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
235.0	77.1	92.3	268.6	76.7	104.5
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
5.67	9	8.93	4.73	7	6.72
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
227.5	167.4	175.6	352.6	251.7	264.6
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
431.8	565.1	483.7	572.7	691.9	628.6

(a) Land Use/landcover

Kagera-1 Landcover	Hectares	% of Total
Settlements and gardens	72,792	51.3
Intensive agriculture	24,837	17.5
Swamp and wetland	14,334	10.1
Bare Soil	12,925	9.1
Settlements	8,928	6.3
Urban areas	5,309	3.7
Wetland agriculture	1,653	1.2
Grassland	652	0.5
Forest plantations	460	0.3
Lakes and rivers	13	0.0
Totals	**141,902**	**100.0**

7.2 Description of the Sub-watershed

7.2.1 Specific nature of Sub-watershed

There are very extensive wetlands and lakes in this Sub-watershed which occupy the very distinctive "reversed" drainage pattern. Kigali city is located just above the Sub-watershed and is a source of considerable pollution.

7.2.2 Key Issues

- Acidic and infertile soils with aluminium toxicity
- Nutrient mining and loss of soil fertility;
- High pollution levels in rivers
- Livestock feed deficits

7.2.3 Characterization of Sub-watershed

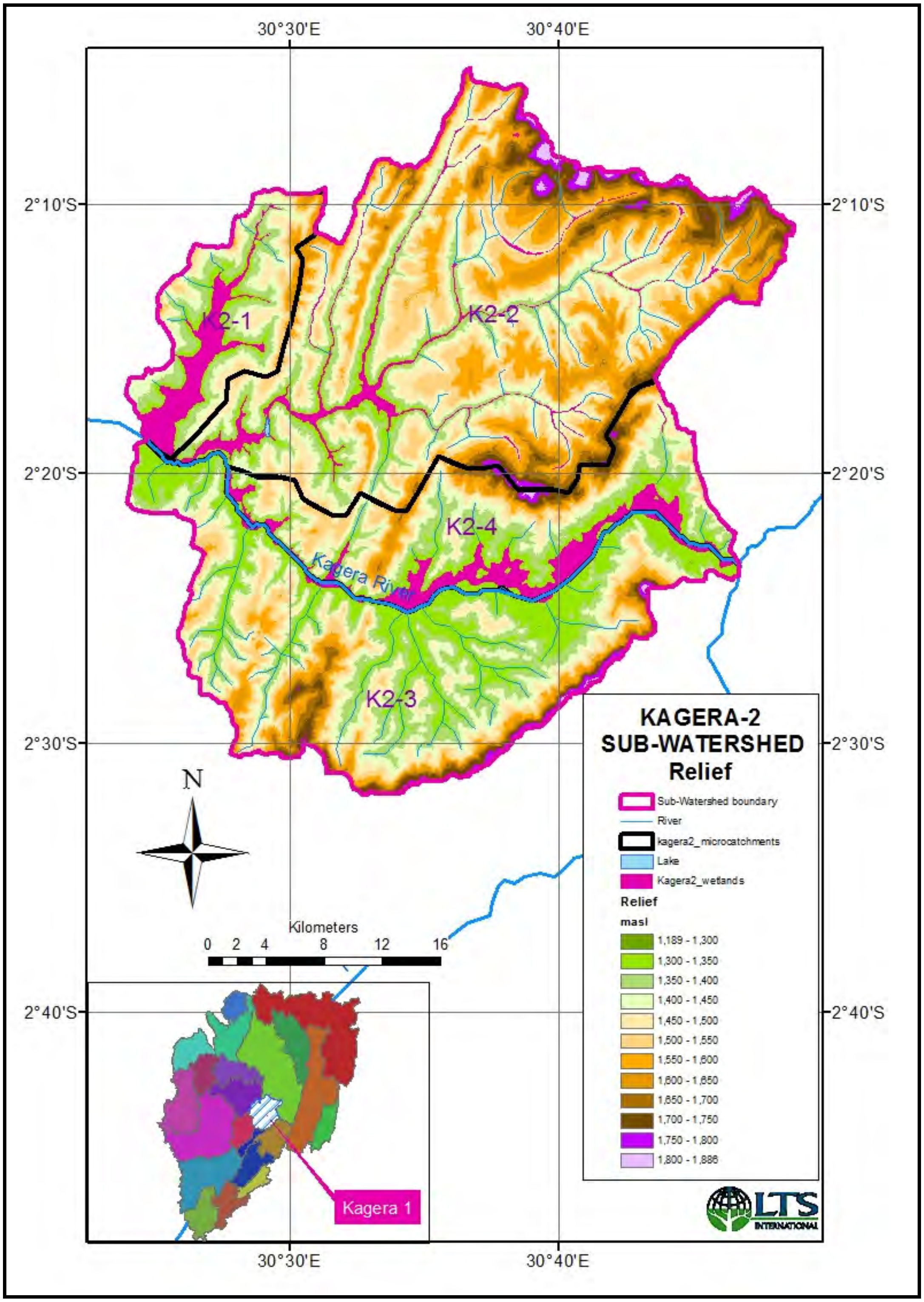
The Sub-watershed is located in the central part of the Sub-basin and covers some141,901 ha.

Mean annual rainfall varies from less than 800 to 1,000mm/yr. PET exceeds rainfall from 200 to 300mm/yr. green (soil0 water is only 150mm/yr. Infertile and acidic Ferralsols are dominant with highly organic Histosols found in the wetlands.

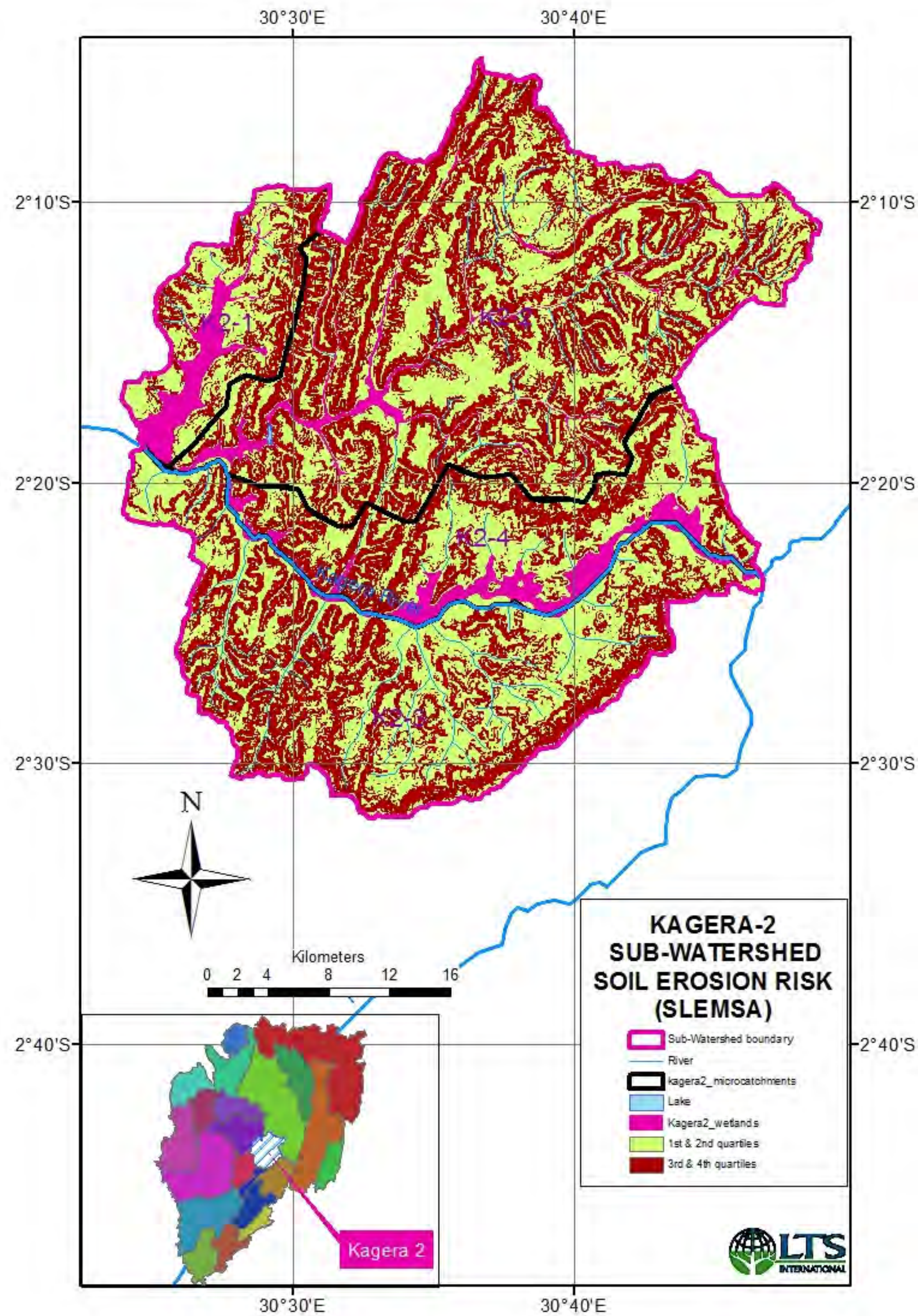
Population densities are high: 750 to 1,250ppk2. Wetlands and lakes coverage is third highest in the Sub-basin covering some 16 percent of the area. Intensive agriculture and settlement with gardens cover some 75 percent however cultivated wetlands are relatively unimportant given their large extent. Some 46 percent of the area has a severe and to very severe soil erosion risk, with 10 percent of the area covered with bare soil.

The High Plateau Farming System is found in the northern half of the Sub-basin and the Kagera Piedmont Farming System in the southern part.

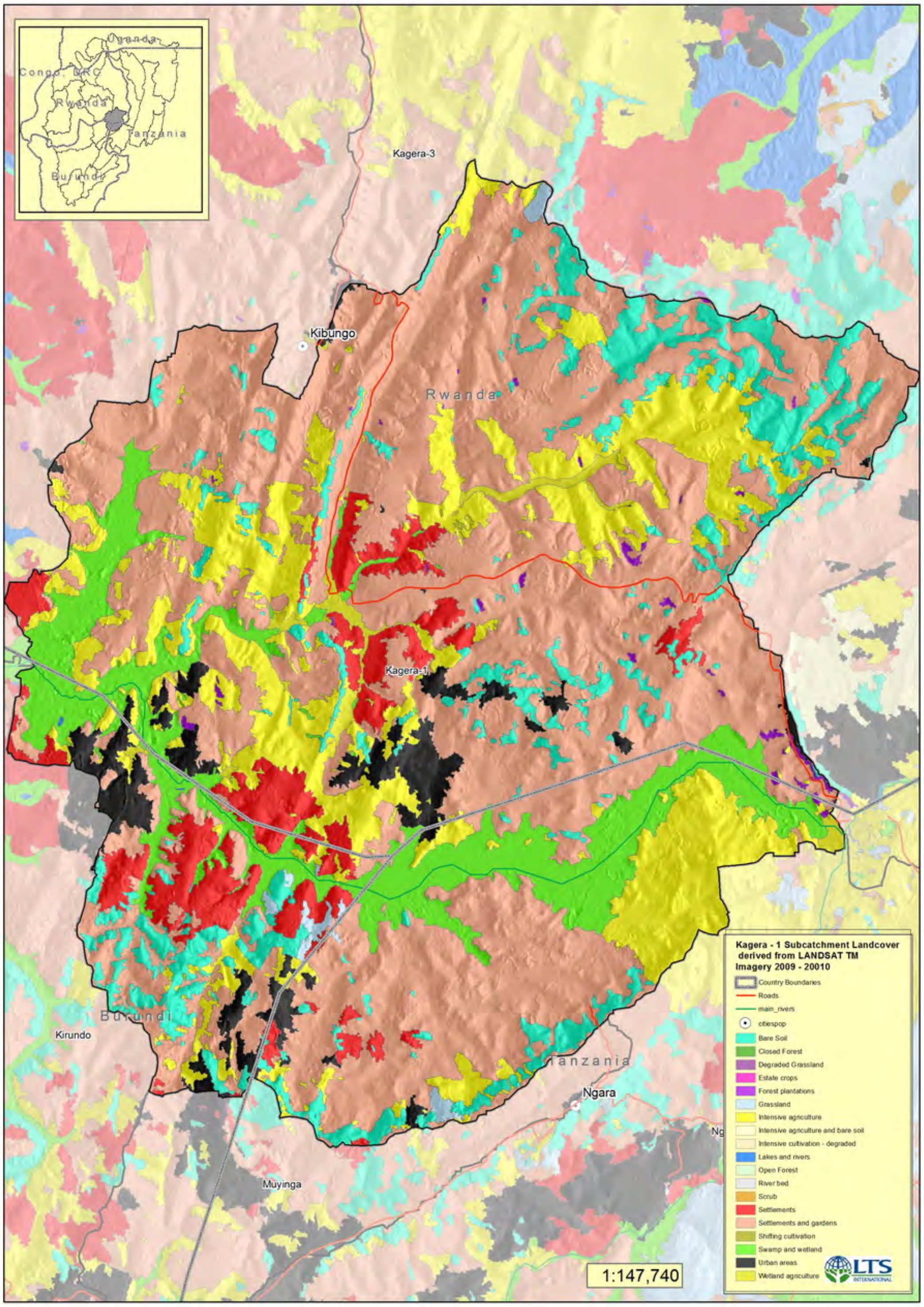
Map 43. Kagera 2 Sub-Watershed Relief



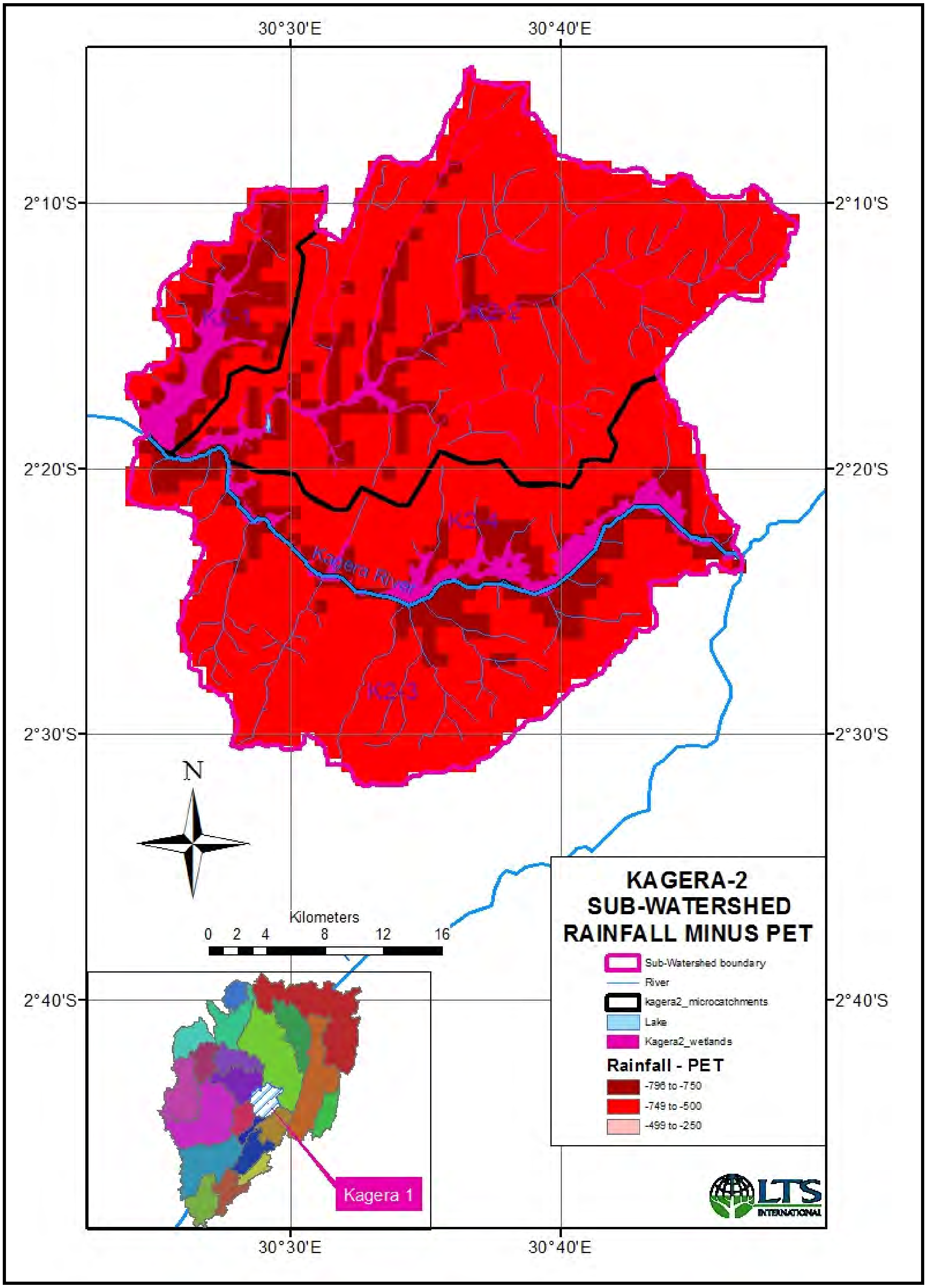
Map 44. Kagera 2 Sub-Watershed Soil Erosion Risk



Map 45. Kagera 1 Sub-Catchment Landcover



Map 46. Kagera 2 Sub-Watershed Rainfall minus PET



8. Kagera 3 Sub-watershed

8.1 Key Parameters

(a) **Hydrology**

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
143.5	31.4	46.6	385.3	184.3	203.3
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
65.7	4.8	7.1	190.9	24.9	61.9
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
7.53	10	10.23	4.33	6	6.84
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
243.9	176.5	186.7	393.6	286.7	295.4
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
363.3	503.7	416	318.7	433.8	369.5

(b) Land use/Landcover

Kagera-3 Landcover	Hectares	% of Total
Grassland	335,665	50.4
Settlements and gardens	80,601	12.1
Swamp and wetland	75,413	11.3
Intensive agriculture	53,675	8.1
Lakes and rivers	47,224	7.1
Bare Soil	24,743	3.7
Settlements	16,634	2.5
Urban areas	14,820	2.2
Intensive agriculture and bare soil	6,073	0.9
Scrub	5,546	0.8
Open Forest	2,292	0.3
Forest plantations	1,617	0.2
River bed	749	0.1
Wetland agriculture	648	0.1
Degraded Grassland	385	0.1
Closed Forest	171	0.0
TOTAL	**666,254**	**100.0**

8.2 Description of the Sub-watershed

8.2.1 Specific nature of Sub-watershed

The Kagera River forms the boundary between Rwanda and Tanzania. The driest of all the Sub-watersheds it is occupied on the Rwanda side by the Akagera National Park. Settlement and cultivation is confined to the higher ground along the western side.

8.2.2 Key Issues

- Encroachment of agriculture and grazing into the Akagera National Park;
- Degraded pastures and livestock feed deficits;
- Lack of water supplies for humans and livestock;
- Uncontrolled bush burning;
- Over fishing and depletion of fish stocks;
- Need for capacity building for sustainable environmental and natural resource management;

8.2.3 Characterization of Sub-watershed

Located in the north central part of the Sub-basin it the most extensive covering some 666,258ha.

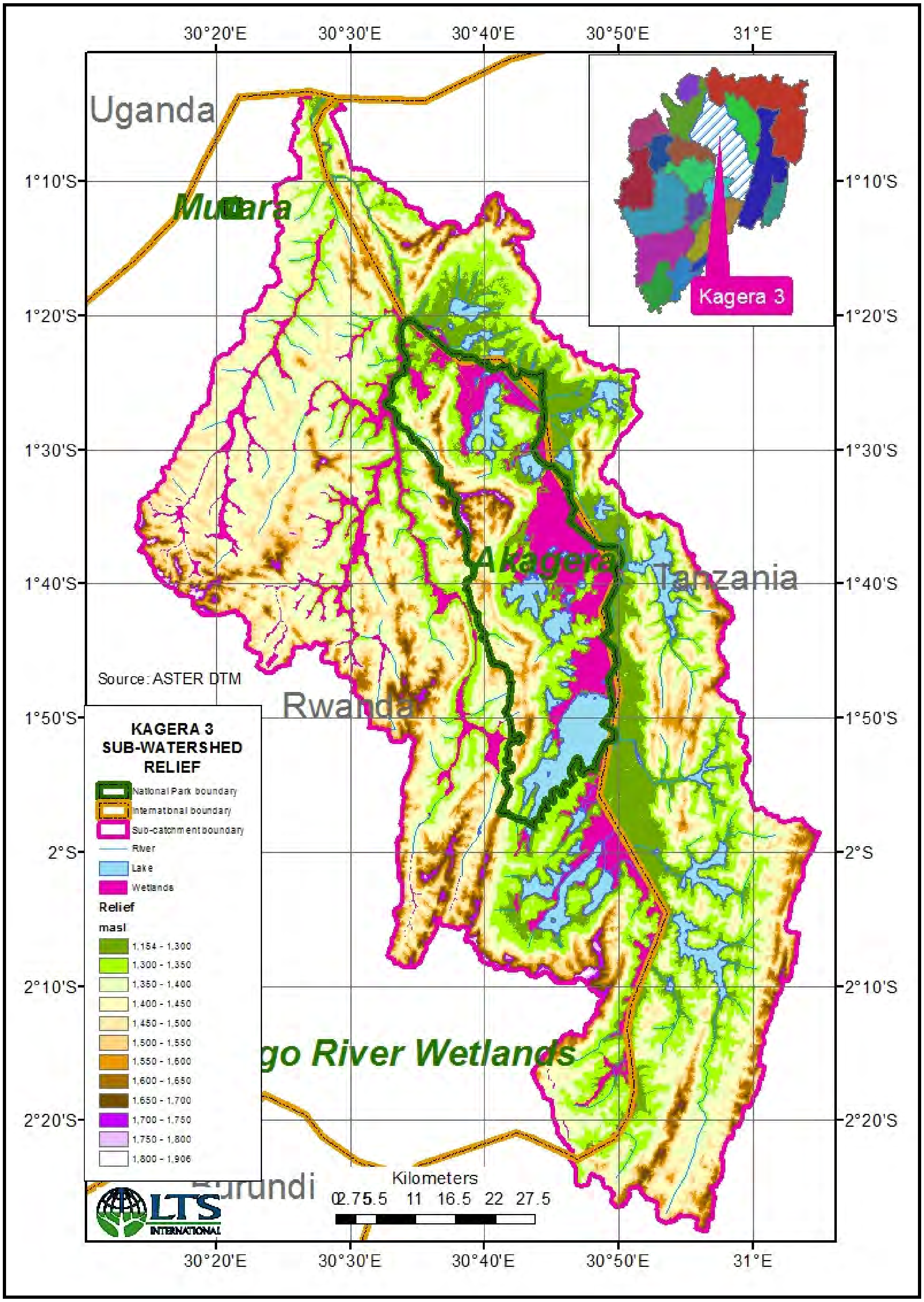
Mean annual rainfall is less than 800 to 900mm/yr. PET exceeds rainfall by 400mm/yr. Green (soil) water is only 100 to 150mm/yr.

Population densities are the lowest in the Sub-basin: less than 15ppk2 except along the higher western part where densities reach 500ppkm2.The dominant land cover types are grassland and woodland (51 percent of the area) and wetlands and lakes (18 percent of the area). Intensive agriculture and gardens only cover 18 percent.

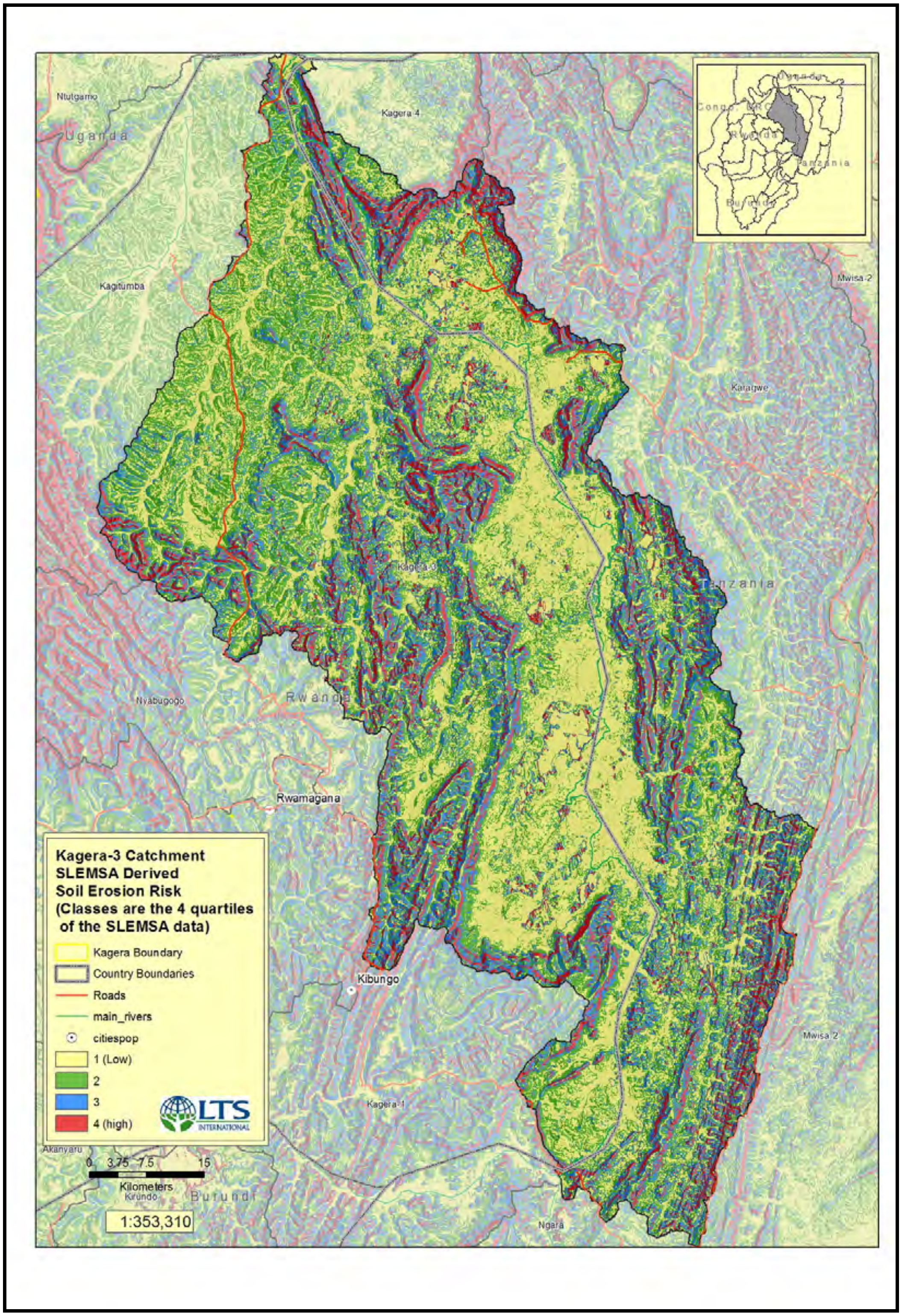
Outside the Akagera National Park the Savanna Lowlands farming system predominates with livestock rearing an important component of the system.

The Akagera National Park is under severe pressure from agriculture, agro-pastoralism and poaching.

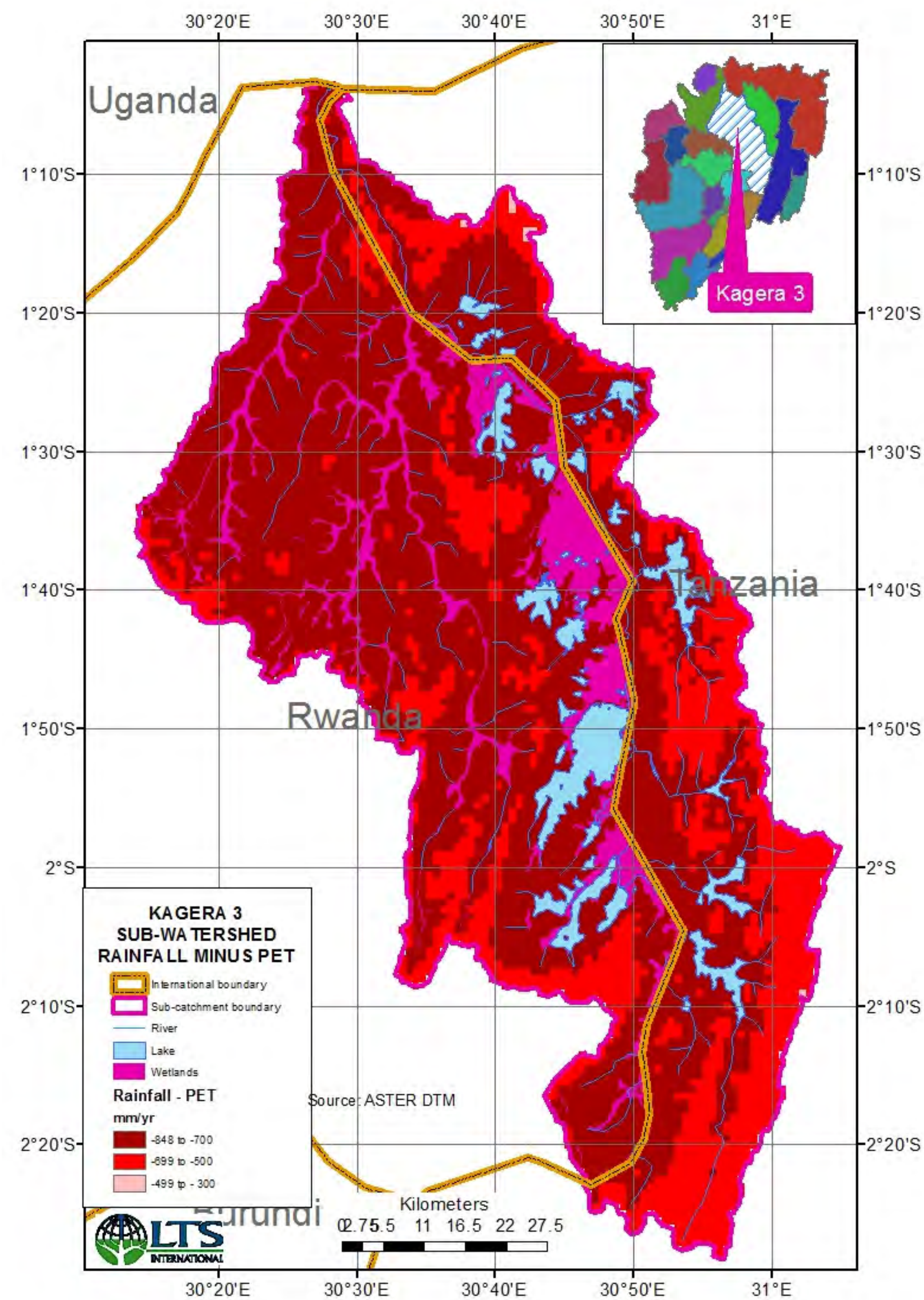
Map 47. Kagera 3 Sub-Watershed Relief



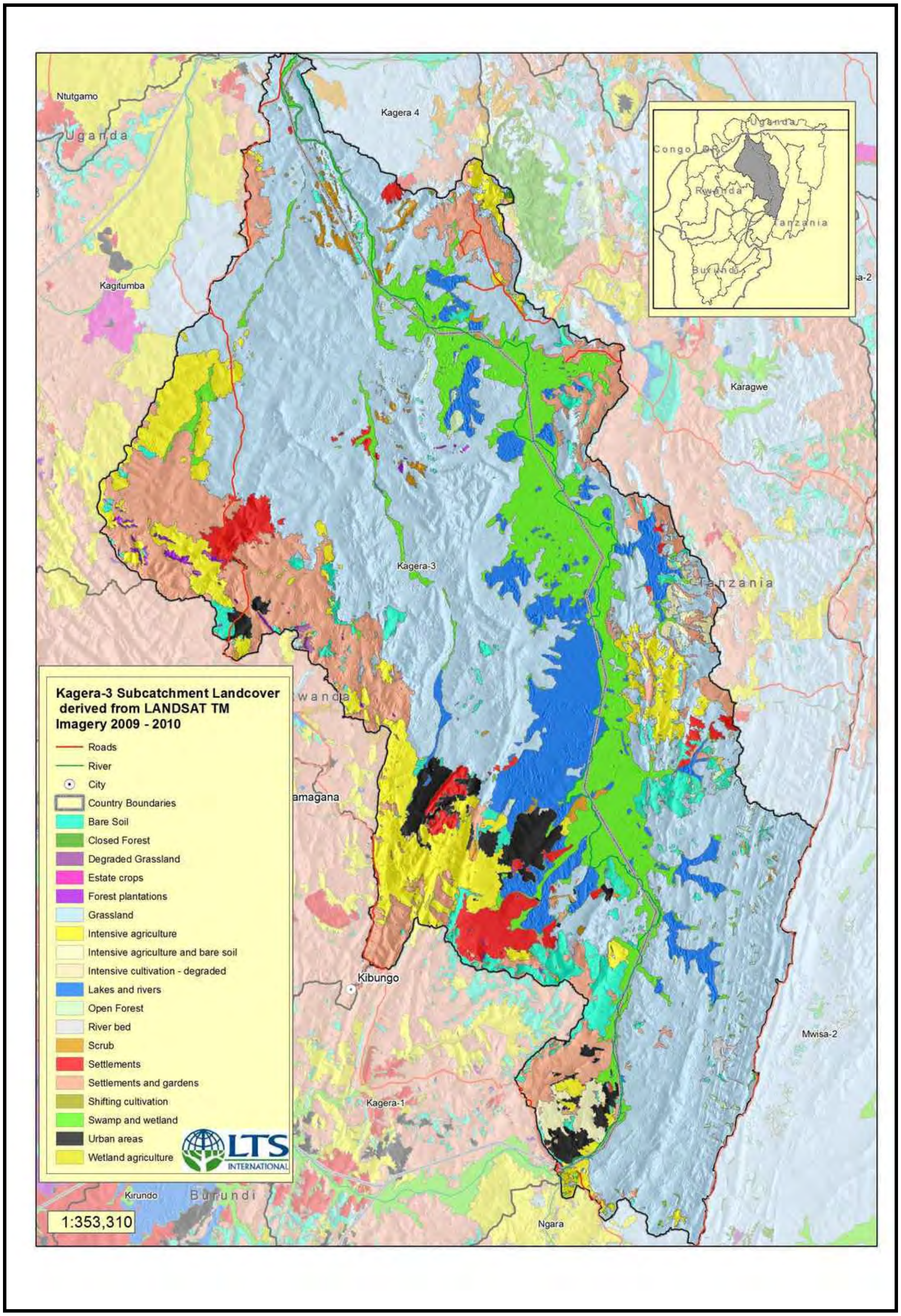
Map 48. Kagera 3 Catchment Soil Erosion Risk



Map 49. Kagera 3 Sub-Watershed Rainfall minus PET



Map 50. Kagera 3 Sub-Catchment Landcover



9. Kagera 4 sub-watershed

9.1 Key parameters

(a) **Hydrology**

Runoff – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
276.2	45.9	83.5	221.2	45.5	60.3
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
123.8	0.8	5.9	94.3	0.0	2.1
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
7.4	11	10.36	6.3	9	9.14
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
276	171.9	203.3	447.7	328.4	340.8
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
349.8	486.2	401.4	888.6	1067.8	955.9

(b) Land Use/Landcover

Kagera-4 Landcover	Hectares	% of Total
Grassland	379,262	44.1
Settlements and gardens	211,846	24.6
Swamp and wetland	93,649	10.9
Closed Forest	44,795	5.2
Bare Soil	33,155	3.9
Scrub	29,583	3.4
Intensive agriculture	23,916	2.8
Settlements	11,835	1.4
Shifting cultivation	11,780	1.4
Urban areas	7,812	0.9
Lakes and rivers	7,232	0.8
Open Forest	4,563	0.5
Degraded Grassland	781	0.1
Forest plantations	346	0.0
River bed	15	0.0
Totals	**860,569**	**100.0**

9.2 Description of the Sub-watershed

9.2.1 Specific nature of Sub-watershed

This is the lowest part of the sub-basin where the Kagera River meets Lake Victoria in a delta. Extensive wetlands occur in the delta. The Sub-watershed is located in both Uganda and Tanzania. The Mwisa River joins the Kagera on its southern border.

9.2.2 Key Issues

- Overgrazing of grasslands and consequent livestock feed deficits;
- Lack of accessible water supplies for humans and livestock;
- Degradation of wetlands from uncontrolled conversion to agriculture;
- Uncontrolled bush burning;
- Fuelwood deficits
- Soil nutrient mining, low fertility, acidification and aluminium toxicities;
- Soil loss due to brick making;
- Chemical pollution of rivers and wetlands from spilled acaricides;
- Soil erosion of hillsides and steep slopes;
- High sediment loads in main rivers;
- Spread of water hyacinth in rivers and lakes;
- Need for capacity building for sustainable environmental and natural resource management;
- Over fishing and depletion of fish stocks;

9.2.3 Characterization of Sub-watershed

The Sub-watershed covers some 856,831ha. Mean annual rainfall increases from less than 800 to 1,000mm/yr over most of the Sub-watershed, but increasing rapidly 20kms from the lake shore to over 1,600mm/yr. The PET:rainfall balance follows the same pattern with PET exceeding rainfall over most of the sub-watershed by 600 to 200mm/yr, and within 20kms of the Lake rainfall exceeds PET by 400mm/yr.

Grasslands, shrublands and woodlands cover some 48 percent of the area, with closed forest some 5percent. Intensive cultivation and gardens cover 27 percent and shifting cultivation only 1.4 percent. Wetlands and lakes are extensive covering over 100,000has.