17. Mwogo Sub-watershed

17.1 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
938.2	657.9	679.2	1329.1	976.5	1017.5
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
412.6	262.3	271.5	590.1	407.5	421.5
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
2.97	6	5.77	2.2	4	4.79
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
89.6	58.2	59.9	109.7	87.6	87.1
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
196.3	340.3	263.4	190.2	339.7	260.4

(b) Land Use/landcover

Mwogo - Landcover	Hectares	% of Total
Intensive agriculture	238,702	71.2
Bare Soil	40,019	11.9
Forest plantations	31,543	9.4
Intensive cultivation - degraded	6,318	1.9
Settlements	6,046	1.8
Settlements and gardens	4,352	1.3
Grassland	3,331	1.0
Closed Forest	1,950	0.6
Shifting cultivation	1,240	0.4
Urban areas	896	0.3
Lakes and rivers	554	0.2
Swamp and wetland	297	0.1
Open Forest	130	0.0
Intensive agriculture and bare soil	33	0.0
TOTAL	**335,409**	**100.0**

17.2 Description of the Sub-watershed

17.2.1 Specific nature of Sub-watershed

The Sub-watershed, the second largest in the Sub-basin, is located on the Nile Divide and Mwogo River meets the Nyabarongo River at its outlet. The head-waters form the official source of the White Nile.

17.2.2 Key Issues

- Acidic and infertile soils, steep slopes with high erosion risk;
- Loss of soil fertility and instability of radical terraces
- High sediment loads in rivers and sedimentation in wetlands
- Livestock feed deficits
- Agricultural encroachment of wetlands
- Limited and irregular rainfall in lower Sub-watershed

17.2.3 Characterization of Sub-watershed

The Sub-watershed is some 335,406ha and is located in the central part of the western watershed.

It lies between 1,400 and 2,900masl with the area west of the main river having the steepest slopes. The area in the southwest forms a high plateau above 2,400masl. Dominant soils are deep moderately fertile Cambisols west and east of the river, with shallow and stony Leptosols on the steepest slopes. Some 74 percent of the area has a severe to very severe risk of soil erosion, the second highest percentage in the sub-basin.

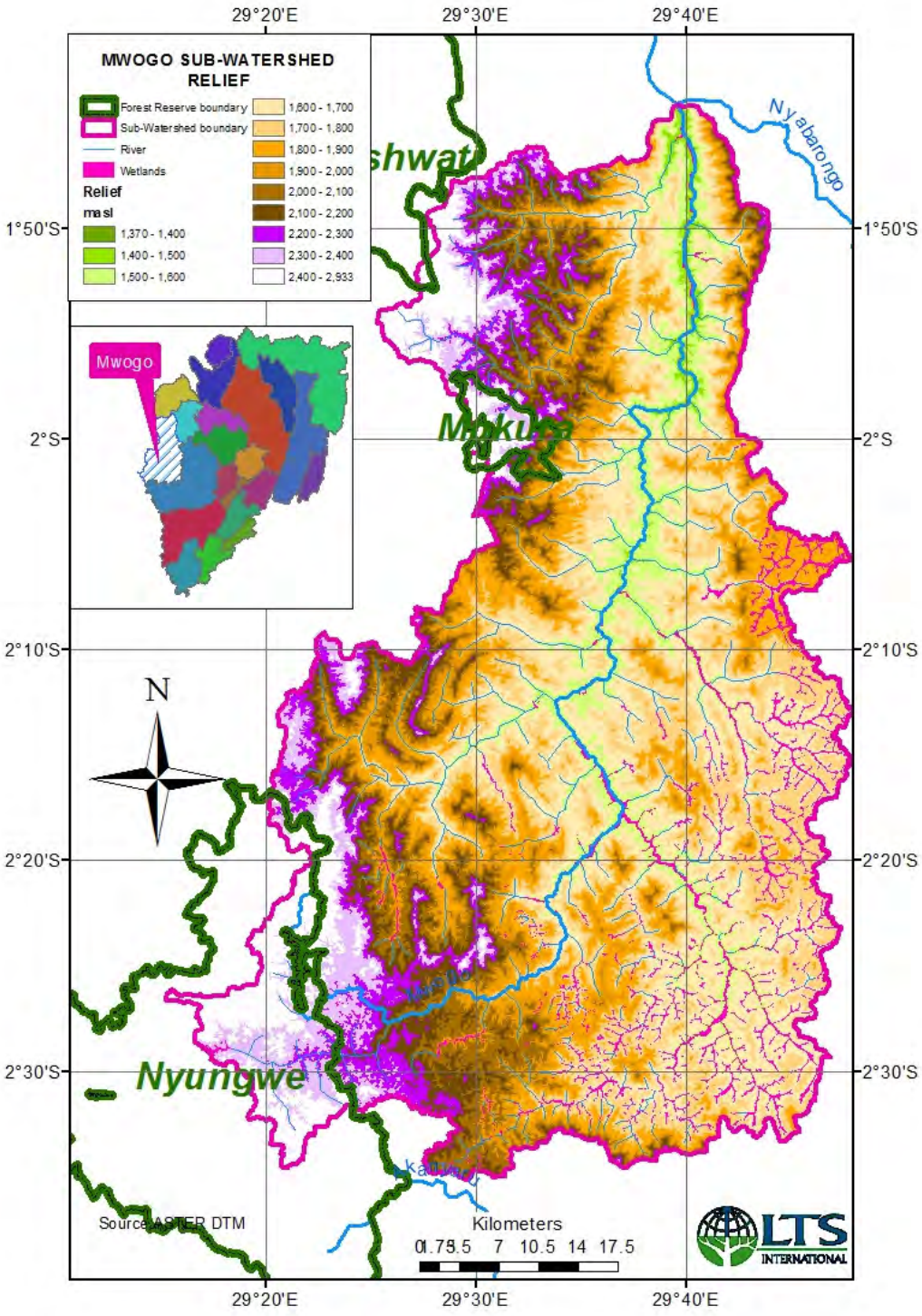
The mean annual rainfall ranges from 800mm/yr in the lowest part to 1,600mm/yr along the Congo-Nile Divide. Rainfall exceeds PET from between 100 and 500mm/yr. Green water is between 500 and 700mm/yr.

Intensive agriculture, gardens and rural settlements cover some 88 percent of the Sub-watershed. The Gishwati, Mukura and part of Nyungwe Forests and forest plantation cover

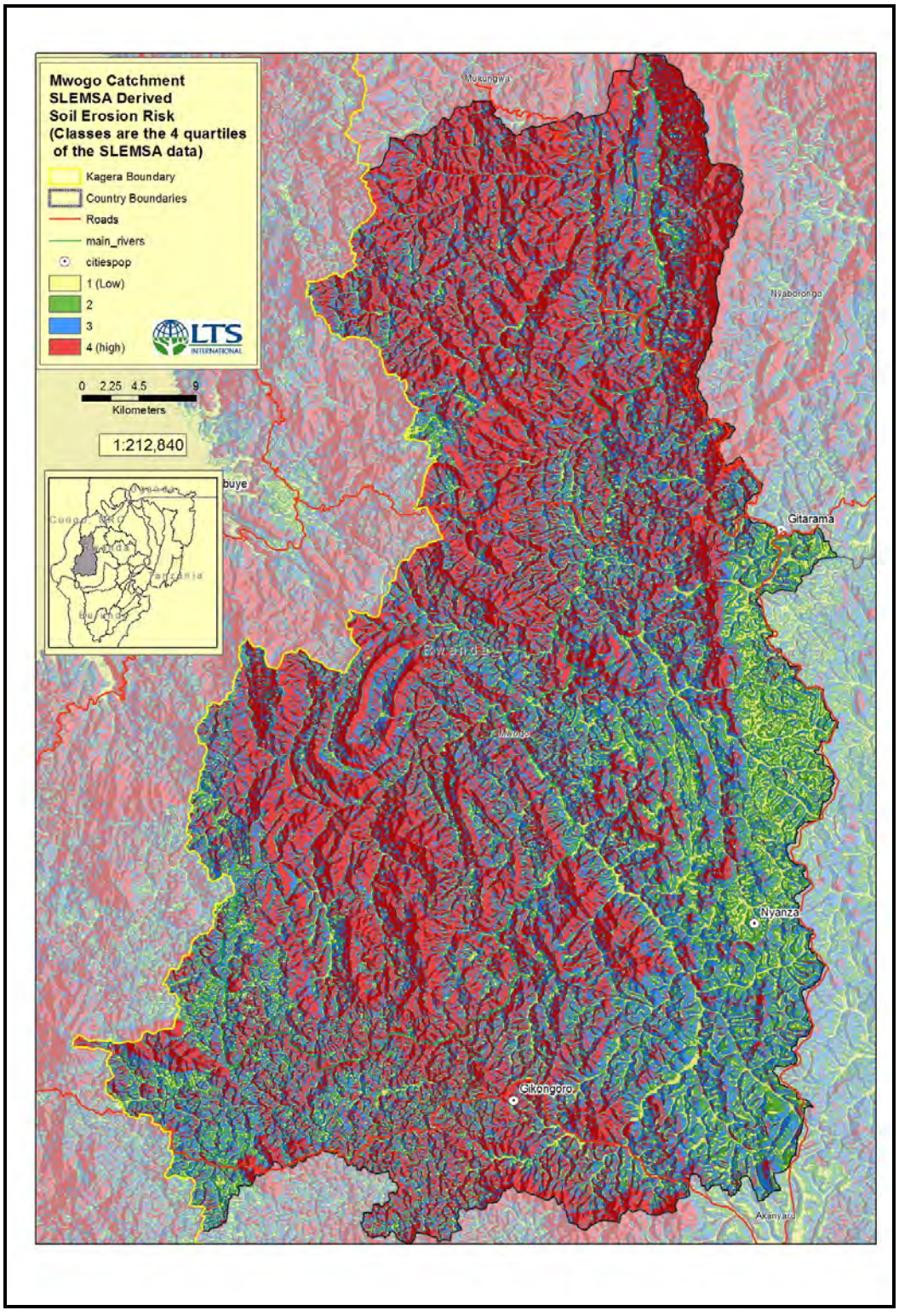
10 percent of the area and are confined to the highest ground. Narrow valley bottom wetlands are extensive in the central and southern eastern side of the Mwogo River.

Population densities are between 500 and 750 ppkm2. The three major Farming Systems: Kagera Piedmont, High Plateau and Nile divide Farming Systems are found between 1,400-1,550, a,550- 1,800 and 1,800-,800 masl respectively.

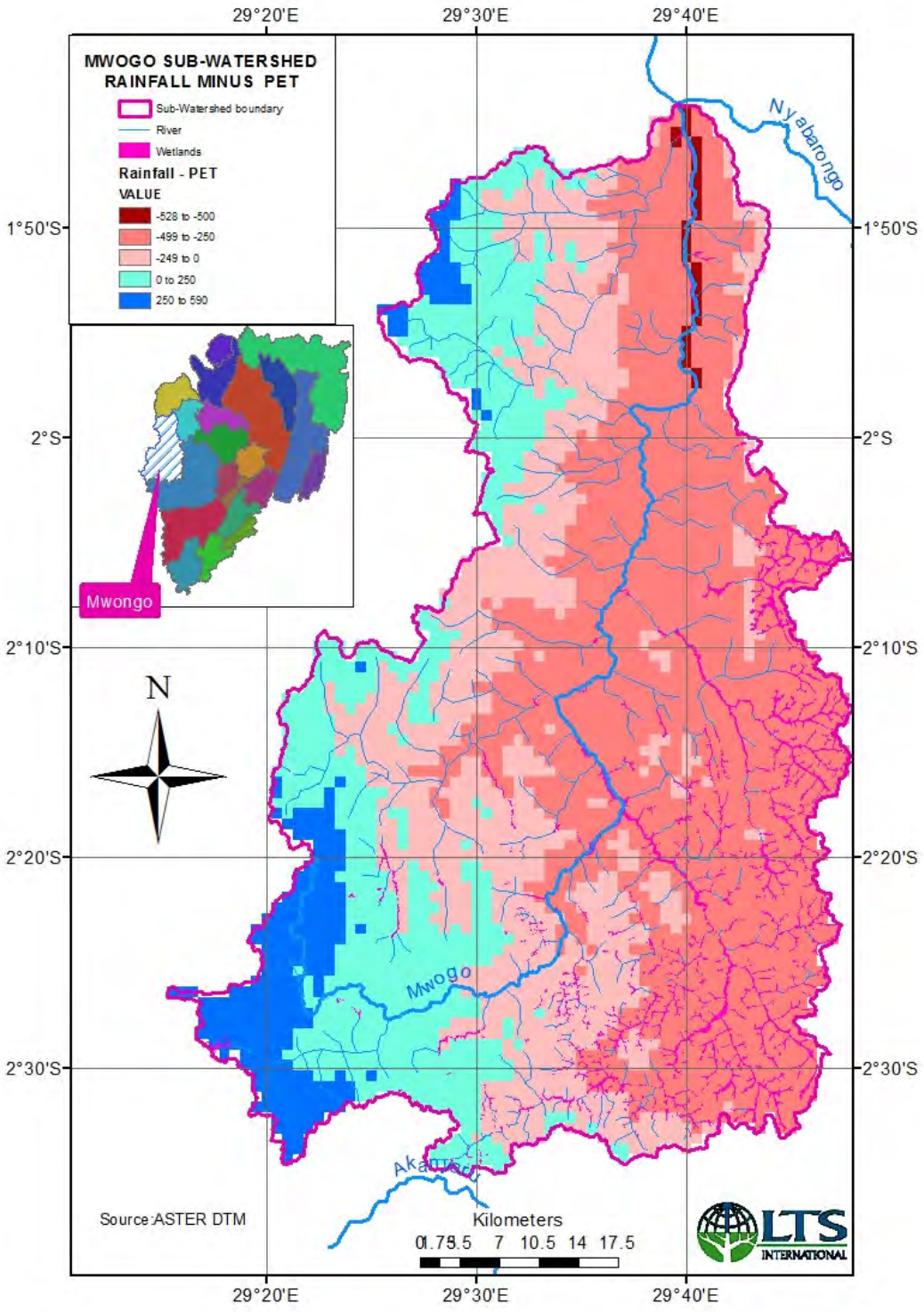
Map 82. Mwogo Sub-Watershed Relief



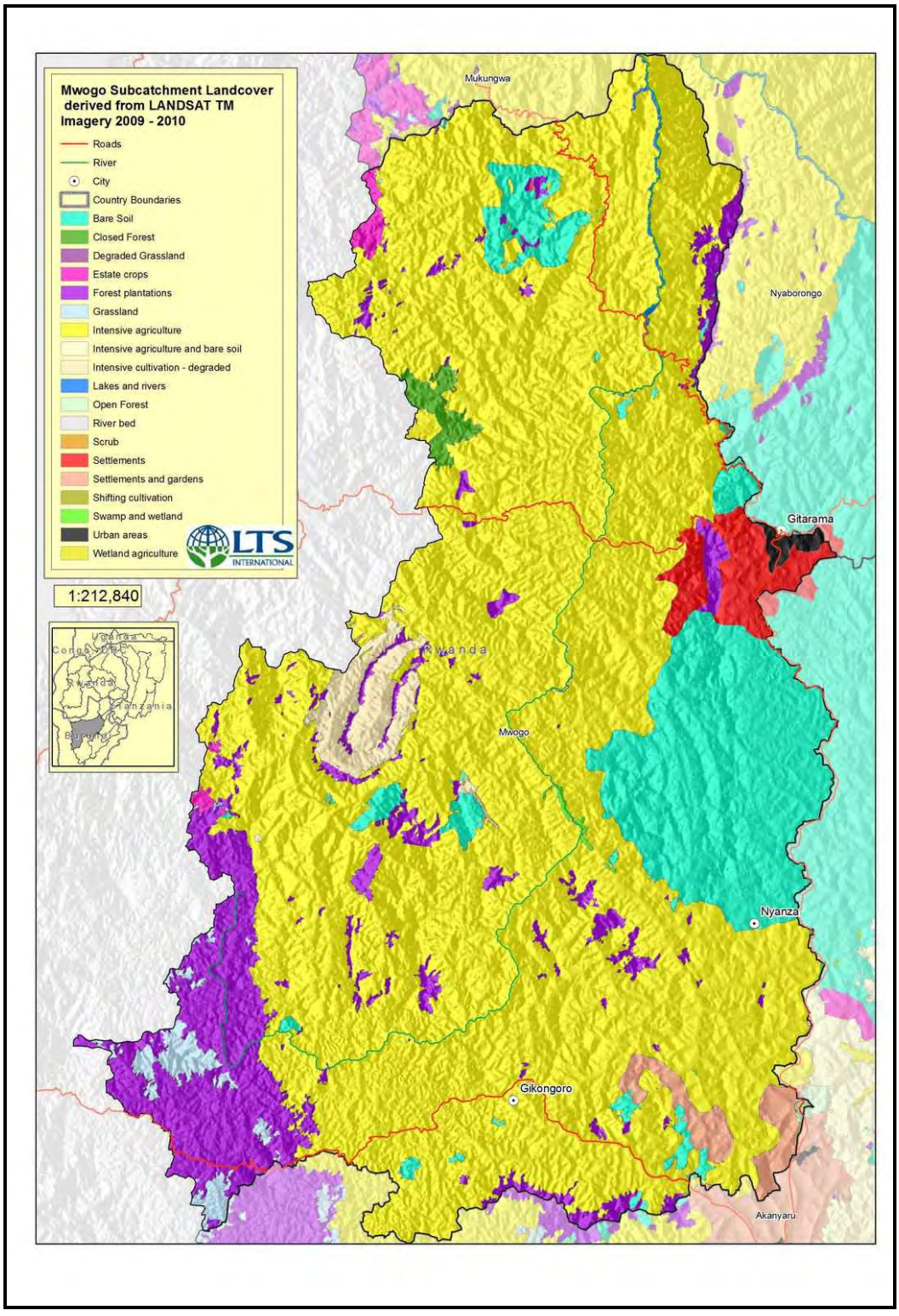
Map 83. Mwogo Catchment Soil Erosion Risk



Map 84. Mwogo Sub-Watershed Rainfall minus PET



Map 85. Mwogo Sub-Catchment Landcover



18. Ngara Sub-watershed

18.1 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
166.2	54.1	61.4	248.7	90.6	114
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
70.2	2.3	5.7	113.0	3.0	17.3
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
6.57	10	9.59	5.2	7	7.36
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
94.8	53.8	62.3	132.5	80.6	93
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
487.1	588.2	537.4	578.1	703.0	626.0

(b) Land Use/Landcover

Ngara - Landcover	Hectares	% of Total
Grassland	58,642	37.5
Settlements and gardens	33,652	21.5
Intensive agriculture	22,711	14.5
Settlements	13,706	8.8
Urban areas	12,017	7.7
Swamp and wetland	8,923	5.7
Bare Soil	4,713	3.0
Forest plantations	1,031	0.7
Wetland agriculture	768	0.5
Lakes and rivers	138	0.1
Degraded Grassland	10	0.0
TOTAL	**156,311**	**100.0**

18.2 Description of the Sub-watershed

18.2.1 Specific nature of Sub-watershed

The Sub-watershed is located within Tanzania and is the lower watershed of the Ruvubu River before it joins the Kagera River at its outlet. Low and unreliable rainfall and high PET rates together with infertile and acid soils result in very low agricultural productivity. The Sub-watershed has very low population density.

18.2.2 Key Issues

- Acidic and infertile soils, steep slopes with high erosion risk;
- Loss of soil fertility and increasing acidification and aluminium toxicity;
- High sediment loads in rivers and streams;
- Overgrazing and Livestock feed deficits
- Agricultural encroachment of wetlands;
- Grazing encroachment into Biharamulo Game reserve.
- Lack of tourist facilities for Biharamulo Game reserve
- Limited and irregular rainfall and PET exceeds rainfall;
- Lack of water supplies for humans and livestock.

18.2.3 Characterization of Sub-watershed

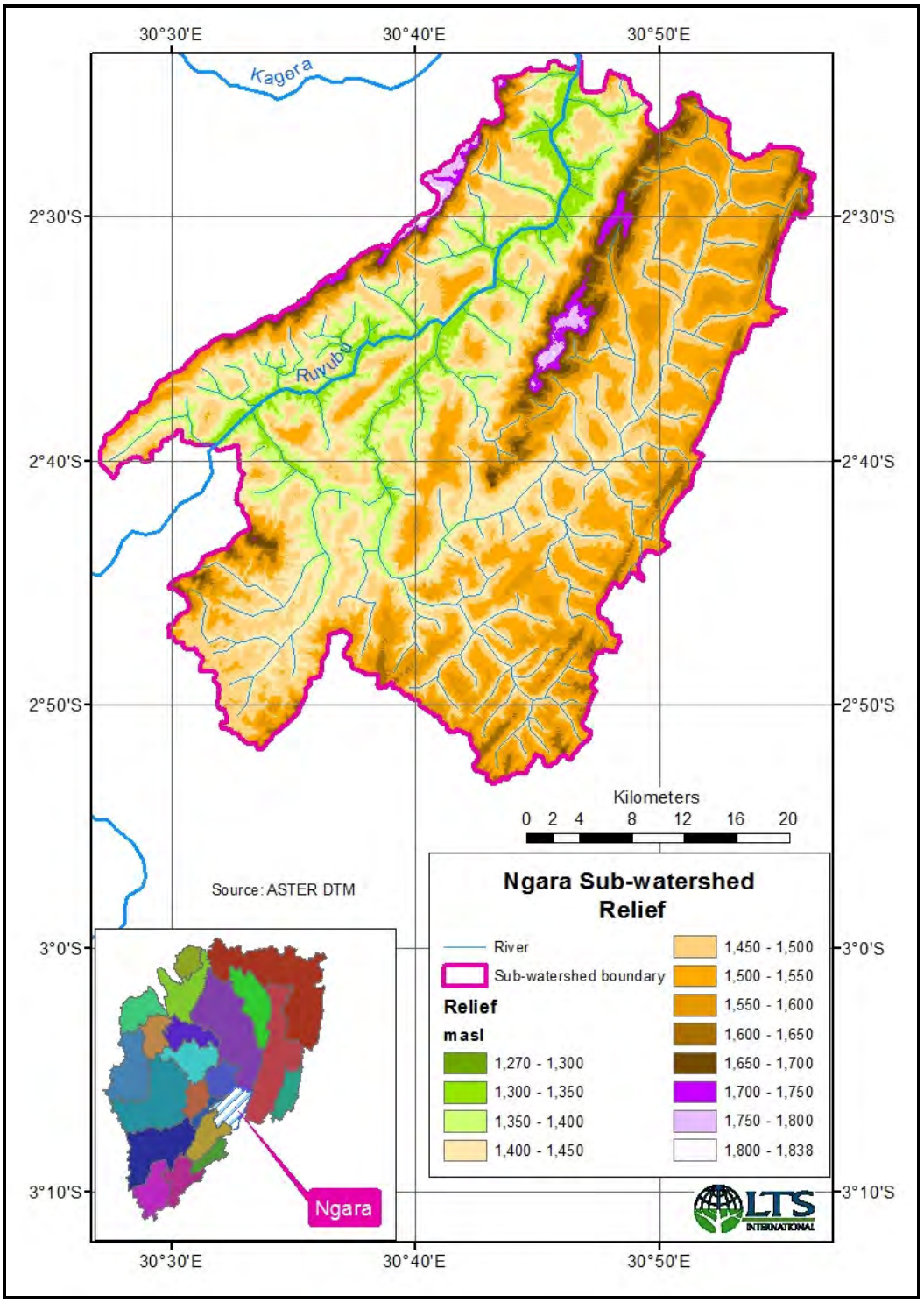
The area of the sub-watershed is 156,316ha and it is located in the southeast corner of the Sub-basin.

The Sub-watershed lies between 1,300 and 1,800masl, with the majority of the Sub-watershed between 1,350 and 1,500masl. . The dominant soil is infertile and acid Ferallsol. Only 31 percent of the area has a severe to very severe soil erosion risk. Biological soil degradation is the main process operating.

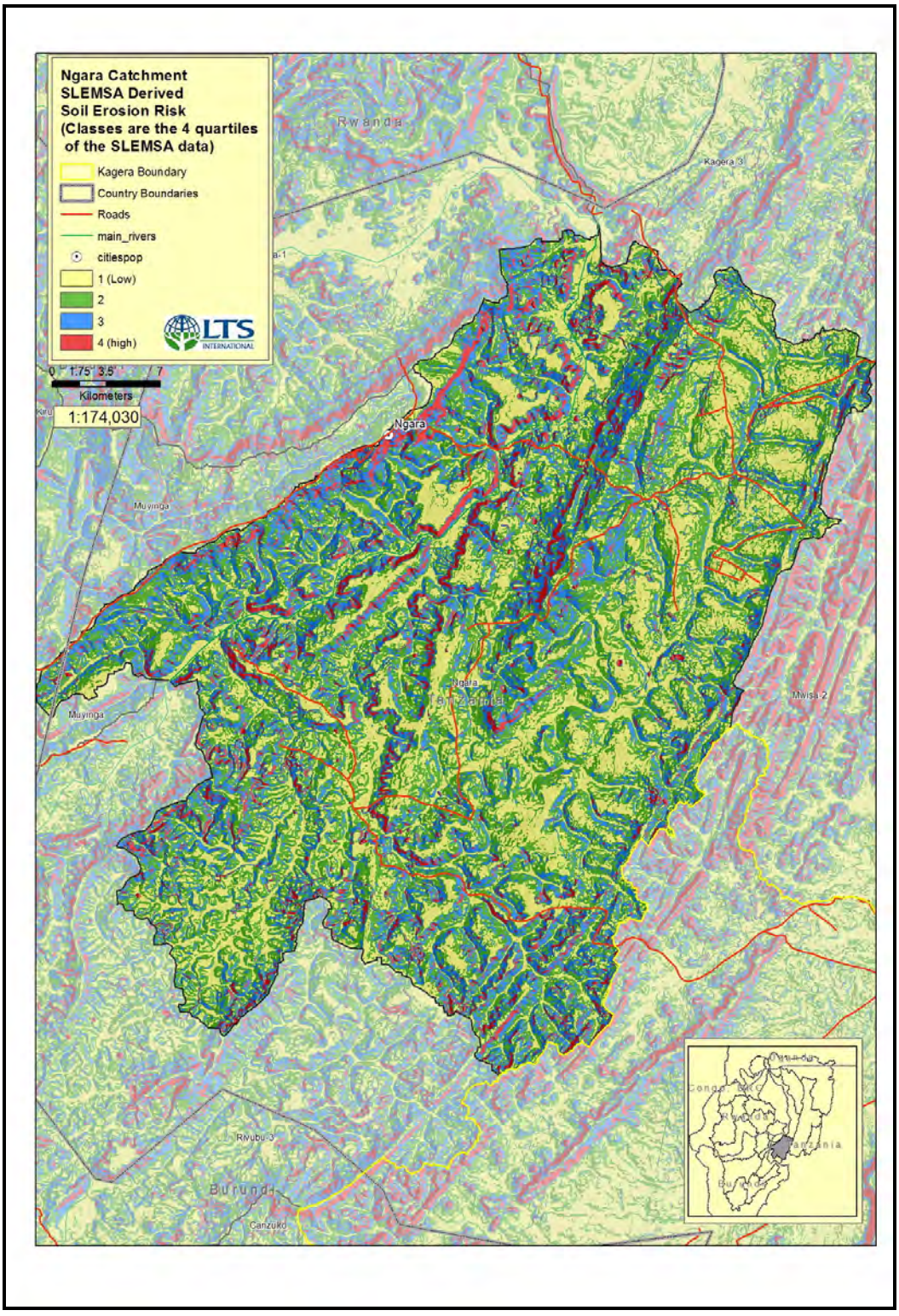
The mean annual rainfall is 800 to 1,000mm/yr, with PET exceeding rainfall between 500 and 600mm/yr. As a consequence green (soil) water is very low between 50 and 100mm, the lowest Sub-watershed in the Sub-basin.

Savanna grassland covers 41 percent of the area. Intensive agriculture, gardens and rural settlement cover a further 45 percent. Wetlands are relatively widespread covering some 6 percent of the area. A substantial proportion of the wetlands are cultivated.

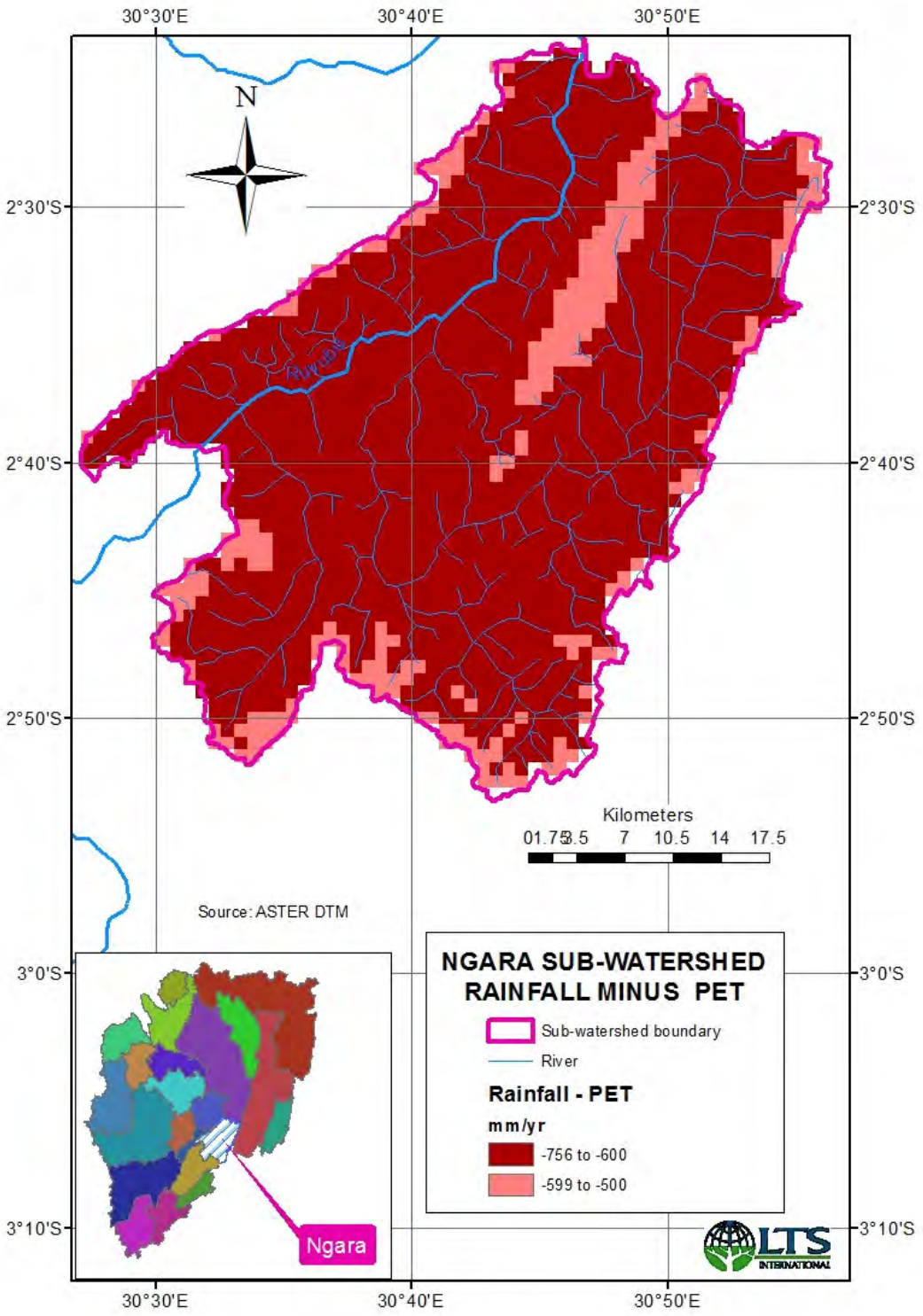
Map 86. Ngara Sub-Watershed Relief



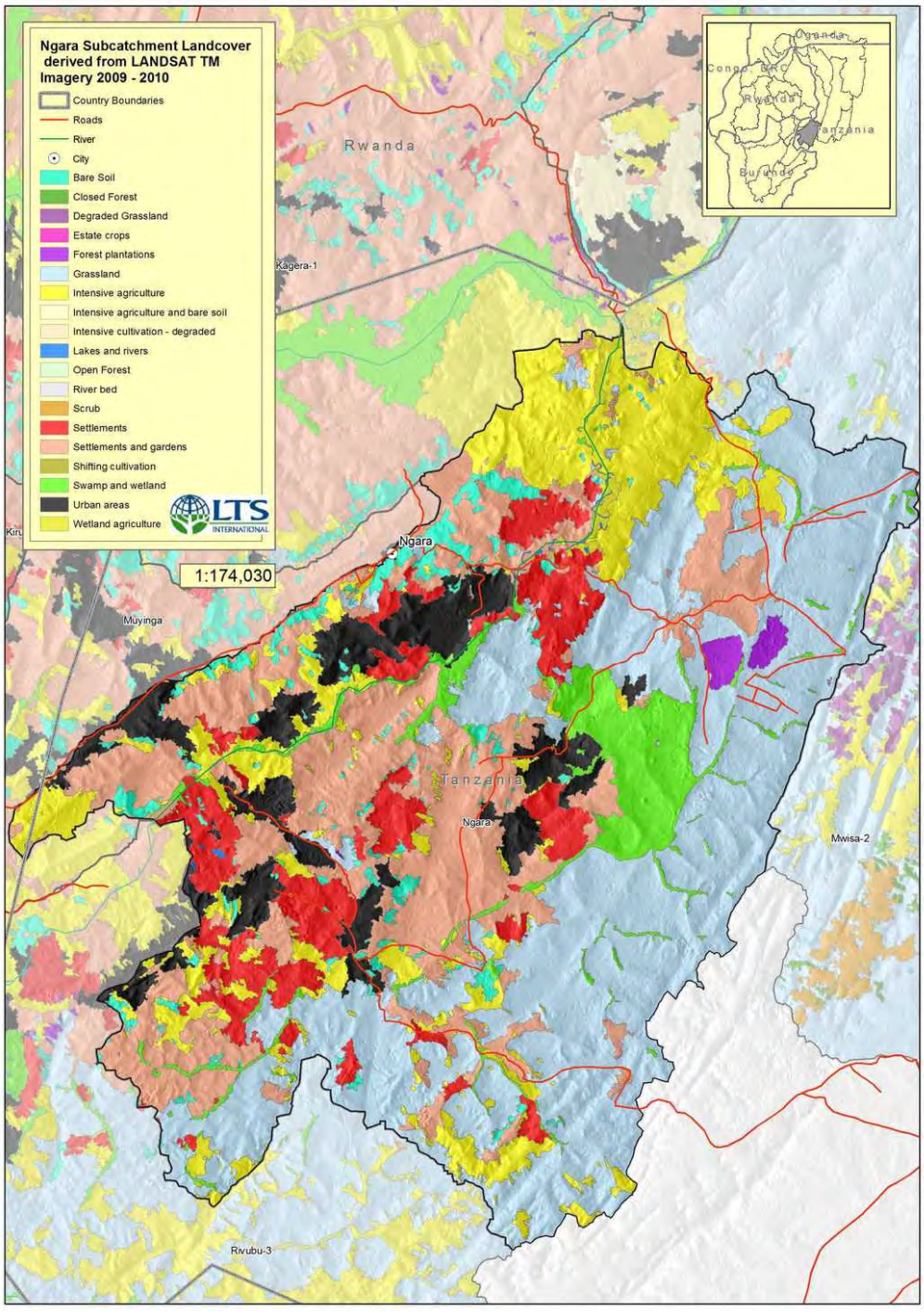
Map 87. Ngara Catchment Soil Erosion Risk



Map 88. Ngara Sub-Watershed Rainfall minus PET



Map 89. Ngara Subcatchment Land Cover



19. Ntungamo Sub-watershed

19.1 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
135.7	220.5	38.6	244.5	52.4	98.5
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
62.9	0.0	1.5	118.9	1.0	9.3
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
7.77	12	12.8	5.67	10	8.67
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
2.4	0.7	1.1	4.1	1.7	2.5
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
286.3	420.9	357.6	342.3	489.5	412.7

(b) Land Use/Landcover

Ntutgamo - Landcover	Hectares	% of Total
Settlements and gardens	47,196	45.9
Intensive agriculture	22,038	21.4
Shifting cultivation	10,904	10.6
Grassland	8,245	8.0
Bare Soil	4,818	4.7
Settlements	4,781	4.7
Swamp and wetland	4,088	4.0
Lakes and rivers	351	0.3
Forest plantations	192	0.2
Scrub	185	0.2
Urban areas	10	0.0
TOTAL	**102,806**	**100.0**

19.2 Description of the Sub-watershed

19.2.1 Specific nature of Sub-watershed

This Sub-watershed is entirely within Uganda. The Ntungamo joins the River Kagitumba at the exit of the sub-watershed.

19.2.2 Key Issues

- High population pressure on natural resource base;
- Degradation of wetlands and conversion to agriculture;
- Limited and irregular rainfall and PET exceeds rainfall leading to soil moisture deficits for plant growth;
- Land fragmentation;
- Heavy siltation in streams and rivers exacerbated by cultivation of stream banks;
- Pollution from poor solid waste management;
- Soil erosion and decreasing soil productivity;
- Increased flooding.

19.2.3 Characterization of Sub-watershed

The Sub-watershed is some 102,810ha and is located in the northwestern part of the sub-basin.

Altitude varies within the Sub-watershed from 1,300 to 2,200mamsl. The steepest slopes are found along the northern, southern and eastern edges. However, only 27 percent of the area has a severe to very severe soil erosion. The river flows through a broad valley with extensive wetlands. Shallow and stony Alisols are found on the steeper slopes. On the upper part of the sub-watershed are deep moderately fertile Nitosols. The remainder of the area is underlain by infertile and acid Ferralsols.

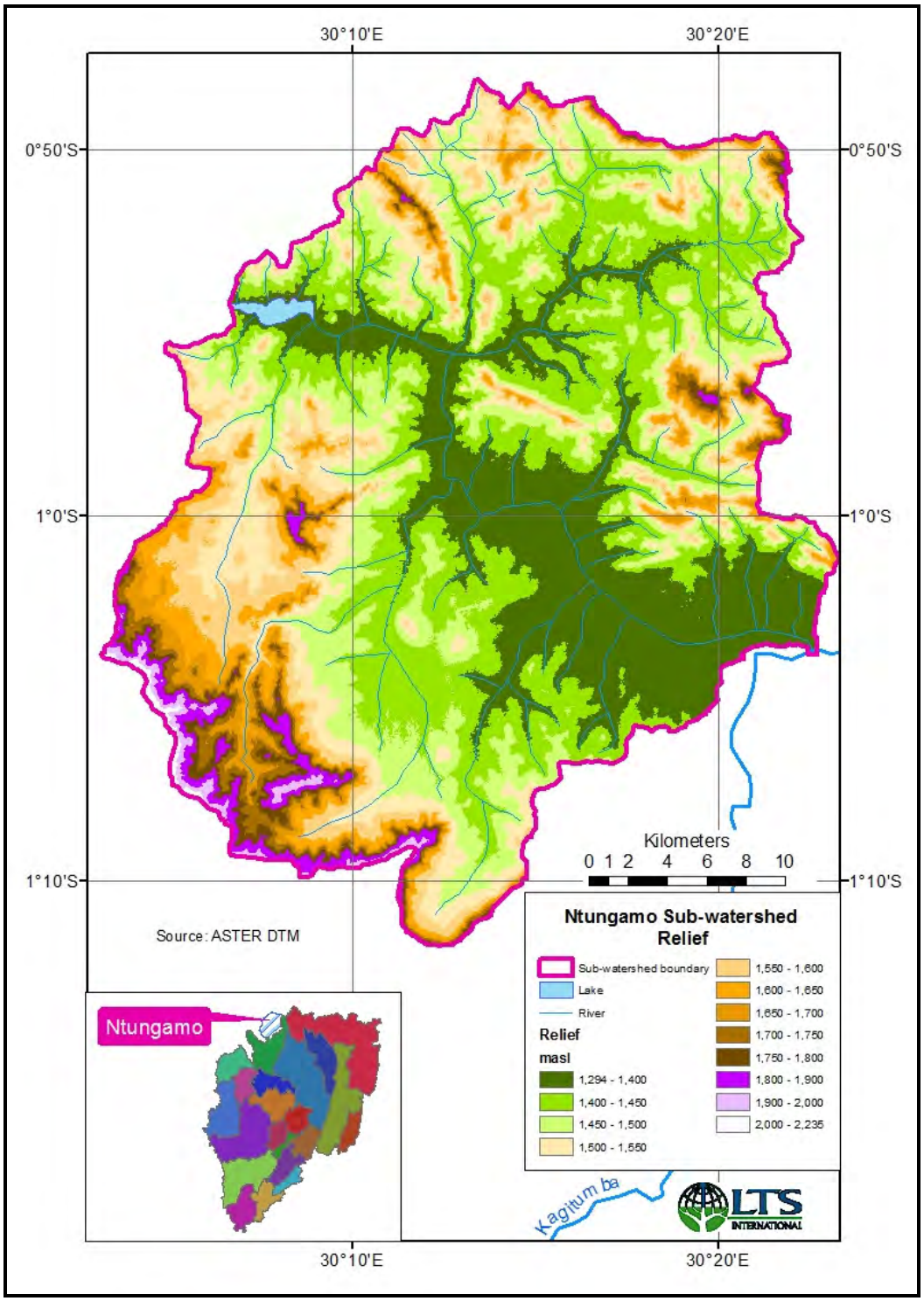
The mean annual rainfall is 800 to 1,000mm/yr. PET exceeds rainfall by 100 to 300mm/yr. Green (soil) water is only 150 to 250mm/yr.

Some 67 percent of the area is covered with intensive agriculture and gardens, with 10 percent being shifting cultivation. Wetlands cover some 4 percent of the area. Population density is being 125 to 250ppkm2.

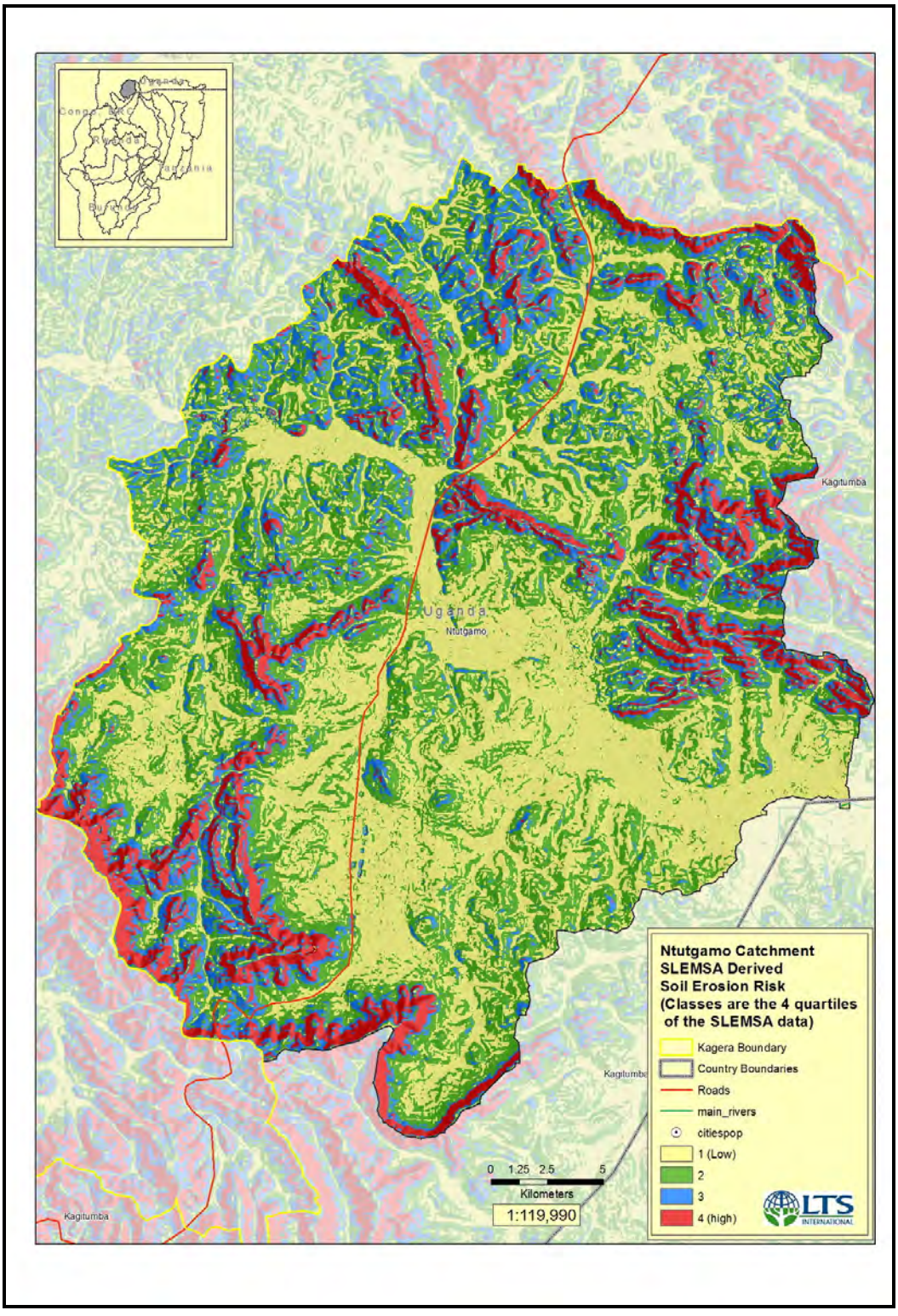
Population density is between 125 and 250ppkm2. The Kagera Piedmont Farming System predominates in the lower parts of the main valley, with the High plateau system at higher

altitudes on the northern and southern sides of the sub-watershed. Wetland cultivation is extensive.

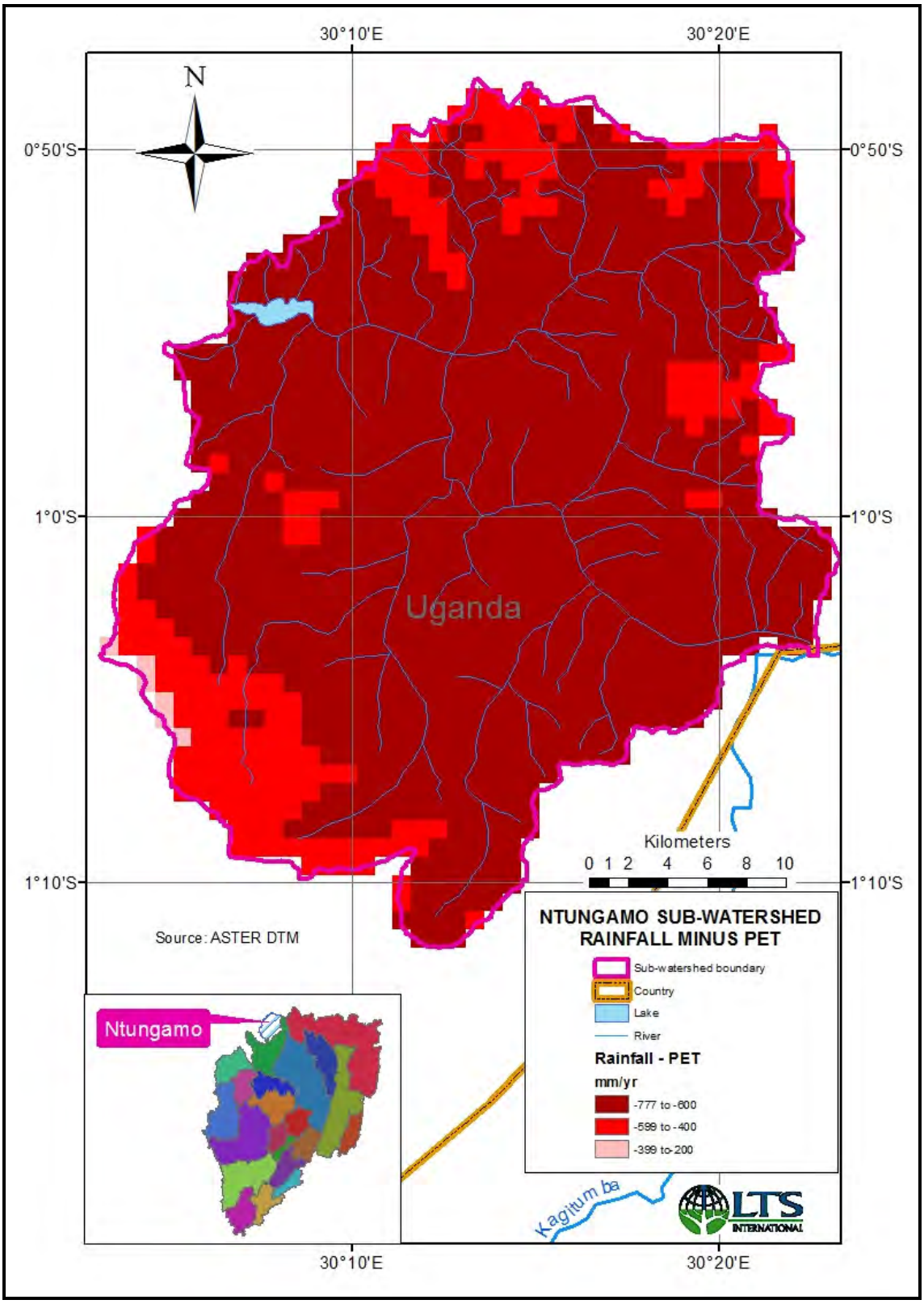
Map 90. Ntungamo Sub-Watershed Relief



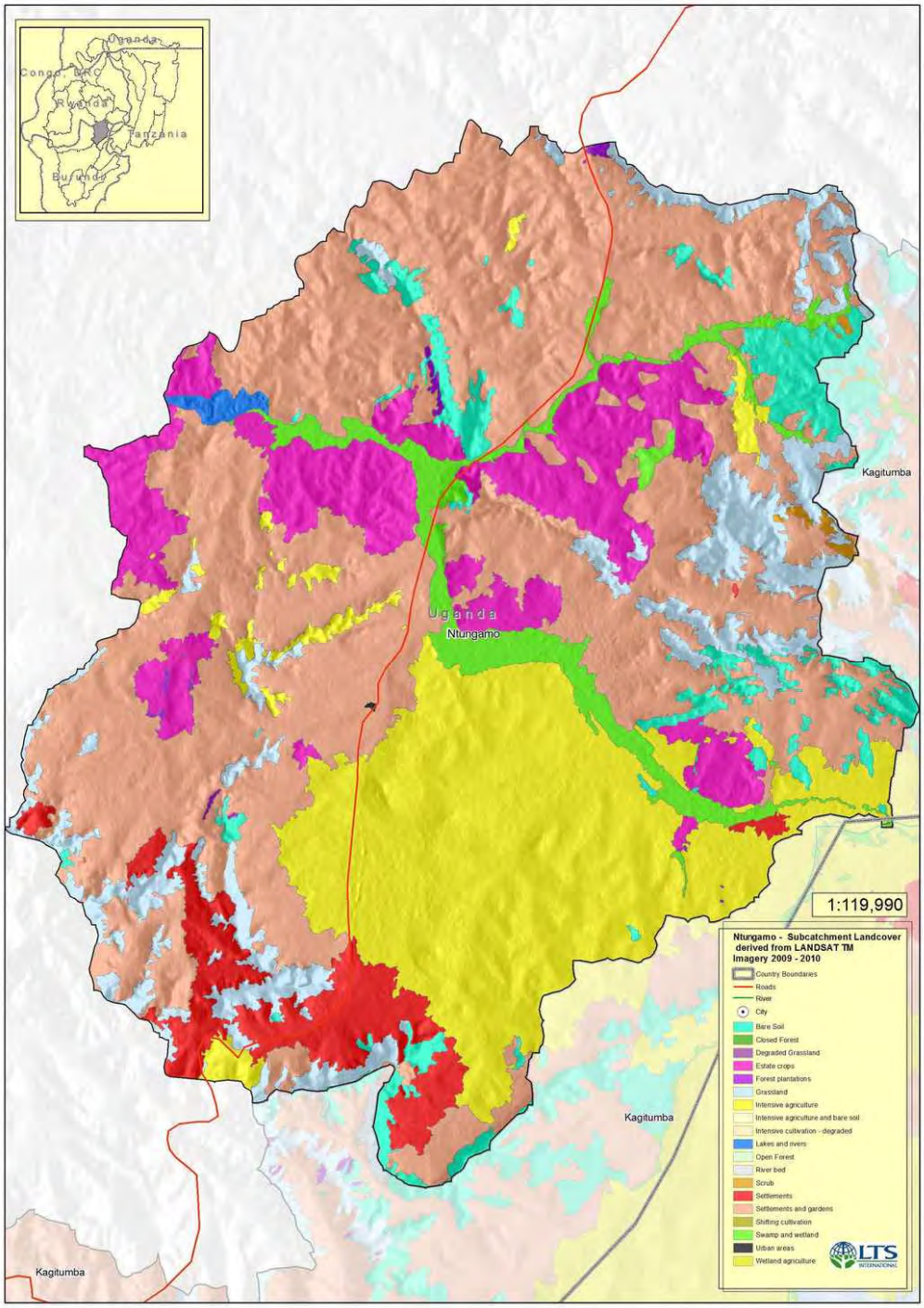
Map 91. Ntungamo Catchment Soil Erosion Risk



Map 92. Ntungamo Sub-Watershed Rainfall minus PET



Map 93. Ntungamo Sub-Catchment Landcover



20. Nyabarongo Sub-watershed

20.1 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
464.9	218.5	268.7	618.8	332.0	378.8
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
226.7	42.6	80.2	308.1	96.4	135.9
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
4.07	7	7.25	3.97	6	6.45
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
88.9	68.3	68.7	123.9	97.8	98.0
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
187.5	322.8	252.8	247.9	390.7	307.4

(b) Land Use/Landcover

Nyaborongo - Landcover	Hectares	% of Total
Intensive agriculture	88,515	61.5
Bare Soil	32,462	22.6
Settlements	11,266	7.8
Settlements and gardens	6,054	4.2
Forest plantations	3,009	2.1
Shifting cultivation	1,382	1.0
Swamp and wetland	548	0.4
Lakes and rivers	451	0.3
Urban areas	237	0.2
TOTAL	**143,923**	**100.0**

20.2 Description of the Sub-watershed

20.2.1 Specific nature of Sub-watershed

This Sub-watershed comprises the middle reaches of the Nyabarongo River in the High plateau zone. It is the second most densely populated sub-watershed and the one with the highest proportion of its area with a severe and very severe soil erosion risk.

20.2.2 Key Issues

- Acidic and infertile soils,
- Very high rates of erosion on steep slopes on shallow and stony soils;
- Loss of soil fertility and instability of radical terraces
- High sediment loads in rivers and sedimentation in wetlands
- Degradation of wetlands and encroachment by agriculture;
- Livestock feed deficits
- Agricultural encroachment of wetlands

20.2.3 Characterization of Sub-watershed

The area of the Sub-watershed is 143,914ha and is located in the west central part of the Sub-basin.

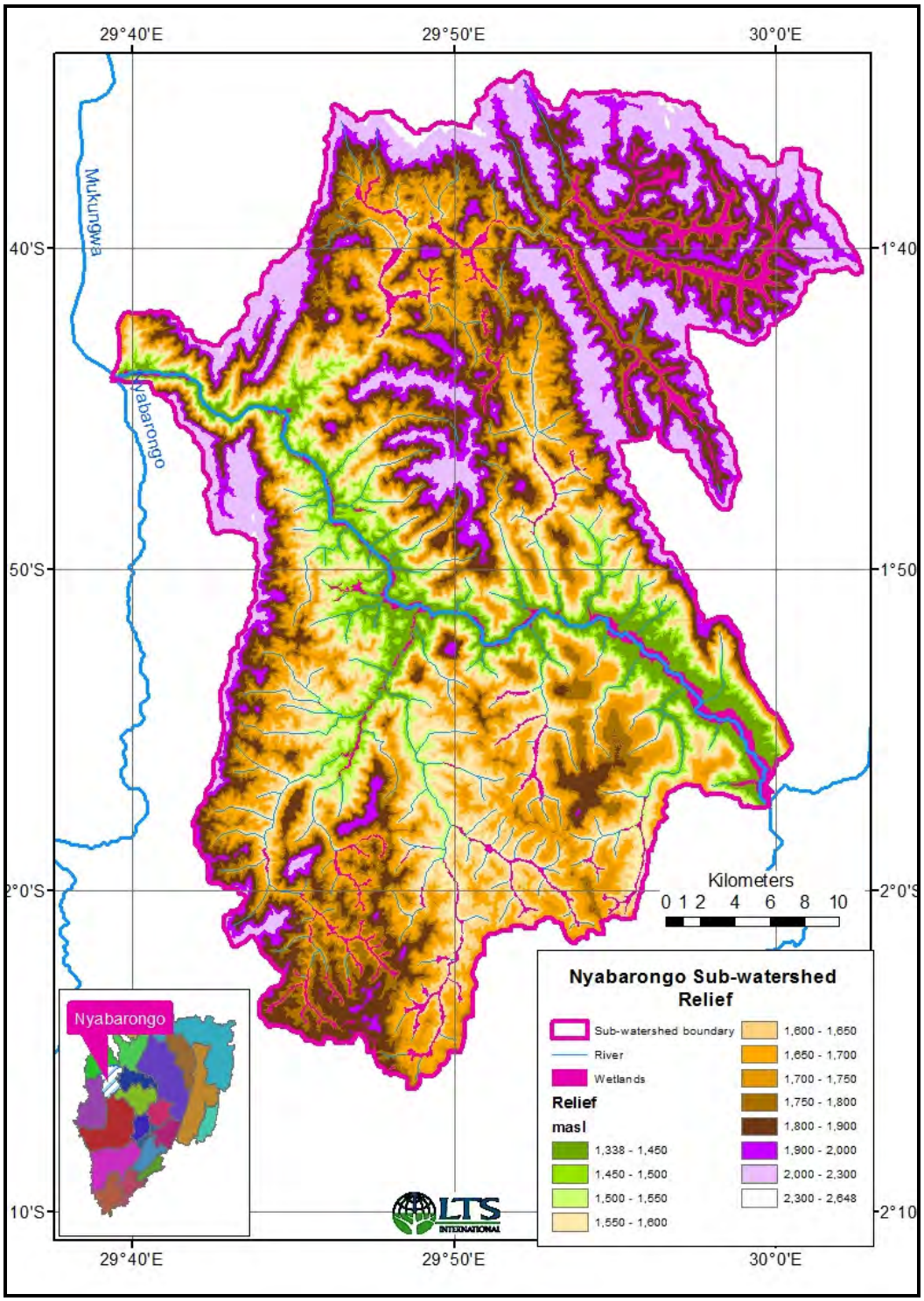
The altitude ranges from 1,300 to 2,600masl the main area of highland being located in the northern part of the Sub-watershed. The dominant soils are shallow and stony Leptosols and infertile and acid Ferralsols. The Sub-watershed has 76 percent of its area with a severe and very severe soil erosion hazard: the highest in the Sub-basin.

The mean annual rainfall is exhibits a sharp gradient from 800mm/yr in the southeast to 1,800mm/yr in the west. The PET just exceeds rainfall in the east and rainfall just exceeds PET in the west.

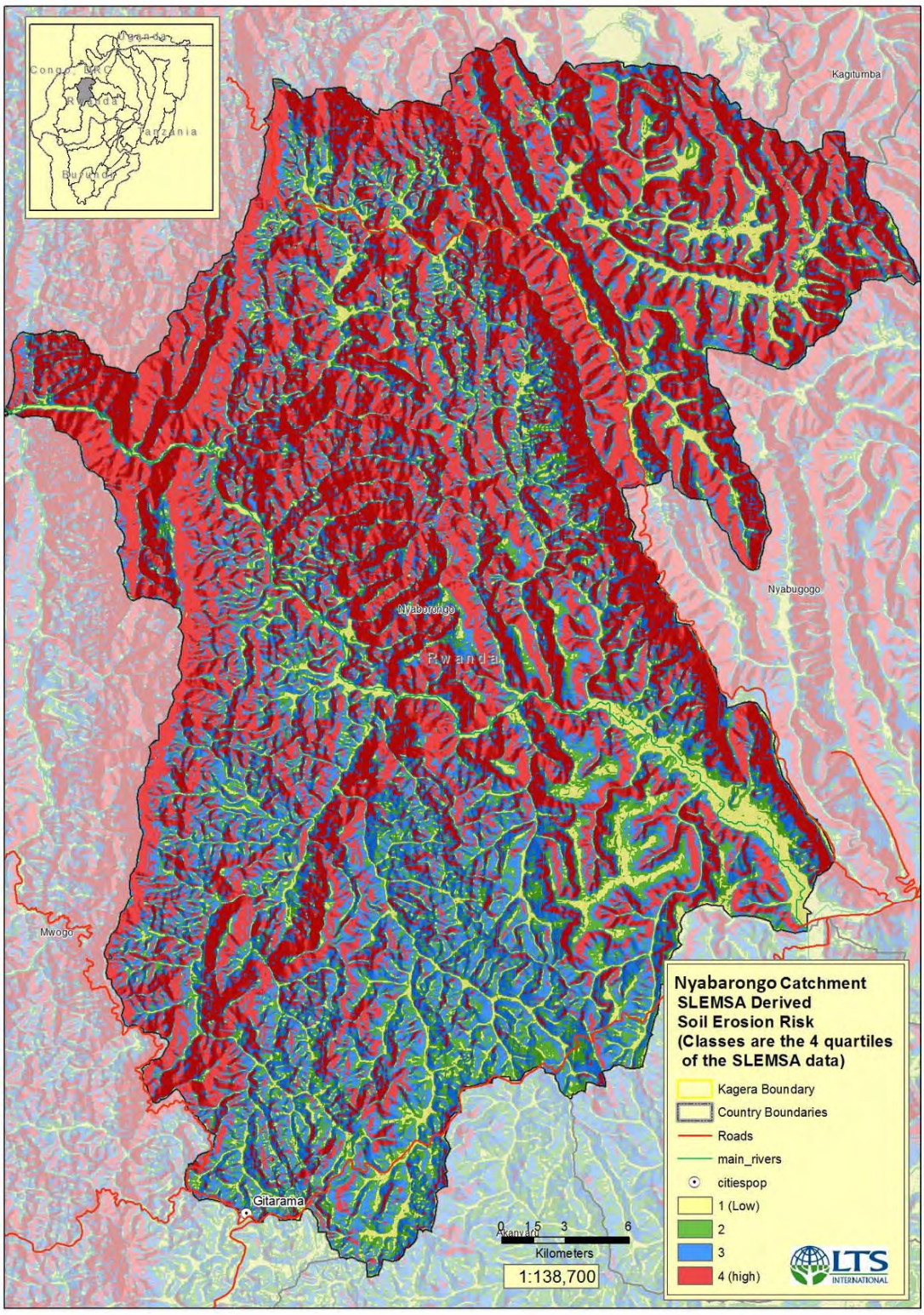
Intensive agriculture, gardens and rural settlement cover some 96 percent of the Sub-watershed, with a further 1 percent of shifting cultivation. Wetlands are found along the main rivers and tributaries in the northern part of the Sub-watershed.

Population density is between 500 and 750ppkm2. The main Farming system is the High Plateau System with coffee as the main cash crop. Above 1,800 masl is the Nile Divide Farming System at an altitude which too cold for coffee.

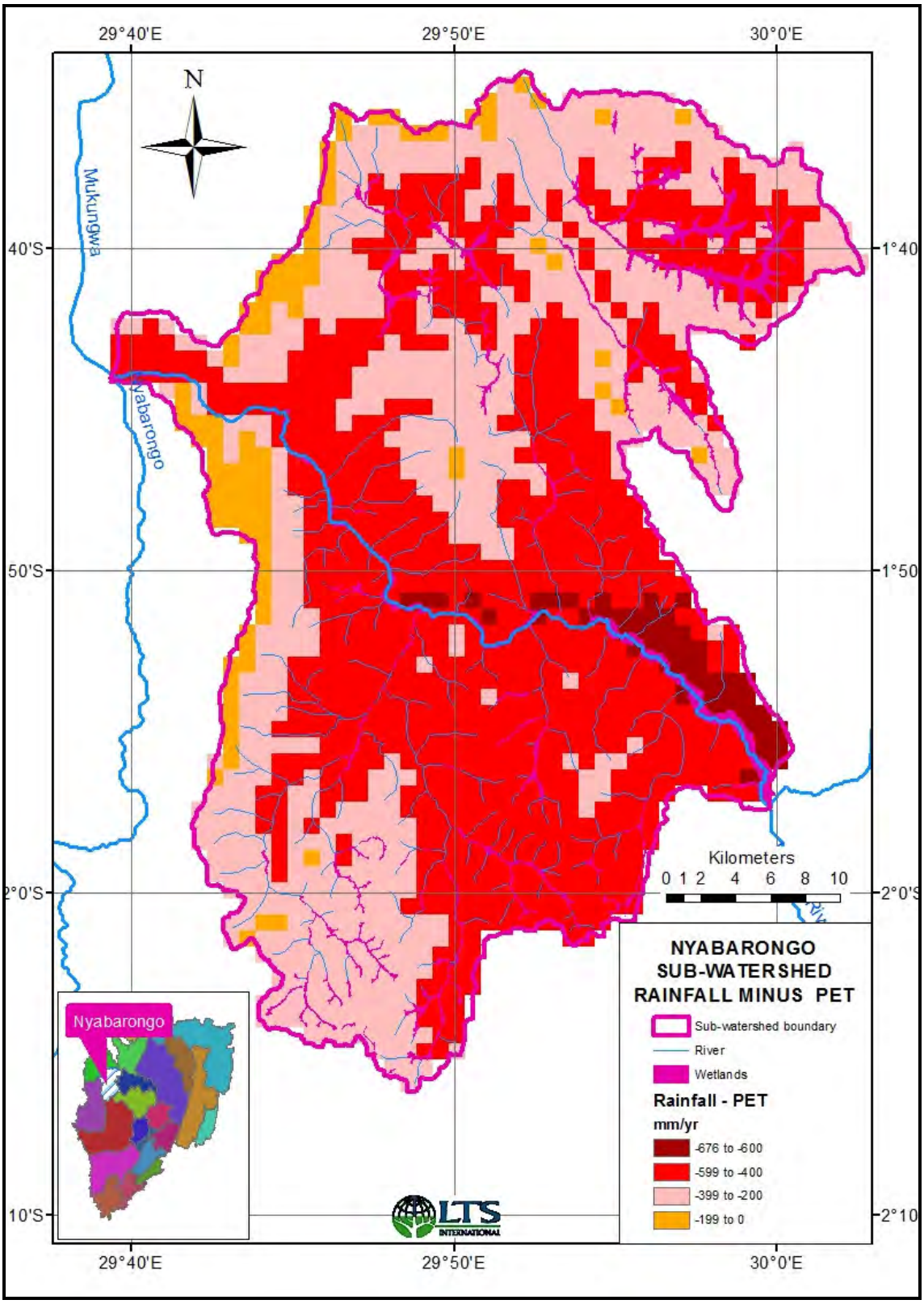
Map 94. Nyabarongo Sub-Watershed Relief



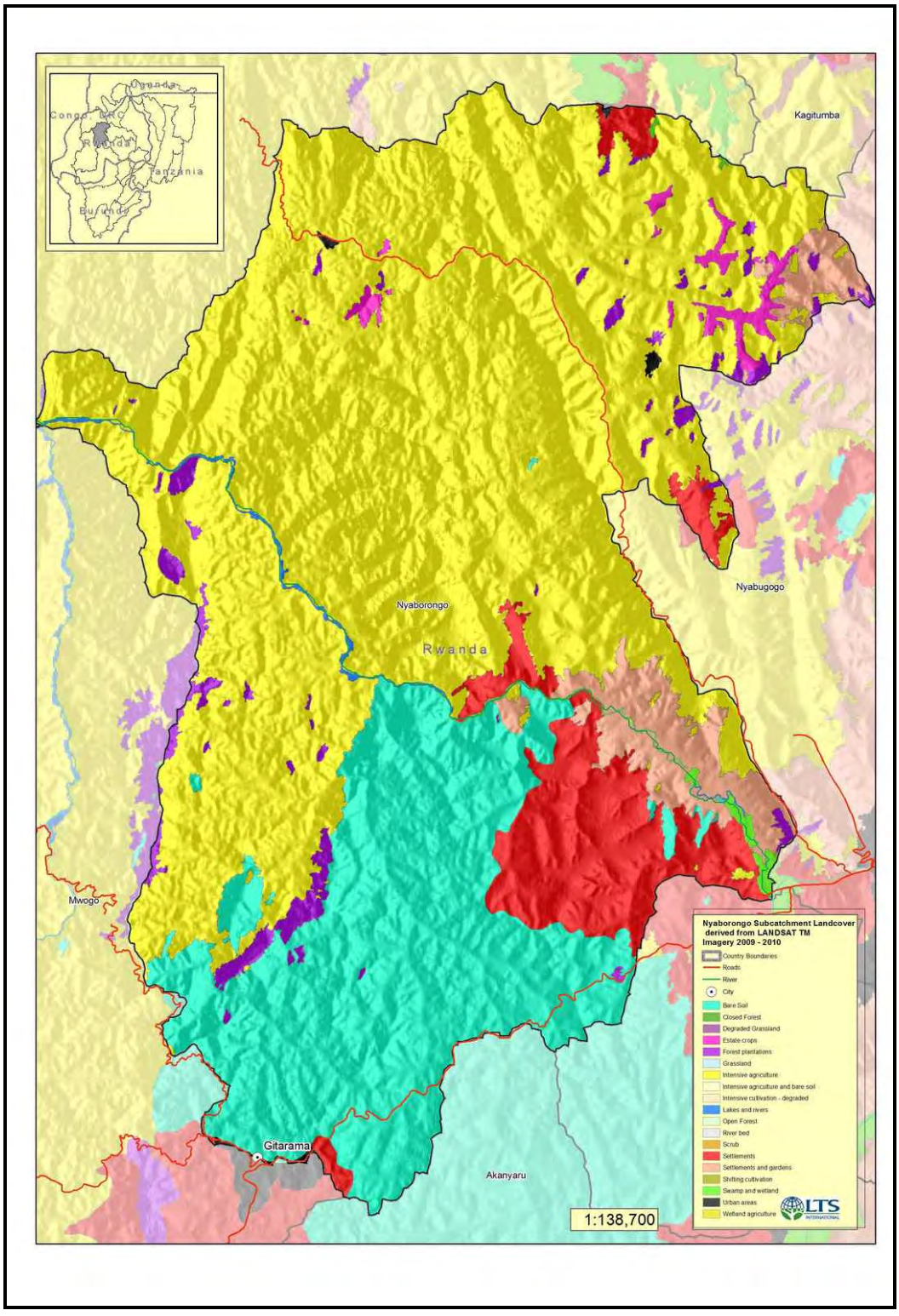
Map 95. Nyabarongo Catchment Soil Erosion Risk



Map 96. Nyabarongo Sub-Watershed Rainfall minus PET



Map 97. Nyabarongo Sub-Catchment Landcover



21. Nyabugogo Sub-watershed

21.1 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
113.6	15.2	23.4	343.2	122.3	145.2
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
52.2	0.0	1.1	172.6	0.6	15.4
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
6.10	9	9.6	3.63	6	6.4
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
3.2	0.8	1.1	9	5.1	5.3
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
378	504.6	423.2	375.4	517.8	434.5

(b) Land Use/Landcover

Nyabugogo - Landcover	Hectares	% of Total
Settlements and gardens	116,193	69.9
Intensive agriculture	22,794	13.7
Urban areas	9,331	5.6
Settlements	8,109	4.9
Lakes and rivers	3,645	2.2
Scrub	2,181	1.3
Forest plantations	1,684	1.0
Swamp and wetland	1,227	0.7
Bare Soil	646	0.4
Grassland	427	0.3
Degraded Grassland	16	0.0
TOTAL	**166,252**	**100.0**

21.2 Description of the Sub-watershed

21.2.1 Specific nature of Sub-watershed

This Sub-watershed has the fourth highest proportion of its area with a severe to very severe soil erosion risk. It also has the third highest population density and its dominant soils are infertile and acid Ferralsols. These indicate that there is severe pressure on its land resources.

21.2.2 Key Issues

- Acidic and infertile soils,
- Very high rates of erosion on steep slopes on shallow and stony soils;
- Loss of soil fertility and instability of radical terraces
- High sediment loads in rivers and sedimentation in wetlands
- Degradation of wetlands and encroachment by agriculture;
- Livestock feed deficits
- Agricultural encroachment of wetlands

21.2.3 Characterization of Sub-watershed

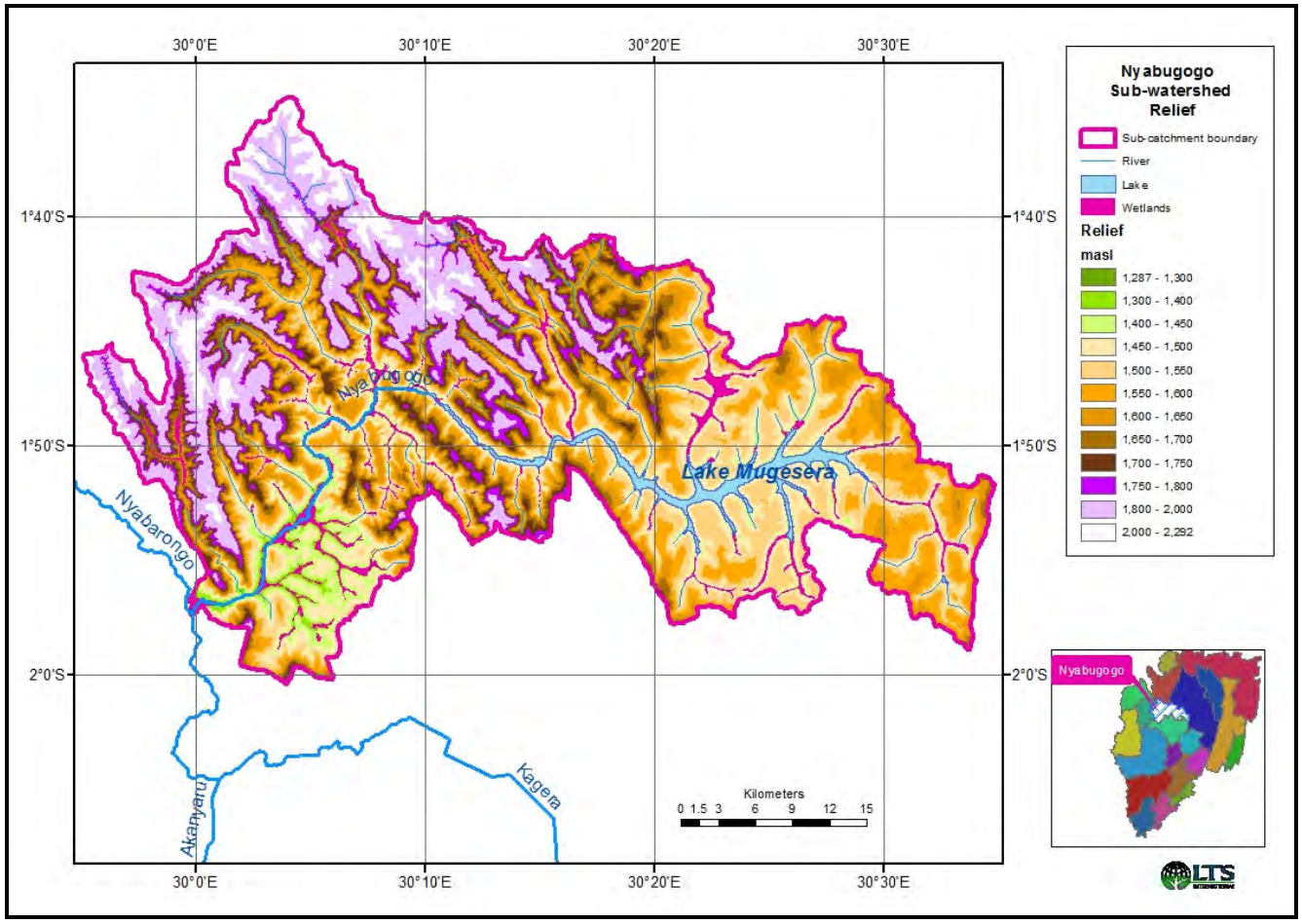
The Sub-watershed is some 166,249ha in extent and is located in the west-central part of the Sub-basin.

It ranges from 1,300 to 2,200masl. The steepest slopes are found in the west half of the Sub-watershed with Lake Mugesera occupying the valley floor in the eastern half. The dominant soils are Ferralsols, which are acid and infertile and under continuous cultivation now suffer from aluminium toxicity. Some 58 percent of its area has a severe to very severe risk of soil erosion.

Intensive agriculture, gardens and rural settlement cover some 89 percent of the area. Lakes and wetlands cover some 3 percent of the area.

Population densities are from 500 to 1,000ppkm2. Kigali city and its densely populated environs are located within the sub-watershed and cover nearly 6 percent of the area. Most of the Sub-watershed encompasses the Kagera Piedmont Farming System. With the high population pressure and declining soil fertility bananas and roots crops are replacing cereal crops. Coffee is an important cash crop.

Map 98. Nyabugogo Sub-Watershed Relief



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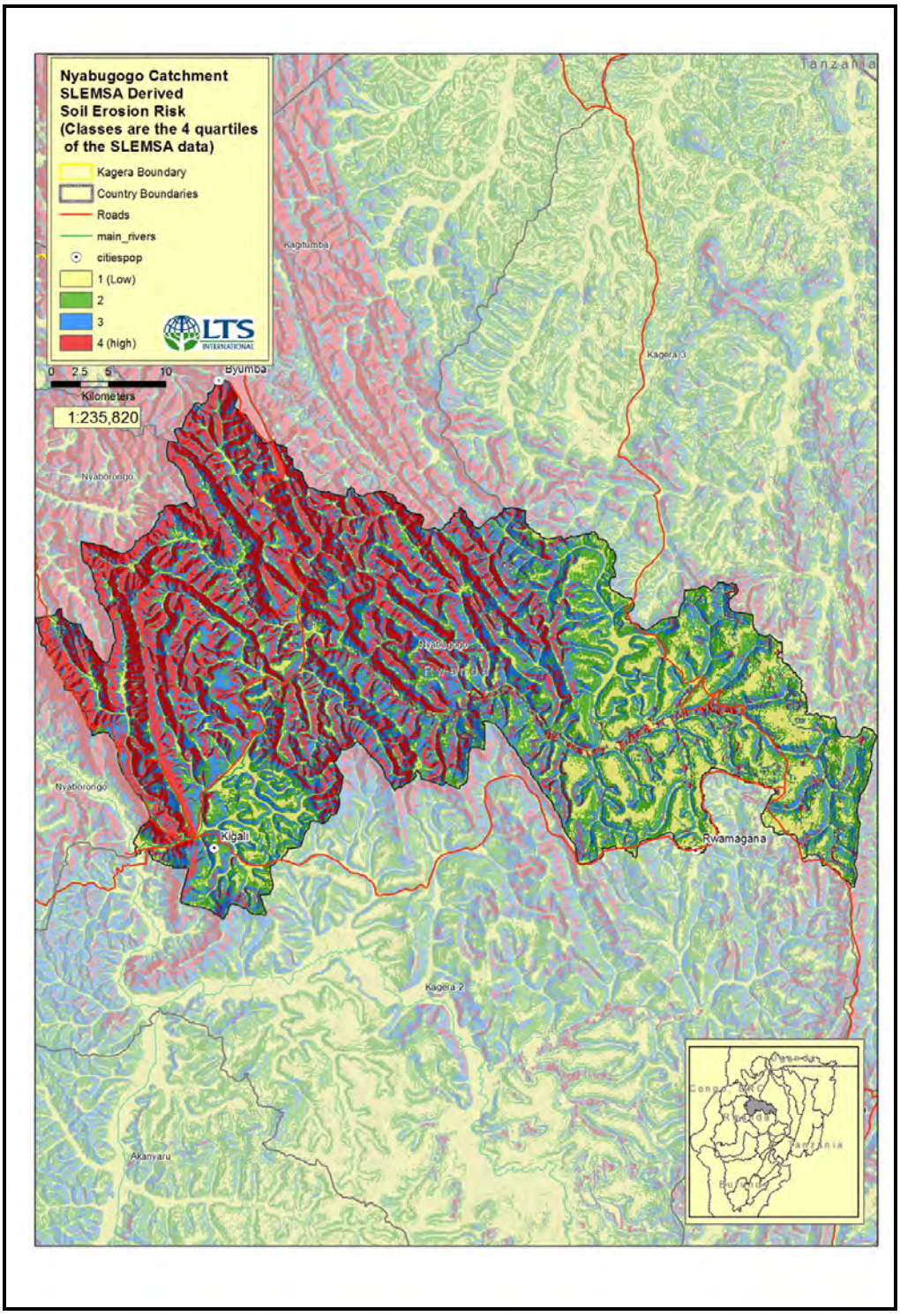
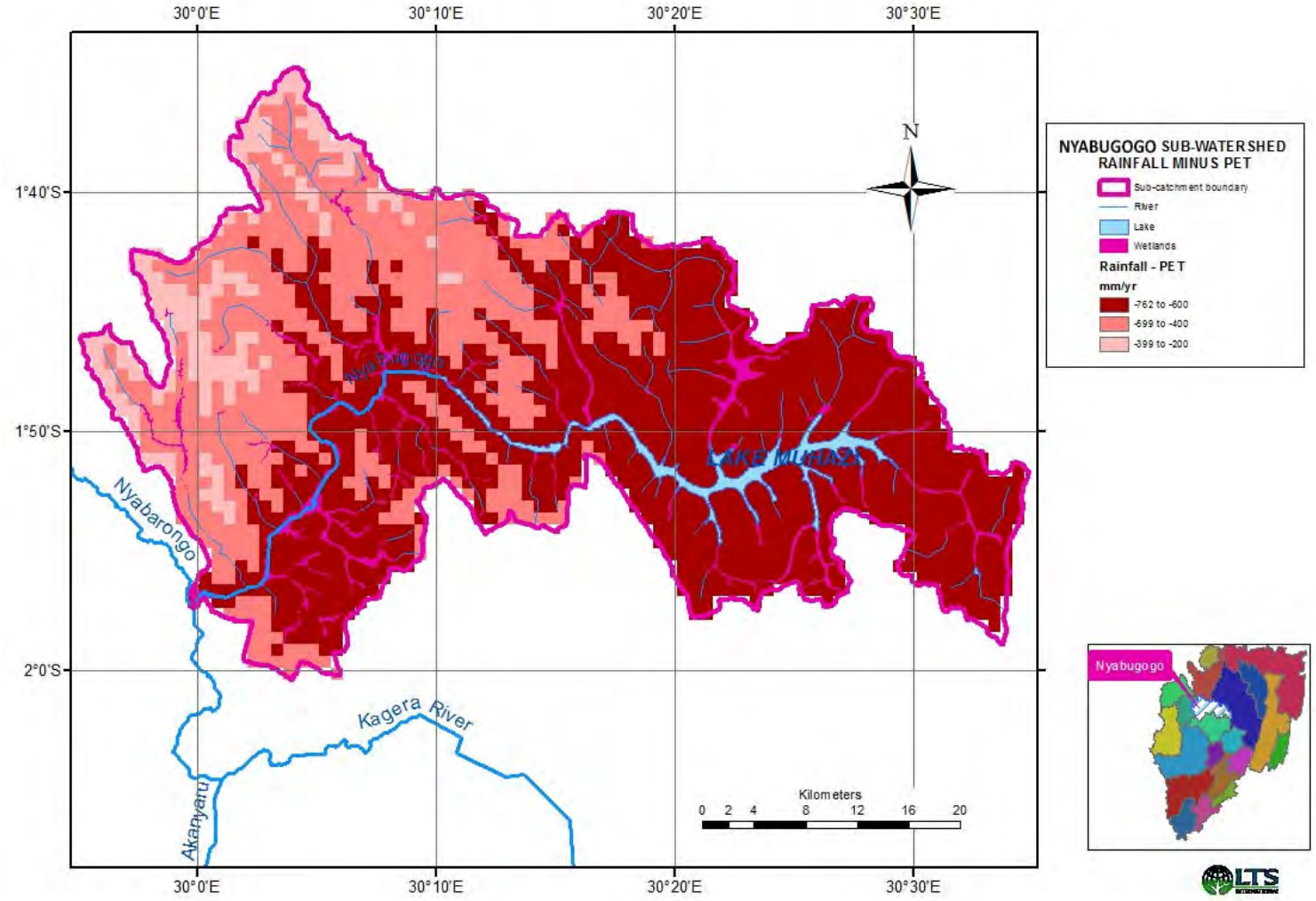
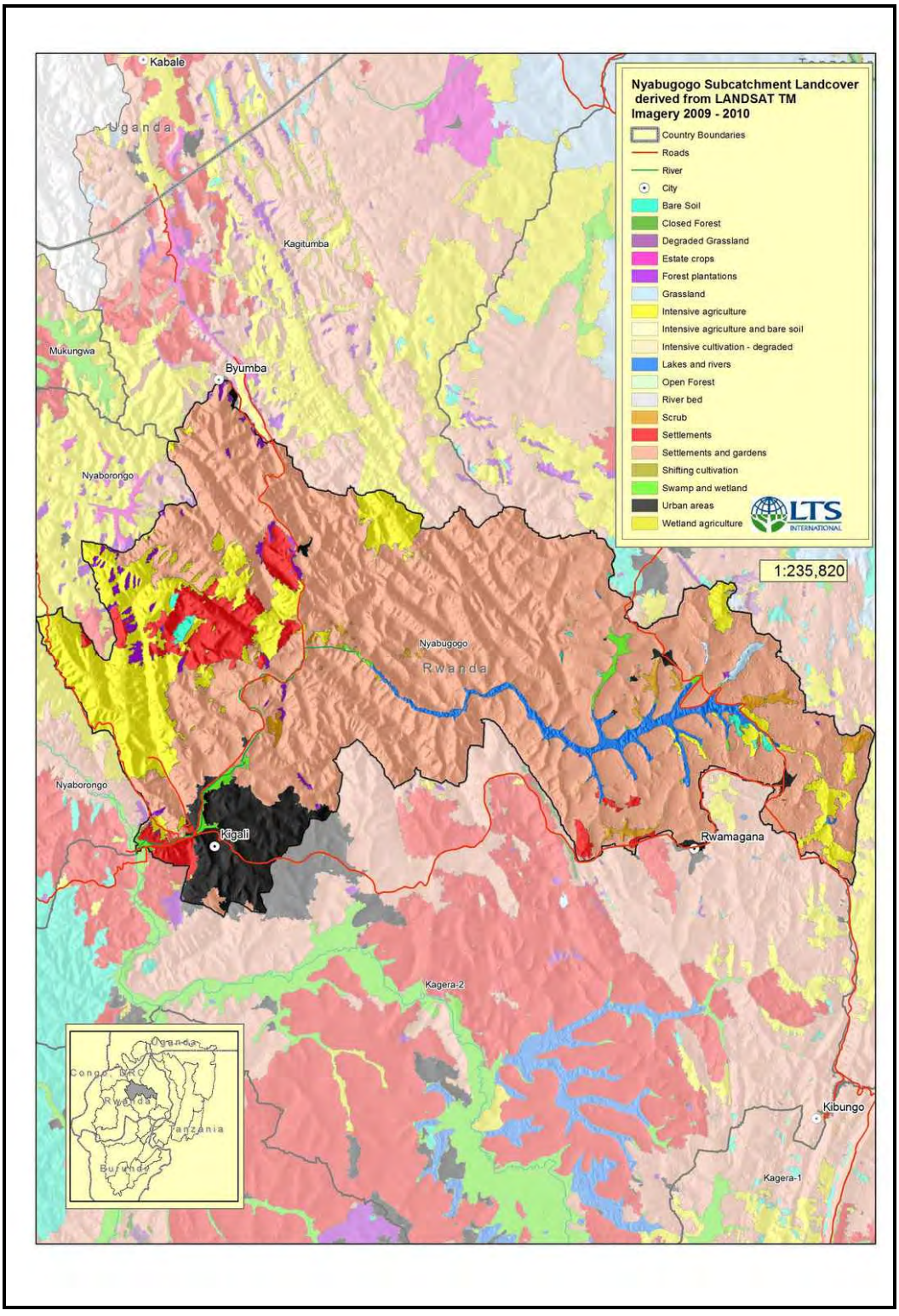
Map 99. Nyabugogo Catchment Soil Erosion Risk



Map 100. Nyabugogo Sub-Watershed Rainfall minus PET



Map 101. Nyabugogo Sub-Catchment Land cover



22. Ruvubu 1 sub-watershed

22.1 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
624.4	244.2	331.2	1011.0	521.7	657.2
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
300.0	103.0	137.7	492.3	235.1	288.6
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
2.80	6	6.81	1.97	3	3.98
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
60.5	34.1	40.4	92.5	57.1	67.1
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
341.3	447.	396.5	320.4	407.9	375.0

(b) Land use/landcover

Rivubo - 1 - Landcover	Hectares	% of Total
Intensive agriculture	292,527	70.0
Intensive agriculture and bare soil	60,831	14.6
Bare Soil	39,986	9.6
Settlements and gardens	9,047	2.2
Closed Forest	5,141	1.2
Grassland	3,138	0.8
Forest plantations	2,145	0.5
Wetland agriculture	1,799	0.4
Swamp and wetland	1,480	0.4
Urban areas	1,372	0.3
Settlements	204	0.0
TOTAL	**417,668**	**100.0**

22.2 Description of the Sub-watershed

22.2.1 Specific nature of Sub-watershed

Lying wholly within Burundi this Sub-watershed forms the headwaters of the Ruvubu River. The Nile-Congo Divide forms the western boundary encompassing the Kibira National Park. It also has the sixth highest population density and its dominant soils are infertile and acid Ferralsols. These indicate that there is severe pressure on its land resources.

22.2.2 Key Issues

- Acidic and infertile soils, steep slopes with high erosion risk;
- Loss of soil fertility and instability of radical terraces
- High sediment loads in rivers and sedimentation in wetlands
- Livestock feed deficits
- Agricultural encroachment of wetlands leading to lack of buffering capacity and flooding;
- Encroachment into Kibira National Park

22.2.3 Characterization of Sub-watershed

The Sub-watershed is some 417,659ha in extent and is located in the southwest corner of the Sub-basin.

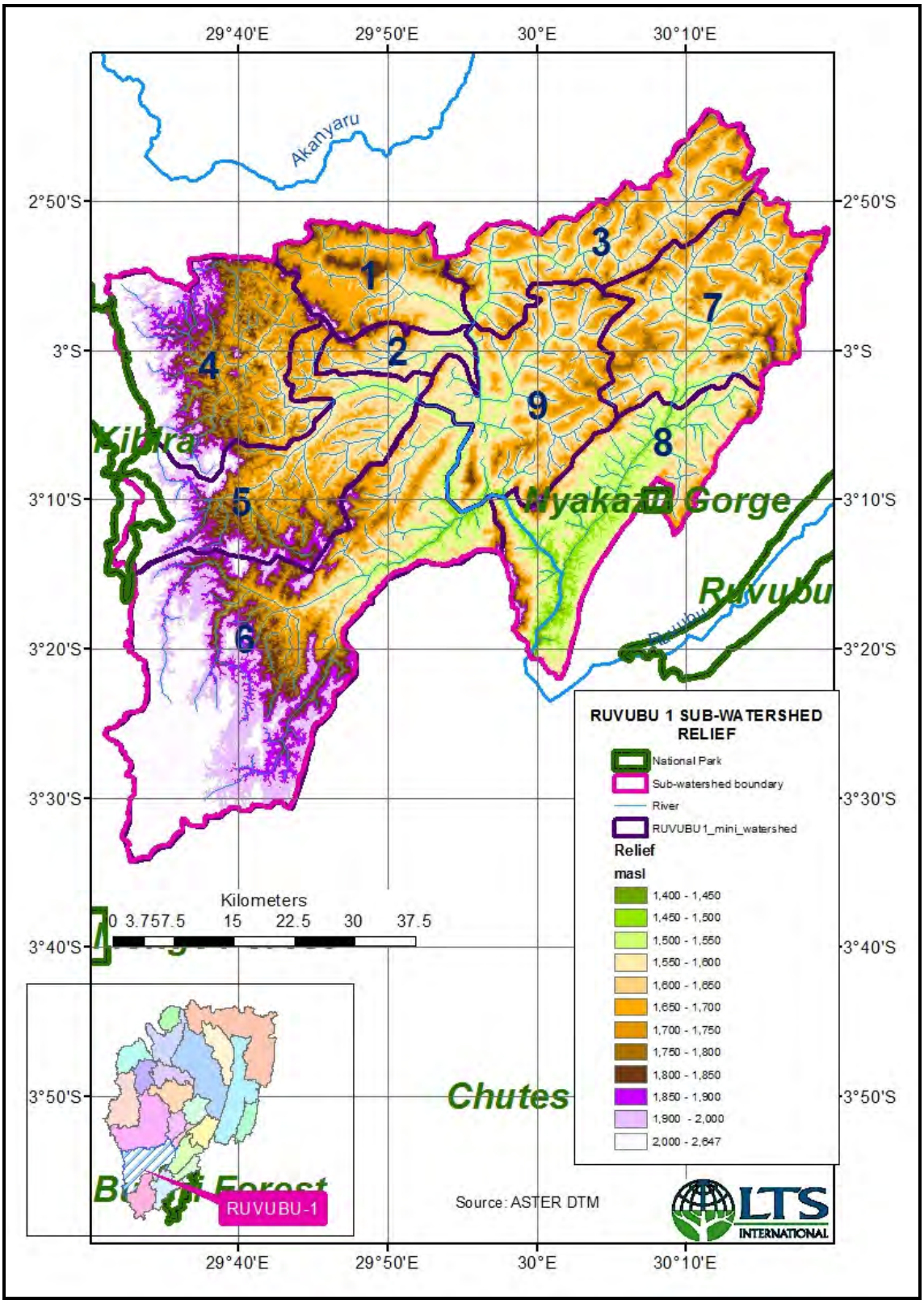
It ranges in altitude from 1,400 to 2,600 masl on the Nile-Congo Divide, although most of the area is between 1,450 and 1,800masl. Soils are mainly infertile Ferralsols except in the head of the Sub0watershed where deeper Cambisols are found. Some 50 percent of the area has a severe to very severe erosion risk.

The mean annual rainfall ranges from 1,200 to 1,600mm/yr- from east to west. PET exceeds rainfall by 200mm in the far east of the area but then rainfall exceeds PET from 100 to 200mm in the west. Green (soil) water exhibits a similar pattern: from 300mm in the east to 500mm/yr in west.

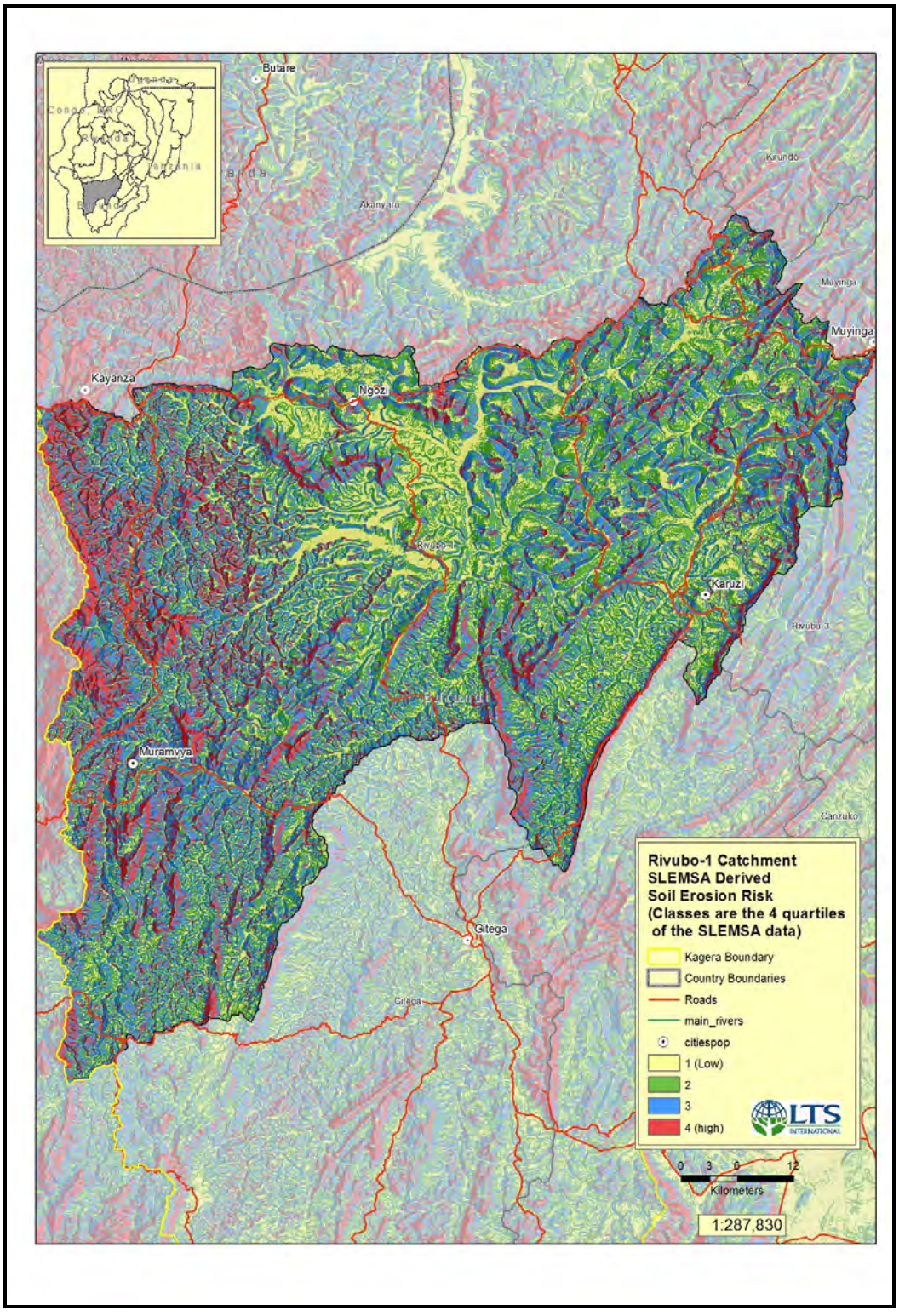
Some 96 percent of the Sub-watershed is covered by intensive agriculture, gardens and rural settlement of which 10 percent has bare soil. The remaining cover is wetlands and lakes, with a small area under plantation forest in the highest parts of the Nile-Congo Divide.

The population density is 750 to 1,250ppkm2. The High Plateau Farming System dominates with small areas of the Nile divide farming System above 1,800masl.

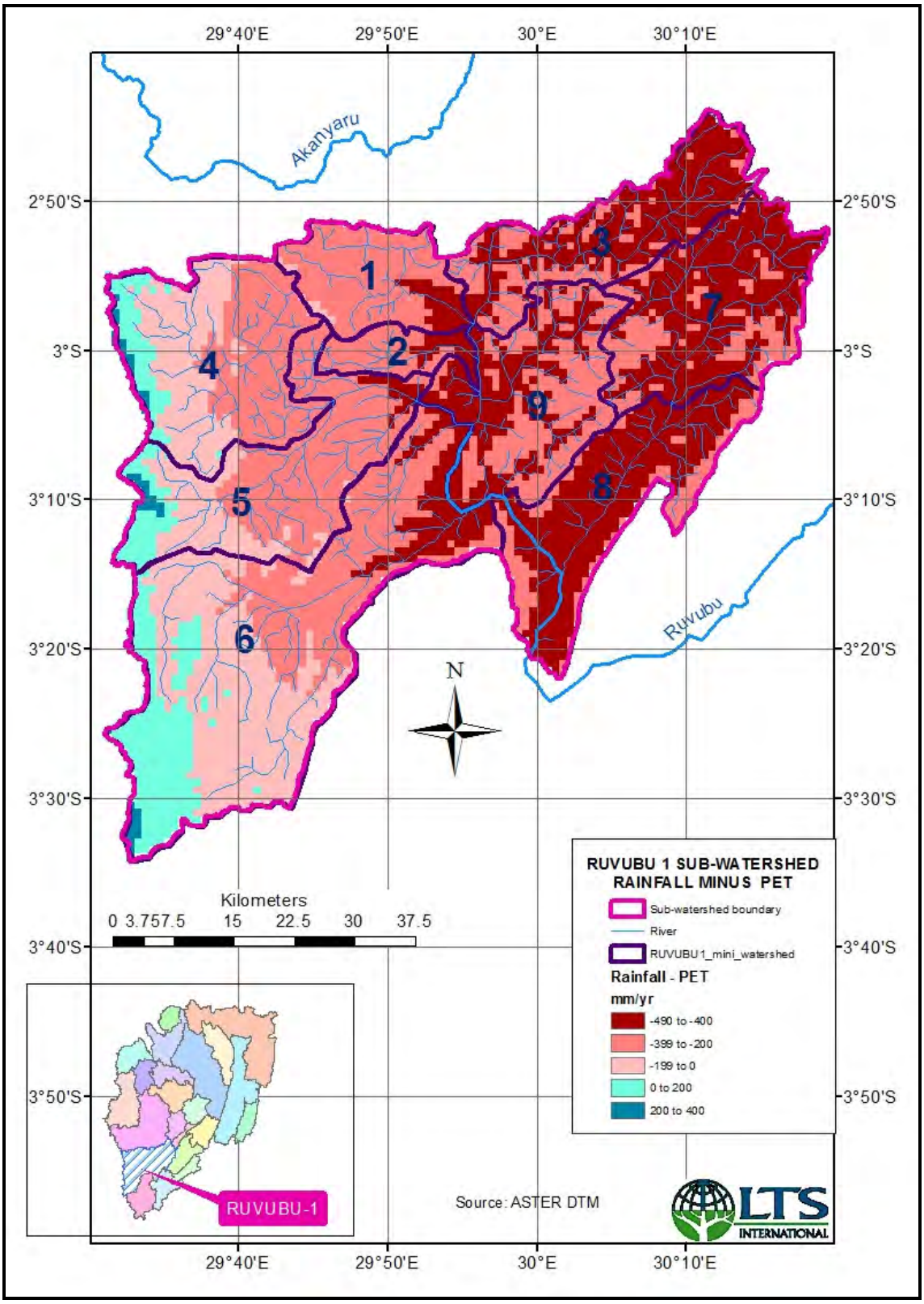
Map 102. Ruvubu 1 Sub-Watershed Relief



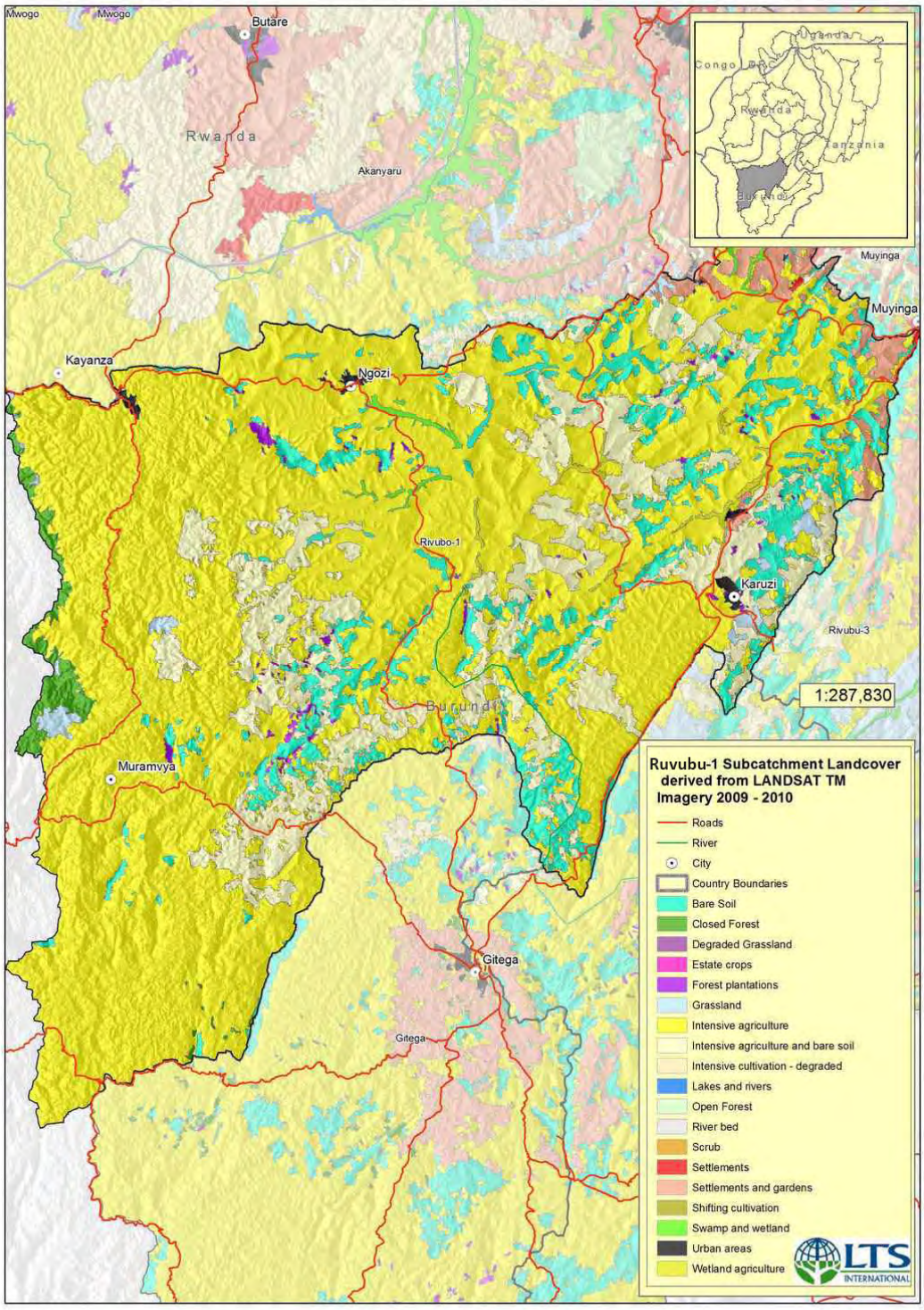
Map 103. Ruvubu 1 Catchment Soil Erosion Risk



Map 104. Ruvubu 1 Catchment Soil Erosion Risk



Map 105. Ruvubu 1 Sub-Catchment Land-Cover



23. Ruvubu 2 Sub-watershed

23.1 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
303.0	68.9	87.6	483.4	124.6	195.6
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
138.4	5.9	11.7	229.9	16.1	45.3
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
5.03	7	7.01	4.67	7	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
68.6	37.2	44.0	105	63	74.3
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
495.2	574.9	535.3	539.2	629.0	576.8

(b) Land Use/Landcover

Rivubo - 2 - Landcover	Hectares	% of Total
Intensive agriculture	73,214	46.9
Bare Soil	34,051	21.8
Grassland	21,478	13.8
Settlements and gardens	18,941	12.1
Intensive agriculture and bare soil	4,125	2.6
Swamp and wetland	2,846	1.8
Forest plantations	974	0.6
Closed Forest	305	0.2
Wetland agriculture	92	0.1
Urban areas	0	0.0
TOTAL	**156,027**	**100.0**

23.2 Description of the Sub-watershed

23.2.1 Specific nature of Sub-watershed

Again, located entirely within Burundi, the Sub-watershed lies immediately below Ruvubu 1 Sub-watershed and has a distinctive “reverse” drainage pattern. It has the eighth highest population density and its dominant soils are infertile and acid Ferralsols. Like Ruvubu 1, these indicate that there is severe pressure on its land resources.

23.2.2 Key Issues

- Acidic and infertile soils, steep slopes with high erosion risk;
- Loss of soil fertility and instability of radical terraces
- High sediment loads in rivers and sedimentation in wetlands
- Livestock feed deficits
- Agricultural encroachment of wetlands leading to lack of buffering capacity and flooding;

23.2.3 Characterization of Sub-watershed

The area of the Sub-watershed is 156,023ha in extent and is located in the south-west corner of the Sub-basin.

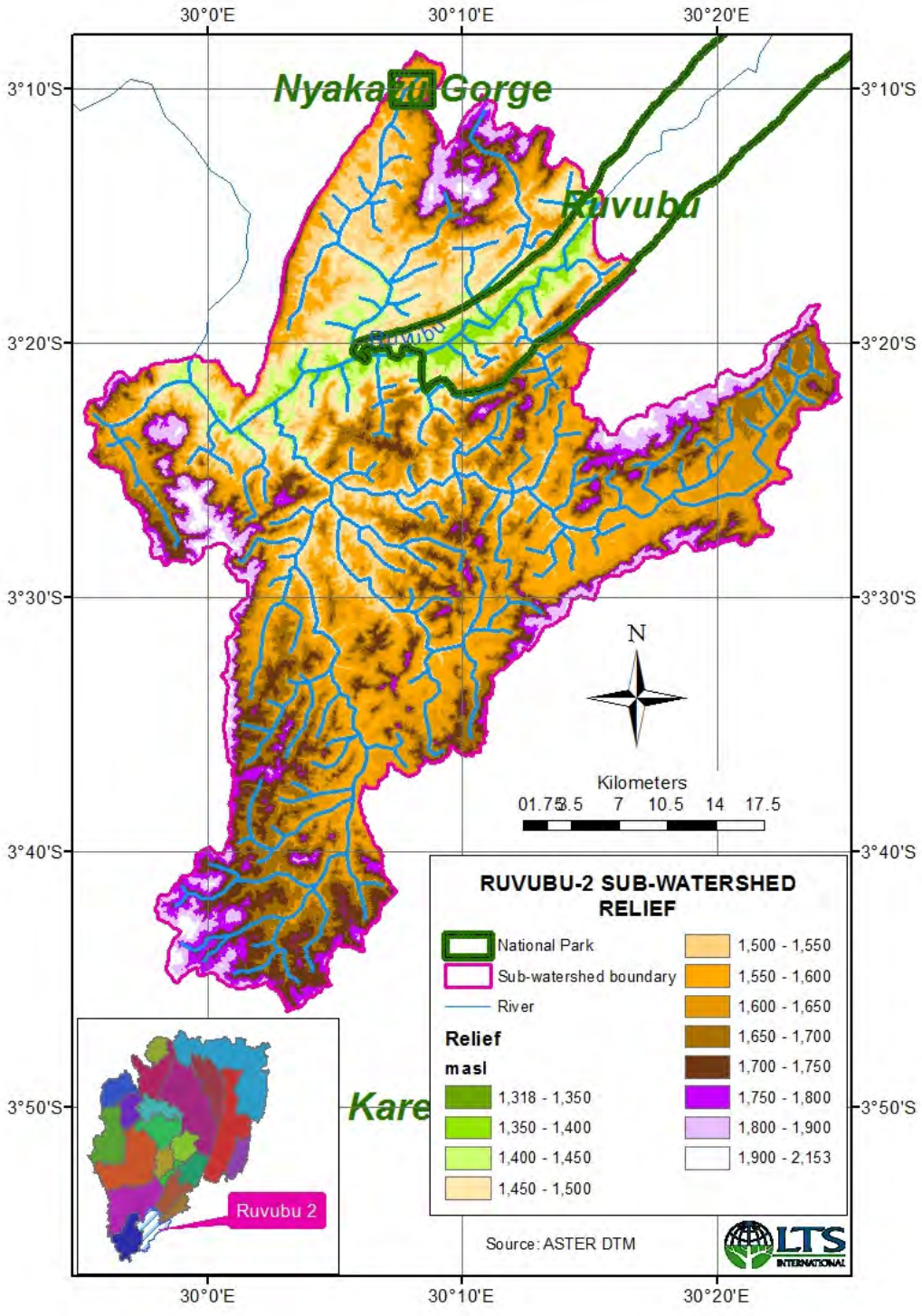
Mean annual rainfall is 1,000 to 1,400mm/yr trending from east to west. PET exceeds rainfall from 300 to 200mm/yr declining east to west. Similarly, green water trends westwards from 400 to 500mm/yr.

The altitude ranges from 1,300 to 2,100 masl although most of the Sub-watershed is between 1,500 and 1,700masl. Some 49 percent of the area has a severe to very severe soil erosion risk. The dominant soils across the whole area are infertile and acid Ferralsols, which under continuous cultivation suffer from aluminium toxicity.

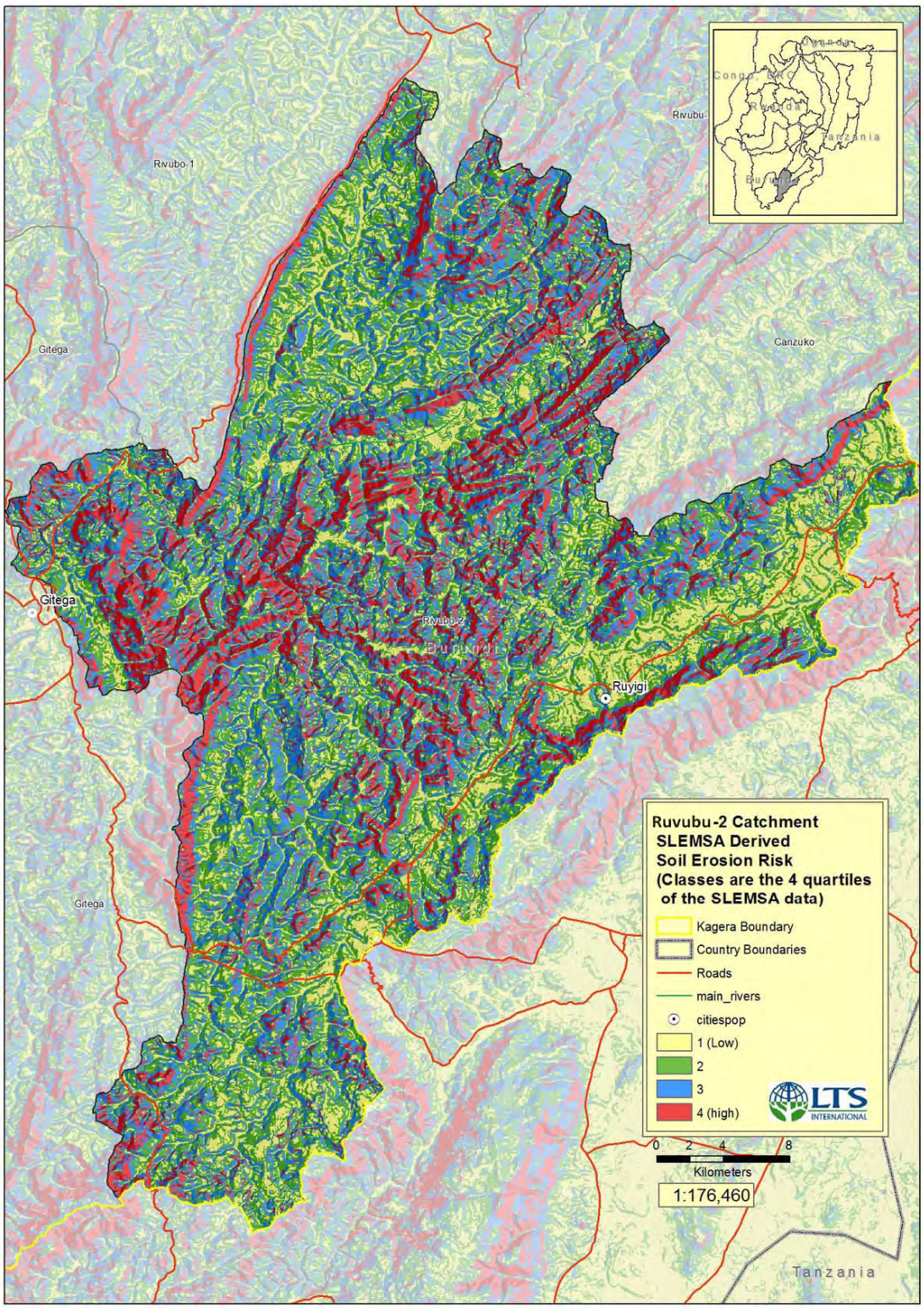
Nearly 84 percent of the area is covered with intensive agriculture, gardens and rural settlement. Some 30 percent of this area has bare soil. The steeper quartzite hills in the northern part are covered in grassland.

Population density is 500 to 750 ppkm2. The High Plateau Farming Systems dominates the area, with coffee as an important cash crop.

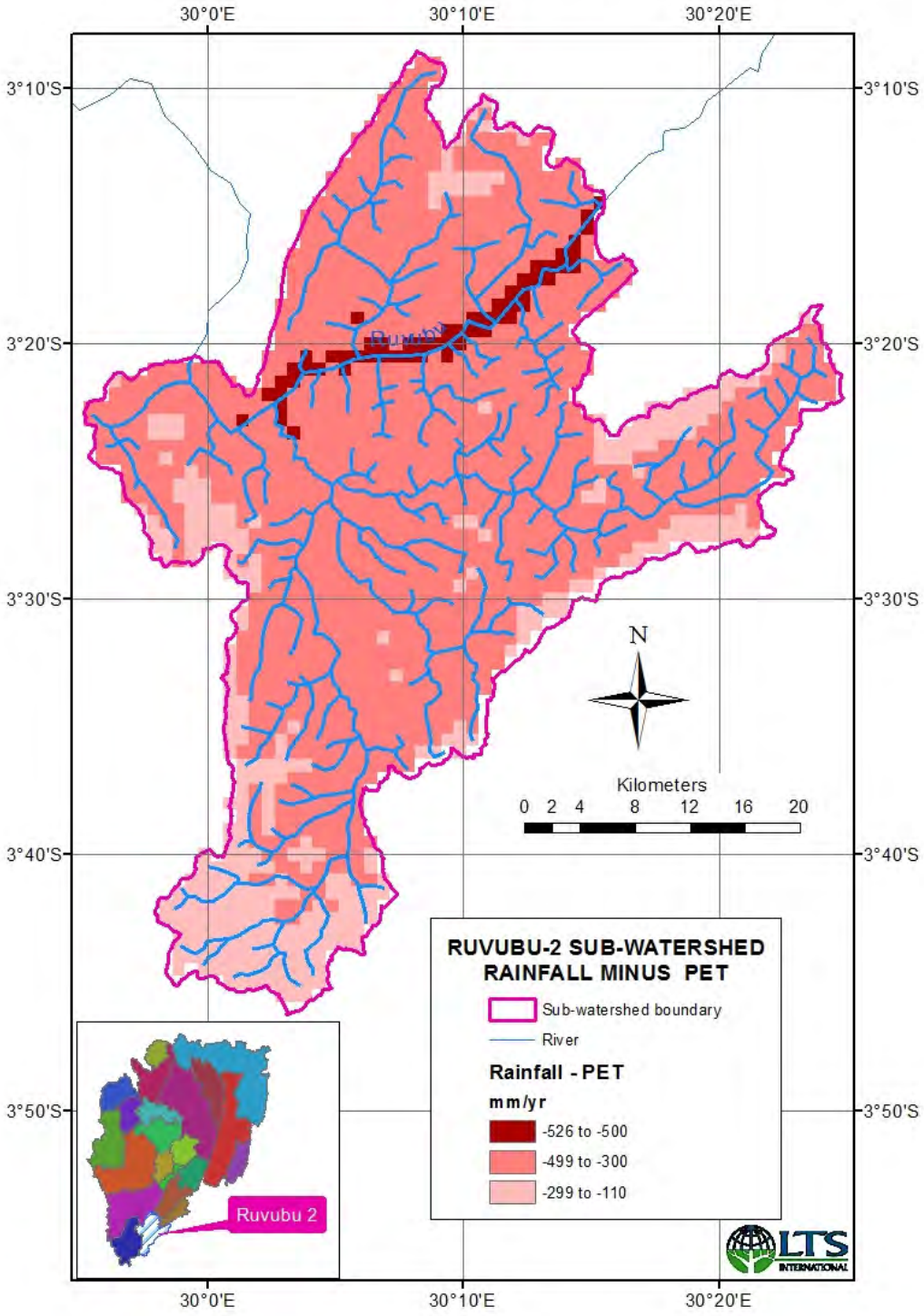
Map 106. Ruvubu 2 Sub-Watershed Relief



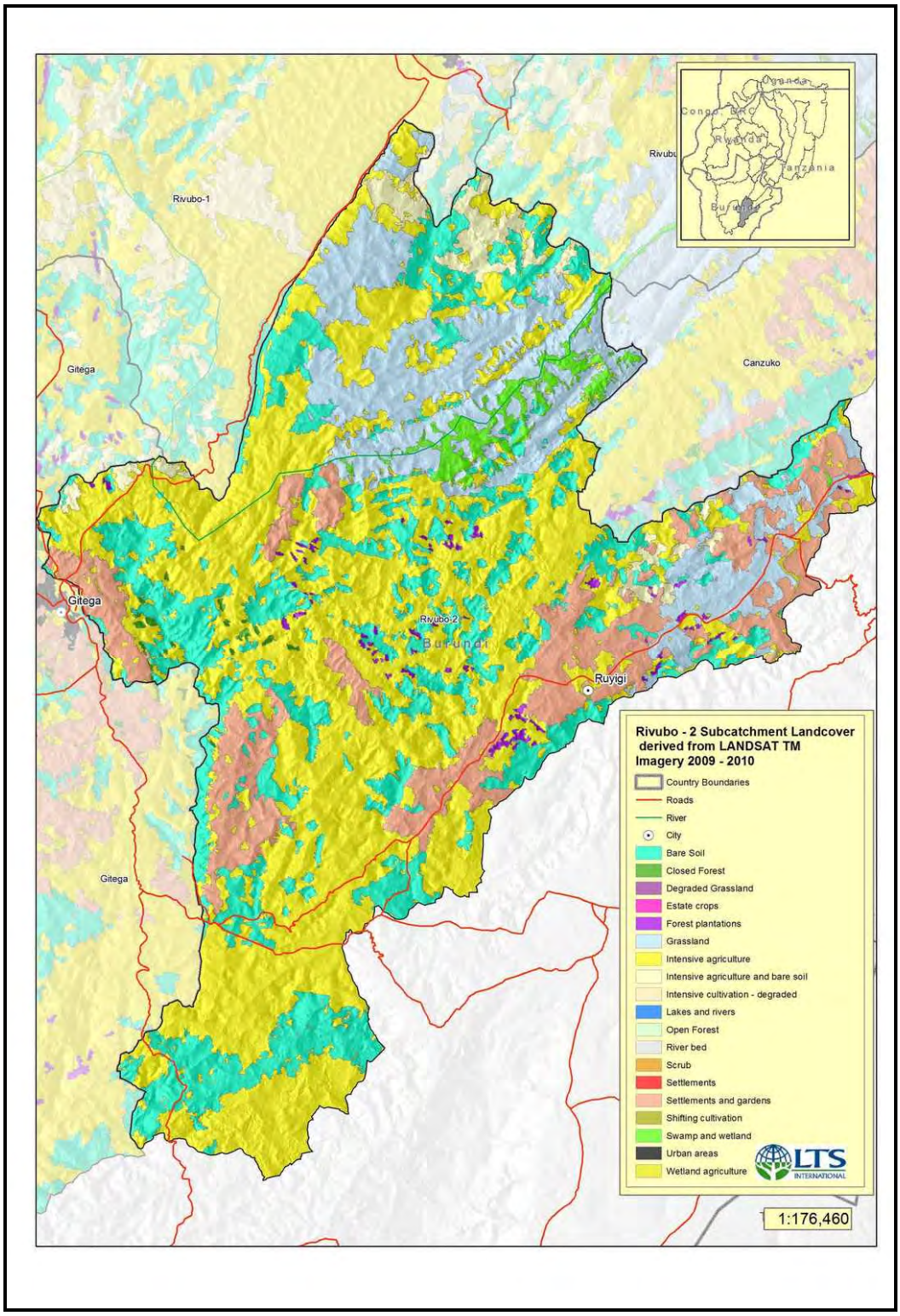
Map 107. Ruvubu 2 Catchment Soil Erosion Risk



Map 108. Ruvubu 2 Sub-Watershed Rainfall minus PET



Map 109. Ruvubu 2 Sub-Catchment Land Cover



24. Ruvubu 3 Sub-watershed

24.1 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
305.3	57.5	97.3	471.3	155.9	217.9
Ground-water re-charge – mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
151.3	5.6	19.3	237.2	28.7	66.3
Months of soil moisture stress					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
5.63	8	9.12	3.9	6	6.62
Monthly river flows m3/s					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
90.1	49	59	125.7	74.4	87.8
Irrigation demand mm/yr					
Observed – 1970 to 1999			**Projected – 2070 to 2099**		
Mean	Minimum	1-in-20	Mean	Minimum	1-in-20
492.4	578.9	536.9	555.4	664.2	598.2

(b) Land use/landcover

Rivubo - 3 - Landcover	Hectares	% of Total
Grassland	63,699	39.2
Intensive agriculture	46,889	28.8
Settlements and gardens	17,437	10.7
Bare Soil	16,208	10.0
Swamp and wetland	7,946	4.9
Intensive agriculture and b	4,758	2.9
Urban areas	3,138	1.9
Settlements	2,191	1.3
Forest plantations	303	0.2
Lakes and rivers	110	0.1
Open Forest	21	0.0
TOTAL	**162,699**	**100.0**

24.2 Description of the Sub-watershed

24.2.1 Specific nature of Sub-watershed

Ruvubu 3 lies immediately below Ruvubu 1 and 2 and partially in Burundi and partially in Tanzania. It is in the transition zone between wetter highlands and drier lowlands and higher and lower population densities. Soil moisture deficits are increasingly a problem in addition to soil infertility.

24.2.2 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;

24.2.3 Characterization of Sub-watershed

The sub-watershed covers some 162,703ha and is located in the southern end of the Sub-basin.

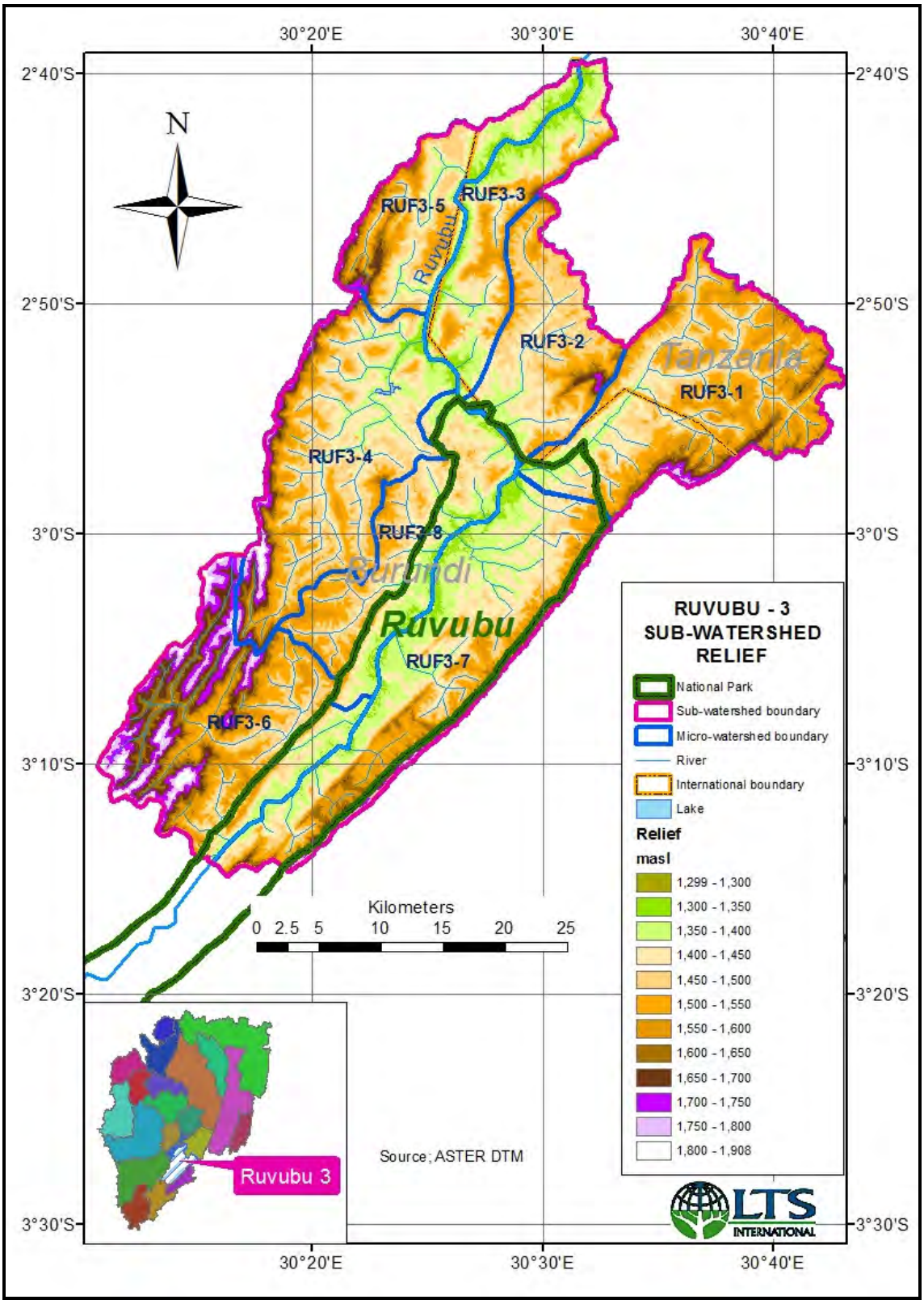
The altitude ranges from 1,300 to 1,900masl but is mostly between 1,400 and 1,550masl. Slopes are locally steep in the northwestern part of the area. The dominant soils are infertile and acid Ferralsols together with shallow and stony Leptosols on the steeper ridges.

Mean annual rainfall varies from 800mm in the east to 1,200mm in the west. Mean annual PET exceeds rainfall by 500mm in the east to 300mm in the west. Green (soil) water follows a similar pattern: from 200mm in the east to 350mm in the west. Soil moisture deficits combined with infertile soils are a significant and increasing constraint to crop and pasture production from west to east.

Grassland and bare soil cover 49 percent of the area, whilst intensive agriculture and gardens cover 453 percent. Wetlands cover 5 percent of the area and assume an increasing importance in reducing risk in crop production.

The population densities are less than 125 to 250ppkm2, increasing from east to west. The Kagera Piedmont Farming System dominates with bananas and roots crops (particularly cassava) together with sorghum assuming a greater importance.

Map 110. Ruvubu 3 Sub-Watershed Relief



Map 111. Ruvubu 3 Catchment Soil Erosion Risk