



SURINAME

CROSS-CUTTING CAPACITY
DEVELOPMENT PROJECT

C C C D

ENVIRONMENTAL PLANNING ATLAS



Kaplan
Planners
Ltd.

FEBRUARY
2019



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SURINAME CCCD PROJECT

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INTRODUCTION

SURINAME

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ENVIRONMENTAL PLANNING ATLAS

1. FOREWARD

The Suriname Environmental Planning Atlas is one of the main products of the CCCD Project. It presents the project's environmental recommendations and guidelines, with an emphasis on sustainability and increasing the capacities set in the Rio conventions. The Atlas completes the guidelines in the written reports, with a clear indication of conservation and development recommendations directed to specific locations.

The guidelines on protecting and preserving natural resources, preventing damage to biological diversity, and mitigating the greenhouse effect are no longer general or declarative. They are directed to specific areas, marked on a series of maps, accompanied by a series of explanations about their sensitivity, vulnerability and protective mechanisms.

In addition to the conservation policy of natural resources, Suriname as a progressive country with aspirations for modern development and prosperity, should also mention the future development areas: residential and industrial development, expansion of seaports and airports, development of modern agriculture, etc. All of these should be channeled to areas where environmental sensitivity is relatively low, while biodiversity and natural resources will be affected to the lowest possible degree.

The Atlas chapters present a series of maps, including an environmental, morphological and ecological analysis of Suriname, alongside existing land use patterns and development aspirations. This series of maps is at the basis of the Roadmap, which outlines the development directions along with the definition of conservation and protection zones.

The Atlas is intended to be used by decision-makers at the level of government ministries, such as SBB, NIMOS, GLIS, for the purpose of providing information upon which national and local-level policies may be outlined. Additionally, the material is meant to be used as a tool for distribution of geographic data in academic institutions, NGOs and the general public.

2. GENERAL BACKGROUND

2.1. Sources

The Atlas maps were all formulated in a digital mapping system, GIS (Geographic Information System), in the software ArcMap 10.5 by ESRI. The maps are based on series of databases in the various knowledge fields, which were generously provided by the Suriname government, research and support units. These entities include, among others, SBB, NIMOS, GLIS, LVV, and CELOS. The series of ecosystem maps, covering the coastal plain, made by Mr. P.A. Teunissen, was a vital source of data. The data were collected and brought into a common denominator in the GIS environment.

Sources for the preparation of the basic databases were multiple satellite imagery datasets, used in cross-sections, including mainly SPOT, TerraColor and DigitalGlobe. A series of high-resolution aerial photography was used to verify and validate data in selected areas.

The additional sources of information included geology, soil, botany maps (some of which appear in Plan Atlas of 1988), as well as a thorough work by the SBB to interpret the state of the forests in Suriname from 2000 onwards.

2.2 Methodology

The initial stage included the collection of data and subsequent categorization. The creation of further data - e.g. land use analysis, vegetation analysis, landscape units - was done based on the information previously collected. The methodology was composed of an integration of manual interpretation and delineation with constructed, automatic processes such as remote sensing and raster model building. The specific processes for the various sets of data are described in the appropriate chapters below.

2.3 Scale

The scale of the data sources was not uniform. The scale used in the preparation of the Plan Atlas in the 1980s was 1:1500, 000. Maps of the current Atlas were mostly obtained by NARENA and placed on top of satellite imagery, and were brought to a scale of about 1:20,000. The boundaries were closely related to the terrain and the topography. The map of the landscape units was based on elevation maps, slopes, the system of rivers and streams, watersheds, geology and soil.

The land use map series was based on the work of SBB in distinguishing between forest and non-forest. In a joint work effort with SBB, non-forest areas were interpreted and classified into natural areas and man-made areas. This map was built on the basis of interpretation of satellite imagery,

combined with digital means and human interpretation. The scale at which the interpretation was carried out on the screens was very detailed, down to 1: 5,000 and further. The land use maps served as a starting point and basis for the calculation and estimation of trends in changing the existing conditions, as expressed in the maps of the Roadmap.

These two series of maps, the maps of the terrain and the Roadmap, appear in the Atlas on a scale of 1: 1,500,000 in the general national view and in a district view on a scale that varies from 1:100,000 to 1:650,000, depending on the specific district. The map of Paramaribo is presented on a more detailed scale, of 1: 80,000.

2.4 Sources, Quality and Accuracy of the Data

The sources, quality and accuracy of the data vary according to the manner in which the data are collected, the method of collection, data processing and presentation. Many of the maps rely on existing sources, provided by NARENA, SBB, and more. Many of the maps were prepared especially for the purpose of the current atlas, especially the maps describing elevation, natural vegetation, land use and the Roadmap.

The accuracy of the land use maps depends on the resolution of the satellite data, which varies by location. However, control, verification and correction have been made, based on additional satellite imagery sources, including Sentinel, Google Earth, and others. In some cases, field trips were conducted, mainly by SBB and LVV experts, for verifying and calibrating the surface conditions compared to the maps - mainly with regards to the interpretation of the built areas and the agricultural areas.

3. STRUCTURE OF THE ATLAS

The atlas is divided into four divisions:

Division 1 - Physical, Abiotic, and Biotic Maps

Division 2 - Land Use Maps

Division 3 - Roadmap

Division 4 - Recommendations for the Expansion of Nature Reserves

The contents of each unit are detailed below.

Division 1 - Physical, Abiotic, and Biotic Maps

The series of maps in the first section includes the state of the surface, natural, abiotic and biotic features.

1. Elevation Maps (General and by district)
2. Landscape Unit Map (General and by district)
3. Series of biological maps: GBIF, NPP, RIBOT

Division 2 - Land Use Maps

Natural lands use map (forests, swamps, grasslands, open savannahs, rivers, lakes, rocky areas, etc.).

Man-made land use (various types of residential construction, urban and rural, agriculture, quarries, roads and infrastructure, etc.).

These maps are displayed on the scale 1:1,500,000 in the general national view, and in varied district scale.

Division 3 - Roadmap

This division is the central part of the Atlas. The maps describing the Roadmap concept contain two main groups, the conservation group and the development group. The development group directs the development activities in the country to areas of low environmental sensitivity, in accordance to the principle of convergence and proximity to built areas. This includes all development levels: residential, industrial, roads, agriculture, etc. This group also includes rehabilitation areas - abandoned bauxite quarries to be turned into industrial parks and similar purposes.

The second group includes the various conservation areas, as well as new proposals of the current plan, mainly for the designation of the Blue Belt, as well as areas for natural rehabilitation.

The Roadmap is displayed in the scale of 1:1,500,000 in the general national view, and in varied district scale view.

Division 4 - Recommendations for the Expansion of Nature Reserves

This division is composed of a map of the reserved areas and concessions for forestry and minerals.

This map is displayed in the scale of 1:1,500,000, in a general national view.

Division 1

Physical, Abiotic, and Biotic Maps

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SURFACE ANALYSIS

INTRODUCTION

Definition of a Landscape Unit

A landscape unit is a given area with typical and unique characteristics, within a clear borderline, (topography, morphology, type of the surface area, scenery) that distinguishes the area from its surroundings. Usually, a landscape unit can be noticed by its unique features - a mountain range, an alluvial plain, a wetland, etc.

Sometimes, a land unit includes several different features within its area, in proximity and with morphologic consistency. For instance, a series of sand ridges, that rises above a wetland. In this case, the series of the sand ridges - wetland transformations will be considered as the landscape unit itself.

The Scale and the Landscape Units

The definition of the unit's boundaries depends on the scale in which the map is presented. In a detailed scale, every single morphologic phenomenon will be marked as a landscape unit. On a detailed scale, for example: a single mount will be a landscape unit on its own, on a general scale, a mountain chain, or a mountain group will have a function as a single landscape unit.

The Boundaries of a Landscape Unit

The borders of a landscape unit may be either sharp and clear or blurry and diffusive.

Sharp borders: An alluvial plain at the foot of a mountain ridge or a sand ridge that rises above a swamp.

Blurry borders: In case that swamps appear inside depressions in a clay plain, alongside grassy elevated areas.

Ecological Landscape Units

In similar given types of land's surface that is subjected to a similar climate, it is expected for the same natural terms to develop, and alongside with a local ecological system that includes a specific composition of flora and fauna, and similar biodiversity with a unique system of connections and bonds.

The different landscape units form the ecological infrastructure enabling the existing of biodiversity, and defining the boundaries for natural population. This point of view enables efficient, available monitoring of changes occurring in local species population. For instance, the destruction of a habitat on a plain may cause migration to an elevated place, resulting in disappearance of parts of population not adjusting to the change. Another example: climate change directly affects landscape units, by erosion, flooding and so on and hence disruption causing abandonment of natural living area, unbalancing the ecosystem.

The system of connections between the landscape units and the vegetation was investigated and described in many previous works (D. Noordam, Teunissen). The ecosystem map of Teunissen expresses the connections between landscape units in north Suriname, for example:

1. The savannah area.
2. The 'Old Coastal Plain', clay hills on Mara Formation.
3. The swamps' vegetation.

The nature of landscape units dictates to a large extent the human behavior that takes place, and determines its land use. At the same time human activity may greatly alter the nature of the landscape unit.

The human activity in any area, especially the traditional form of it, occurs with correlation and connection to the area's landscape units. It is easy to demonstrate this phenomenon in a simple way - it is more likely for agriculture to develop in a plain than on a mountain ridge. Another example for it is that settlements will usually develop along coastlines and main rivers. In Suriname, there are many examples of the human-landscape connection:

1. The populated areas in Suriname, and mainly in the capital Paramaribo, developed on the great sand area, on the west side of Suriname's (river) downriver. Paramaribo and Wanika developed on a series of sand ridges that constituted good conditions for a settlement development and a preferable area in compare to the surrounding wetland.
2. The primary road network in Suriname is built upon sand ridges. The majority of the main east-west road is built on a sequence of sand ridges, parallel to the coastline. In the south of Suriname, the secondary road from Moengo to Apoera is also built upon the savannah's sand hills.

The common division of landscape units in the context of human activity is:

- Natural: Landscapes unaffected by human actions, with flora and fauna spontaneous.
- Sub natural: Landscapes, which, if human activity were removed, would revert to a natural state, with largely spontaneous flora and fauna.
- Semi-natural: Landscapes drastically modified by human activity, with the vegetation formation different from potential natural vegetation, but with a considerable degree of natural elements left impact.
- Agricultural: Landscapes predominantly arranged by human activities Where no natural areas remain

Landscape units - The Planning Aspect

The main attraction of the landscape scale as a framework for spatial planning is its holistic nature, and its capacity to integrate human and environmental systems within identifiable and distinct places. The landscape unit constitutes a customary basis for spatial planning. Every unit has a unique set of characteristics with a planning significance - natural values, ecological sensitivity, local biodiversity, vulnerability to land erosion, etc.

The Contribution of Landscape Units Division to Rio Convention's Principles

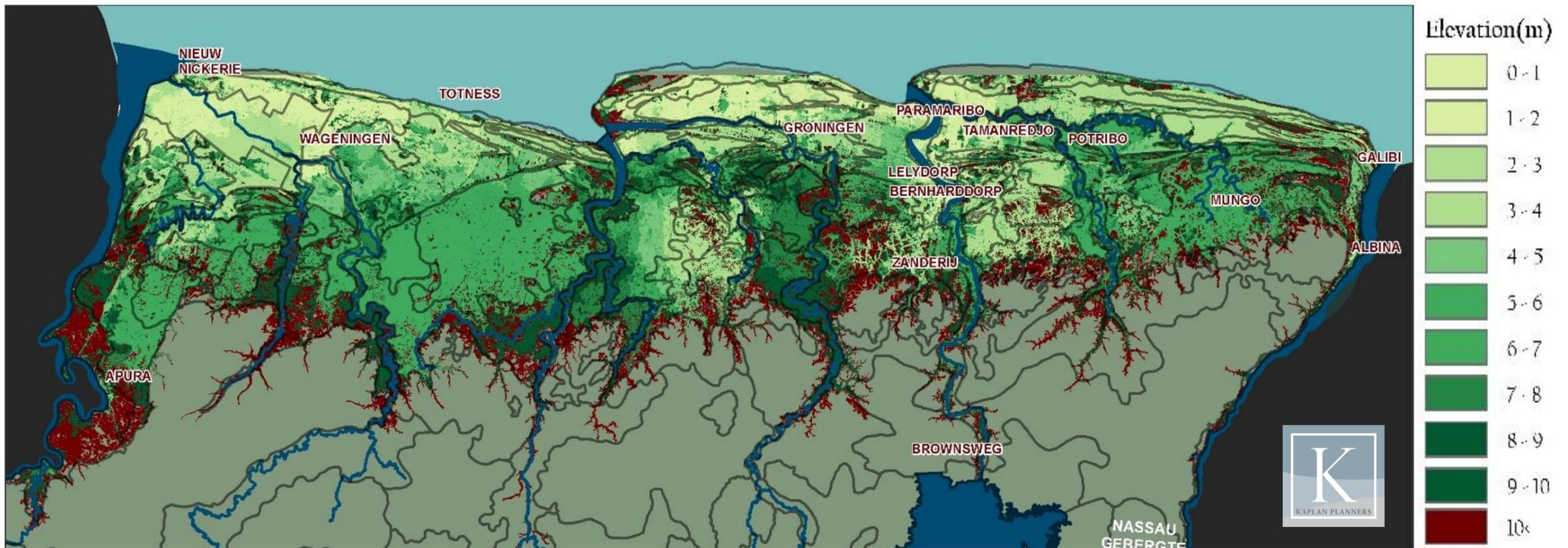
It is possible to give quantitative values to every unit in the aspects of its linkage and contribution to Rio declaration:

1. Description of the unique Biodiversity within the unit - composition of species, species scarcity and endangered species.
2. The ecological services in which the unit specializes - supply, support, culture, etc.
3. The contribution of the unit's vegetation to carbon fixation and the unit's role in the moderation of the greenhouse effect.
4. The unit's level of erosion or its typical parts.

Description of Physical Maps

The series of maps presented below depicts the physical attributes of the landscape of Suriname. The maps are shown in a series for each extent - the national extent, and the individual districts. The series depicts three separate subjects:

1. Surface elevation above sea level, in meters. The elevation values have been classified into groups, colored to distinguish them.
2. A three-dimensional representation of the elevation and landscape.
3. Delineation of landscape units and their physical characteristics - namely, geology and soil types, ecosystems etc.

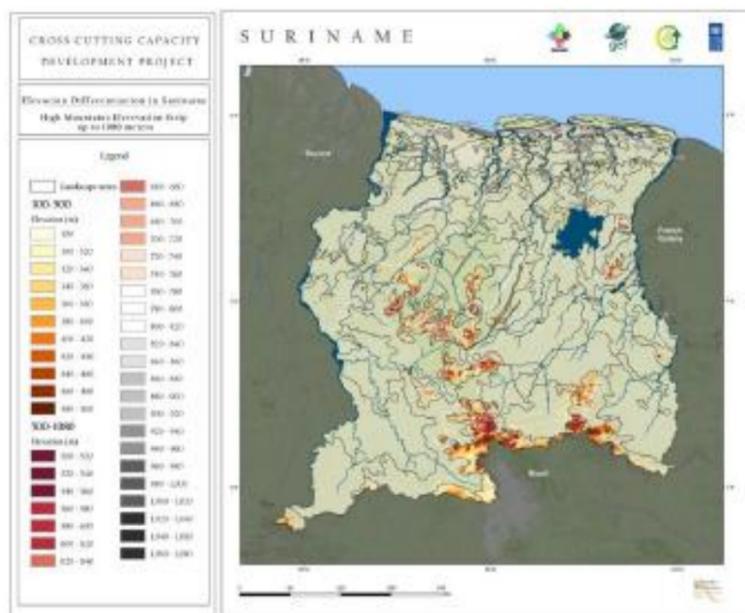
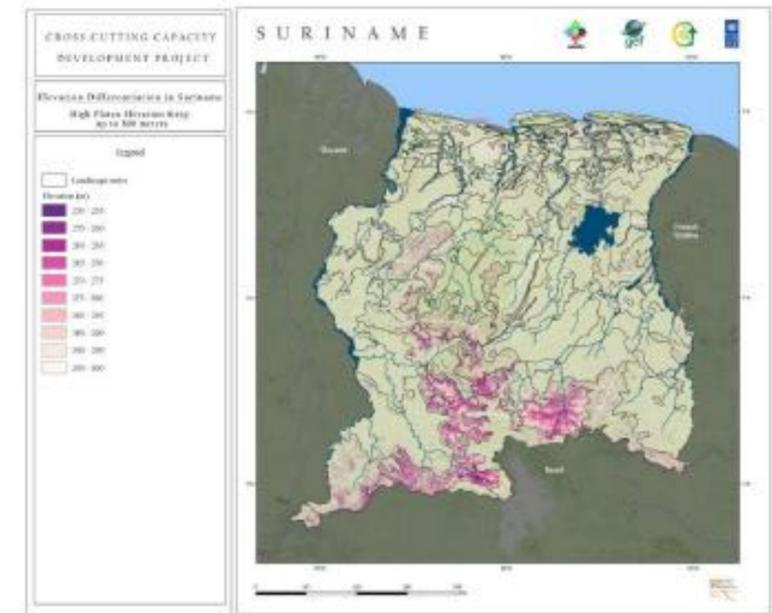
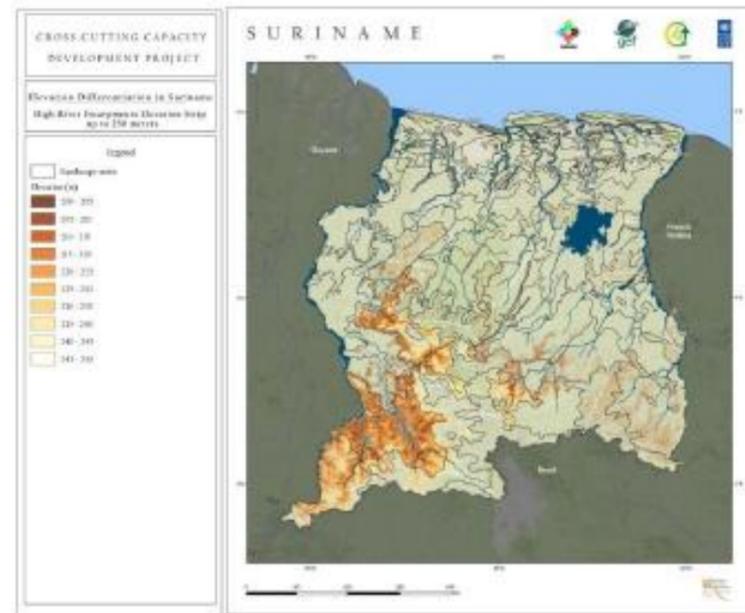
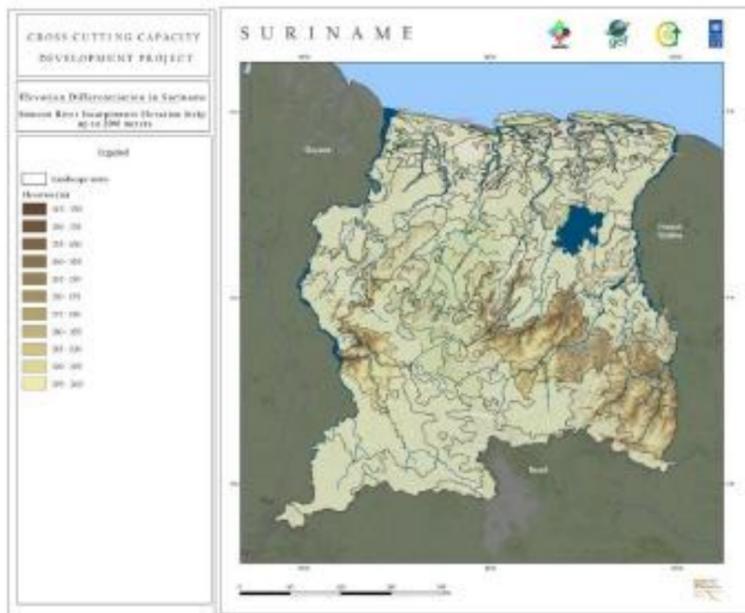
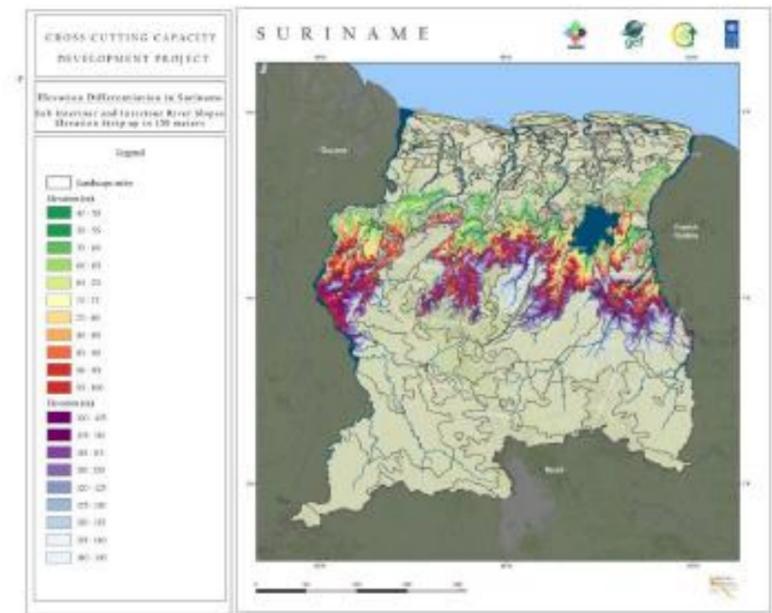
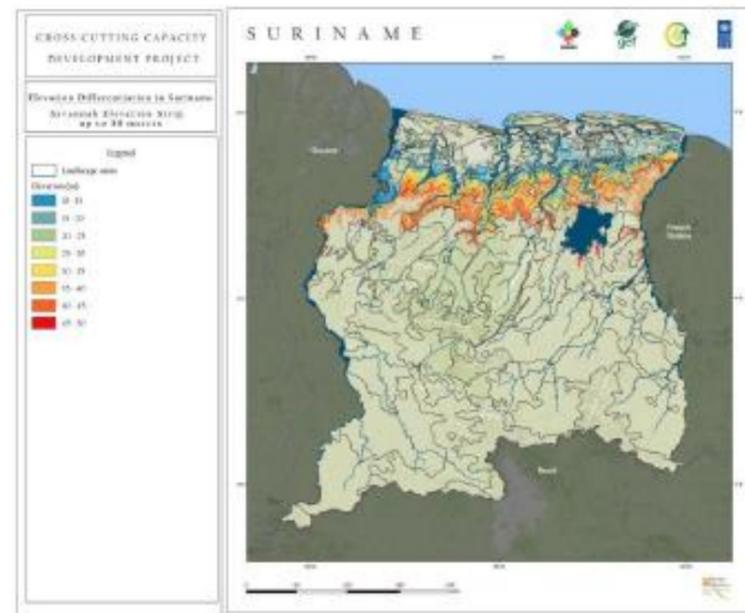
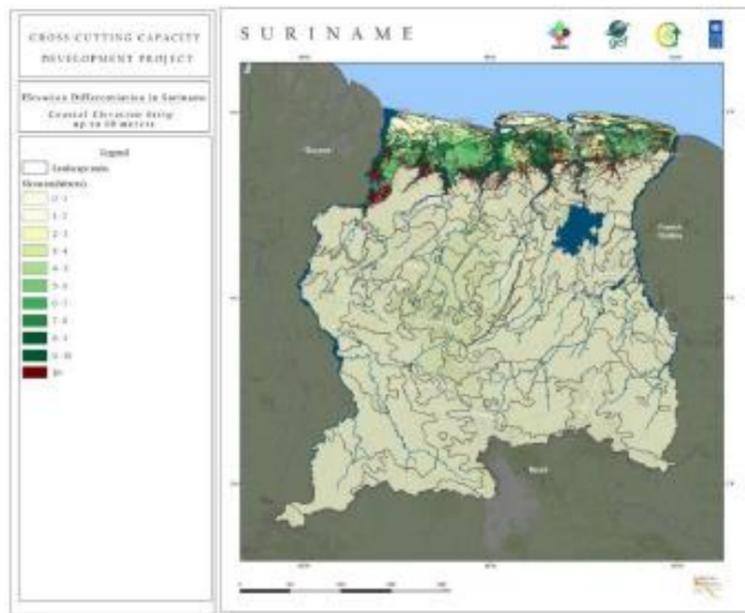


Surface Elevation of the Coastal Plain

The majority of Suriname's population lives on the coastline, the location of most of the cities, agricultural areas and road and infrastructure systems.

The map above presents the surface elevation, in meters above sea level. The map shows that the coastline elevation is between 0-10 meters. Vast areas are low, 0-3 meters above sea level, including in the Paramaribo metropolitan area and are prone to floods - in both a sea level rise scenario and a scenario of storms and floods. Such events are to be taken in consideration by decision makers, as they have the potential to severely affect the lives of the residents of coastal area, whether in personal safety, housing, transportation, agriculture, employment, etc.

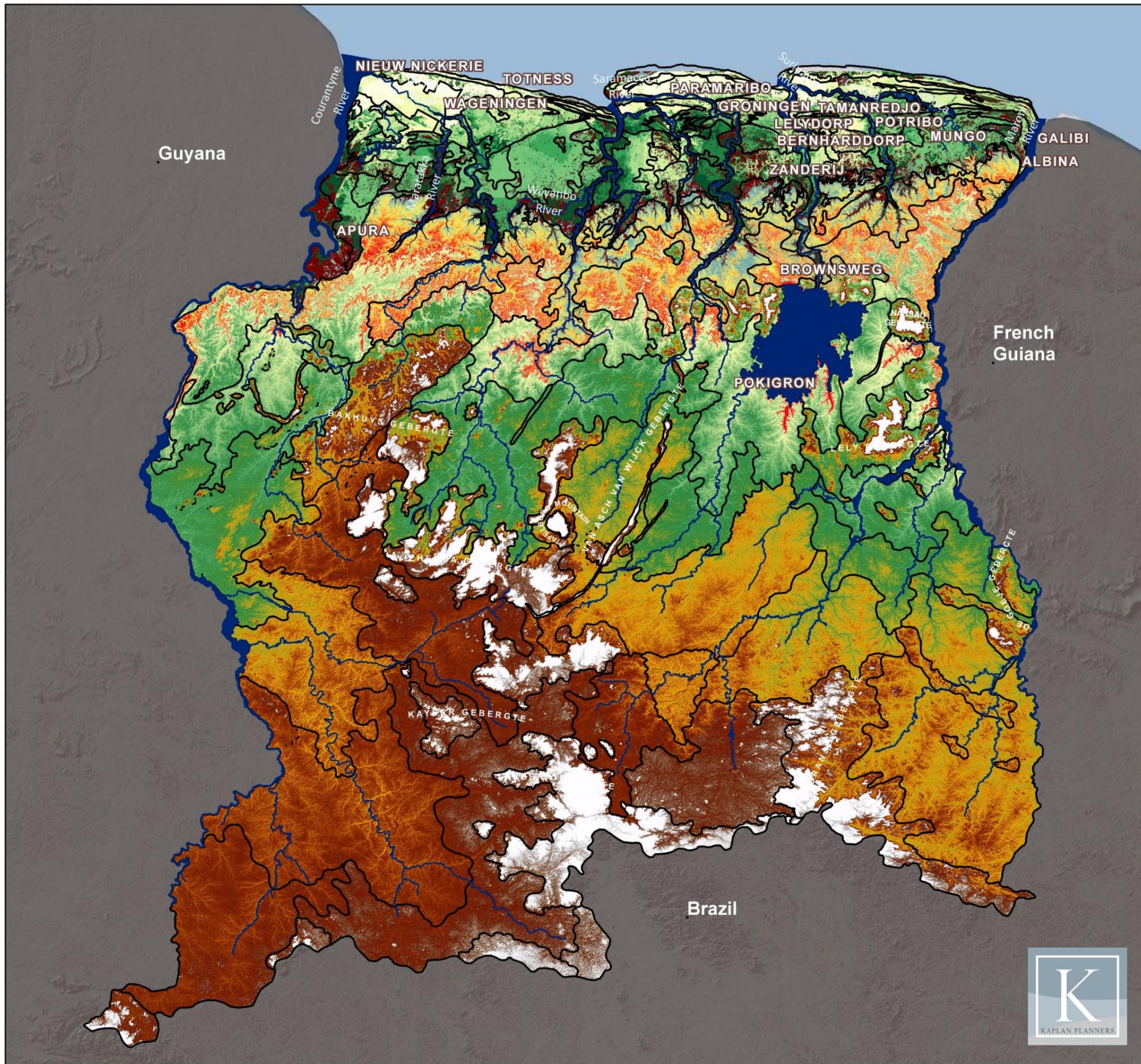
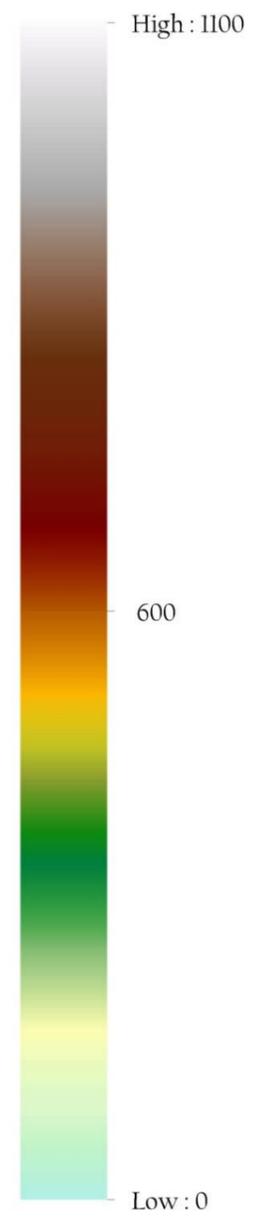
The proper adaptation strategy would mainly include the prevention of development in low areas, prone to flooding, and directing development towards higher areas - such as sand ridges - as well as taking measures to protect lower built areas. These measures include regulation and drainage, and quick removal of flooding waters. This is a classic process of proactive planning, set to adapt towards future scenarios, and potentially significantly saving resources in the future.



The delineation of landscape units is tightly linked to topography. The different values of terrain elevation dictate the nature of the geology, soil, drainage, vegetation type and patterns. This series of maps demonstrates the connection of landscape units to sets of values of surface elevation above sea level across Suriname. The top right map depicts the lowest points of the country's territory, near the Atlantic Ocean, with each next map presenting a higher altitude until the map on the bottom of the page, demonstrating the highest mountain peaks in the south.

ELEVATION MAP
NATIONAL EXTENT

Elevation (meters above sea level)



LANDSCAPE UNIT MAP

CLASSIFICATION & DISTRIBUTION

Elevation (meters above sea level)

Young Coastal Plain

- Saline To brackish
- Young Marine flats
- Mangrove Belt (Coronie)

- Young Marine
- Freshwater Flats (Coronie)

- Young Sand Ridges (Coronie)

- Young freshwater Swamps

- Young freshwater Peats (Mara)

- Human Cultivation

Old Coastal Plain

- Old Marine Seaclay Flats (Para)

- Old Sand Ridges (Lelydorp)

Cover (Dek)

- Zanderij Savannah Belt 'Dek' (Sand)

- Open Savannah (Coarse Sand)

Upland Interior

High Mountains

- Mountain Peaks (300 m >)

- High Plateau (250-300 m)

- Dykes

Hills & Slopes

- High Undulating Hills (200-250 m)

- Low Undulating Hills (150-200 m)

- Sub Interior and Interior River Slopes (50-150 m)

Greenstone Belt

- Greenstone Belt Mountains

- Greenstone Slopes

Tafelberg

- Tafelberg Mountain Peak

- Tafelberg Mountain Plateau

Bakhuis Granulite Belt

- Bakhuis High Belt

- Bakhuis Low Belt

Aluvium & Wetlands

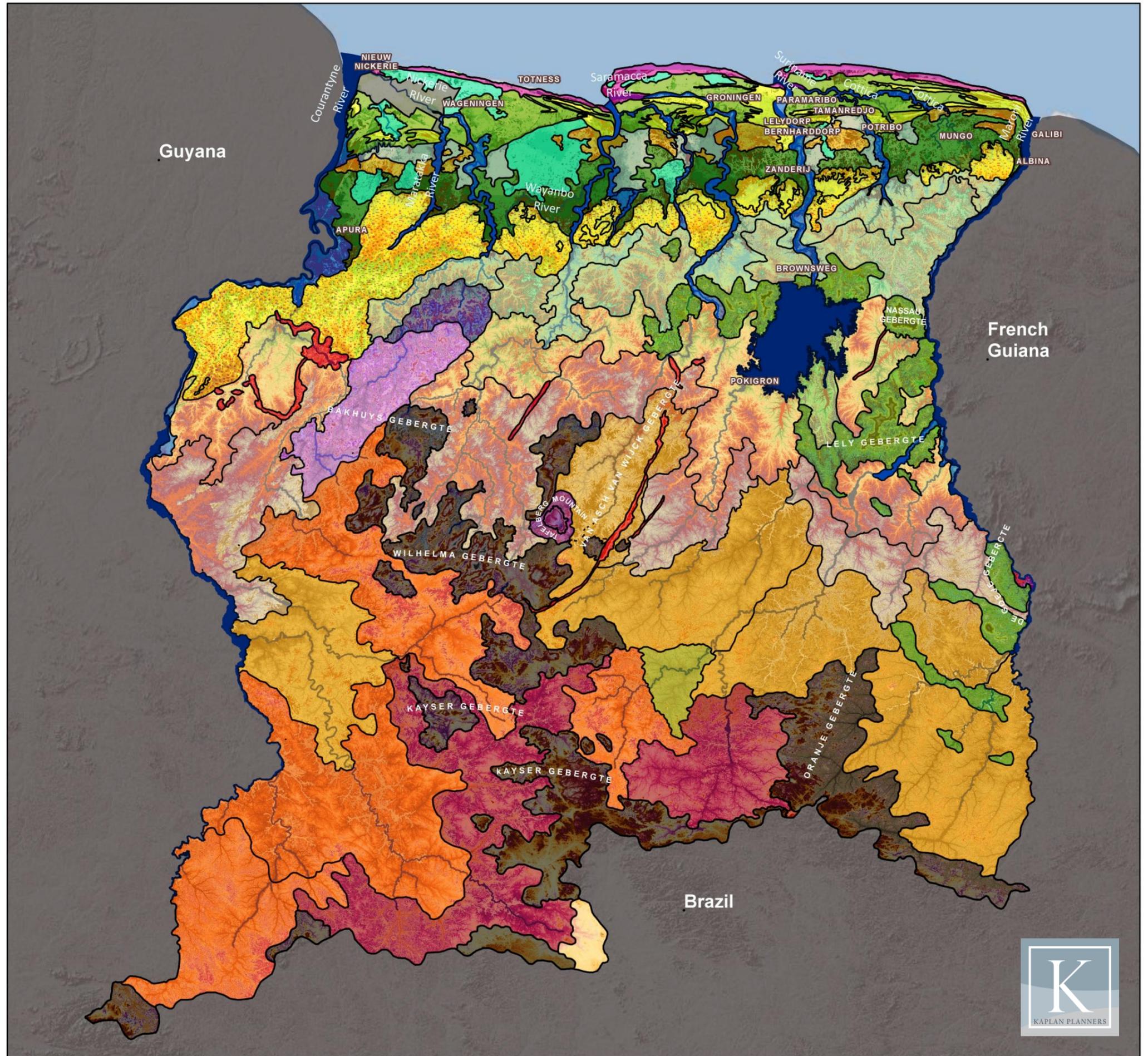
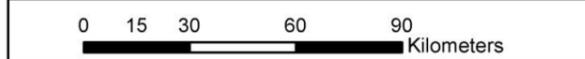
- Aluvium

- Great Rivers Valleys lowlands South to Cover-'Dek' (10-50 m)

- Swampy area upstream Tapanahony river

Other

- South Savannah



LANDSCAPE UNITS OF SURINAME - LEGEND

Coastal Plain

The coastal plain extends from the Atlantic Ocean in the north, to the foot of the Savannah strip in the south. It is divided into two subdivisions: the northern strip - young coastal plain - from the Holocene period, and the southern strip – old coastal plain – from the Pleistocene period.

Young Coastal Plain

The landscape units in the northern coastal plain consist of:

 **Saline to Brackish Young Marine Flats, Mangrove Belt (Coronie):** The coastal strip, situated at **0-4** MASL (meters above sea level), a narrow strip characterized by a saline to brackish young marine flats, is subject to fluctuations in erosion and sedimentation.

 **Young Marine Freshwater Flats (Coronie):** Wide clay plain, covered by heavy marine sediments. Influenced by brackish water and mostly covered with swamps. Height ranges from **1-3** MASL.

 **Young Sand Ridges (Coronie):** Elongated sand and shell ridges. Appear in clusters, in parallel rows, with narrow clay valleys between them. The sand ridges rise above the clay plain by **3-7** MASL Their width is usually several dozen meters.

 **Young Fresh Water Swamps:** Broad swamps, some of which are seasonal and flooded only during the rainy season. The northern swamps such as Bigi Pan, Commewijne and Buku are situated on approximately **1-2** MASL while Coronie and Nani swamps are approximately **3-6** MASL.

 **Young Freshwater Peats (Mara):** The landscape consists of gullies, filled with young heavy sediment. Height ranges from **3 - 8** MASL

Alluvium: Rivers valleys covered with sediment. An extended unit that connects the interior with the coastal plain. The approximate elevation of the units is **4-8** MASL.

 **Agricultural Cultivation:** Planar areas, many of which are cultivated in a concentration of rice growing in Nickerie. Estimated elevation of the area is around **1-2 MASL**.

Old Coastal Plain

The Old Coastal Plain consists of two prominent landscape units:

 **Old Sand Ridges (Lelydorp):** Consists of eroded and flattened ridges with fine sandy clay soils. Height ranges from **5-12 MASL**.

 **Old Marine Seaclay Flats (Para):** Clay plains, consists of gullies, filled with young sediment. Height ranges from **4-7 MASL**.

The Savannah

 The savannah hills are located on an elongated strip stretched west to east, and characterized by sandy soils, the texture of which varies from coarse sand to silty sand. The coarse sand formations. The height of the savannah area varies from **20-60 MASL**

Interior Hills and Plains

 **Great Rivers Valleys and low Hill Slopes:** Wide valleys covered with alluvial sediments around the great rivers, and delineated by mountainous formation to the south and Savanna hills to the north. Elevation varies from **10-50 MASL**.

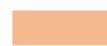
 **Sub Interior and Interior River Valleys:** River valleys, forming low ravines around the main rivers, delineated by high and low hills formations that descend northward. Units height ranges from **50-150 MASL**.

 **Low Undulating Hills:** Hills, geographically consecutive of the high hills. The hills' elevation ranges between **150-200 MASL**, consisting mostly of gneiss and younger granites.

High Undulating Hills: Hills, the height of which ranges between **200-250 MASL**. These sub-groups encircle the high plateaus and the mountain ridges. These units consist mostly of younger granites.

 **High Plateaus:** The high plateau series are located at the base of the mountain ridges, its height ranges from **250-300 MASL**. The plateau is characterized by a common composition of igneous rocks, mostly granite.

 **Swampy Area Upstream Tapanahony River:** Characterized by a closed, flat and confined valley, poorly drained and flooded occasionally. Its height ranges between **170-180 MASL**.

 **South Savannah:** A distinct landscape unit, the bare surface, containing little to non-existing tree covers, is covered with seasonal herbaceous vegetation. Its elevation range is **250-500 MASL**.

The Mountainous Formations

 **The Mountains Peaks:** Mountain peaks consisting of several types of igneous rocks: granites, gabbros (coarse-grained rock containing feldspar and calcium) and volcanic rocks. Elevation varies between **300-1220 MASL**

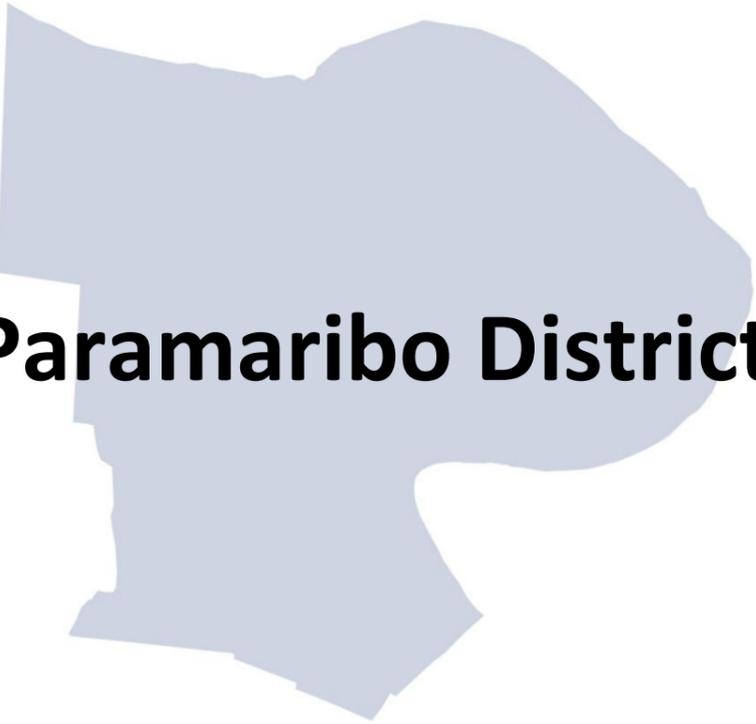
 **The Green Belt Mountains:** The mountains height ranges from **200-1000 MASL**. Consisting mostly of Rosebel, Kabel Tonalite, Armina and Paramaka formations.

 **Mount Tafelberg:** Located at the center of Suriname, and rises to a maximum height of approximately **1050 meters MASL**. The mountain is divided into two sub-units – the mountain peak, reaching approximately **1050** height and the surrounding plateau, rising to approximately **500 MASL**. The unit is composed of red sandstones and conglomerates.

 **Mt. Bakuys:** An elongated mountainous structure. Height ranges from **50-400 MASL** Mt. Bakuys, formulated of originally sedimentary rocks, which underwent an intensive process of metamorphosis (granolites and gneisses).

 **The Dyke Series:** An elongated landscape configuration of dykes, consisting of hard rock (dolerite), elevation ranging from **300-400 MASL**.

Physical Maps by District

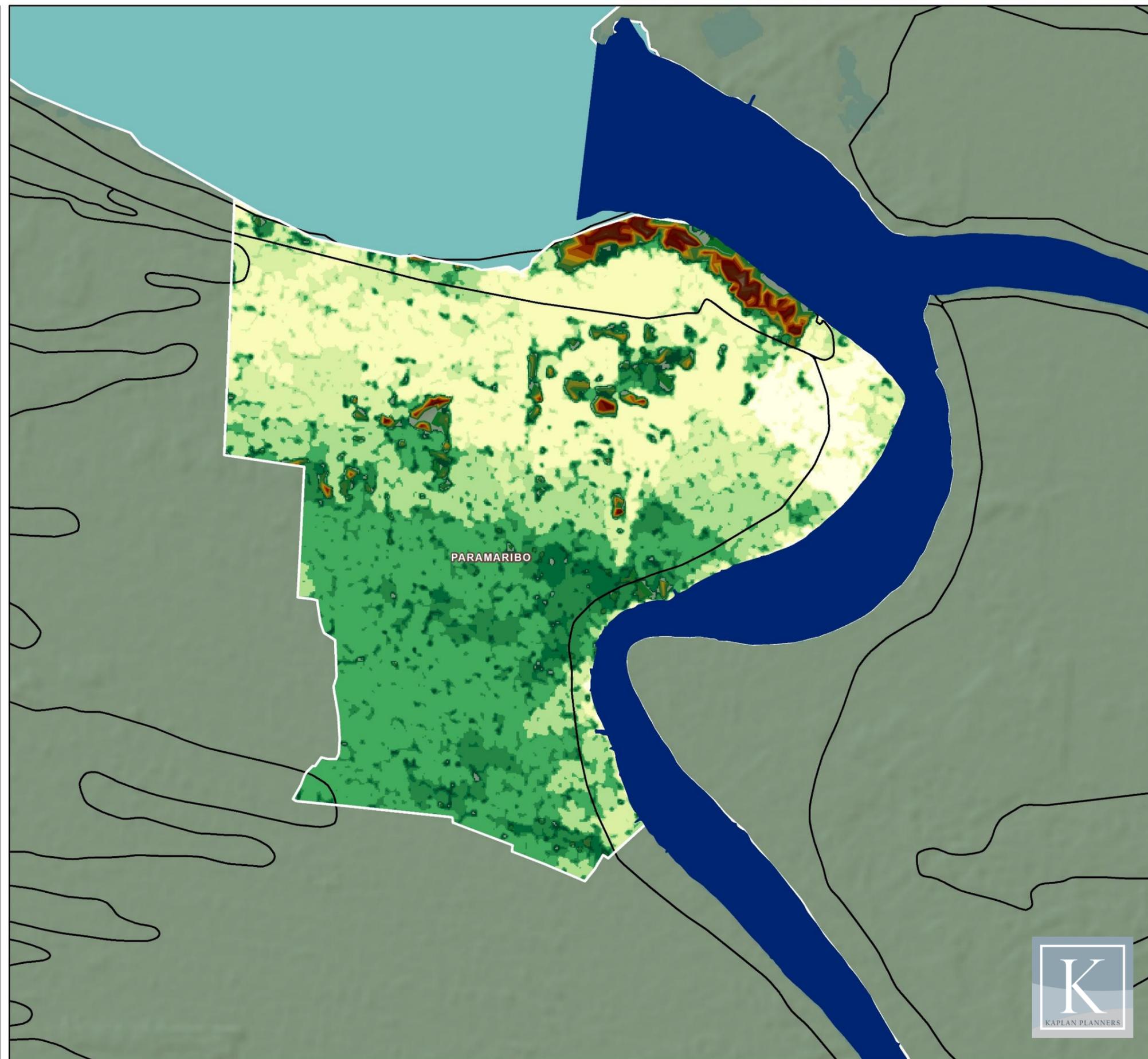
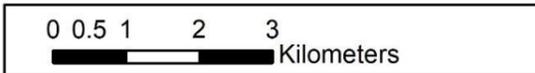
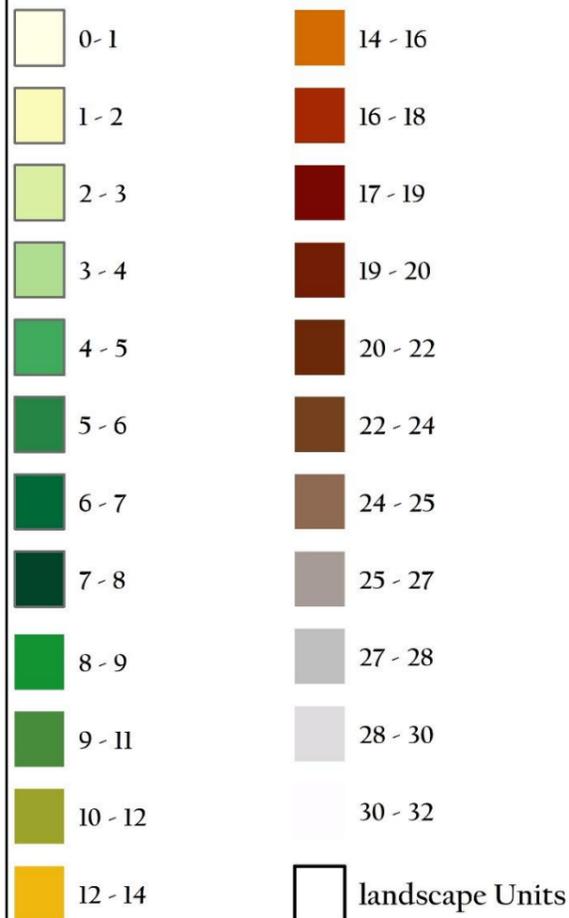


Paramaribo District

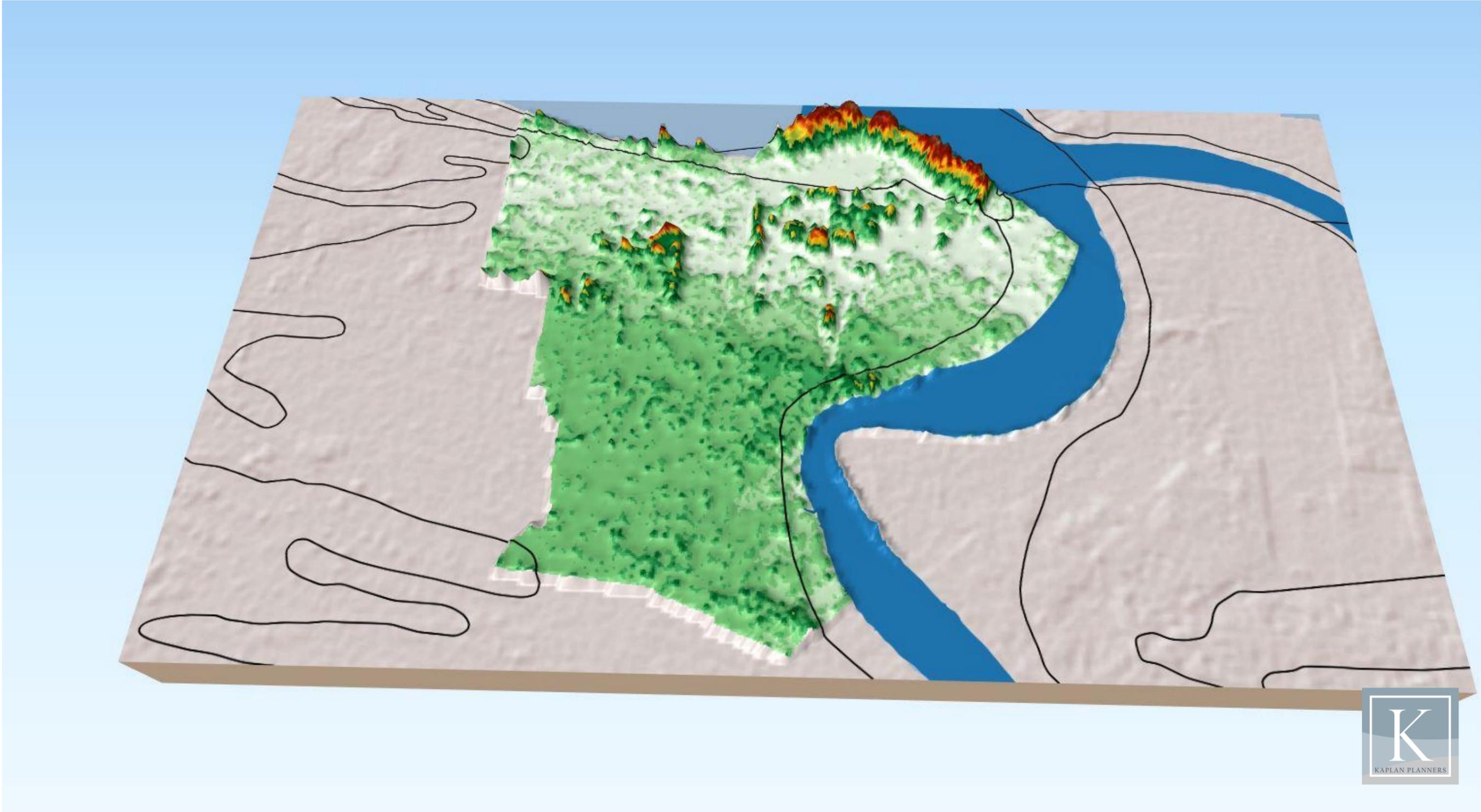
ELEVATION MAP

PARAMARIBO DISTRICT

Elevation (m' above sea level)



3D INTERPRETATION



LANDSCAPE UNIT MAP

PARAMARIBO DISTRICT

Young Coastal Plain

Saline To brackish Young Marine flats
Mangrove Belt (Coronie)

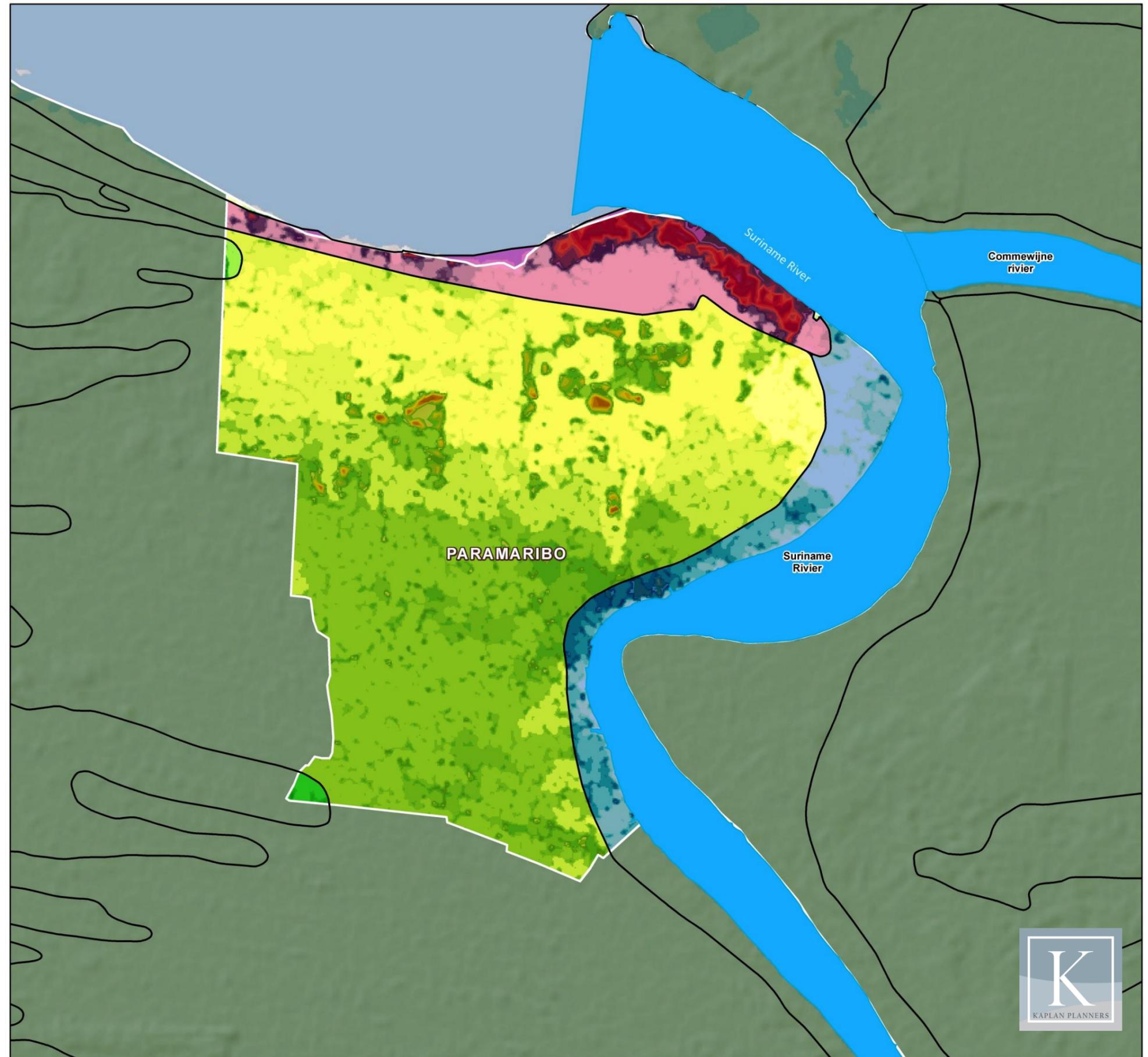
Young Marine Freshwater Flats
(Coronie)

Young Sand Ridges (Coronie)

Aluvium & Wetlands

Aluvium

0 .75 1.5 3 4.5
Kilometers



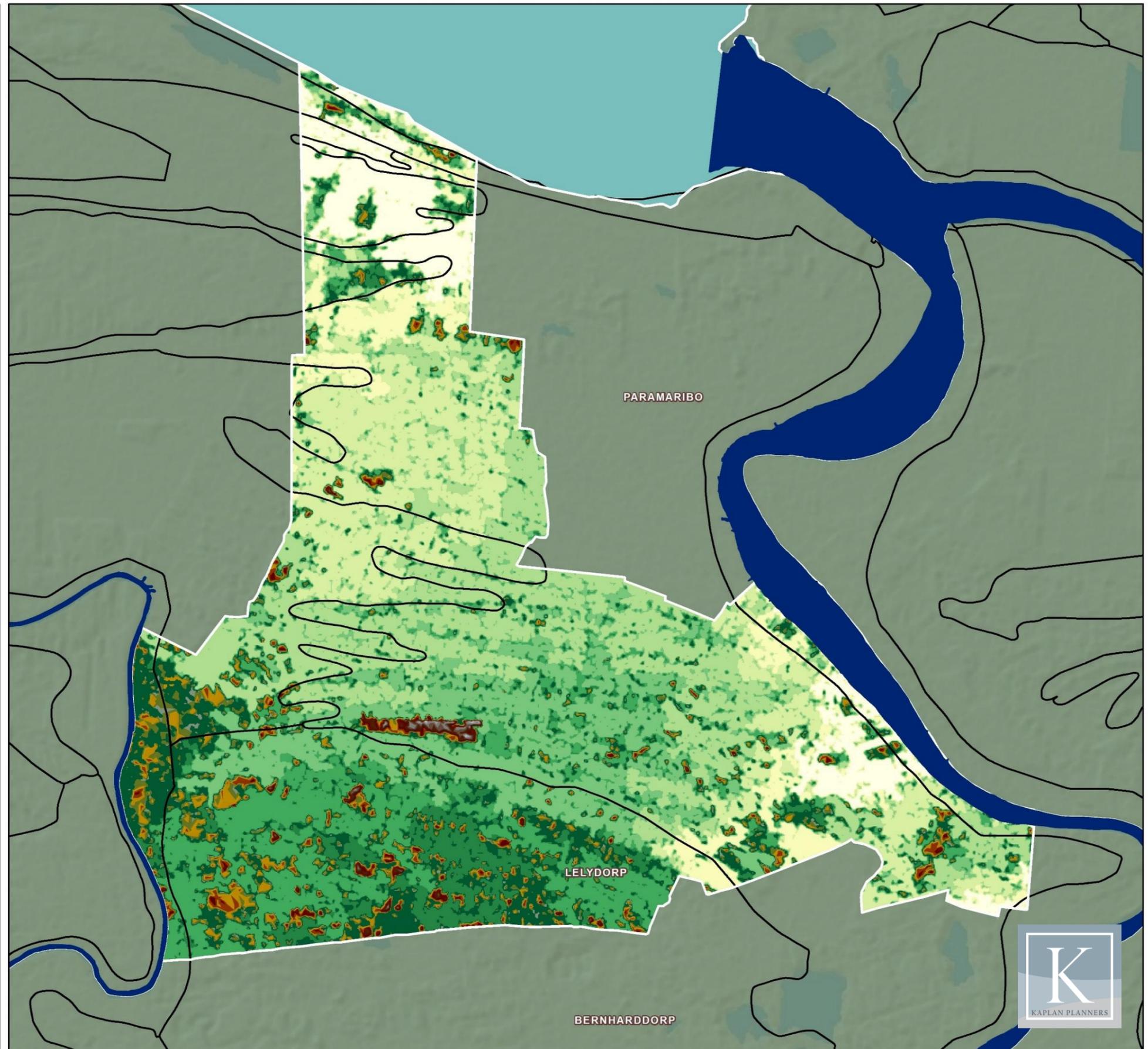
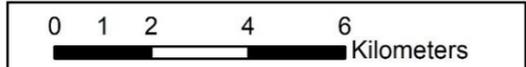
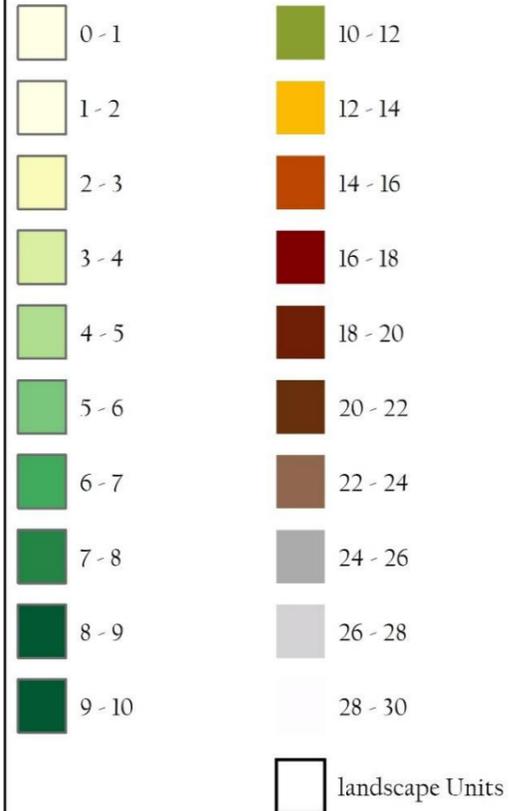


Wanica District

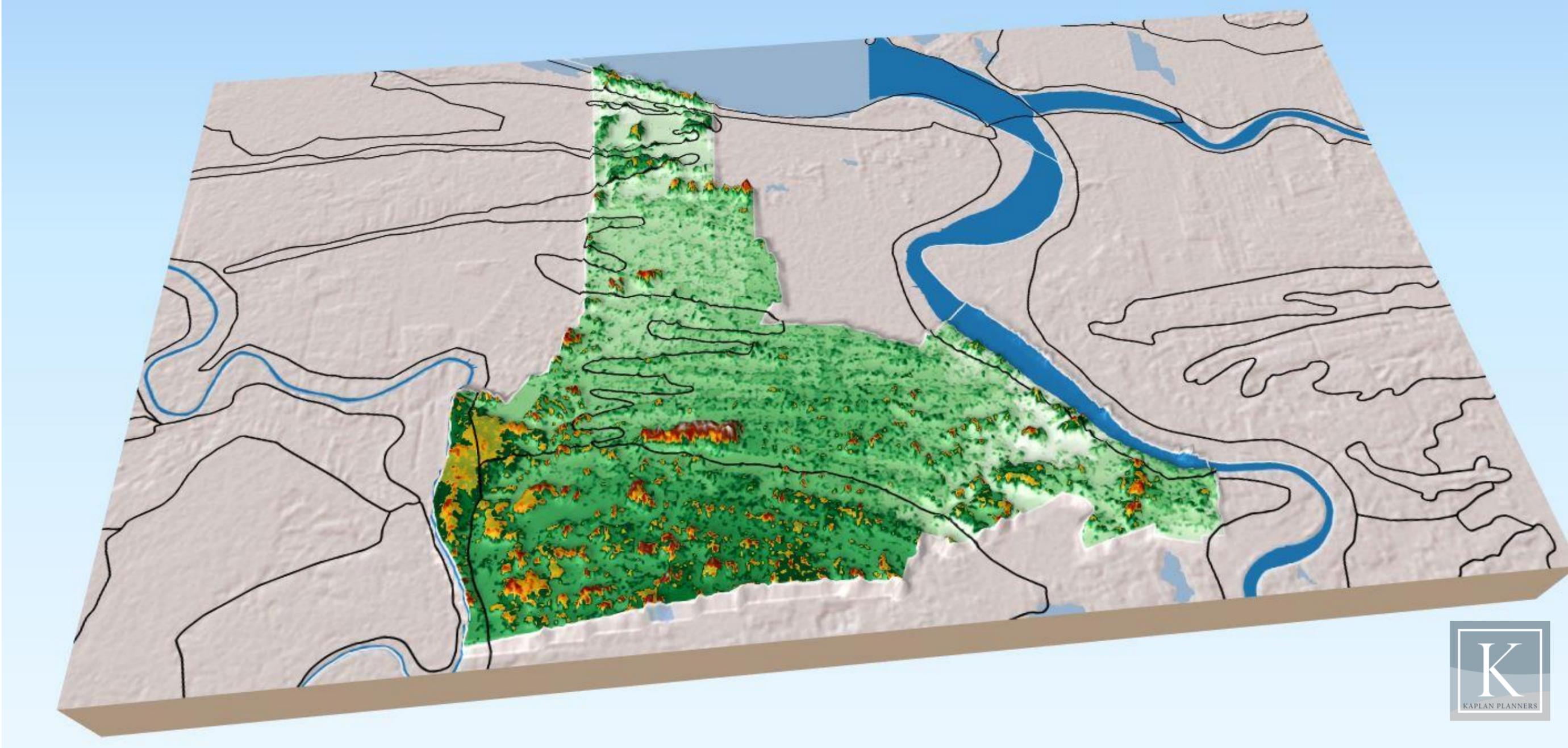
ELEVATION MAP

WANICA DISTRICT

Elevation (m' above sea level)



3D INTERPRETATION



LANDSCAPE UNIT MAP

WANICA DISTRICT

Young Coastal Plain

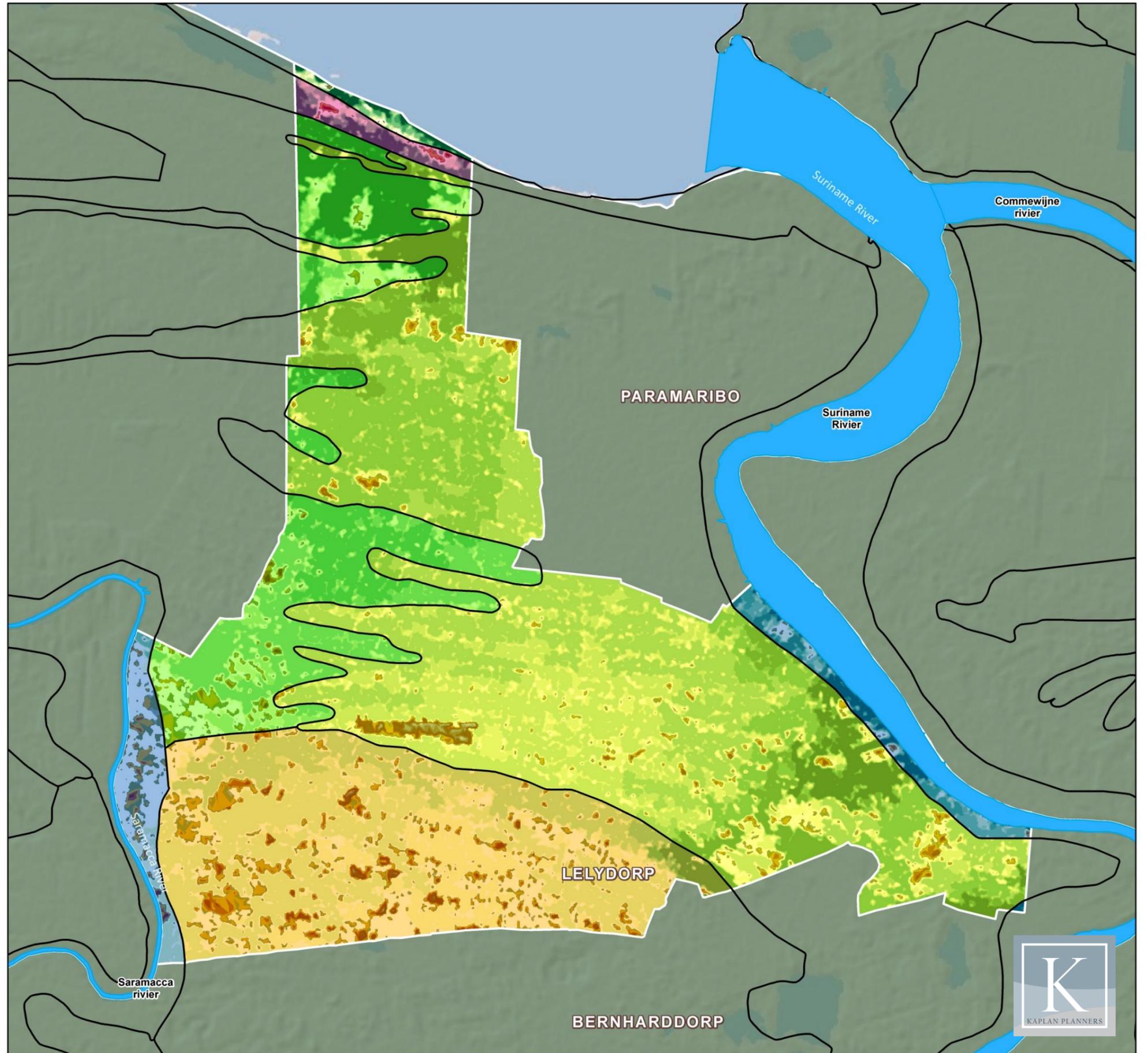
-  Saline To brackish Young Marine flats
Mangrove Belt (Coronie)
-  Young Marine Freshwater Flats
(Coronie)
-  Young Sand Ridges (Coronie)

Old Coastal Plain

-  Old Sand Ridges (Lelydorp)

Aluvium & Wetlands

-  Aluvium





Nickerie District

ELEVATION MAP

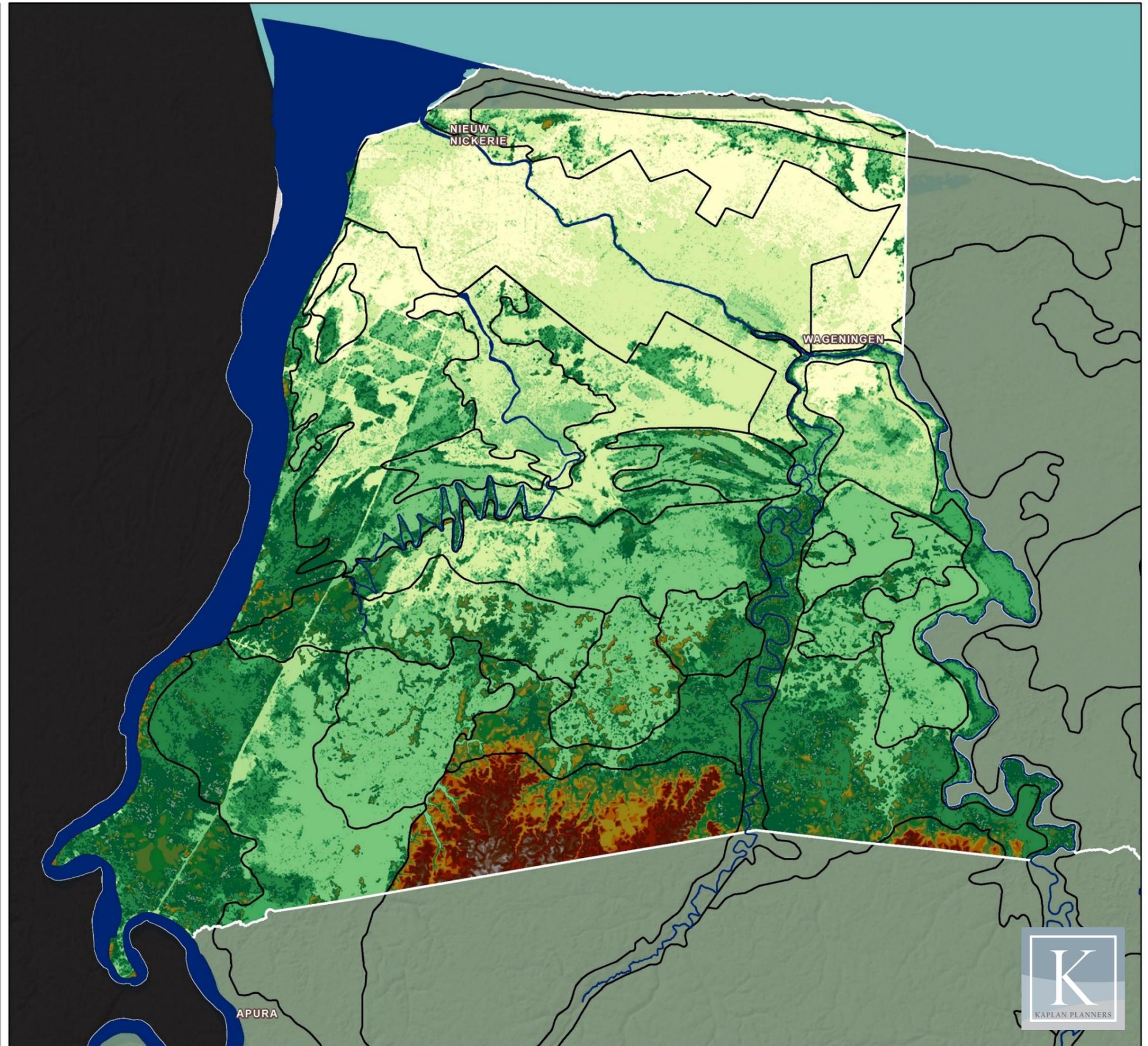
NICKERIE DISTRICT

Elevation (m' above sea level)

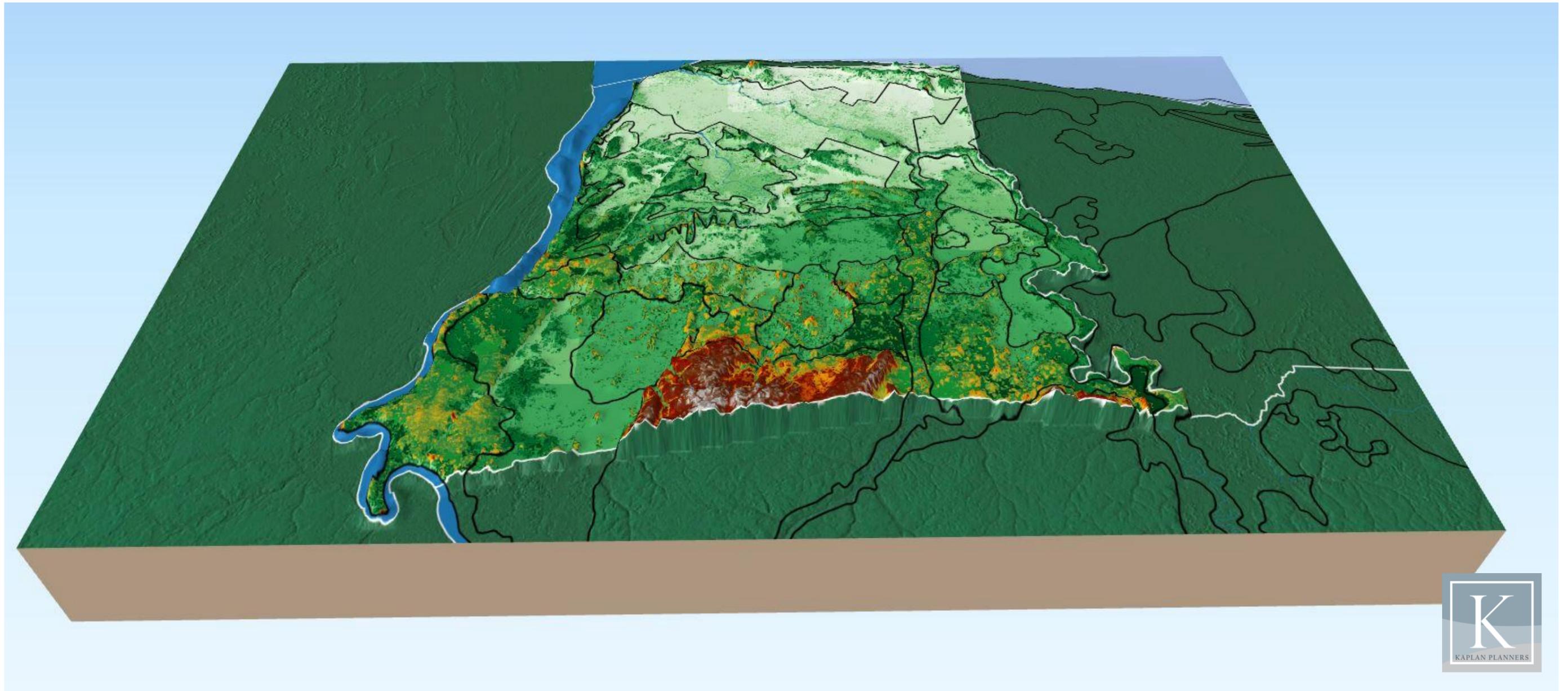
0 - 1	12 - 15
1 - 2	15 - 18
2 - 3	18 - 21
3 - 4	21 - 24
4 - 5	24 - 27
5 - 6	27 - 30
6 - 7	30 - 33
7 - 8	33 - 36
8 - 9	36 - 39
9 - 10	39 - 42
10 - 11	42 - 45
11 - 12	45 - 48

landscape Units

0 2.5 5 10 15
Kilometers



3D INTERPRETATION



LANDSCAPE UNIT MAP

NICKERIE DISTRICT

Young Coastal Plain

-  Saline To brackish Young Marine flats Mangrove Belt (Coronie)
-  Young Marine Freshwater Flats (Coronie)
-  Young Sand Ridges (Coronie)
-  Young freshwater Swamps
-  Young freshwater Peats - Mara
-  Human Cultivation

Old Coastal Plain

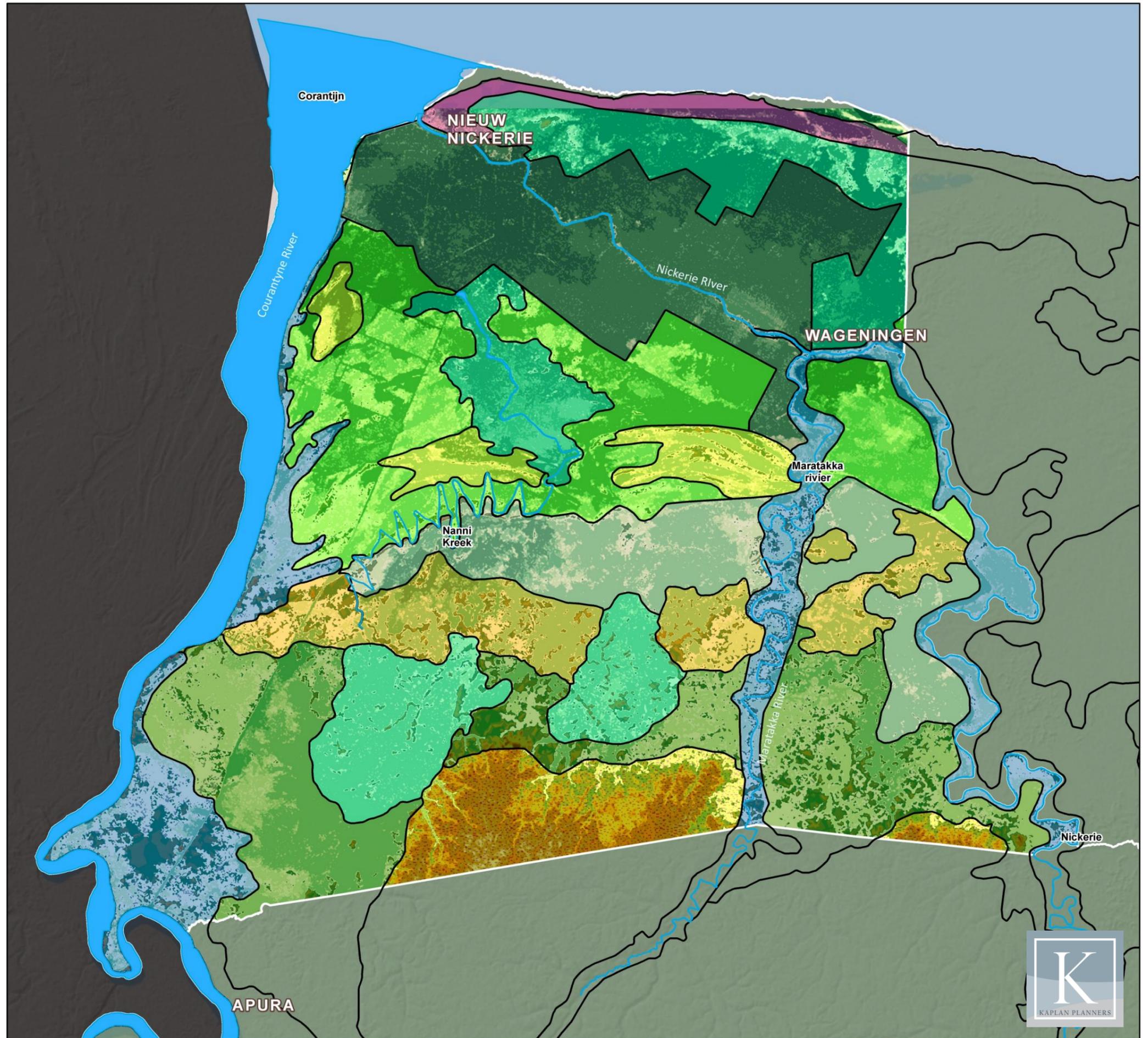
-  Old Marine Seaclay Flats (Para)
-  Old Sand Ridges (Lelydorp)

Cover (Dek)

-  Zanderij Savannah Belt 'Dek' (Sand)

Aluvium & Wetlands

-  Aluvium

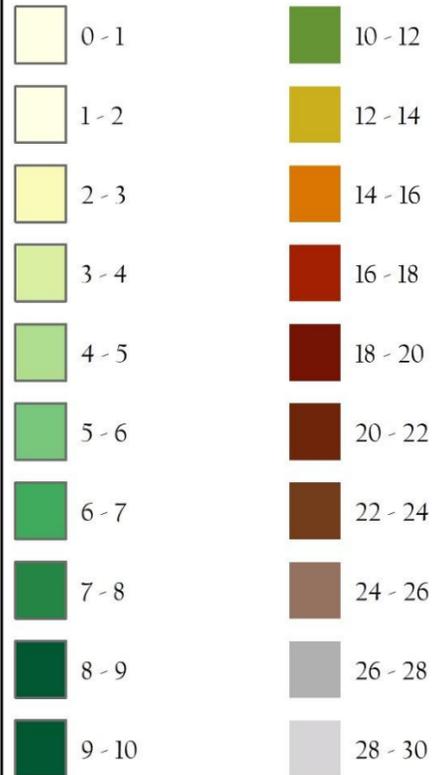




ELEVATION MAP

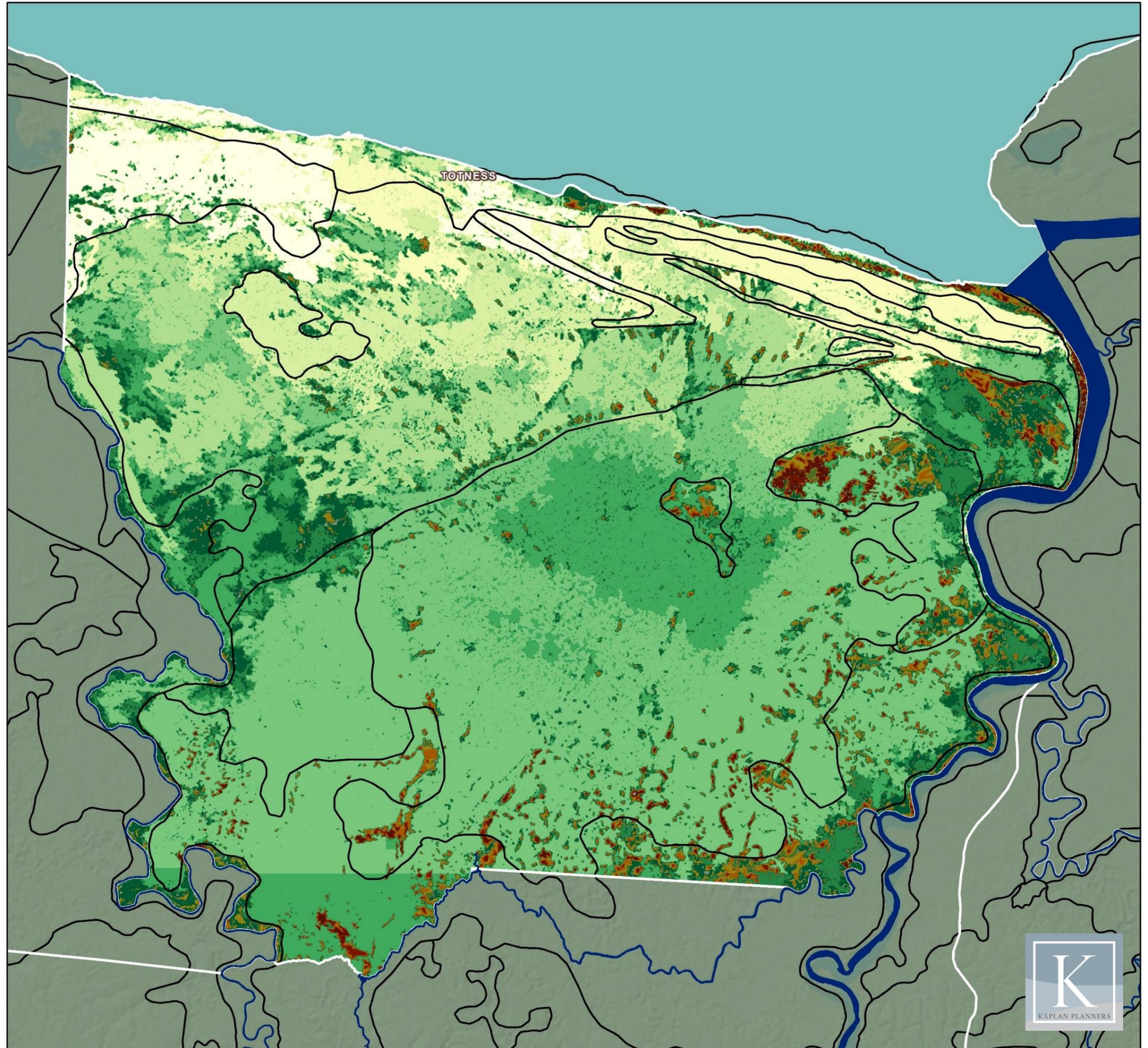
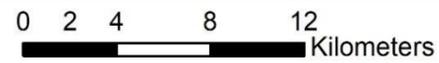
CORONIE DISTRICT

Elevation (m' above sea level)

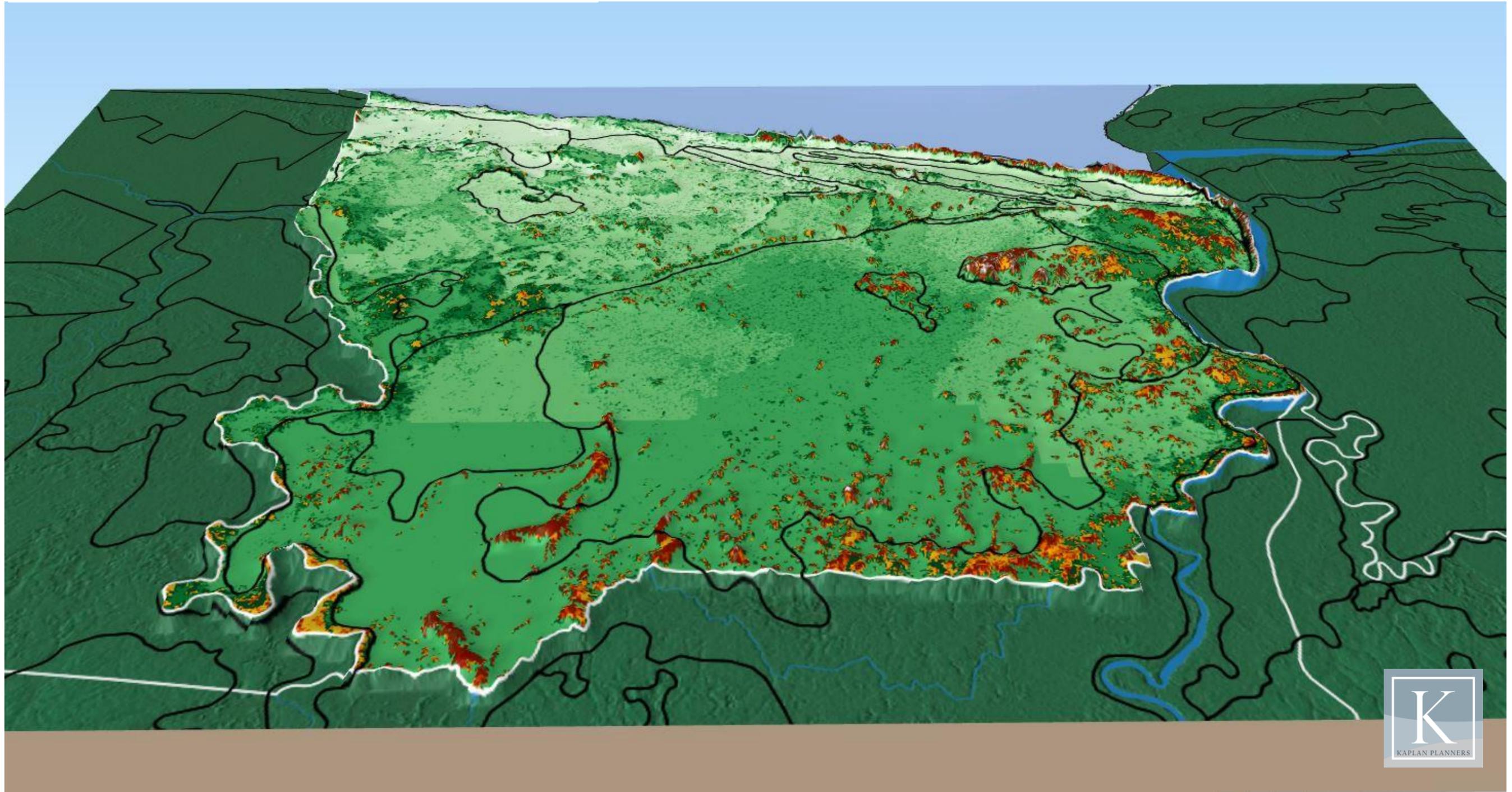


30 - 32

landscape Units



3D INTERPRETATION



LANDSCAPE UNIT MAP

CORONIE DISTRICT

Young Coastal Plain

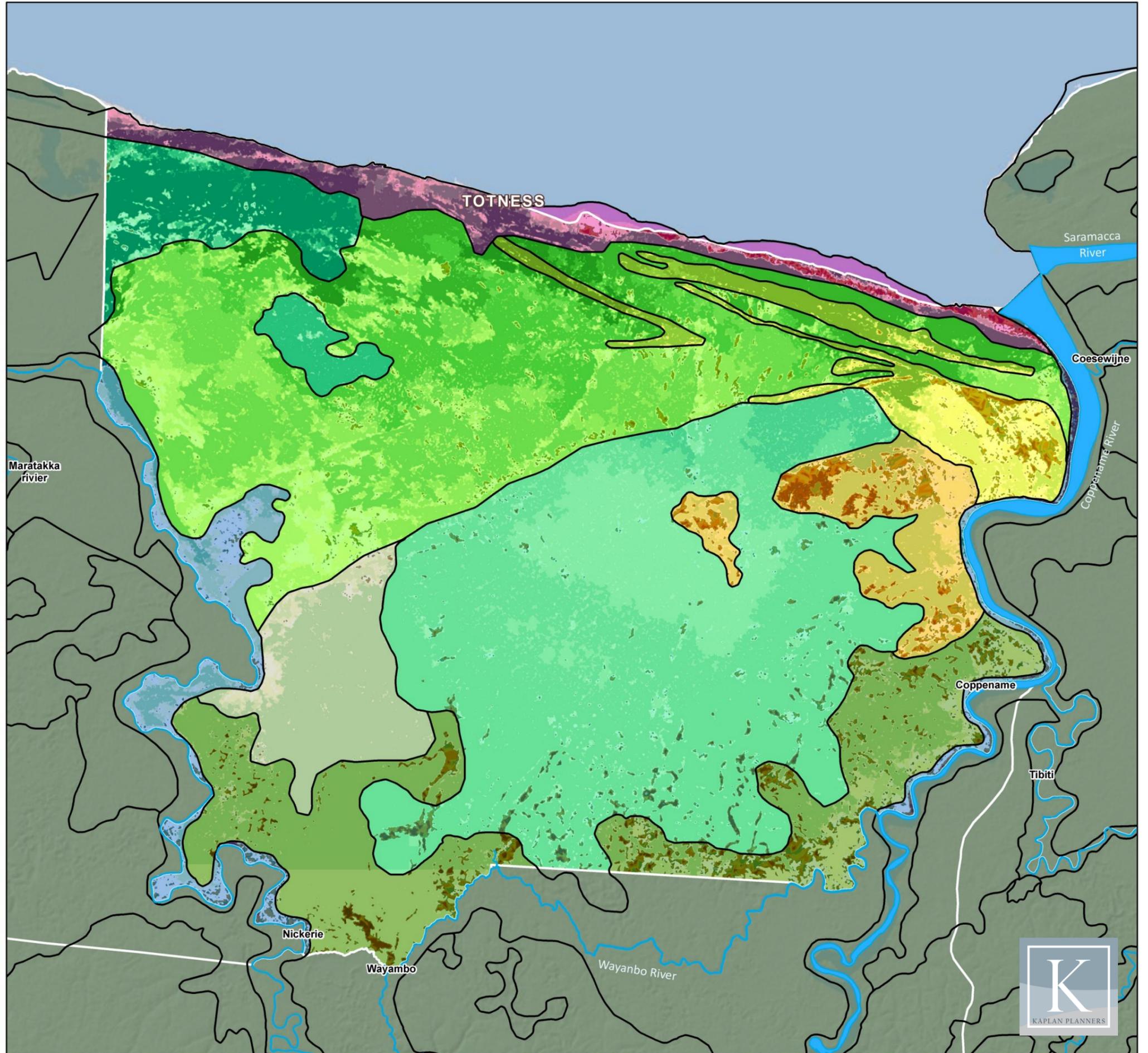
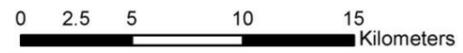
-  Saline To brackish Young Marine flats
Mangrove Belt (Coronie)
-  Young Marine Freshwater Flats
(Coronie)
-  Young Sand Ridges (Coronie)
-  Young freshwater Swamps
-  Young freshwater Peats (Mara)

Old Coastal Plain

-  Old Marine Seaclay Flats
(Para)
-  Old Sand Ridges (Lelydorp)

Aluvium & Wetlands

-  Aluvium



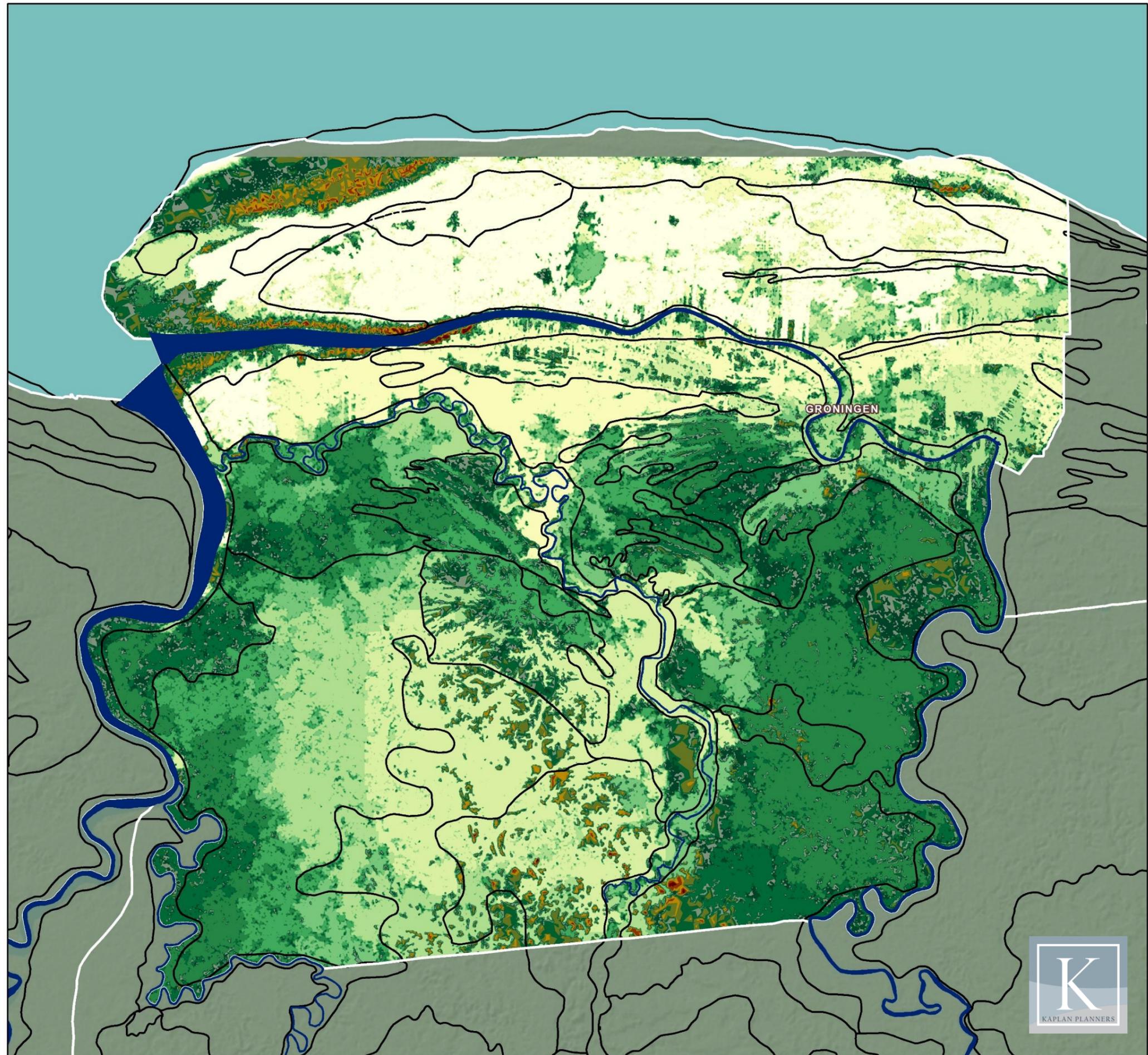
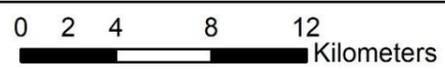
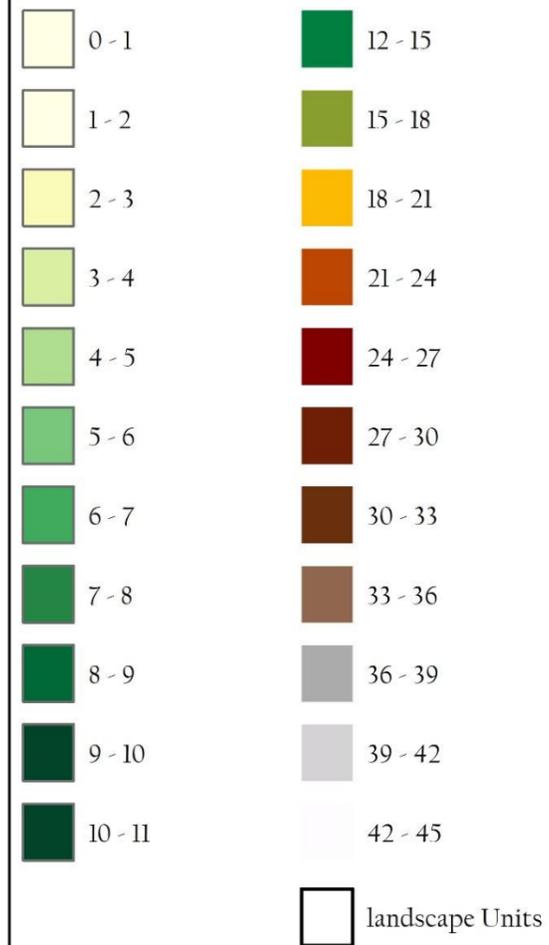


Saramacca District

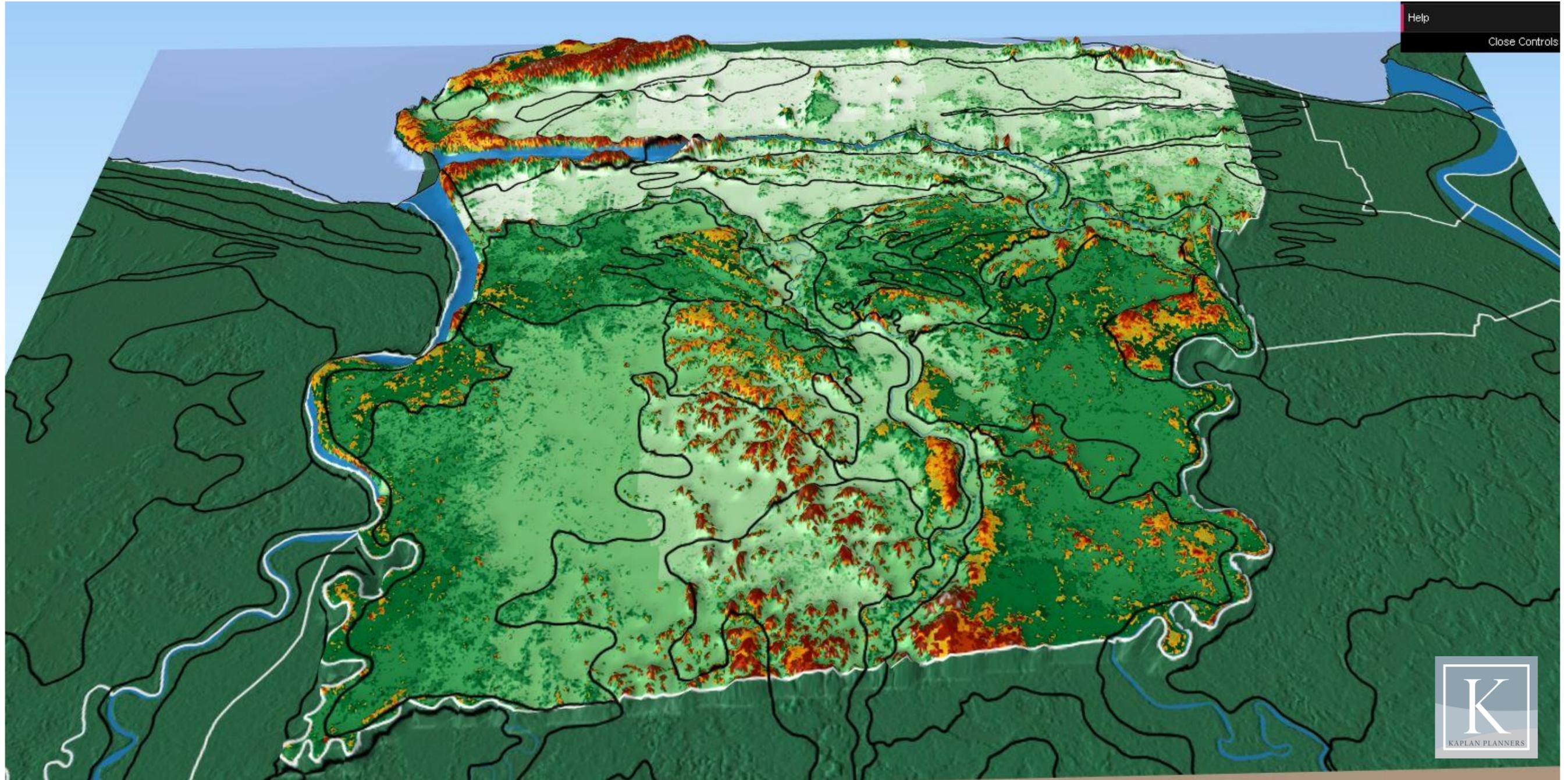
ELEVATION MAP

SARAMACCA DISTRICT

Elevation (m' above sea level)



3D INTERPRETATION



LANDSCAPE UNIT MAP

SARAMACCA DISTRICT

Young Coastal Plain

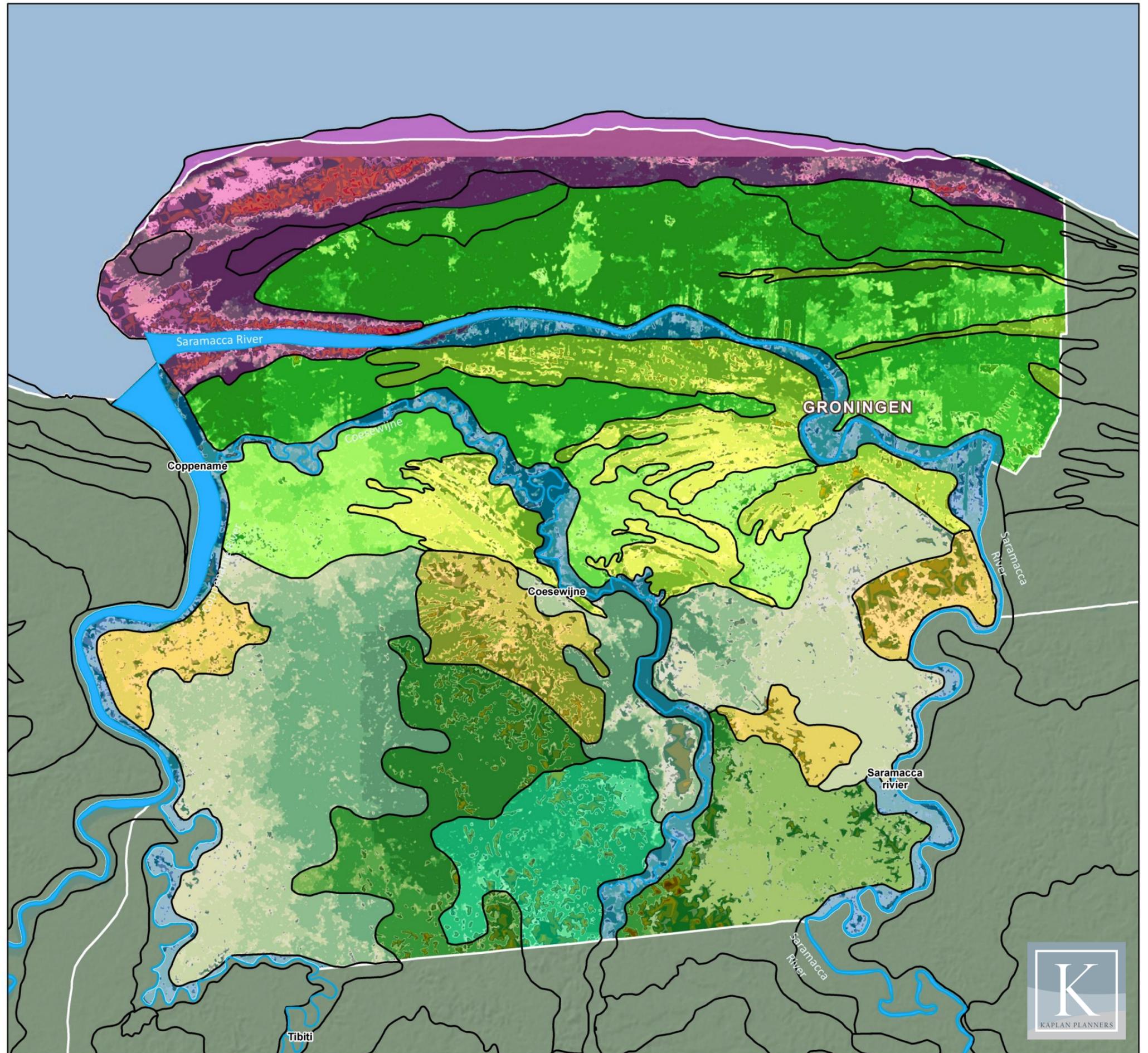
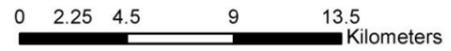
- Saline To brackish Young Marine flats
Mangrove Belt (Coronie)
- Young Marine Freshwater Flats
(Coronie)
- Young Sand Ridges (Coronie)
- Young freshwater Swamps
- Young freshwater Peats (Mara)

Old Coastal Plain

- Old Marine Seaclay Flats (Para)
- Old Sand Ridges (Lelydorp)

Aluvium & Wetlands

- Aluvium



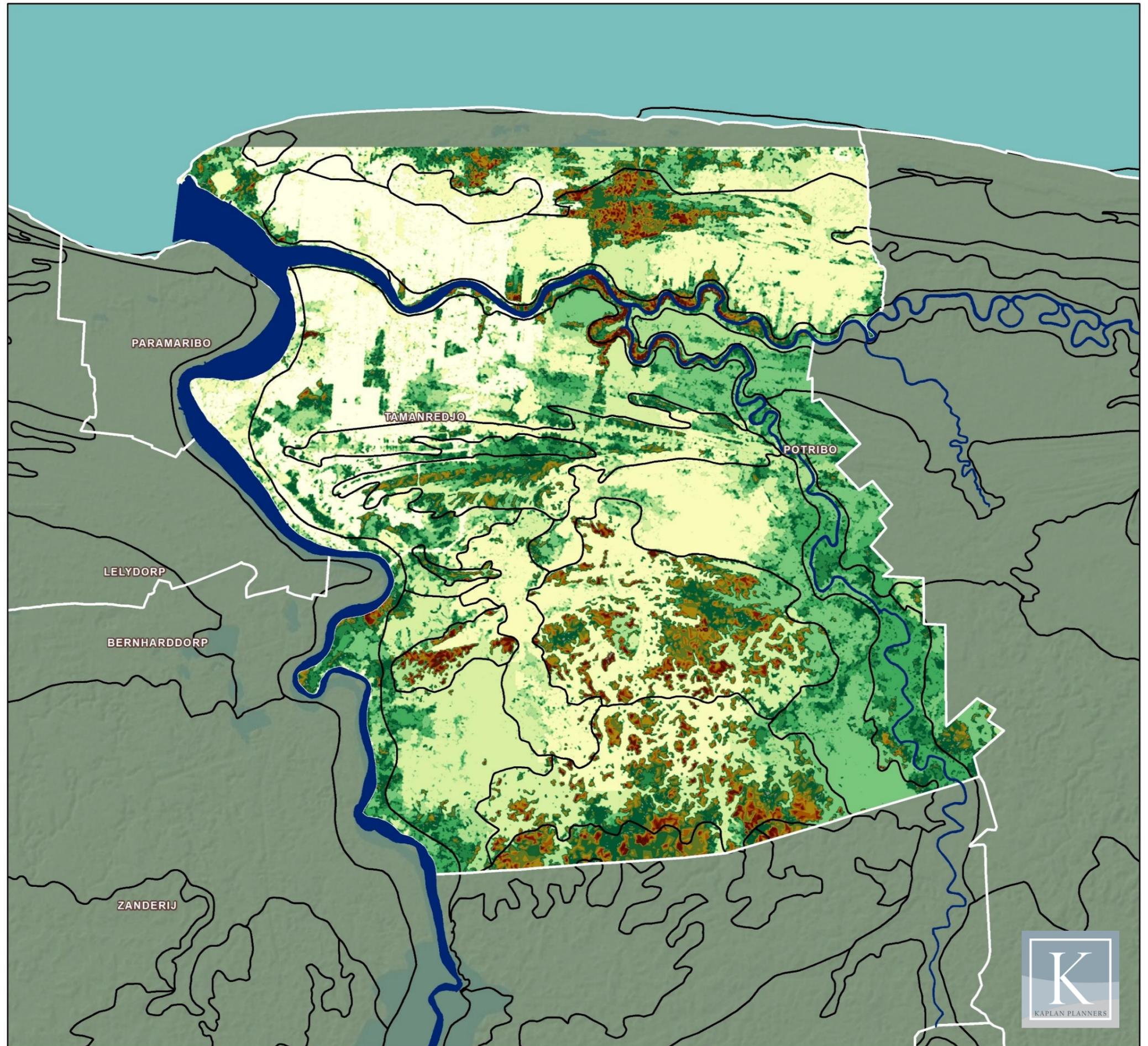
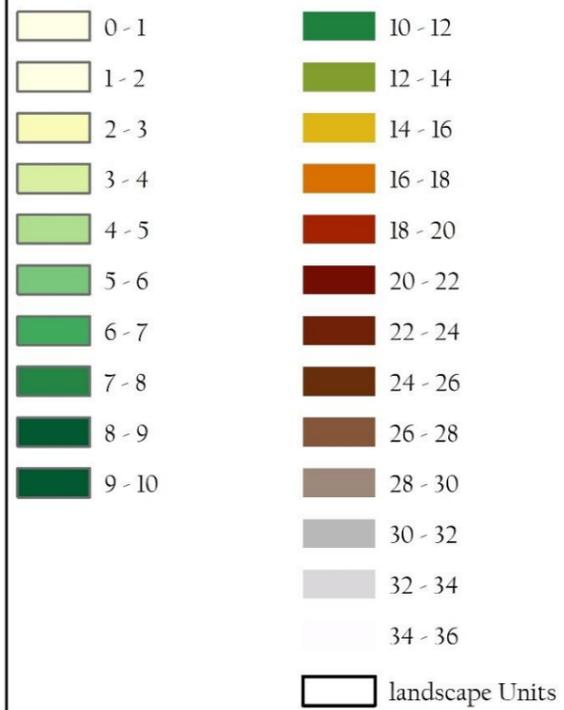


Commewijne District

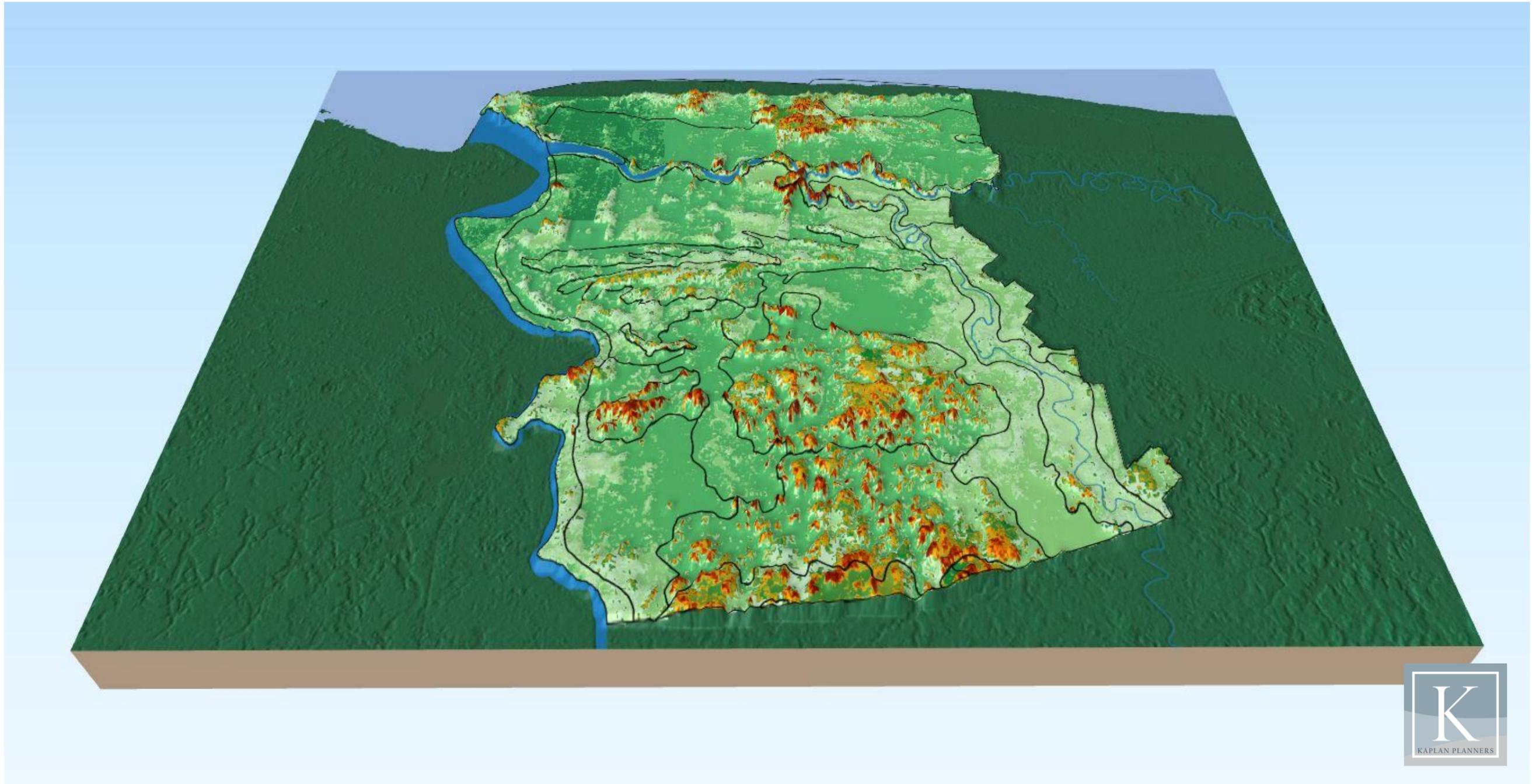
ELEVATION MAP

COMMEWIJNE DISTRICT

Elevation (m' above sea level)



3D INTERPRETATION



LANDSCAPE UNIT MAP

COMMEWIJNE DISTRICT

Young Coastal Plain

-  Saline To brackish Young Marine flats
Mangrove Belt (Coronie)
-  Young Marine Freshwater Flats
(Coronie)
-  Young Sand Ridges
(Coronie)
-  Young freshwater Peats (Mara)

Old Coastal Plain

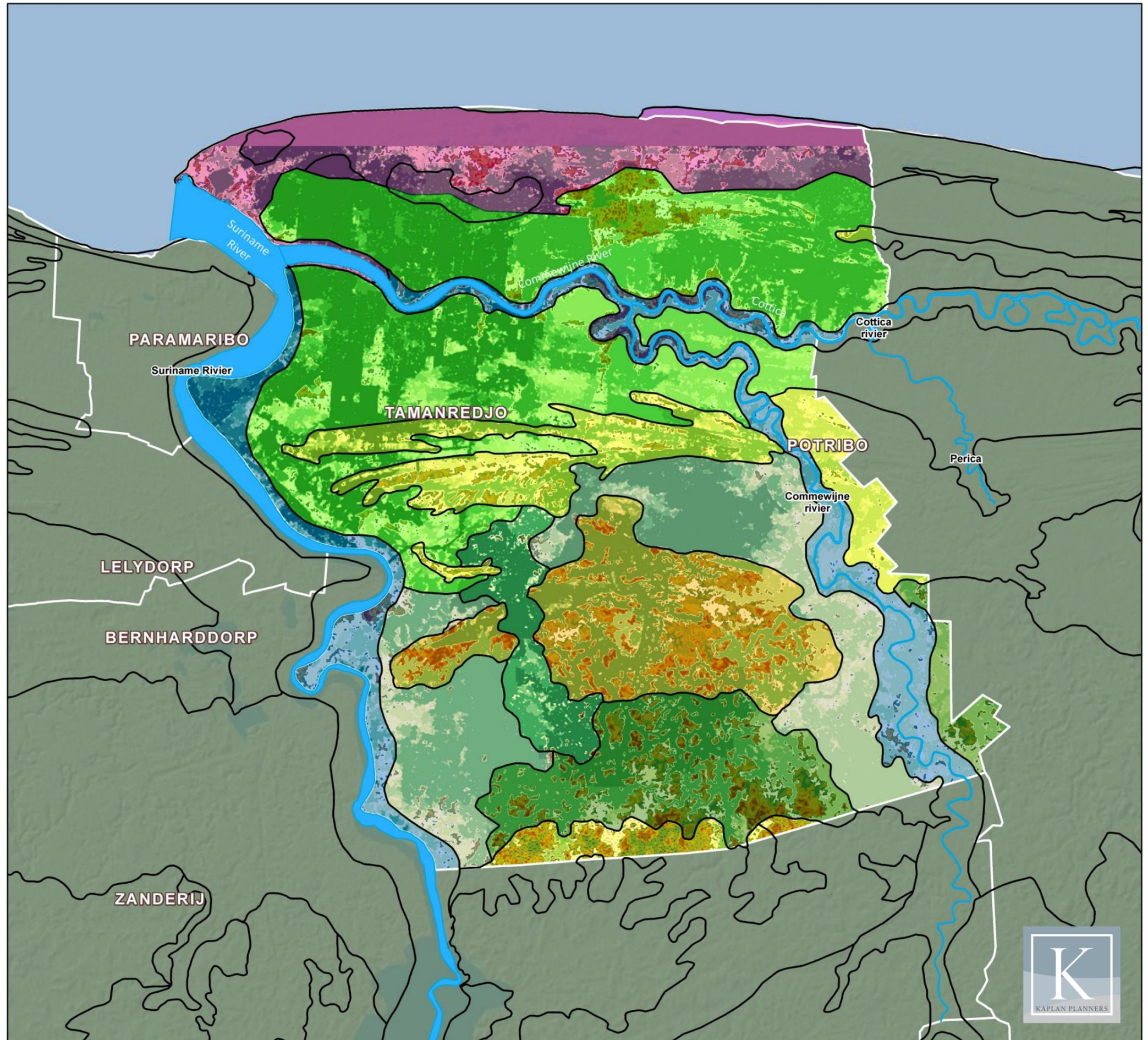
-  Old Marine Seaclay Flats (Para)
-  Old Sand Ridges (Lelydorp)

Cover (Dek)

-  Zanderij Savannah Belt
'Dek' (Sand)
-  Open Savannah (Coarse Sand)

Aluvium & Wetlands

-  Aluvium



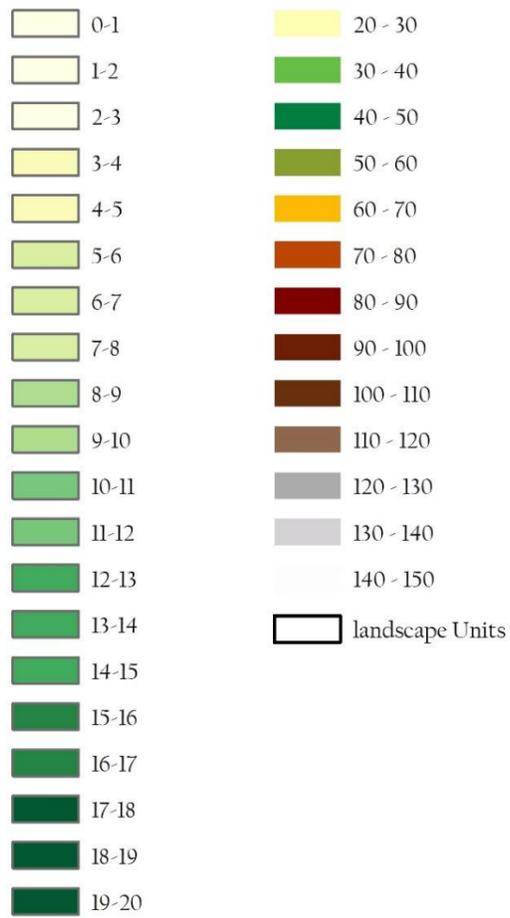


Marowijne District

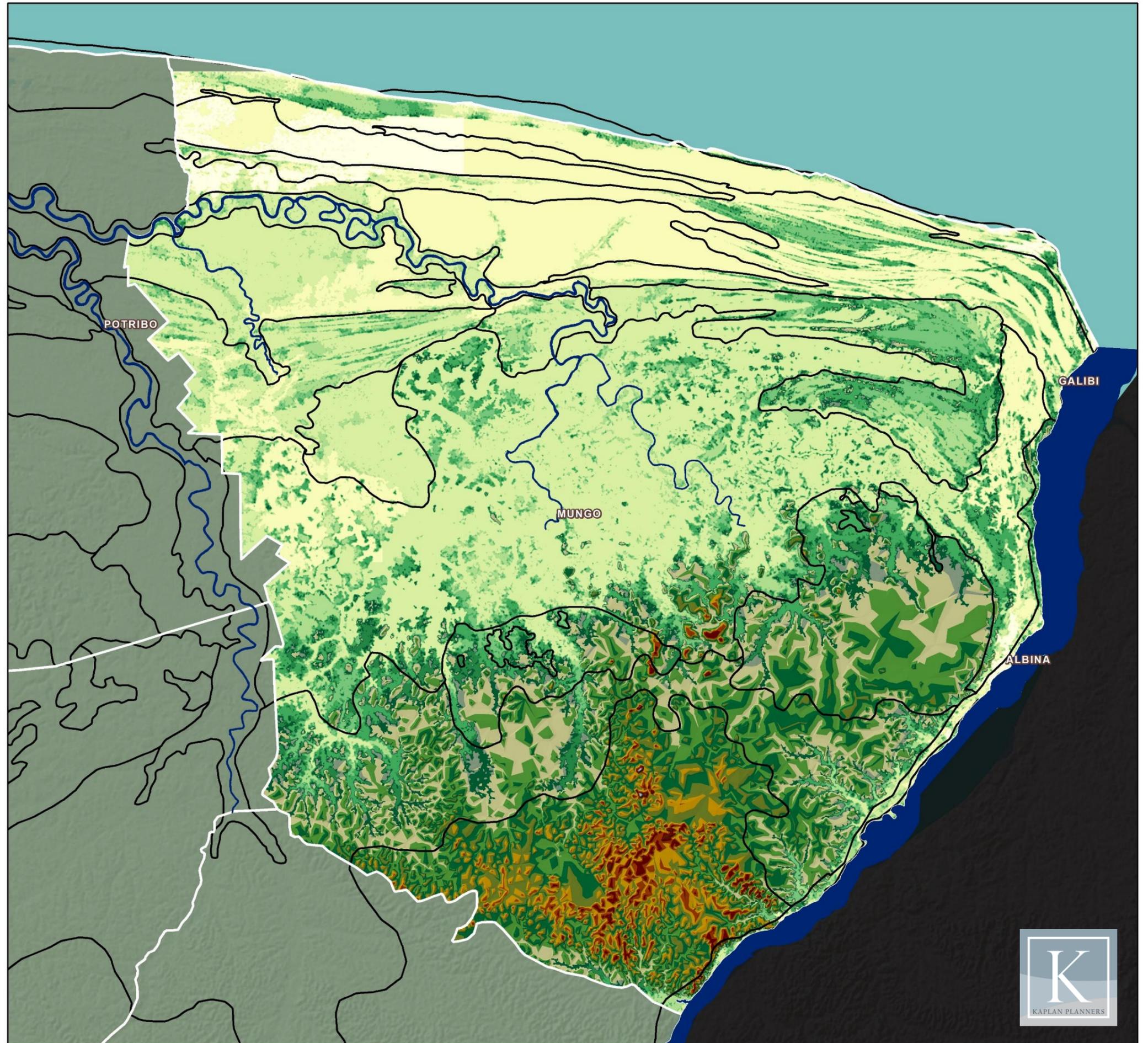
ELEVATION MAP

MAROWIJNE DISTRICT

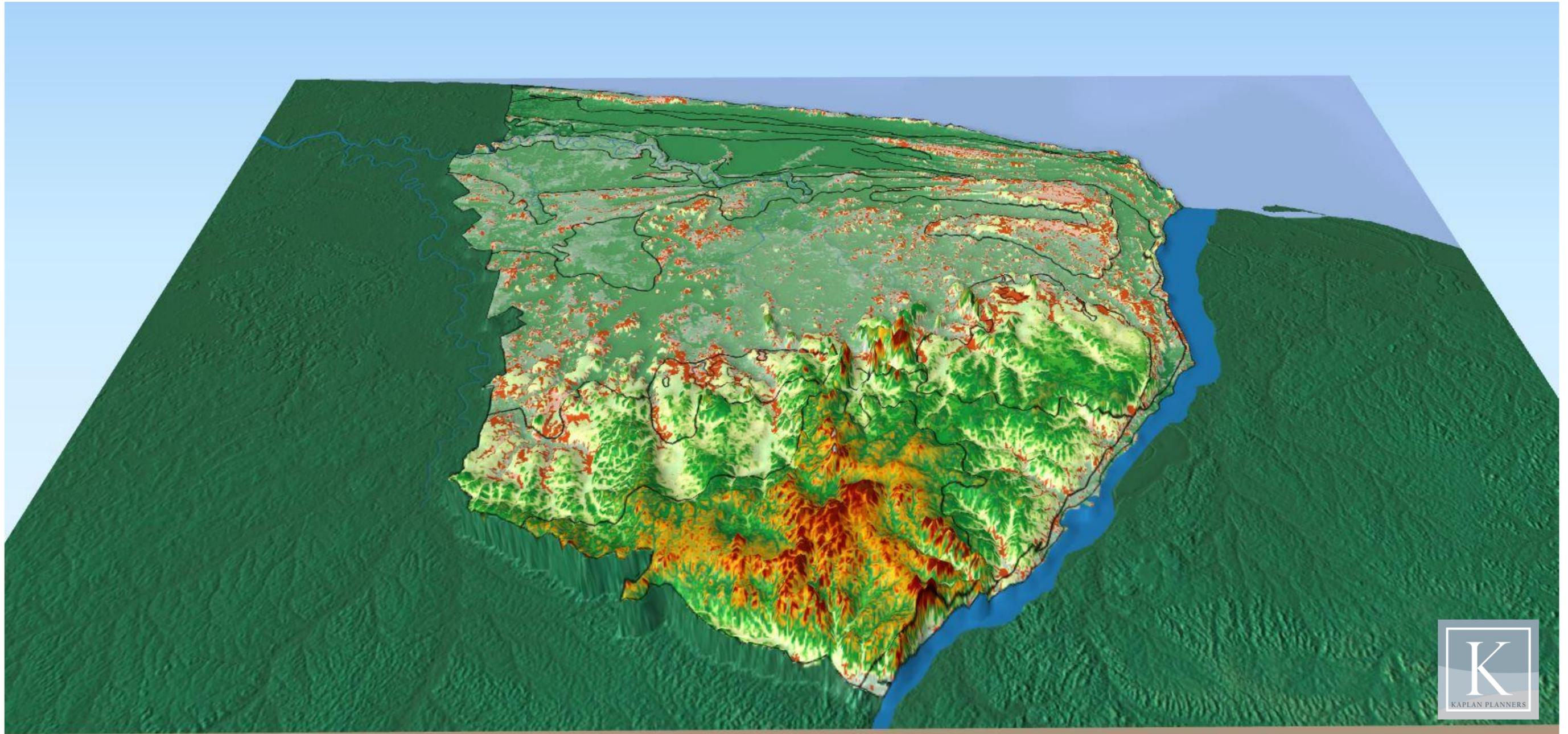
Elevation (m' above sea level)



0 2.25 4.5 9 13.5
Kilometers



3D INTERPRETATION



LANDSCAPE UNIT MAP

MAROWIJNE DISTRICT

Young Coastal Plain

-  Saline To brackish Young Marine flats
Mangrove Belt (Coronie)
-  Young Marine Freshwater Flats
(Coronie)
-  Young freshwater Peats (Mara)
-  Young Sand Ridges (Coronie)

Old Coastal Plain

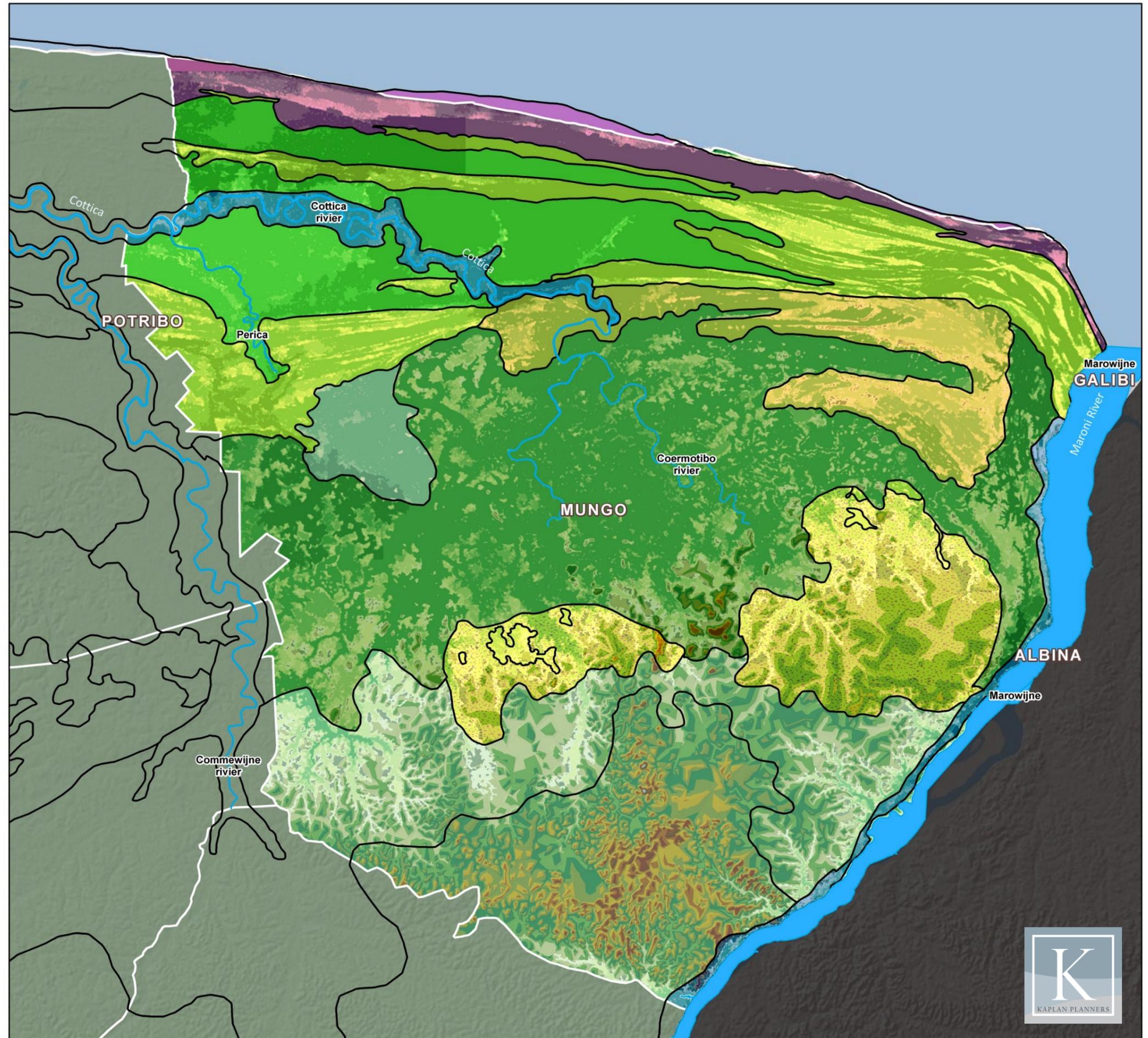
-  Old Marine Seaclay Flats (Para)
-  Old Sand Ridges (Lelydorp)

Cover (Dek)

-  Zanderij Savannah Belt
'Dek' (Sand)
-  Open Savannah (Coarse Sand)

Aluvium & Wetlands

-  Aluvium
-  Great Rivers Valleys and lowlands
South to Cover - 'Dek' (10-50 m)

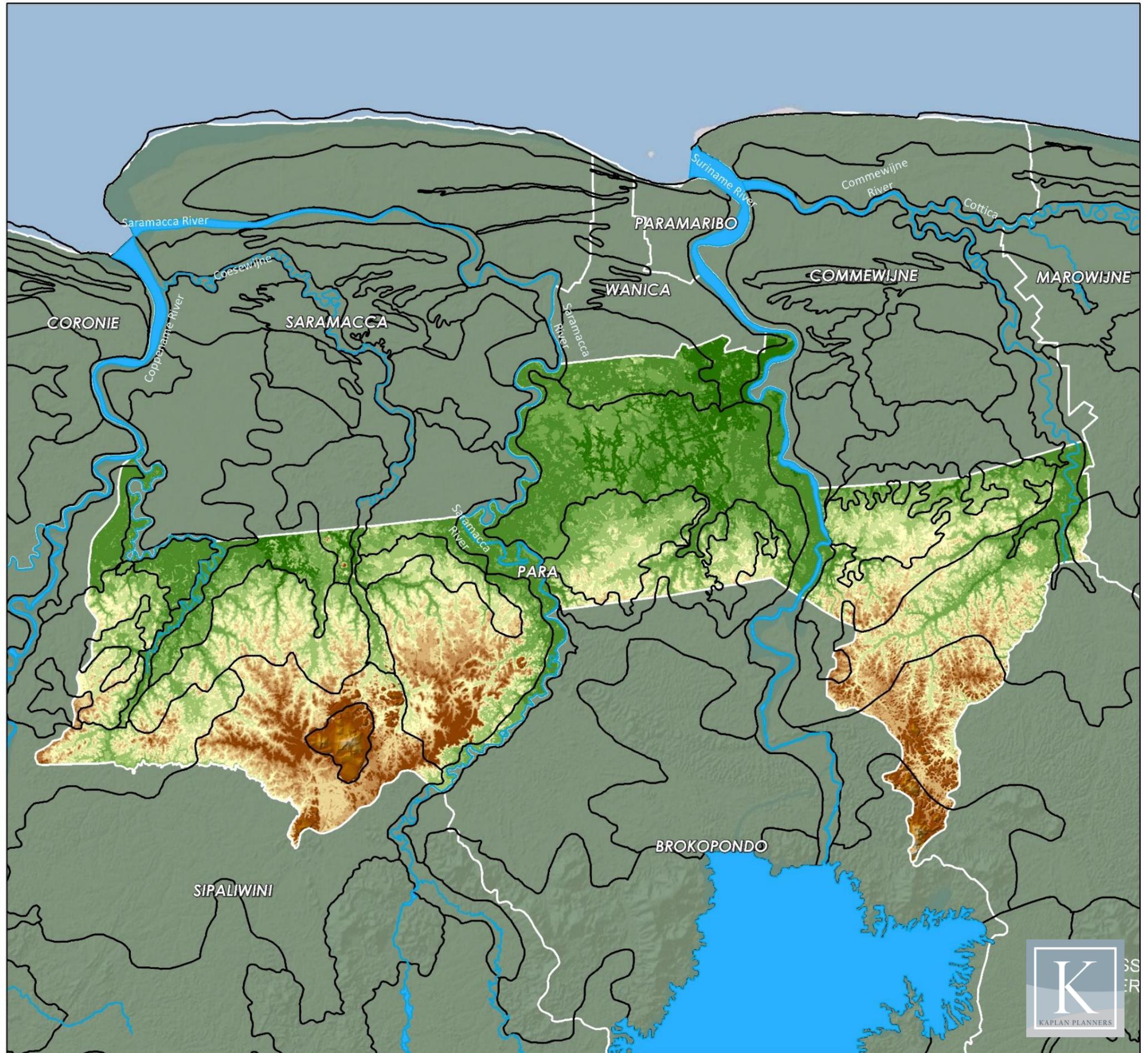
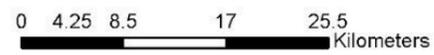
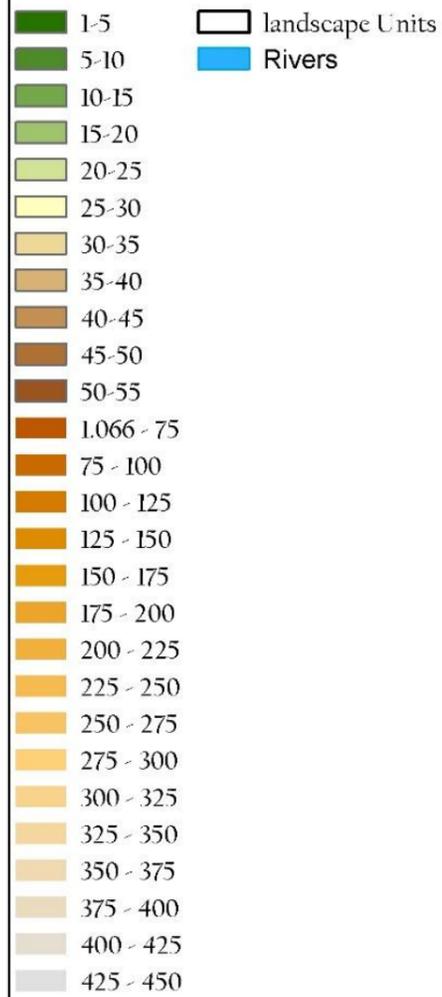




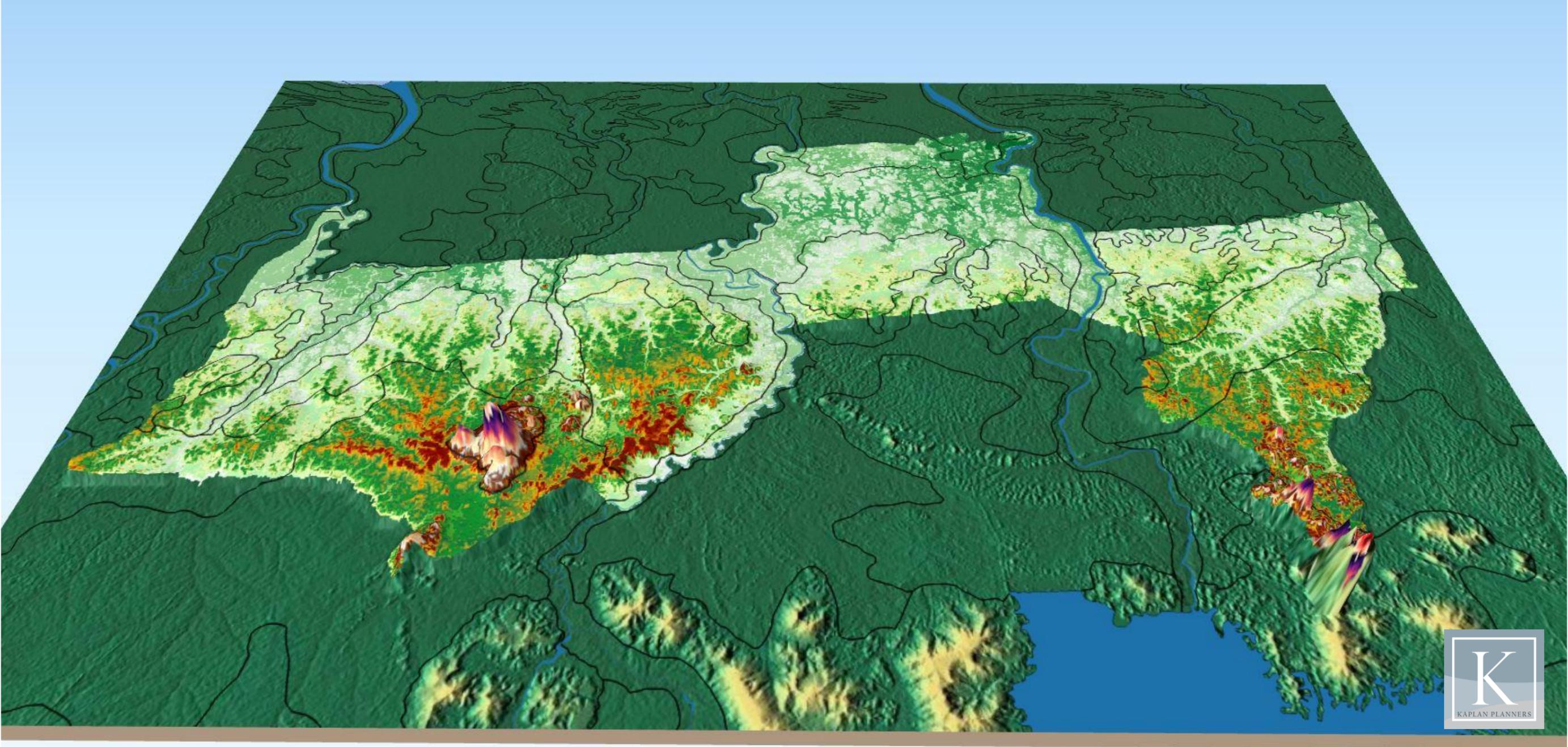
ELEVATION MAP

PARA DISTRICT

Elevation (meters above sea level)



3D INTERPRETATION



LANDSCAPE UNIT MAP

PARA DISTRICT

Young Coastal Plain

-  Young Sand Ridges (Coronie)
-  Young freshwater Swamps
-  Young freshwater Peats (Mara)

Old Coastal Plain

-  Old Marine Seaclay Flats (Para)
-  Old Sand Ridges (Lelydorp)

Cover (Dek)

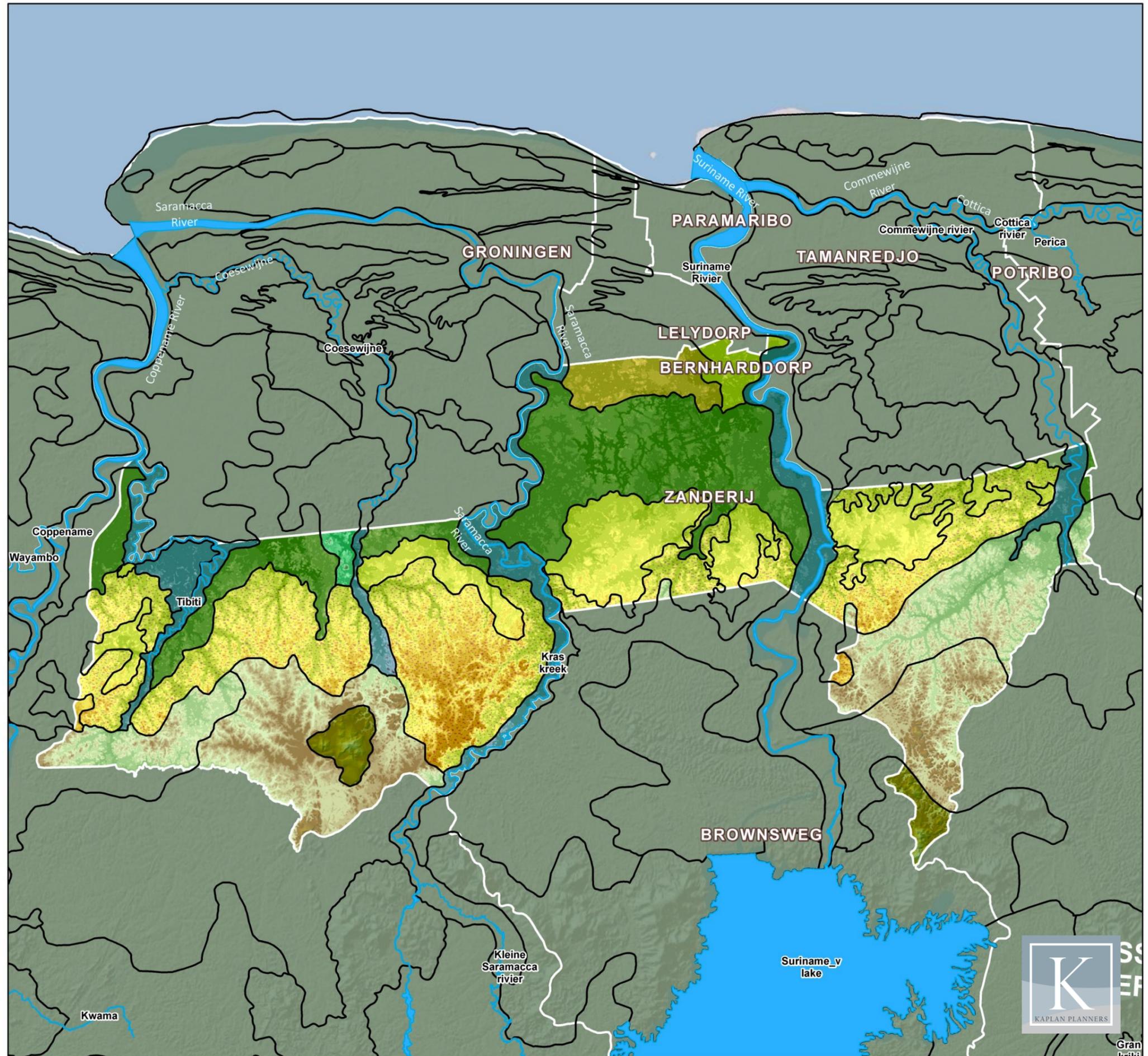
-  Zanderij Savannah Belt - 'Dek' (Sand)
-  Open Savannah (Coarse Sand)

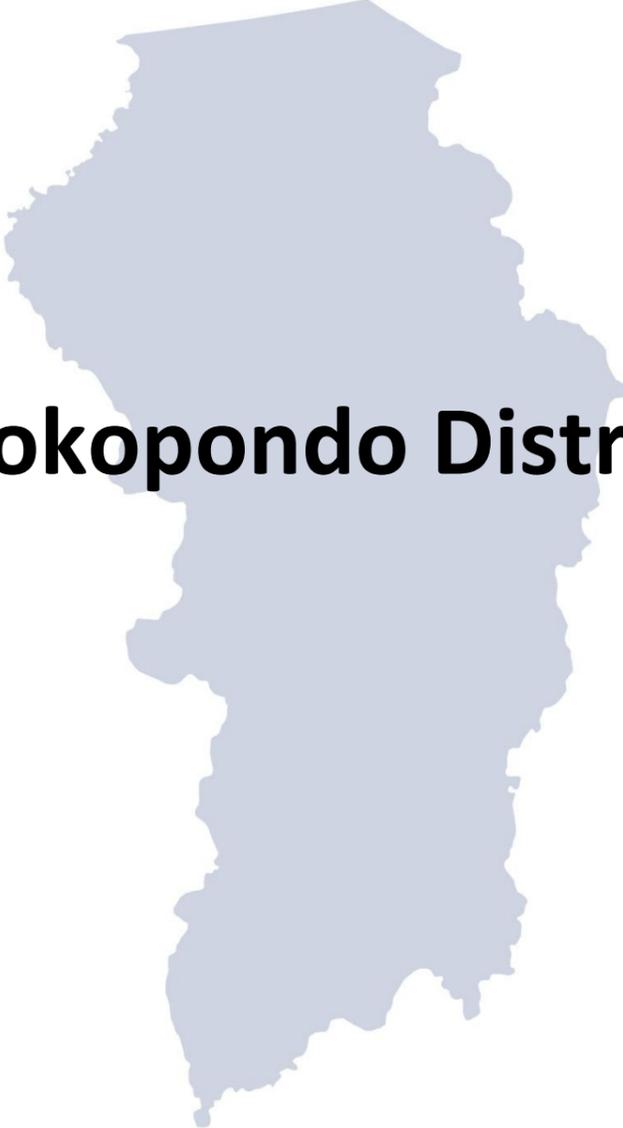
Greenstone Belt

-  Greenstone Belt Mountains

Aluvium & Wetlands

-  Aluvium
-  Great Rivers Valleys and lowlands South to Cover-'Dek' (10-50 m)

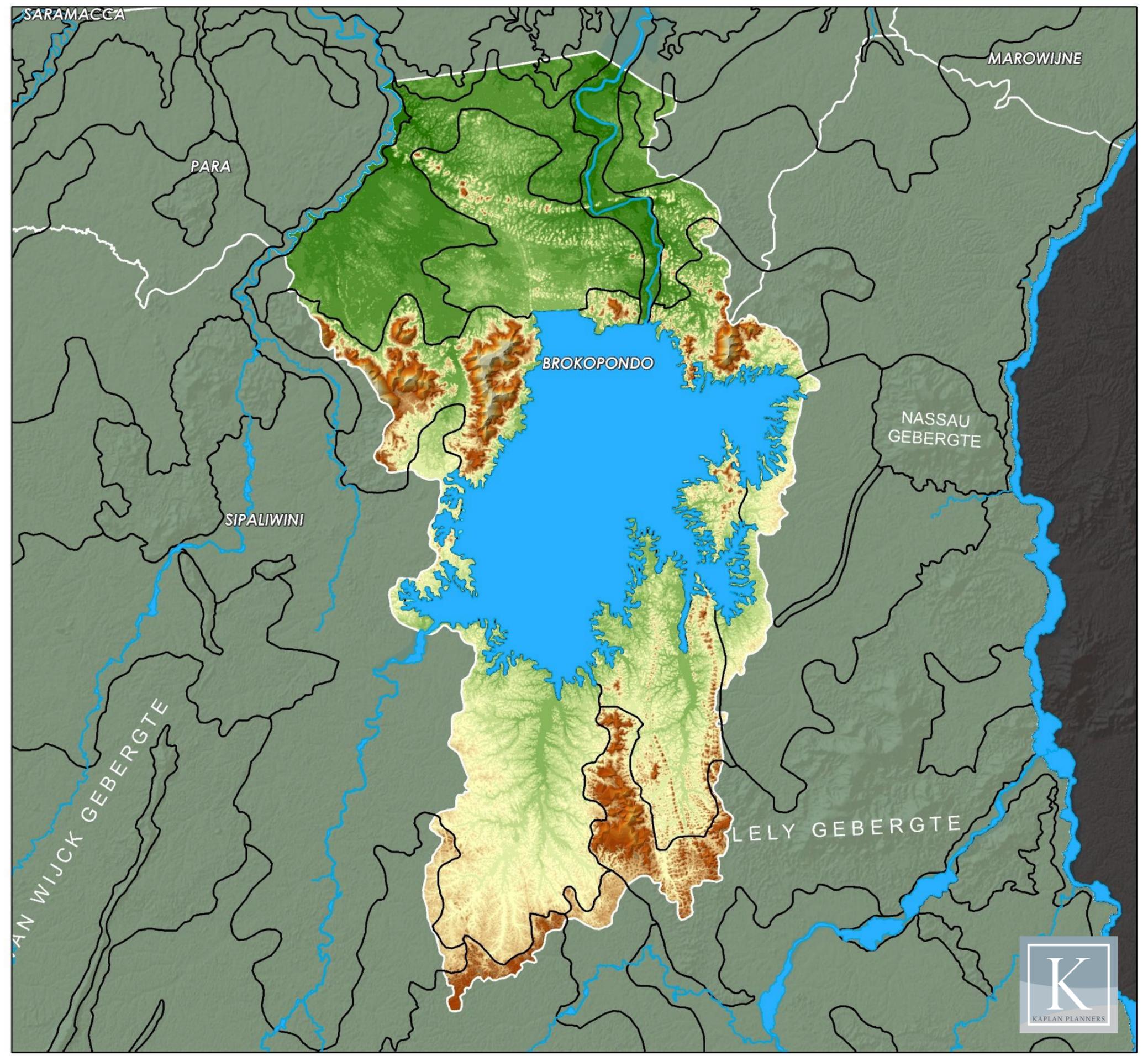
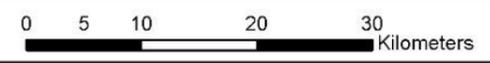
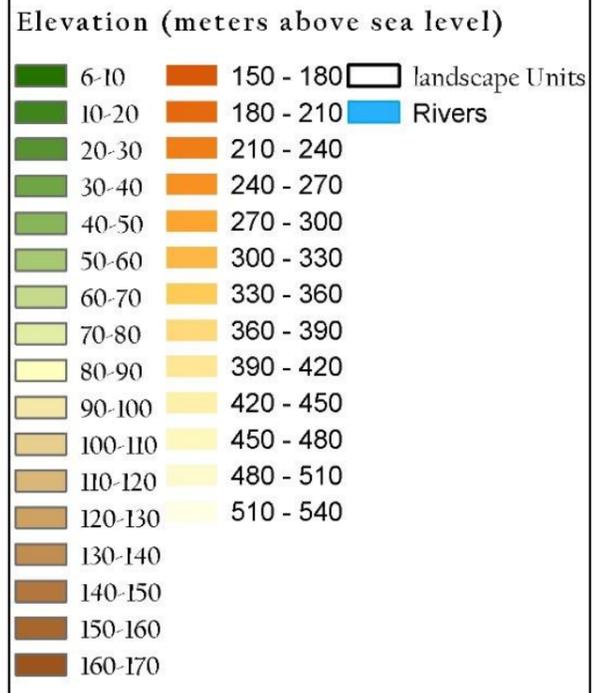




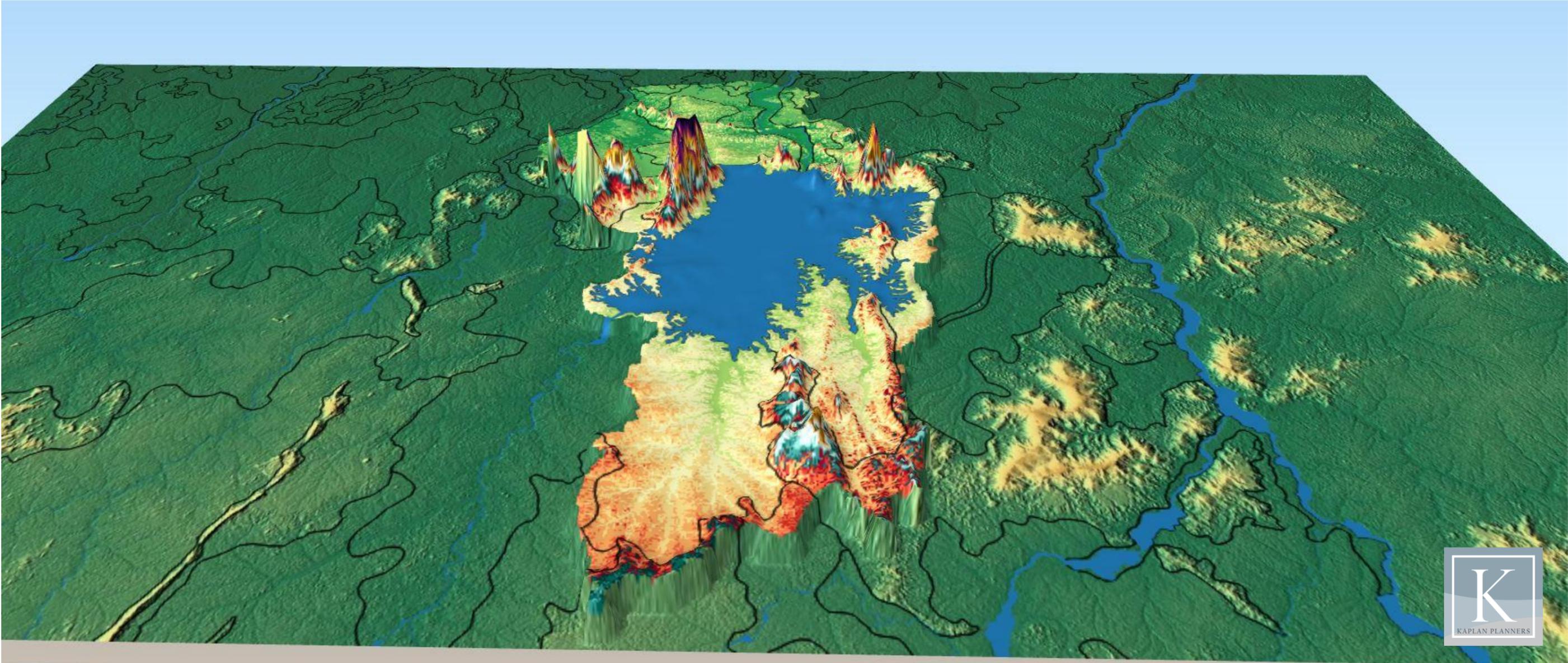
Brokopondo District

ELEVATION MAP

BROKOPONDO DISTRICT



3D INTERPRETATION



LANDSCAPE UNIT MAP

BROKOPONDO DISTRICT

Cover (Dek)

-  Zanderij Savannah Belt - 'Dek' (Sand)
-  Open Savannah (Coarse Sand)

Greenstone Belt

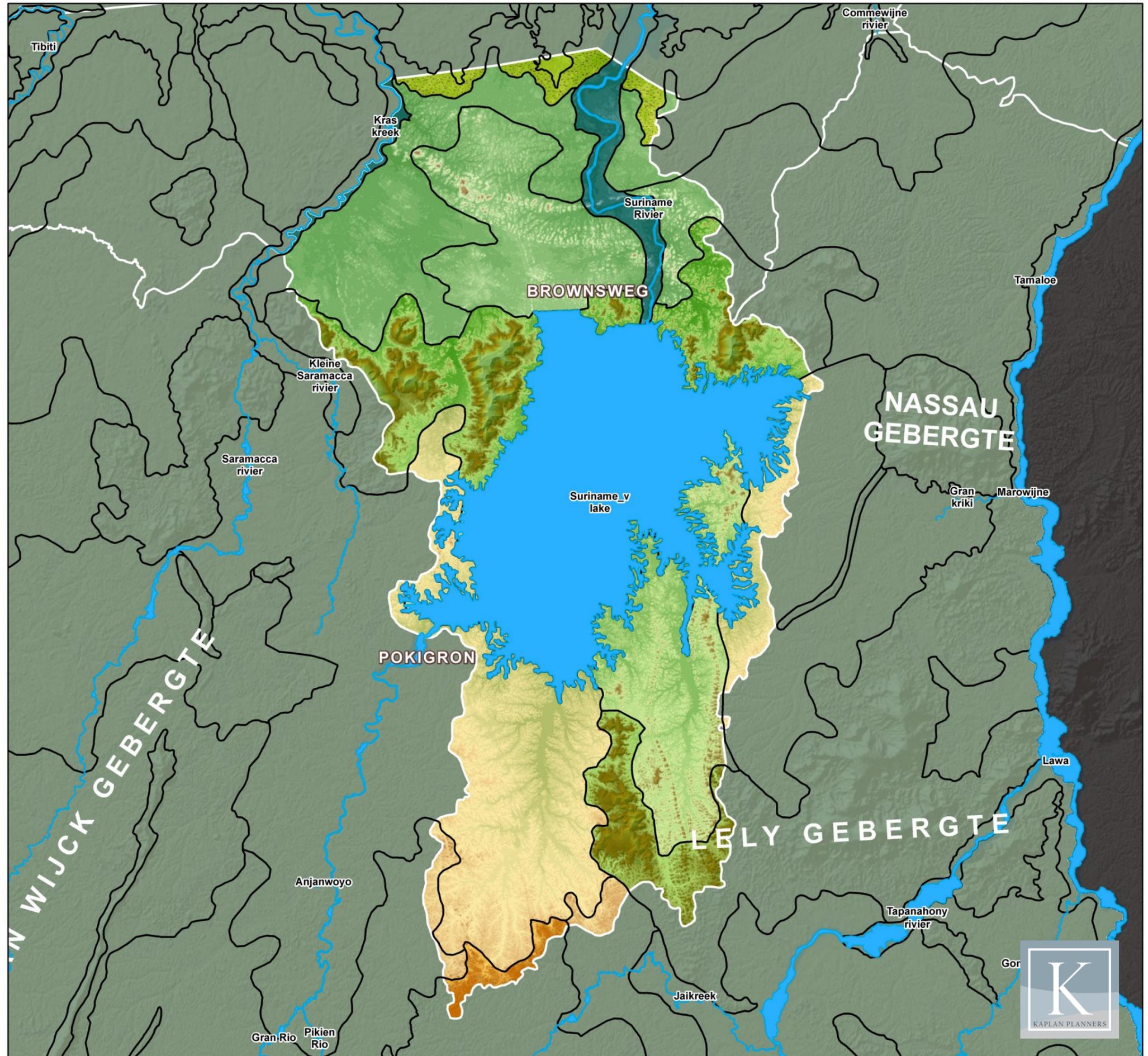
-  Greenstone Belt Mountains
-  Greenstone Slopes

Hills and Slopes

-  Low Undulating Hills (150-200 m)
-  Sub Interior and Interior River Slopes (50-150 m)

Aluvium & Wetlands

-  Aluvium
-  Great Rivers Valleys and lowlands South to Cover-'Dek' (10-50 m)



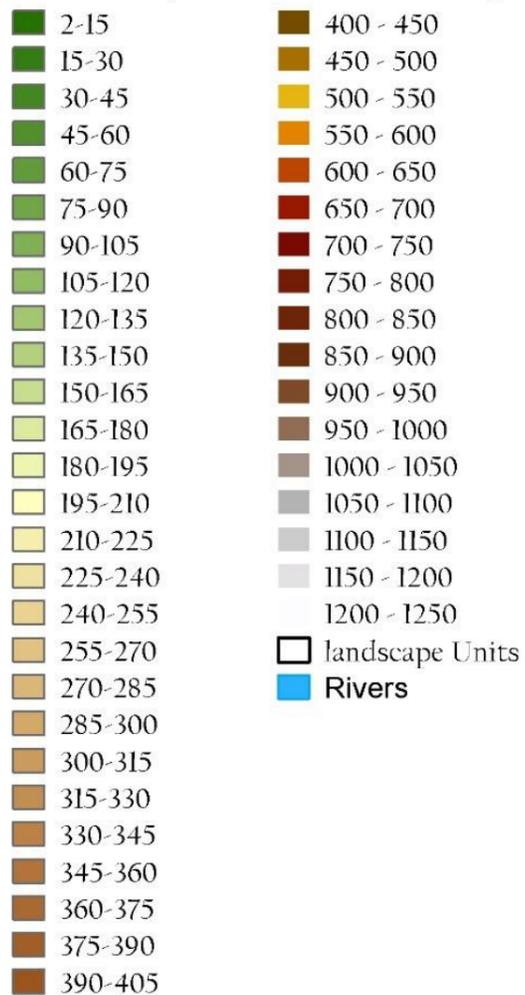


Sipaliwini District

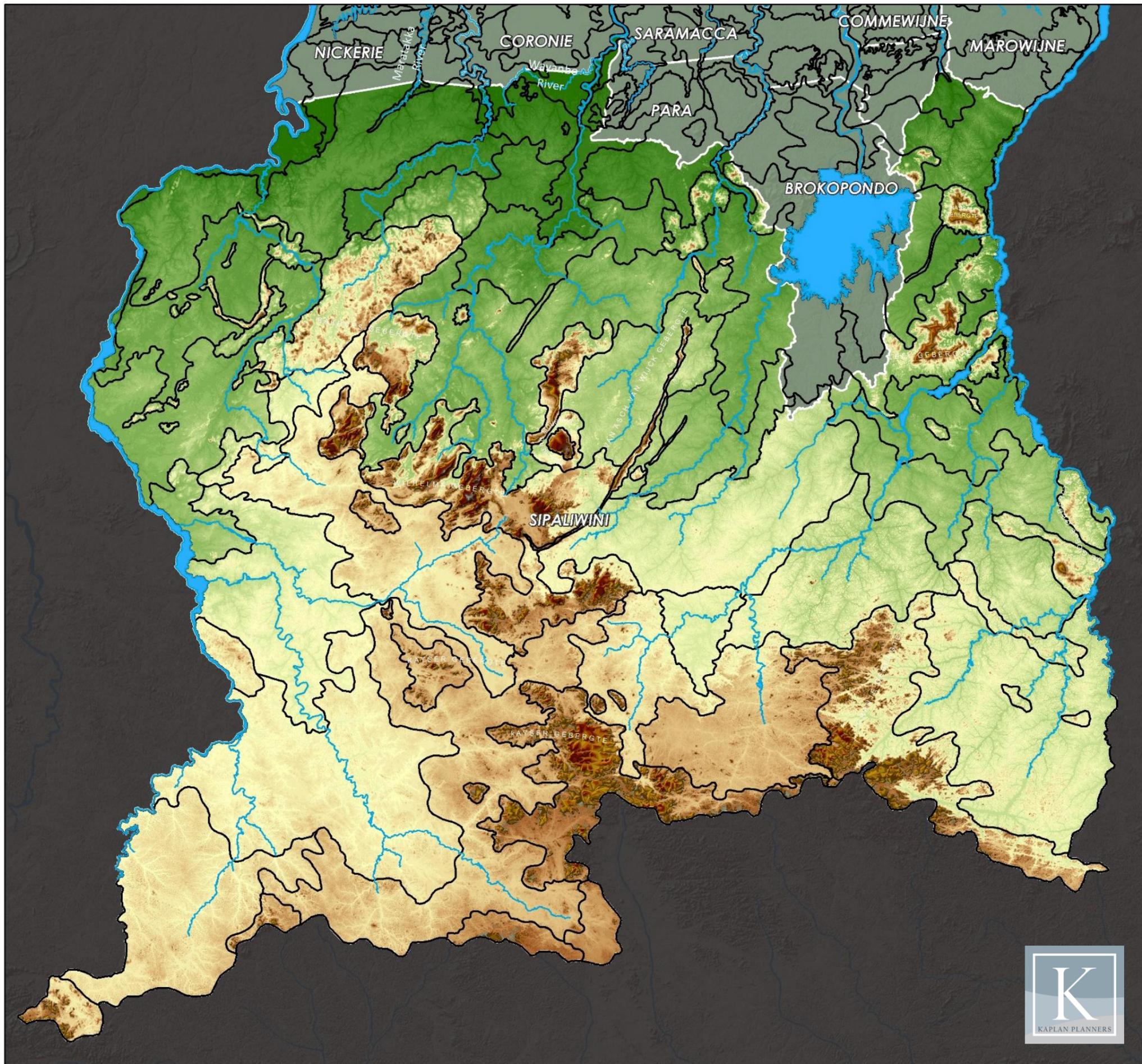
ELEVATION MAP

SIPALIWINI DISTRICT

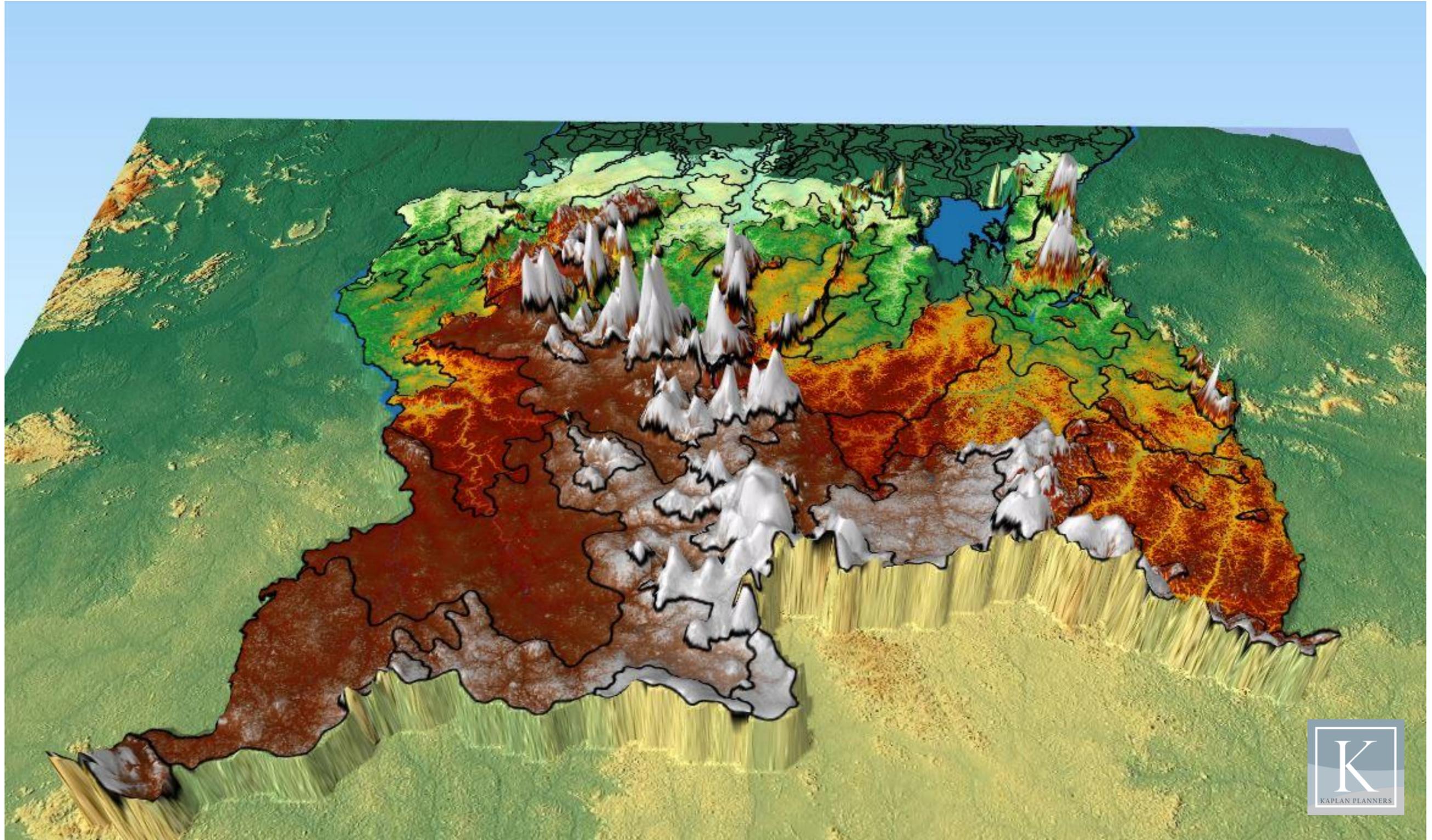
Elevation (meters above sea level)



0 12.5 25 50 75 Kilometers



3D INTERPRETATION



BIOLOGICAL ANALYSIS: TREE COVER & NPP

SERIES OF BIOLOGICAL MAPS: GBIF, NPP, RIBOT

MODIS Vegetation Continuous Field (VCF)

The mapping of tree cover in Suriname for the CCCD Project was carried out using the MODIS Vegetation Continuous Fields (VCF) product. The VCF is a global representation of the Earth's surface as gradations of three components of ground cover: percent of tree cover, percent of non-tree vegetation cover and percent of bare soil. The VCF has a spatial resolution of 250 meters. Out of the three VCF sub-products, only the tree cover mapping has been used.

Suriname's tree cover estimate shows high tree cover of more than 70% in the western part of the country, around the Lucie and the Coeroeni Rivers, west of the main mountain ridge. Whereas the eastern part of the country and especially around the Upper Suriname and the Saramacca Rivers contains areas with lower tree cover – around 50%. The northern part of Suriname, where the majority of population is found, is characterized by areas with low tree cover. These include the metropolitan area of Paramaribo; swamps scattered along the northern part of the country, and agricultural plots and especially rice cultivation lands in the northwestern part along the coastline. The savanna area in the south of Suriname, on the border with Brazil, also demonstrates very low tree cover.

MODIS Net Primary Productivity

Net Primary Productivity (NPP) defines the rate at which all plants in an ecosystem produce net useful chemical energy. In other words, NPP is equal to the difference between the rate at which plants in an ecosystem produce useful chemical energy (or GPP), and the rate at which they spend some of that energy for respiration.

This product and analysis **only relate to live plants and not the whole ecosystem.**

NPP values in Suriname: High values were found west of the main mountain ridge in the Zand, Kabalebo, Lucie and the Coeroeni River basins, and relatively high NPP values east of the main mountain ridge in the Paloemeu, Tapanahony and Suriname River basins. Lower NPP values were found on top of the main mountain ridge and the plateaus in the southeast and northwest of the country. The NPP values along the northern savanna are also lower than in the interior. The lowest NPP values were found in the metropolitan area of Paramaribo, swampy areas and agricultural areas in the northern part of Suriname, and in the savannah in the southern part of Suriname. These findings corroborate well with the VCF tree cover map.

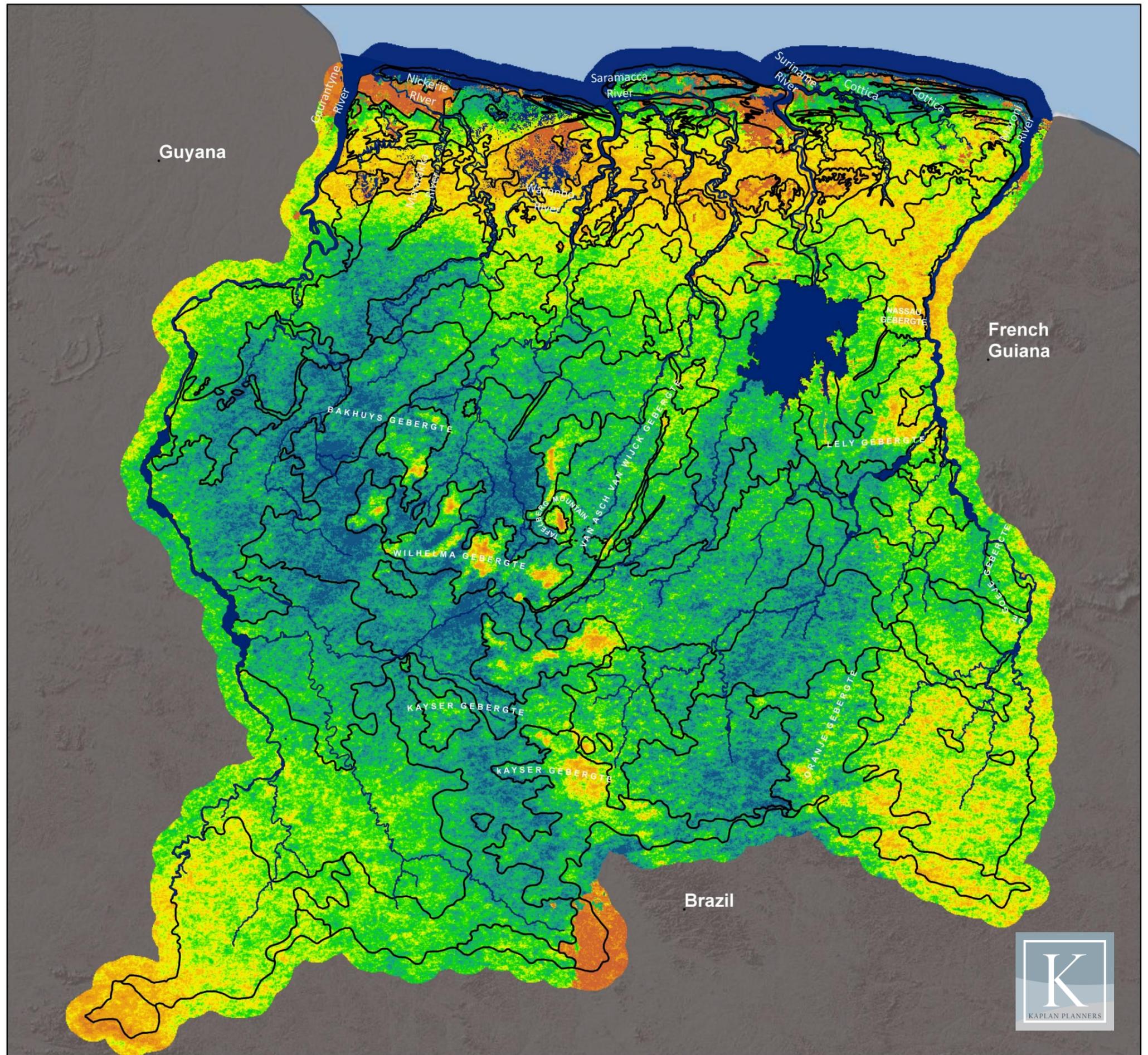
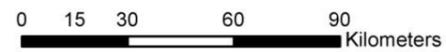
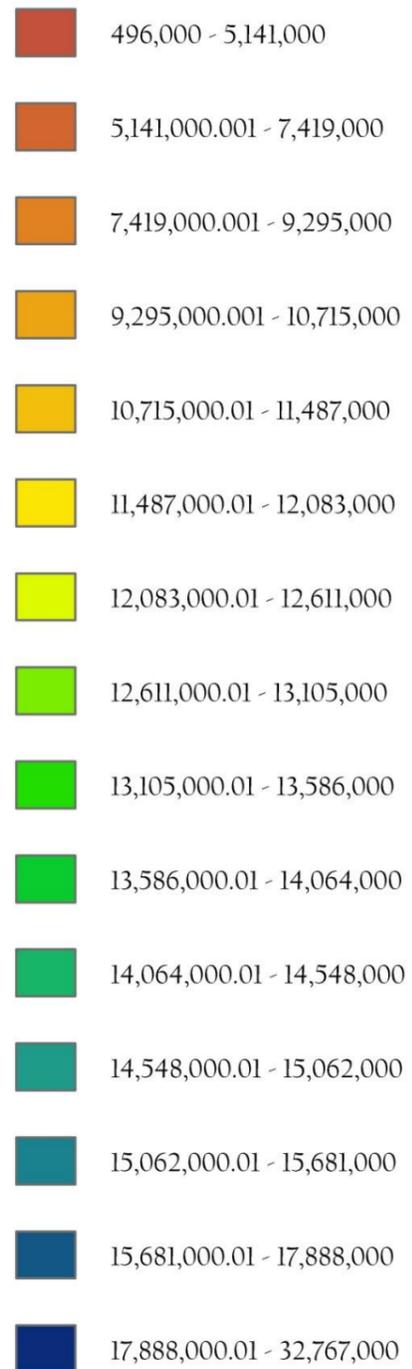
Vegetation formations map

Combining the NPP with the tree cover map and differentiating between flat lands, (less than 3% slope) and higher slopes enabled us to create a vegetation formation map. The map shows areas with high, medium and low productivity and several categories of tree cover: No tree cover; Low tree cover; Medium tree cover; High tree cover and Very high tree cover. Combining these three parameters and their different sub-categories enable us to differentiate between the different vegetation formations in Suriname. The vegetation formation map is additionally presented below divided into the individual districts.

VEGETATION DATA MAP

NATIONAL EXTENT

NPP



COVER TREE DATA

NATIONAL EXTENT

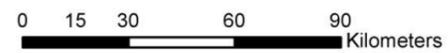
Cover Tree & NPP Correlated by Slope

Extreme To Stip Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
- 12,088 - medium productivity, high tree cover
- 14,345 - high productivity, medium tree cover
- 14,367 - high productivity, high tree cover
- 14,388 - high productivity, very high tree cover
- 17,945 - very high productivity, medium tree cover
- 17,967 - very high productivity, high tree cover
- 17,988 - very high productivity, very high tree cover
- 33,010 - no vegetation - Built area

Moderate To Mild Slope

- 300,000 - water
- 309,810 - flat area, low prod, no trees
- 309,845 - flat, low prod, medium tree cover
- 312,045 - flat, med prod, med tree cover
- 312,067 - flat, med prod, high tree cover
- 312,088 - flat, med prod, very high tree cover
- 314,345 - flat, high prod, med tree cover
- 314,367 - flat, high prod, high tree cover
- 314,388 - flat, high prod, very high tree cover
- 317,945 - flat, very high prod, med tree cover
- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built



VEGETATION DATA MAP

PARAMARIBO DISTRICT

Cover Tree & NPP Correlated by Slope

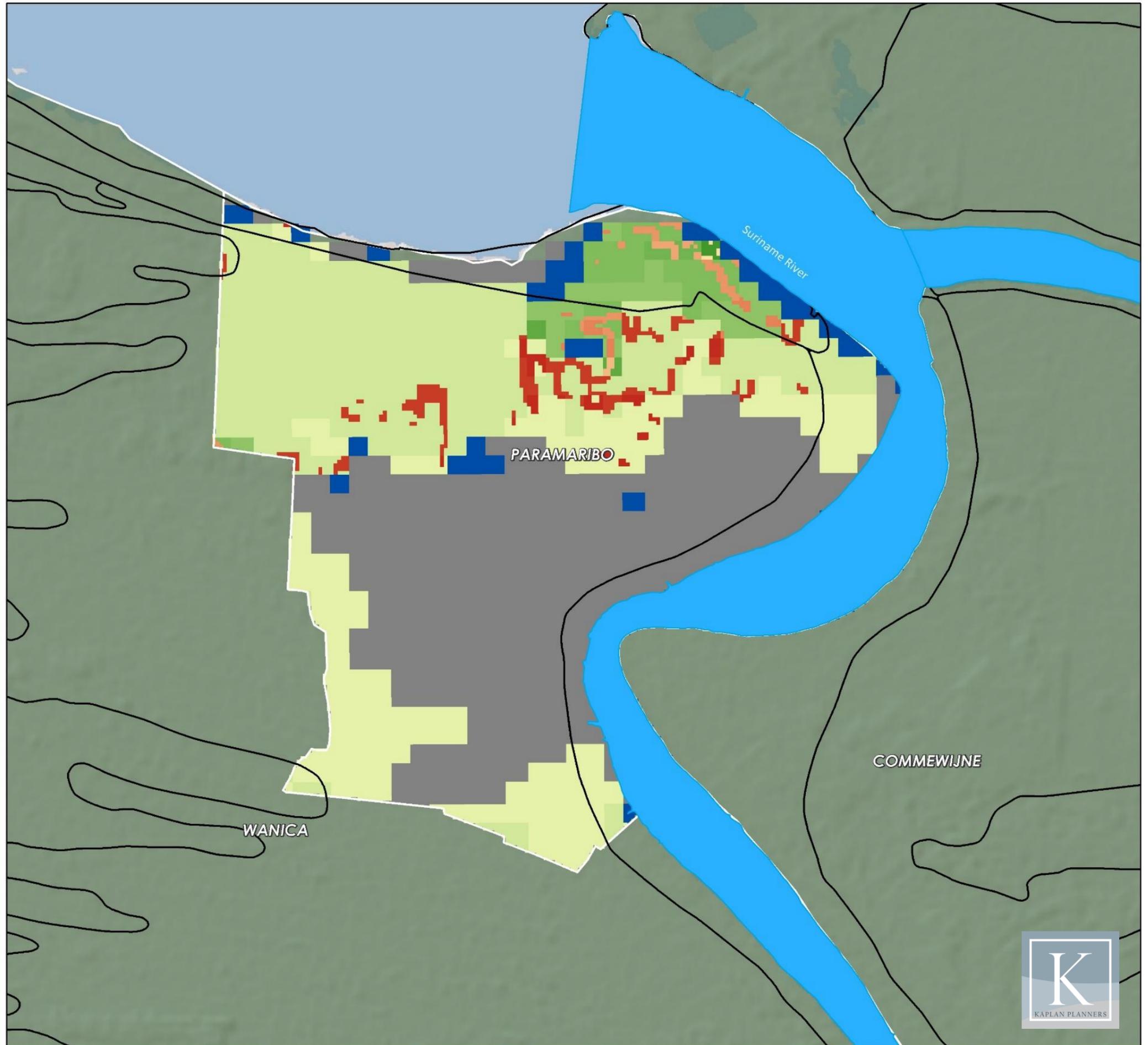
Extreme To Steep Slope

- 0 - water
- 9,810 - low productivity, no trees
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- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
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- 317,945 - flat, very high prod, med tree cover
- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built

landscape Units



VEGETATION DATA MAP

WANICA DISTRICT

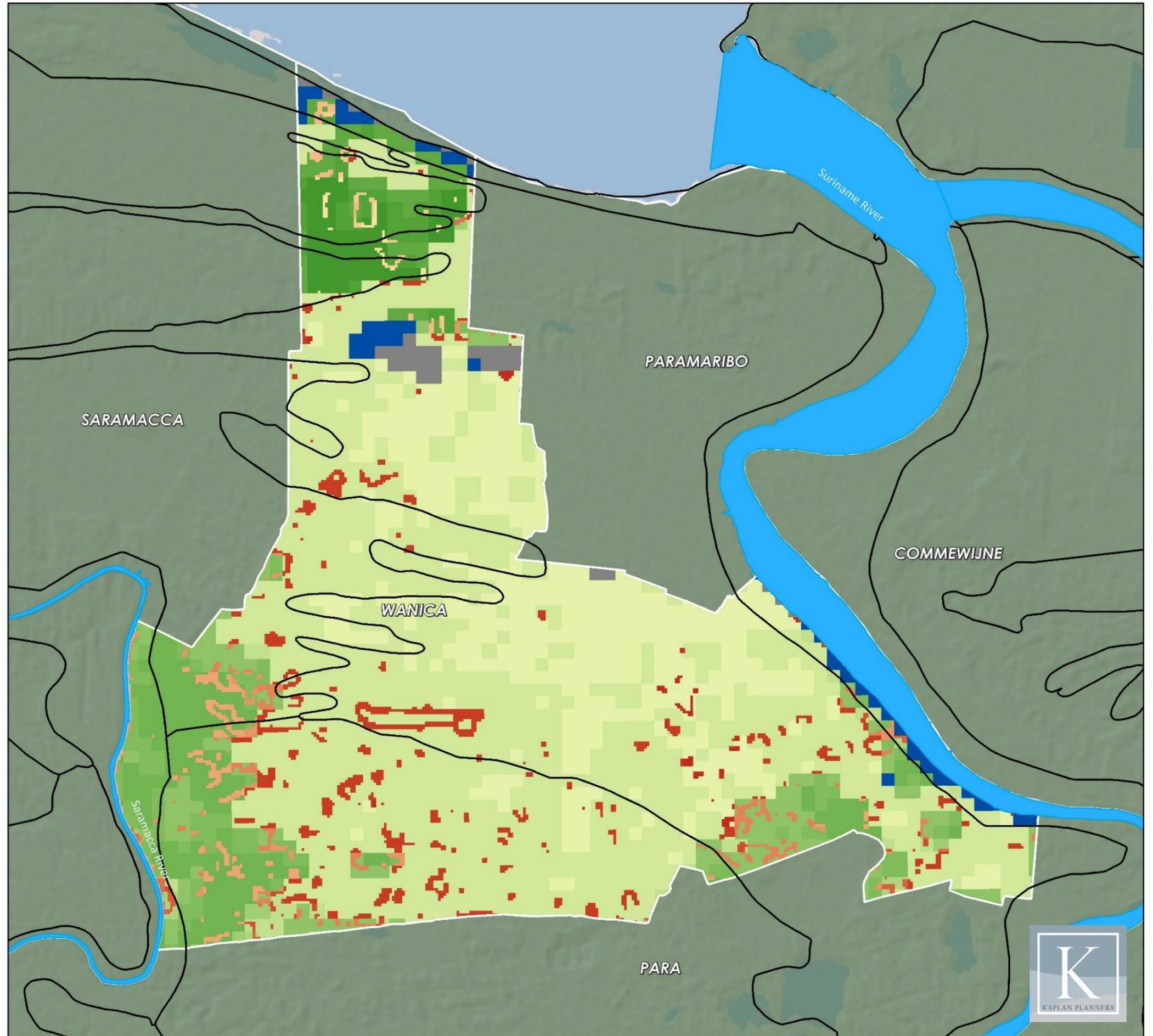
Cover Tree & NPP Correlated by Slope

Extreme To Steep Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
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Moderate To Mild Slope

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- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units



VEGETATION DATA MAP

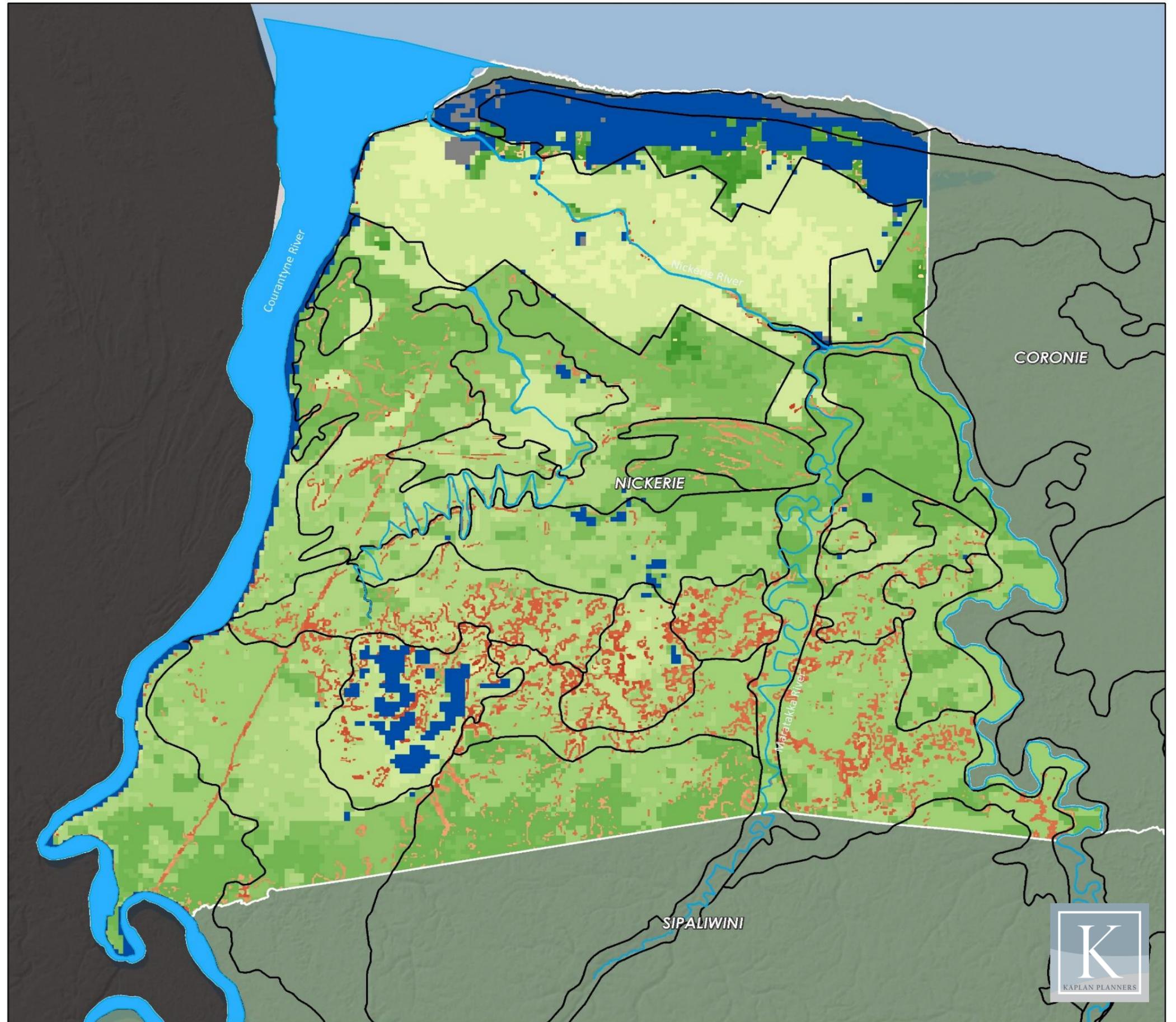
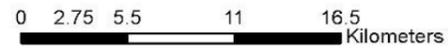
NICKERIE DISTRICT

Cover Tree & NPP Correlated by Slope Extreme To Stip Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
- 12,088 - medium productivity, high tree cover
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Moderate To Mild Slope

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- 312,067 - flat, med prod, high tree cover
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- 317,945 - flat, very high prod, med tree cover
- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units



VEGETATION DATA MAP

CORONIE DISTRICT

Cover Tree & NPP Correlated by Slope

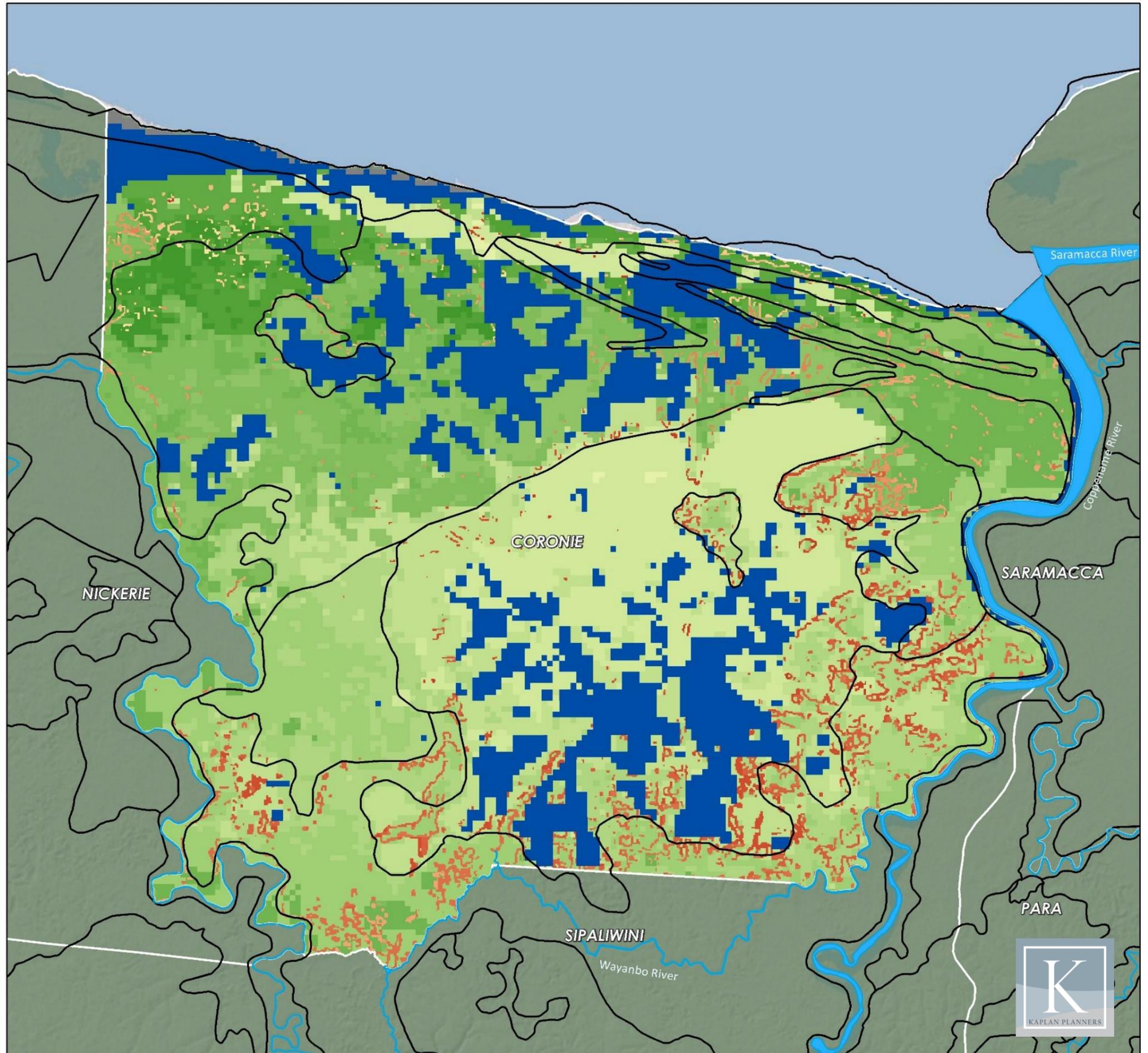
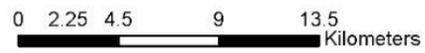
Extreme To Steep Slope

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- 317,945 - flat, very high prod, med tree cover
- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built

landscape Units



VEGETATION DATA MAP

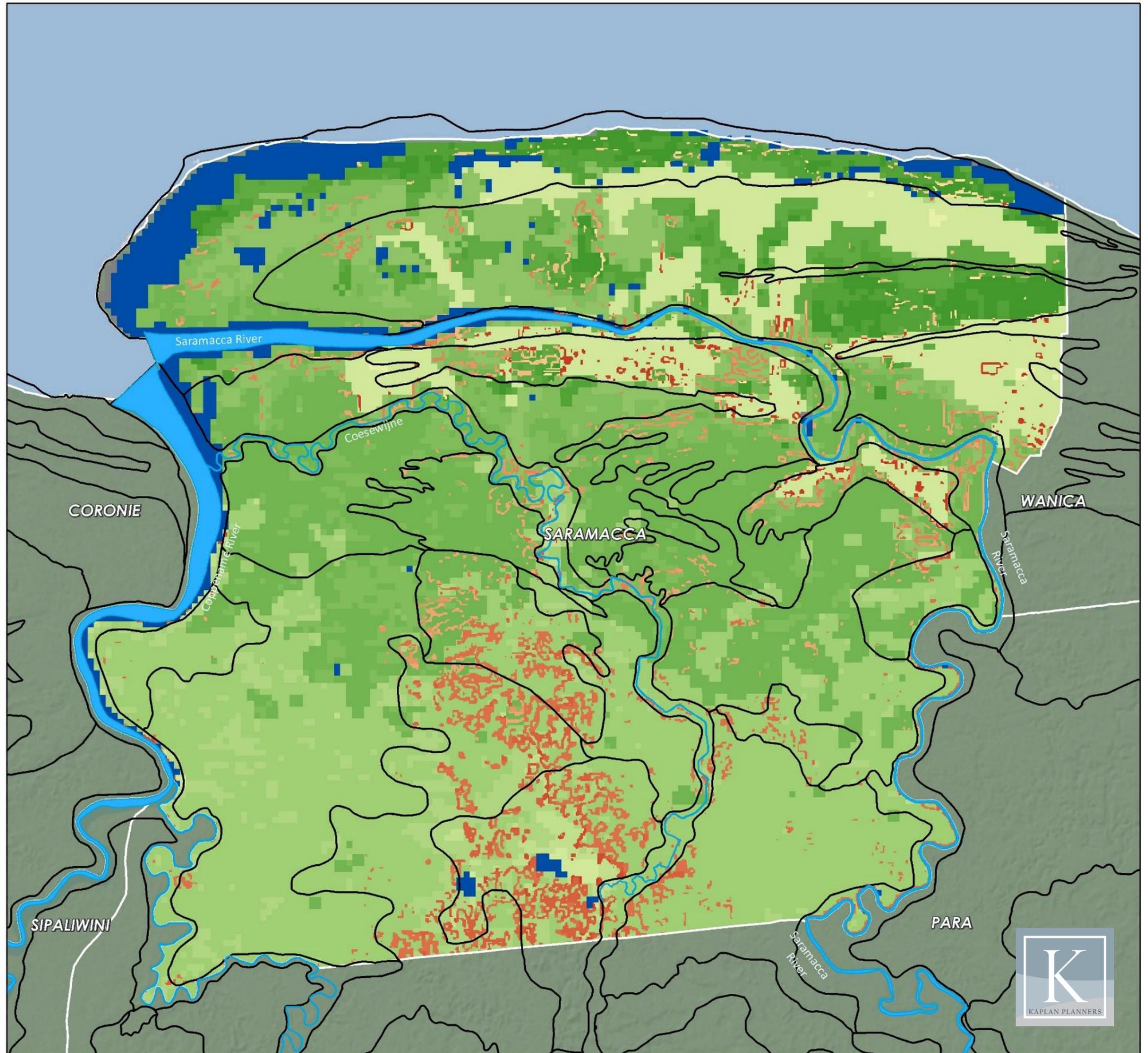
SARAMACCA DISTRICT

Cover Tree & NPP Correlated by Slope Extreme To Stip Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
- 12,088 - medium productivity, high tree cover
- 14,345 - high productivity, medium tree cover
- 14,367 - high productivity, high tree cover
- 14,388 - high productivity, very high tree cover
- 17,945 - very high productivity, medium tree cover
- 17,967 - very high productivity, high tree cover
- 17,988 - very high productivity, very high tree cover
- 33,010 - no vegetation - Built area

Moderate To Mild Slope

- 300,000 - water
- 309,810 - flat area, low prod, no trees
- 309,845 - flat, low prod, medium tree cover
- 312,045 - flat, med prod, med tree cover
- 312,067 - flat, med prod, high tree cover
- 312,088 - flat, med prod, very high tree cover
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- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units



VEGETATION DATA MAP

COMMEWIJNE DISTRICT

Cover Tree & NPP Correlated by Slope

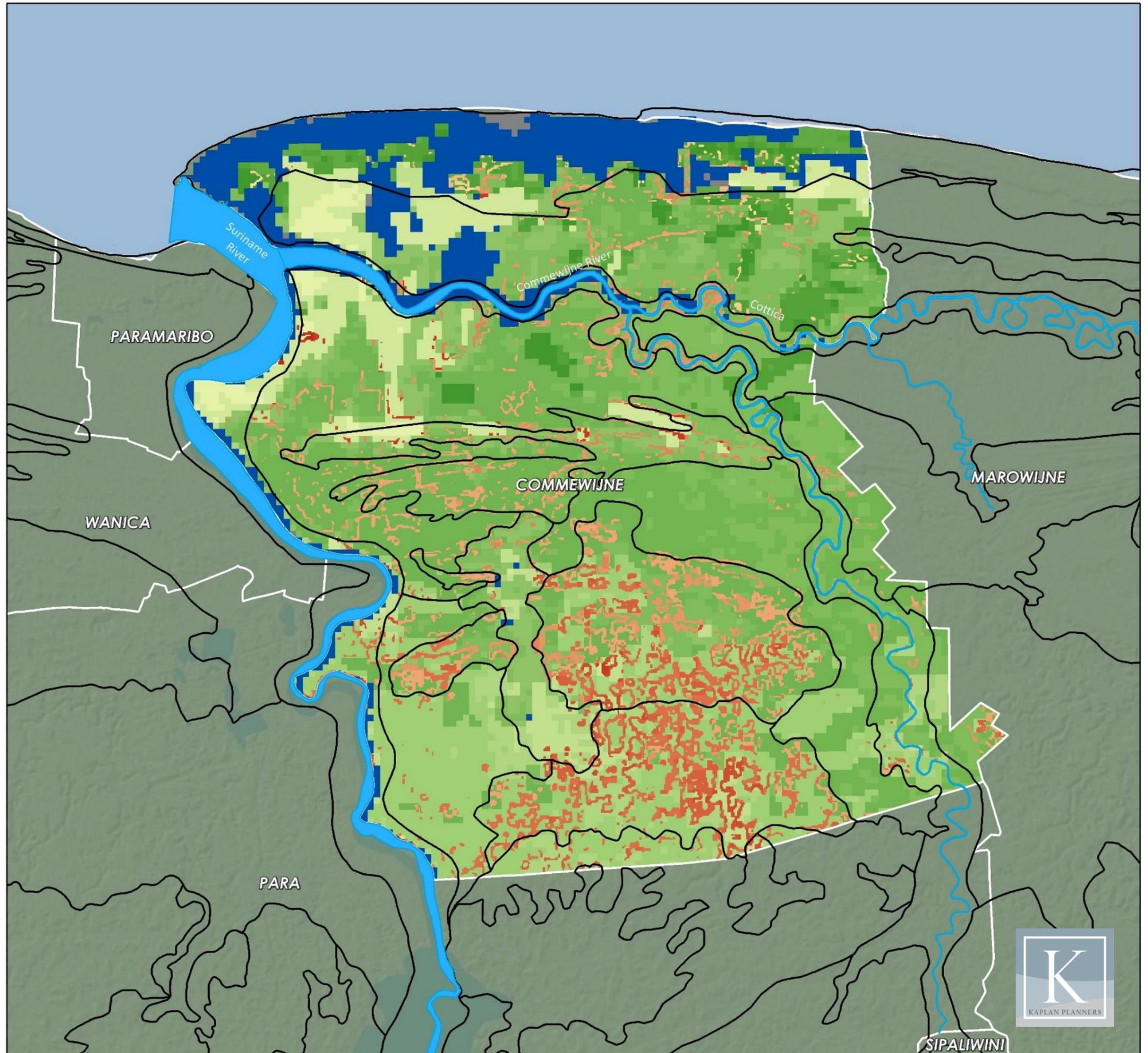
Extreme To Steep Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
- 12,088 - medium productivity, high tree cover
- 14,345 - high productivity, medium tree cover
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- 317,945 - flat, very high prod, med tree cover
- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units

0 2 4 8 12 Kilometers



VEGETATION DATA MAP

MAROWIJNE DISTRICT

Cover Tree & NPP Correlated by Slope

Extreme To Steep Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
- 12,088 - medium productivity, high tree cover
- 14,345 - high productivity, medium tree cover
- 14,367 - high productivity, high tree cover
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- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units



VEGETATION DATA MAP

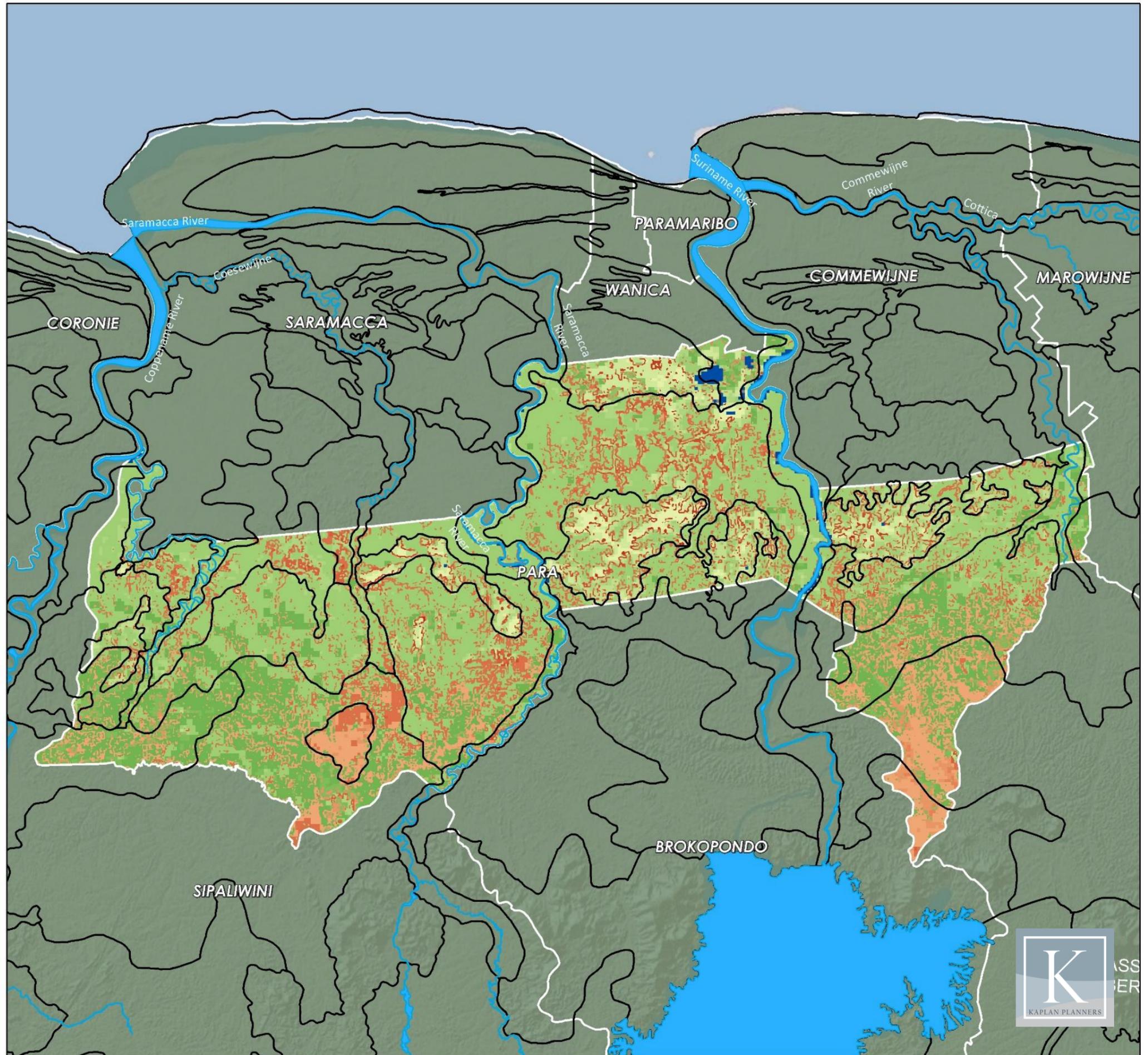
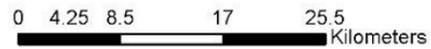
PARA DISTRICT

Cover Tree & NPP Correlated by Slope Extreme To Stip Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
- 12,088 - medium productivity, high tree cover
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- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units



VEGETATION DATA MAP

BROKOPONDO DISTRICT

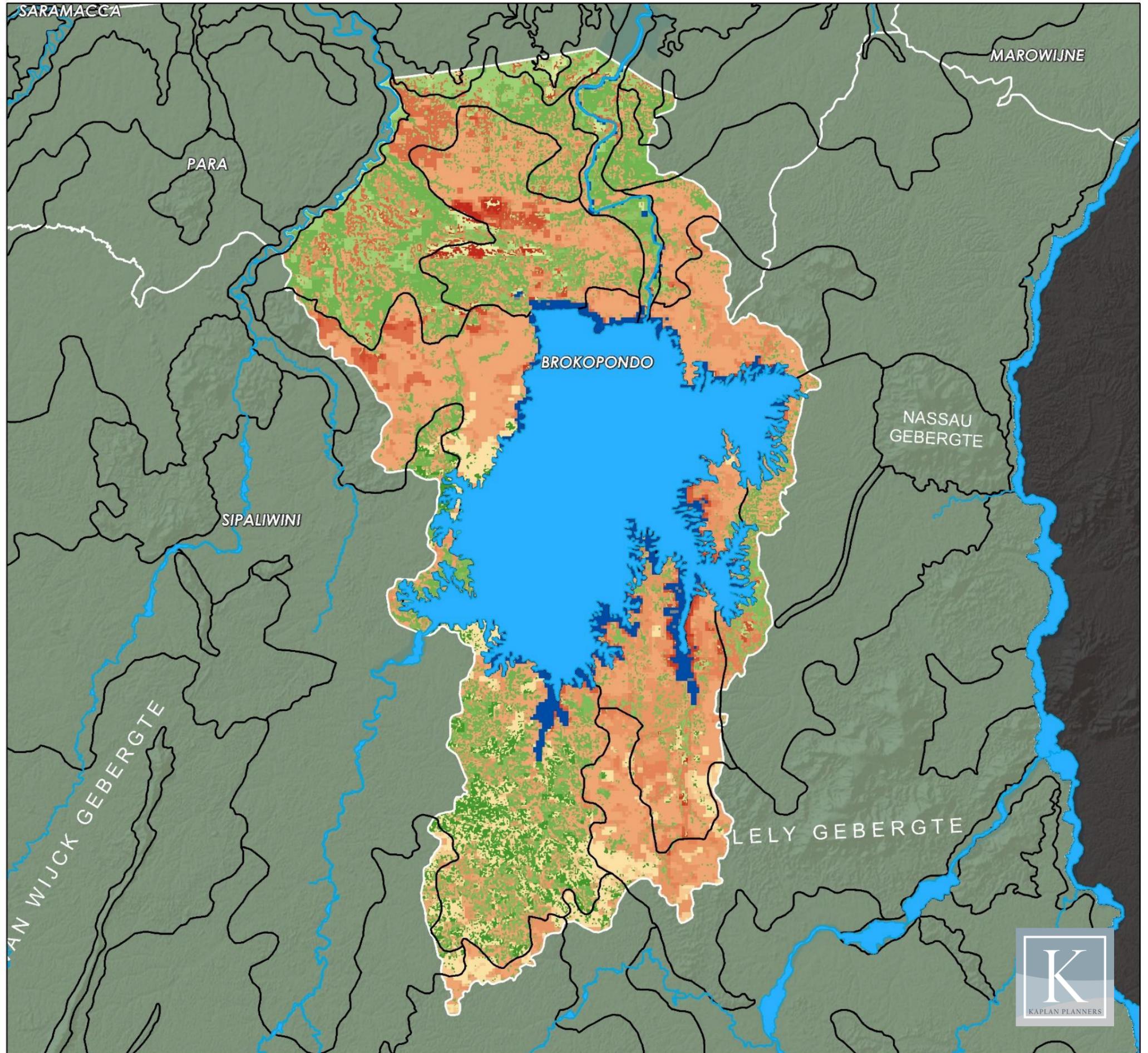
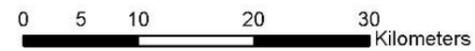
Cover Tree & NPP Correlated by Slope

Extreme To Stip Slope

- 0 - water
- 9,810 - low productivity, no trees
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- 12,045 - medium productivity, medium tree cover
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- 317,967 - flat, very high prod, high tree cover
- 317,988 - flat, very high prod, very high tree cover
- 333,010 - No vegetation - built
- landscape Units



VEGETATION DATA MAP

SIPALIWINI DISTRICT

Cover Tree & NPP Correlated by Slope

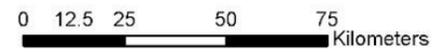
Extreme To Stip Slope

- 0 - water
- 9,810 - low productivity, no trees
- 9,845 - low productivity, Medium tree cover
- 12,045 - medium productivity, medium tree cover
- 12,067 - medium productivity, high tree cover
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- 333,010 - No vegetation - built

□ landscape Units



1. The Young Ridge Landscape - The Kwatta Formation

The Young Ridge Landscape is characterized by wide complex sand and shell ridges and narrow, parallel depressions. In addition, series of individual ridges exist running parallel and close to each other (bundles); they are separated by narrow clay flats. Ridges and ridge bundles alternate with vast marshes and wet clay flats. The sand ridges consist of very fine (loamy), fine, or medium sand; the shell ridges are build up of whole or broken shells. The depressions are usually filled with clay forms loamy materials. The marshy clay flats near the ridges mark the transition to the swampy areas. Often, these flats also have a sandy subsoil.

The highest parts of the ridges are well (and sometimes excessively) drained and have yellowish brown to reddish brown soils. The lower-lying parts are imperfectly drained. On the lower edges of the ridges, podzols often occur. A podzol is soil developed in a moist environment, and generally has an organic mat covering a thin organic-mineral layer. Beneath these layers are leached soils and clays. The process of podsolization is enhanced by fluctuating groundwater. Podzols are also encountered on the flat plateaus of complex ridges. Depressions and clay flats are imperfectly to very poorly drained. The clays that occur here are ripe in the marshes to half-ripe in the swamps. (Clay soils are more fully discussed in the description of the Nickerie Landscape.) With respect to fertility and physical characteristics, the (moderately) well-drained soils of the ridges are the most interesting, although the highest parts of the ridges may suffer from drought in the dry season. The lower parts are less interesting because of periodic water stagnation. Use of podzol soils is limited due to low fertility.

Although not covering large areas, the ridges are very important because their good physical properties and fertility make them suitable for raising a great variety of crops and for animal husbandry.

2. The Young Clay Landscape - Nickerie Formation

This formation developed on heavy marine sediments. The flats of this landscape are inundated for some period each year. On the surface pegasse (the local name for slightly decomposed organic material) may be found in thin layers. The recently deposited clays of this landscape are soft and saline. After sediments of the mudflats rise above sea level and the first forms of vegetation appear, a number of processes begin to ripen the soil. As a result of water loss, the clay gradually becomes firmer and develops a structure, air enters the soil through crack and pores, and causing the oxidation of reduced iron; in this way mottles are forms. Salts and bases are removed by percolating rain water, resulting in desalinization and a gradual lowering of the pH, so that the soil becomes more acid. It should be stressed that ripening only occurs after drainage, which can be natural or artificial (i.e., creating polders).

The soil fertility of all young marine clay soils is good. Due to their slow permeability, aeration and traffic ability may be poor. Also, their clay content may make them unworkable in some seasons of the year. However, the half-ripe and ripe non-saline clays are very suitable for irrigated rice

cultivation, as the physical condition of the soil is of minor importance in this type of land use. Apart from rice cultivation, these soils are suitable for most annual and perennial crops and for animal husbandry, provided that drainage is adequate.

3. The River Landscape

The River Landscape was formed by sediments deposited by the rivers and the sea. The landscape as a whole is less flat than the marine clay flats. The soils are heavy textured (clay or silty clay) and almost ripe to ripe. The drainage is imperfect near rivers and poor to very poor in the back swamps. Ancient river channels are found in this landscape filled with half-ripe, peaty (silty) clay. In the inner bends of rivers, a recently deposited zone of half-ripe and slightly ripe clays often occurs.

The Apura area soils consist of silty loam to silty clay. Drainage is imperfect; in the rainy season, the soils suffer from an excess of water, while in the dry season they become desiccated. Their physical characteristics are quite distinct from those of other River Landscape soils.

Diverse agricultural activities may be undertaken in the River Landscape, which is suitable for the cultivation of a great number of annual and perennial crops, as well as for animal husbandry. (It may also be used for large-scale, mechanized rice cultivation in large, flat areas.) The soils of the

Apura area can sustain few activities other than animal husbandry, due to their poor physical properties, although crops that can tolerate water logging can be grown in the rainy season.

4. The Polder Landscape

This landscape is a result of human activity and is characterized by a geometric pattern of canals, trenches, dams, and/or roads. The construction of a water management system often results in radical changes in the soil.

The topsoil structure of the paddy soils is adversely affected by continuous puddling, a tillage operation that often leads to impermeability. This makes the cultivation of crops other than rice infeasible, unless they have a tolerance for waterlogging. Certain grasses have developed this tolerance, making animal husbandry possible. However, after building drainage systems and taking measures to improve the soil structure, other crops may be cultivated.

5. The Mara Landscape

Deep to very deep swamps at very low elevations. Under such conditions, organic material decomposes much more slowly than it is deposited, this causes thick to very thick layers of peat to form. Peat may even exceed 3 m. The peat formed in mineral-poor rainwater is called ombrogenous (ombros = rain). The slow decomposition of peat allows it to accumulate above the surface of the water.

Some of the Mara Landscape is unripe to half-ripe pyrite clays with a high content of organic matter covered by a layer pegasse. If drained, the pyrite in these soils is transformed into sulfuric acid. This potential acidity makes them unsuitable for agricultural purposes. The possibility of using the swamp water for irrigation is currently being studied.

6. The Lelydorp or Old Landscape

Complex eroded and flattened ridges, intersected by erosion gullies, characterize this landscape. The flattened ridges form "islands" surrounded by depressions and low flats. Erosion gullies filled by later deposits also occur.

Drainage is determined by the elevation: well drained at the highest levels to imperfectly drained at the lowest. Physically, the soils are fair. As a rule, the depressions and low flats are poorly to very poorly drained although scattered area may only be imperfectly drained. The percentage of clay in the soil increases with depth. The natural fertility is moderate to very low, and soils are often bleached as result of podsolization. Physically, the soils are moderate to fair.

Soil conditions of the filled erosion gullies are similar to those in the Mara Landscape. The ridge soils are suited to animal husbandry and the cultivation of fruit trees (e.g., citrus) and less demanding crops, such as pineapple, cassava, and sorghum, however, the soil must be constantly fertilized, as the leaching process quickly robs the soil of its nutrients. Small-scale activities predominate because the scattered ridges only permit the land to be broken into small fields. The lower flats and depressions are suitable for grazing. The vast area of bleached soils is not suitable for agriculture.

7. The Para or Old Marine Clay Landscape

The Para deposits are characterized by schollen (island-like, flat surfaces) surrounded by erosion gullies. They are generally poorly to very poorly drained soils consisting of silty loam over silty clay loam to silty clay. Physically, these soils are poor. Their natural fertility is moderate to low. The agricultural options, therefore, are limited, extensive cattle raising may be possible on soils with a relatively stable topsoil. Mulching (covering the soil with slightly decomposed organic material) leads to higher biological activity, a reduction of weed growth, and improvement of the structure and the organic matter content in the soil.

8. The River Floodplain and River Terrace Landscape

This landscape has been built up from the river plain to the low, middle, and high terraces. The river plain is comprised of river levees, backswamps, and creek valleys. The levees overflow only at very high water levels; the backswamps and creek valleys, however, are regularly inundated in the rainy season, the soils usually consist of clay or silty clay. The drainage varies from poor in the backswamps to well drained at the highest parts of the levees, the fertility of the soils is moderate, while physically they are moderate to unfavorable, the narrow strip of well-drained soils along the rivers is suitable for small-scale agriculture, horticulture, and animal husbandry; the backswamps are mostly suited to small-scale rice cultivation.

The soils of the terraces range from loamy sand to sandy loam to sandy clay. Sand, however, is the least common. The drainage is good at the highest parts to imperfect or poor at the lower levels. Fertility is moderately poor to poor, the better-drained areas with more clayey soils are particularly suitable for certain annual and perennial crops (notably oil palm, but also citrus, peanut, tobacco, and cassava), and animal husbandry. Proper soil management is required to make the land productive.

9. The Cover Landscape

The most typical form of the Cover Landscape consists of slightly sloping plateaus and shallow to moderately deep valleys with gently sloping to sloping sides. In western Suriname, however, broad, rather deep valleys are also found. Flat-bottomed valleys only occur where there are permanent rivers. The soils of the Cover Landscape are old and strongly weathered. Some of the soils show white (bleached), medium to coarse sands, the drainage is excessive to imperfect. These soils are extremely poor and have a very low water-retention capacity therefore they are not suitable for agriculture. Other plain soils are yellow-brown to red (unbleached); the texture varies from medium (loamy) sand to sandy clay. As a rule, general, fertility is very low. Physically, they may be favorable to moderate. The brown, unbleached soils are suitable for mechanized cultivation but, before making the decision to clear land for permanent agriculture, the soil fertility must be studied in detail. Fertilization is important. Rotation with grassland is very desirable if annual crops are to be raised, peanut, soybean, dryland rice, and pineapple are possible crops.

10. The Older Landscape of the Interior

The soils of the interior are quite diverse. However, they are all very old, have good to moderate physical condition, and low fertility. Nutrients are concentrated in the humus topsoil. Many soils contain gravel or stones; some even have continuous laterite or bauxite caps at the surface. In general, these soils are unsuitable for permanent agriculture. Only in the less steep areas of the undulating to moderately steep, low hilly land, are cultivation of perennial crops (notably oil palm) and cattle raising possible.

Division 2

Land Use Maps

SURINAME

CROSS-CUTTING CAPACITY
DEVELOPMENT PROJECT

C C C D

ENVIRONMENTAL PLANNING ATLAS

BACKGROUND

DEFINITION

The term "land use" expresses the status of the surface in a certain area. It describes the distribution of land cover, or the active uses of the land. The current status is reflected in a "land use map". It is customary to divide land uses and land cover into two main categories:

1. Natural, without human interference - such as forests, swamps and water bodies, etc.
2. Manmade - towns, agricultural areas, roads, etc.

CREATION PROCESS

The creation of a land-use map is a basic practice for every planning system. It is the starting point to facilitate change or improve the status.

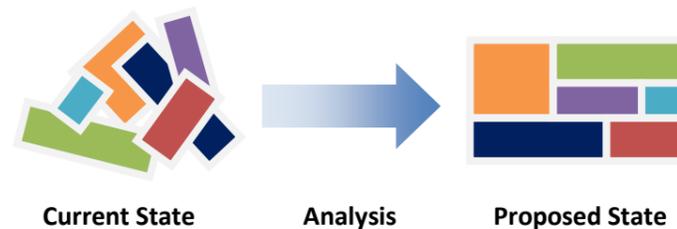


Figure 1: Simplified planning process

It is important to emphasize that a land-use map reflects a current existing situation and does not involve future plans for land planning or use. For instance: a tropical forest is a form of natural land cover. Should it be decided to declare a nature reserve, the legal state will be designated "nature reserve".

The creation of a land-use map includes analysis and interpretation of aerial photographs, satellite imaging, examination of maps and any relevant material that can exhibit the field in detail. This can be achieved by human or computerized interpretation of the imagery. It is best to integrate both methods, while visits to the area are required for completion and calibration.

PROCESS OF CURRENT WORK

The maps included in this project were made in cooperation with SBB (Stichting Bosbeheer en Bostoezicht). In recent years, SBB has created a series of periodic maps, presenting the state of land use over a course of several years, starting from the year 2000. This work was done for the purpose of

forest management and control, monitoring deforestation trends and patterns, one of SBB's central tasks. Interpretation was carried out using remote sensing technology, a completely automated process, with a pixel size of 30 meters. The differentiation was mainly of "forest" and "non-forest" areas. "Forest" is defined by SBB as "land mainly covered by trees which might contain shrubs, palms, bamboo, grass and vines, in which tree cover predominates with a minimum canopy density of 30%, a minimum canopy height (in situ) of 5 meters at the time of identification, and a minimum area of 1.0 ha."

This work was further elaborated in the framework in the CCCD project, with human interpretation and visits to the field intended for verification of the interpretation. The result was the "Land Use Map of Suriname" presented here. The map includes an extensive list of land use types, divided as mentioned to natural and manmade areas. The interpretation process was done on a detailed scale between 1:2,500 to 1: 5,000. The national map is presented on a scale of 1:1,500,000. District maps are presented on a more detailed scale of 1:50,000. The following chart presents the land use types, divided into the two categories, as described above: man made land use and natural land use. Chart 2 presents the two categories and division into sub-categories. Under the Man Made category, the subdivision is done according to the types of activities. Under the Natural category, the subdivision is into Forest and Non-Forest.

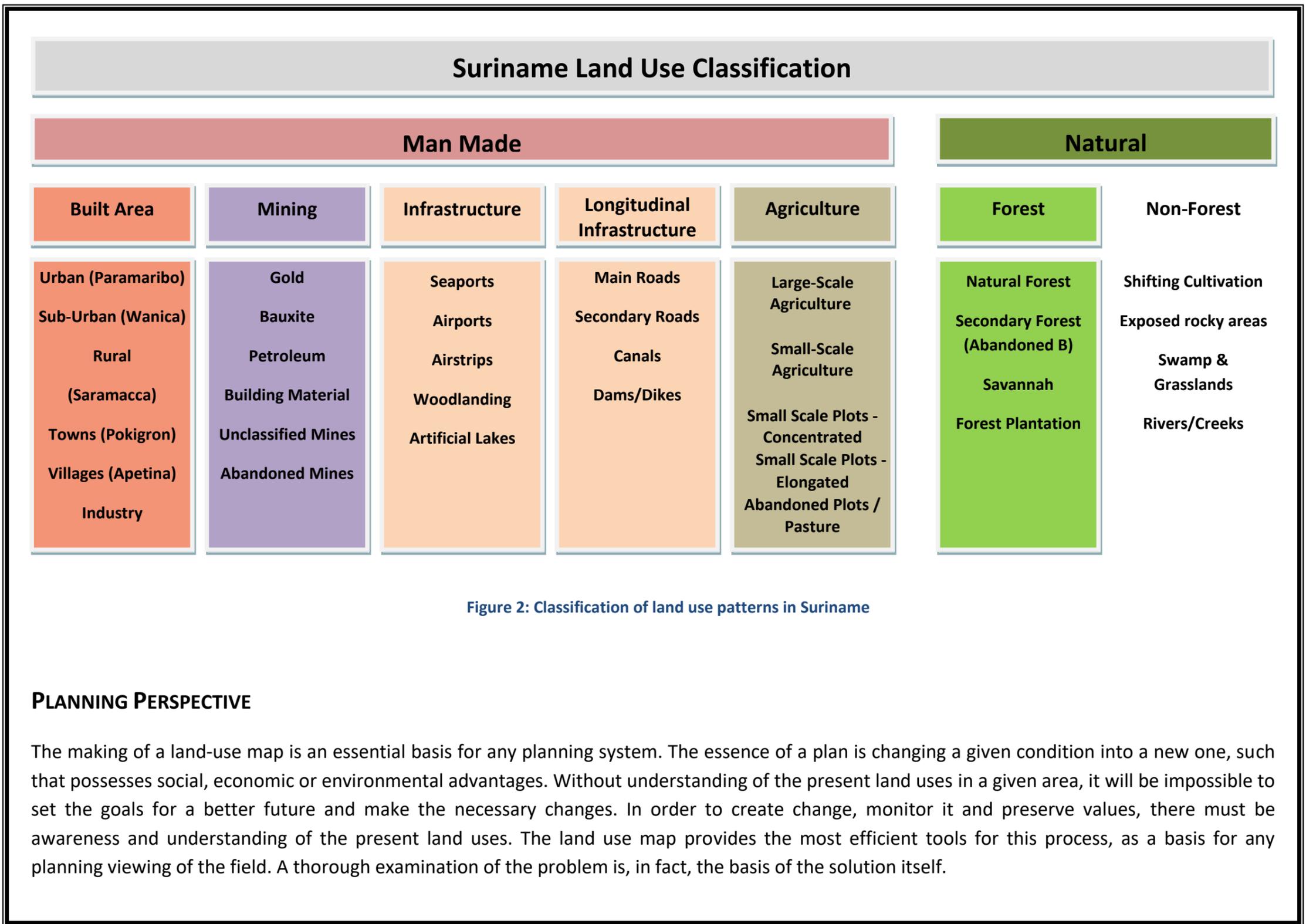


Figure 2: Classification of land use patterns in Suriname

PLANNING PERSPECTIVE

The making of a land-use map is an essential basis for any planning system. The essence of a plan is changing a given condition into a new one, such that possesses social, economic or environmental advantages. Without understanding of the present land uses in a given area, it will be impossible to set the goals for a better future and make the necessary changes. In order to create change, monitor it and preserve values, there must be awareness and understanding of the present land uses. The land use map provides the most efficient tools for this process, as a basis for any planning viewing of the field. A thorough examination of the problem is, in fact, the basis of the solution itself.

One of the foundations of this planning approach is the zoning that is the separation of land uses contradicting each other, e.g. keeping an industrial area away from residential areas; distancing quarries and their area of effect from natural reserves and so on. The creation of zoning relies first and foremost on the existing reality - as expressed in the land use map - and on the proposals for removal or separation of conflicts.

The analysis work is done in order to identify opportunities and hazards and suggest ways to solve difficulties that might arise with means of planning. In summation, the land cover map makes the current state clear and understandable, to be used as a basis and starting point for required changes.

LAND USE IN RELATION TO SUSTAINABLE DEVELOPMENT & RIO CONVENTIONS

A land use map is a basis for the establishment of land designation, formulation of sustainable development policies, and protection of natural resources. The map depicts the location of resources, the threats they face, and so it becomes a basis for meeting the demands set in the Rio-Conventions. A land use map marks and defines natural resources and the kinds of threats to be anticipated. It calculates opportunities and hazards, suggesting ways to solve difficulties that might arise using planning means.

Land use information is required for many different kinds of spatial planning, from regional development to urban planning at a local level. In protection of biodiversity, it is necessary to know the location of the areas carrying certain values – forests, swamps etc., and where the factors threatening them are; definition of the areas threatened by climate change, identification of land uses in areas prone to flooding and the proper assessment, such as cultivation on steep slopes; location of erosion- and degradation-prone areas and the means to protect them. Without a clear knowledge of the distribution and characterization of areas, there would be no possibility to take rational policy measures for the protection of environmental values.



Figure 3: the process of changing an existing status - using planning means - into a designed, preferred status

LAND USE CLASSIFICATION

LAND USE PATTERNS - DEFINITIONS

The unique characteristics of Suriname require addressing its distribution of land uses into two main categories, as mentioned: "natural" and "manmade". This division is chiefly done in order to outline the basis for land use allocation and planning, and in Suriname's case - especially in an environment-oriented project - to distinguish the areas planned for future development from those intended to be preserved and safeguarded. Below is a detailed description of each category and its sub-categories used in preparation of the land use maps presented in the Atlas.

MAN-MADE LAND COVER

Human presence and activity is necessarily accompanied by changes of the surface. They are divided to five categories, in turn divided into sub-categories: **Built Areas**: urban, sub-urban, rural areas, etc.; **Mining**, in turn divided into gold, bauxite, building material etc.; **Infrastructure** areas such as airports; **Longitudinal Infrastructure** including roads and canals; **Agriculture**: large-scale, small scale cultivation, shifting cultivation and more. The planning process relies on delineation of human activities in order to plan their further development or restriction, in this context in relation to the surrounding natural environment. The detailed description of the Man Made category is specified below.

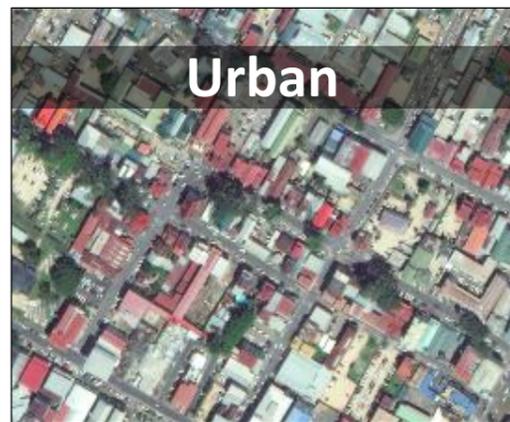
NATURAL LAND COVER

More than 90% of Suriname's areas are covered with natural rainforests, making it the world's leading country in percentage of forest cover. From a national, as well as international, planning point of view, it is crucial to delineate the natural resources spread throughout the country's territory. The two main categories include forest and non-forest, divided in turn to sub-categories, as decided upon by SBB. This category includes natural land cover, with no human intervention: natural forest, open savannah lands, swamps and grasslands, bare rocky lands and rivers. Also included are forests covering abandoned agricultural plots from years and even decades ago, where the forest has regained the area and the area returns to its natural state. The agricultural sub-category of shifting cultivation is also included here, since the small plots. Secluded from each other, were delineated with their surrounding forested areas.

MAN-MADE LAND COVER

Built Areas

Through interpretation of satellite imagery, combined with other data, this section was divided into six sub-categories, which include dense urban areas like Paramaribo and New Nickerie, small towns adjacent to Suriname's coastline, rural settlements and small isolated villages in the Interior.



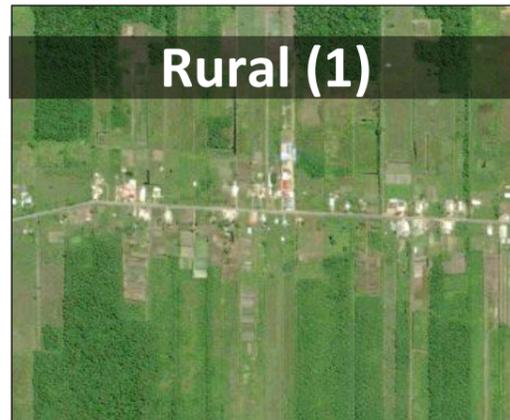
High concentration of population over a defined area characteristically gridded and functional (Paramaribo). This is the densest and most concentrated form of construction in Suriname, and it presents a gradual tendency to spread, mostly to the south and west of the capital.



Lower density areas, located outside of an urban center and its outskirts. In most cases characterized by more agricultural activity than the urban area. Housing in the sub-urban pattern is usually spread along local roads, adjacent to family plots. This model is common in Wanica and its surroundings.

Rural Areas

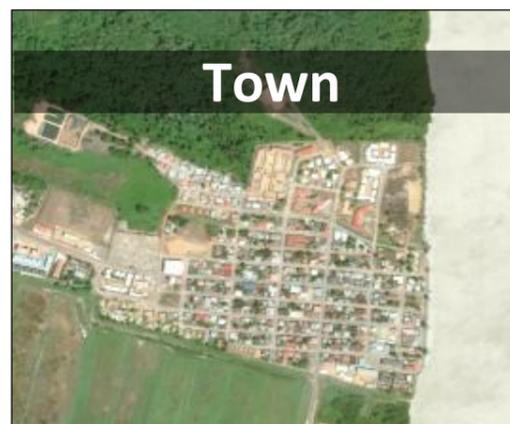
Remote settlement alongside small roads. Structures are somewhat far apart with natural vegetation and agriculture in between. This model is divided into two:



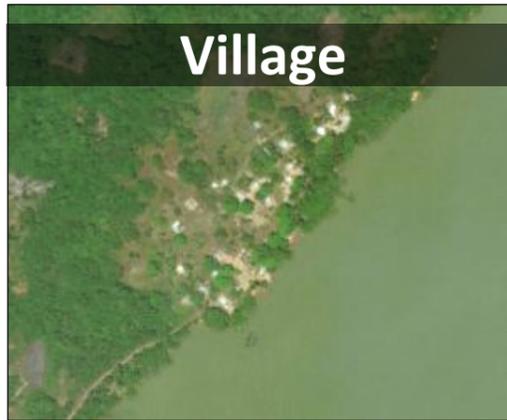
1. **Rural settlement with adjacent family plots:** Housing along main roads such as the West-East Road, were small family plots, up to a few hectares in size, are cultivated, organized next to the houses, typically identified as having boundaries similar to housing width.



2. **Rural settlement with surrounding shifting cultivation:** Scattered housing near roads, mainly in remote areas, surrounded by shifting cultivation plots, attached to houses. Para district holds a significant amount of these settlements.



A small urban area, usually located in a relatively remote part of the country, apart from any other bigger settlement. The pattern of a relatively large number of structures clustered together is the main characteristic feature of the town. Albina, Pokigron and Groningen are examples of this type of community.



Small settlements commonly composed of dozens of structures usually located in a comparatively remote part of the Interior. Typically surrounded by plots of shifting cultivation at varying distances. Most of these villages are located on riverbanks, isolated from the road system and are only accessible by boat.



Areas found mostly in Paramaribo on the west bank of the Suriname River and along the Saramacca Canal, in defined areas. Typically composed of large, clustered structures used for production or storage.

Mining

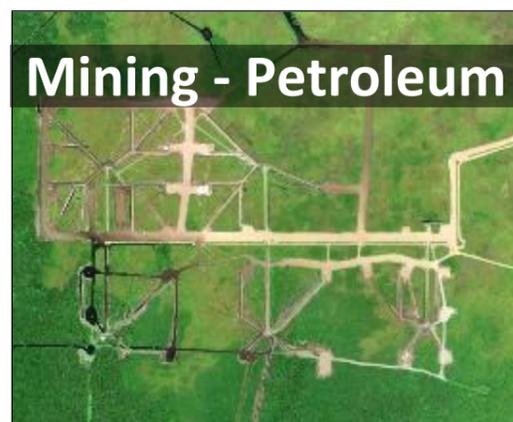
Mines can be split into two sub- groups: Active and Abandoned.



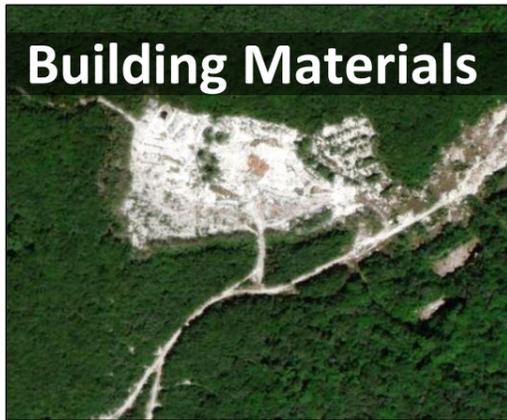
Found across streams, gold mines are typically elongated areas, with multiple small digs, dozens of hectares in size. The vast majority of gold mining is done in the Brokopondo and Sipaliwini districts, in proximity to the lake, east and north of the lake. In many cases, the mines are left open and the land disrupted after extraction is complete.



Quarries of bauxite are hundreds of hectares in size, usually wide and found near the East-West highway, mainly southern to Wanica and the eastern part of Suriname. As is the case with gold mines, that are often left open and damaged, with no rehabilitation. Some of the bauxite mines were identified out of the Non-Forest category.



Three large plots exist in Saramacca along the east-west highway, designated for palms for oil extraction purposes. The plots are divided and a system of roads is paved between them. A processing centre is located in the largest plot.



Several mines exist in Suriname, mostly in the coastal area, on top of sand ridges and the savannah, along the east-west highway and the road to Brokopondo. These quarries exist to provide sand and other types of ore as construction material.



Mines and quarries of various kinds of resources, with no explicit identification available. This appearance is relatively less-than-common, and may require further classification in the future, whether by familiarity with the field or by accumulating knowledge from relevant stakeholders.

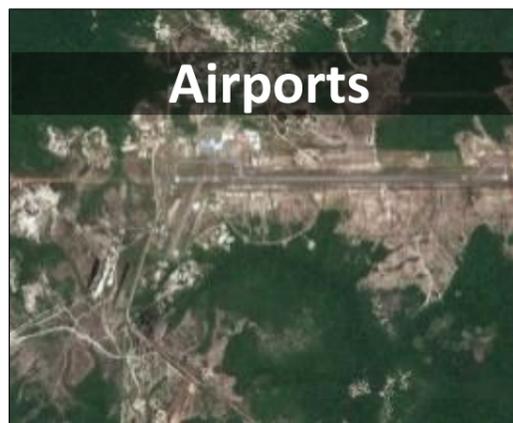


This sub-category is divided to abandoned sand mines, of relatively small area (in Saramacca, east Coronie), and abandoned bauxite mines, spread across significantly large areas (mostly in Para and Marowijne), as well as gold mines where mining has ceased (mainly in Brokopondo and Marowijne). Some of the abandoned mines are flooded and artificial lakes were formed.

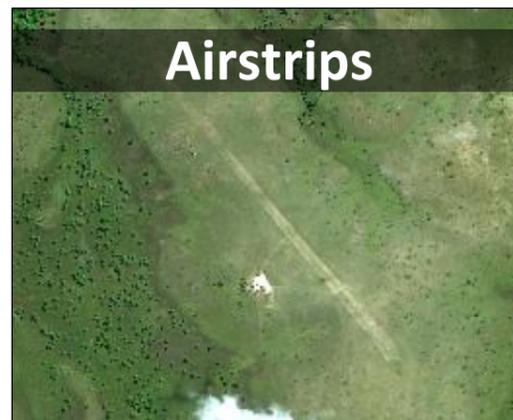
Infrastructure



Two main ports on Surinam River. One is located in front of the Saramacca Canal and the second, smaller port is located in the suburbs of Wanica, in the estuary of the Nickerie River. In their proximity warehouses and operation zones are typically found.



The two international airports of Surinam are Zanderij (In the attached picture) and Zorg En Hoop. These are large, developed facilities, the main airport in Zanderij used for international commercial flights and the secondary airport in Zorg En Hoop for light aircraft for local flights.



Small landing strips located nearby populated areas and throughout the mainland's forest in which they were used by research expeditions in order to get to unexplored areas. There are 55 airstrips, four of which have paved runways. In most cases, they are composed of simple, bare soil in a single strip.



Sites cleared out of vegetation, used for storage of wood and timber produce and preparation for shipment. These areas are not quite common in appearance, and are typically located adjacent to timber concession lands.



Brokopondo - An artificial lake, located nearly 100 kilometers southern to Paramaribo, with a surface area of approximately 1,560 km². An additional lake is found south of Mungo.

Longitudinal Infrastructure

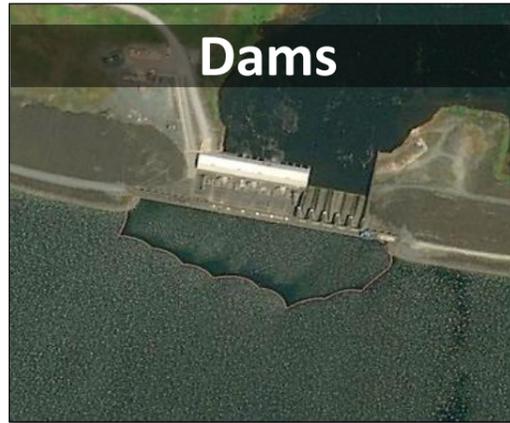
This sub-category includes infrastructure connecting and serving human settlements. The longitudinal Infrastructure includes roads, canals, dams and dikes. They are found stretched across town and villages or between them. In order to depict them accurately, the features were drawn as polygons, so that their changing width and shape may be expressed in the map.



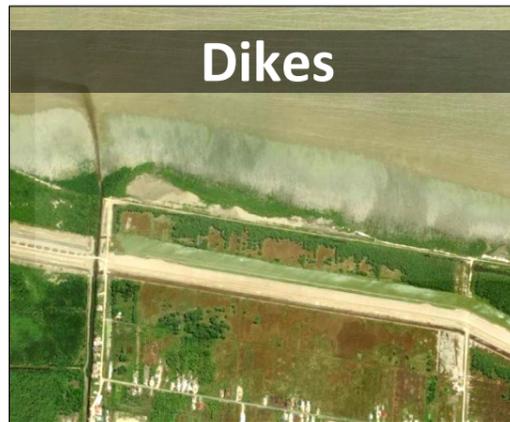
Wide pathways, connecting different built areas, agricultural fields and quarries. The roads mapping was based on OSM (OpenStreetMap) layers and other existing maps. Primary roads and secondary roads are outlined with wide and narrow lines, respectively. In addition, a manual examination was done in dense areas like Paramaribo city, in which a hierarchy of significance and maintenance level classified the roads.



The canals run between agricultural plots as means for irrigation and drainage. Grids of canals are found where organized cultivation takes place, most prominently in Nickerie. The Saramacca Canal running through Paramaribo is used sporadically for transportation by boat.



Dam is a barrier restricting the flow of water. The Afobaka dam was constructed across the Suriname River in order to generate hydroelectric power and as a result - Brokopondo reservoir was created.



The dikes were built to protect the towns and their surrounding cultivated area from flood by seawater, as it is an area of high risk due to its low elevation and proximity to the shoreline. In Coronie, the dike was built along the shoreline to protect from seawater penetration to Totness. An additional dike was built on the southern limit of the rice paddies, to protect them from floods in the swamp, located on the bank of the Corantijn River.

Agriculture

Listed below are the major types of agricultural patterns and layouts in Suriname. Most of the agricultural activity takes place in the coastal districts, on the outskirts of towns and villages, and along major transportation routes. Modern agriculture can be found mainly in the Nickerie district.



Large, consecutive cultivated areas, over five hectares in size. These are typically commercial plots, most of which are rice paddies and banana plantations, found mainly in Nickrie. The active, cultivated plots are distinguishable from the abandoned plots in the unity of colour and pattern, the lack of natural vegetation in the plot and adjacent similar plots.



Partly cultivated Plots, adjacent to houses, usually 1-5 hectares in size. Characterizes especially the Wanica district. The family holding creates a unique form of settlement, which consists of a grid of roads, along which the rows of houses and fields are intertwined.



Similar to the concentrated form described above, the elongated small-scale plots are located next to housing attached to roads. A prominent example of this use of land is located in Saramacca District, along the West-East highway.



Large, consecutive cultivated areas. Abandoned over years and covered partial vegetation coverage. In many cases, those areas are used as pasture. It is difficult to distinguish recently abandoned plots from pasture areas - as both are characterized by deforested areas in rectangular plots, with natural vegetation to a small degree - these uses were classified in a single category.

NATURAL LAND COVER

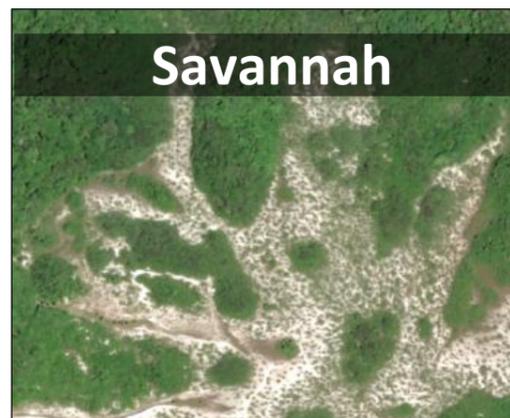
Forest



The various types of rainforests in Suriname, including forests in the coastal area, savannah, high and low lands, hills and mountains. The most common type of land cover, stretched on more than 90% of the country's territory. Land covered primarily by trees, but also often containing shrubs, palms, bamboo, herbs, grass and climbers, with a minimum tree crown cover of 30%.



Forest areas once cleared and used for agricultural purposes, where cultivation has ceased many years ago and the plots were eventually abandoned. Natural vegetation has gradually returned and currently covers the majority of the area, which can in fact be considered a natural forest once again.



A type of tropical biome with large stretches of grasslands mixed with sparse trees and shrubs. Note that only visible occurrences of typical savannah patterns are mapped, not fully compatible with the morphological definition of "savannah".



Commercial forests - mainly consisting of pine trees - planted for use of timber as a raw material to be sold and exported to international markets. They typically present a significantly large canopy in the satellite imagery presented in the maps.

Non-Forest



The traditional use of the forest by ITP's. It is composed of a mosaic of small-deforested land combined with fallow land at different stages of regeneration of the forest. These areas are located in large clusters in the province of Marowijne, north of Mungo, along the Marowijne River, along the WE road all the way up the Suriname River.



Exposed rock areas, in a size order larger than five hectares. Found in-land. On mountain tops such as Vilhelmina.



Naturally-occurring swamps in large flat basins, found mainly in the lower, coastal area. Additionally, Abandoned mines or agricultural plots, in which grassy vegetation or a swamp has covered the area since the human activity has stopped long ago.



The main river system of Suriname consists of four large rivers running south to north into the Atlantic Ocean. Additionally, secondary streams connected to the rivers were mapped.

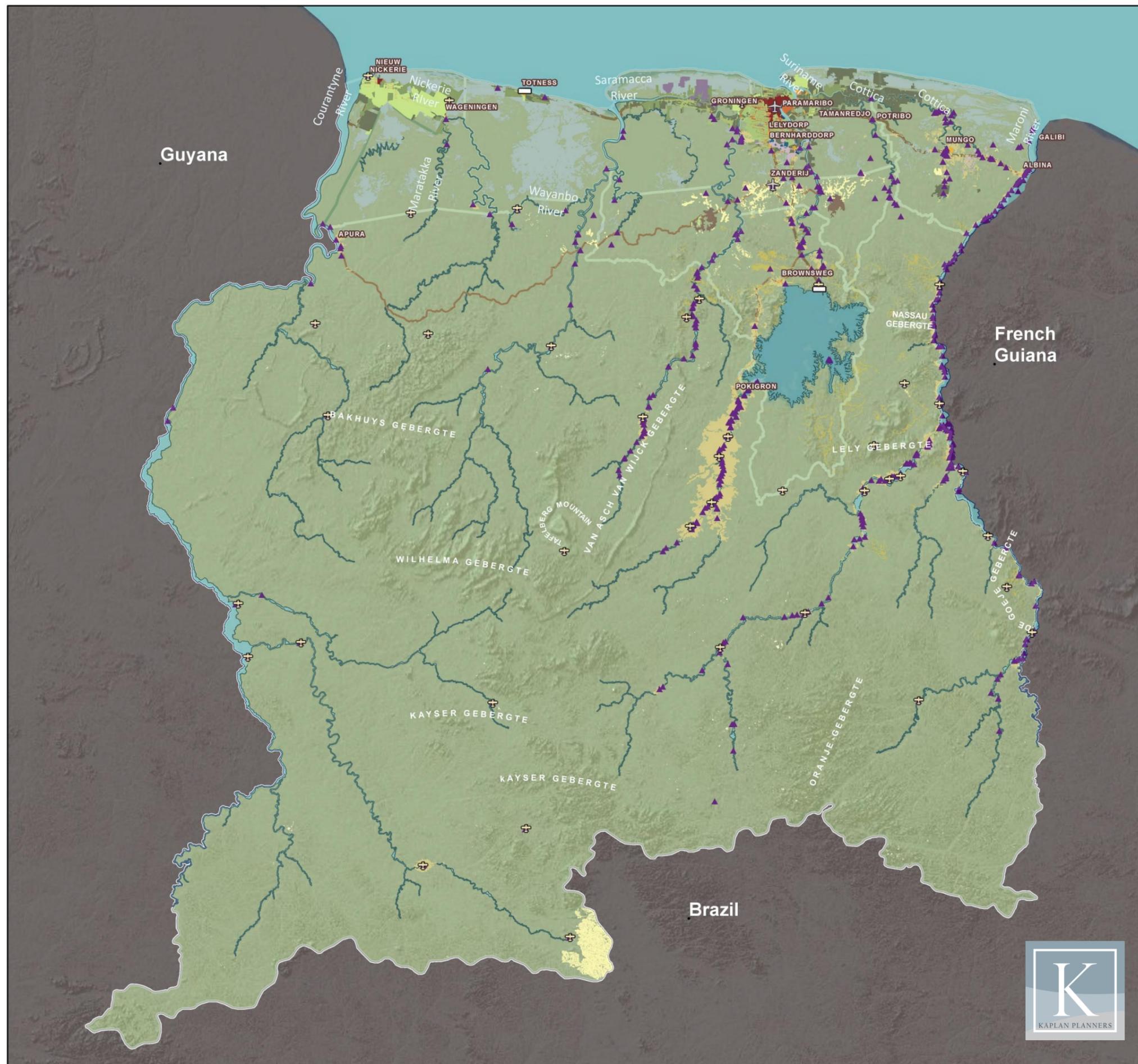
LAND USE ANALYSIS MAPS

LAND USE MAP

NATIONAL EXTENT

- | | |
|-----------------------------|-----------------------------|
| Built Area | ▲ Settlement |
| ■ Industrial | Infrastructure Sites |
| ■ Urban | □ Dam\Dike |
| ■ Sub Urban | ✈ Airport |
| ■ Rural | ✈ Airstrip |
| ■ Town | — Primary Road |
| | — Secondary Road |
| Agriculture | — Canal |
| ■ Large Scale | |
| ■ Small Scale | |
| ■ Small Scale\Abandoned (A) | |
| ■ Abandoned (A)\Pasture | |
| Infrastructure | |
| ■ Airport | |
| ■ Port | |
| ■ Woodlanding | |
| ■ Brokopondo Lake | |
| Mining | |
| ■ Bauxite | |
| ■ Gold | |
| ■ Oil | |
| ■ Building Material | |
| ■ Abandoned Mine | |
| ■ Unclassified Mine | |
| Human Forest | |
| ■ Shifting Cultivation | |
| ■ Forest Plantation | |
| Natural Non Forest | |
| ■ River | |
| ■ Open Swamp (N) | |
| ■ Savannah | |
| ■ Rock | |
| Natural Forest | |
| ■ Undisturbed Forest | |
| ■ Abandoned (B) | |

0 15 30 60 90 Kilometers



LAND USE MAP

PARAMARIBO DISTRICT

- | | |
|-----------------------------|---------------------------|
| — Canals | ■ Woodlanding |
| — Primary Road | ■ Brokopondo Lake |
| — Secondary Road | ■ Dam/Dike |
| Infrastructure Sites | Mining |
| □ Dam/Dike | ■ Gold |
| ✈ Airport | ■ Oil |
| ✈ Airstrip | ■ Bauxite |
| Built Area | ■ Building Material |
| ■ Industrial | ■ Unclassified Mine |
| ■ Urban | ■ Abandoned Mine |
| ■ Sub Urban | Human Forest |
| ■ Rural | ■ Shifting Cultivation |
| ■ Town | ■ Forest Plantation |
| ■ Village | Natural Non Forest |
| Agriculture | ■ River |
| ■ Large Scale | ■ Open Swamp (N) |
| ■ Small Scale | ■ Savannah |
| ■ Small Scale\Abandoned (A) | ■ Rock |
| ■ Abandoned (A)\Pasture | Natural Forest |
| Infrastructure | ■ Undisturbed Forest |
| ■ Airport | ■ Abandoned (B) |
| ■ Port | |



LAND USE MAP

WANICA DISTRICT

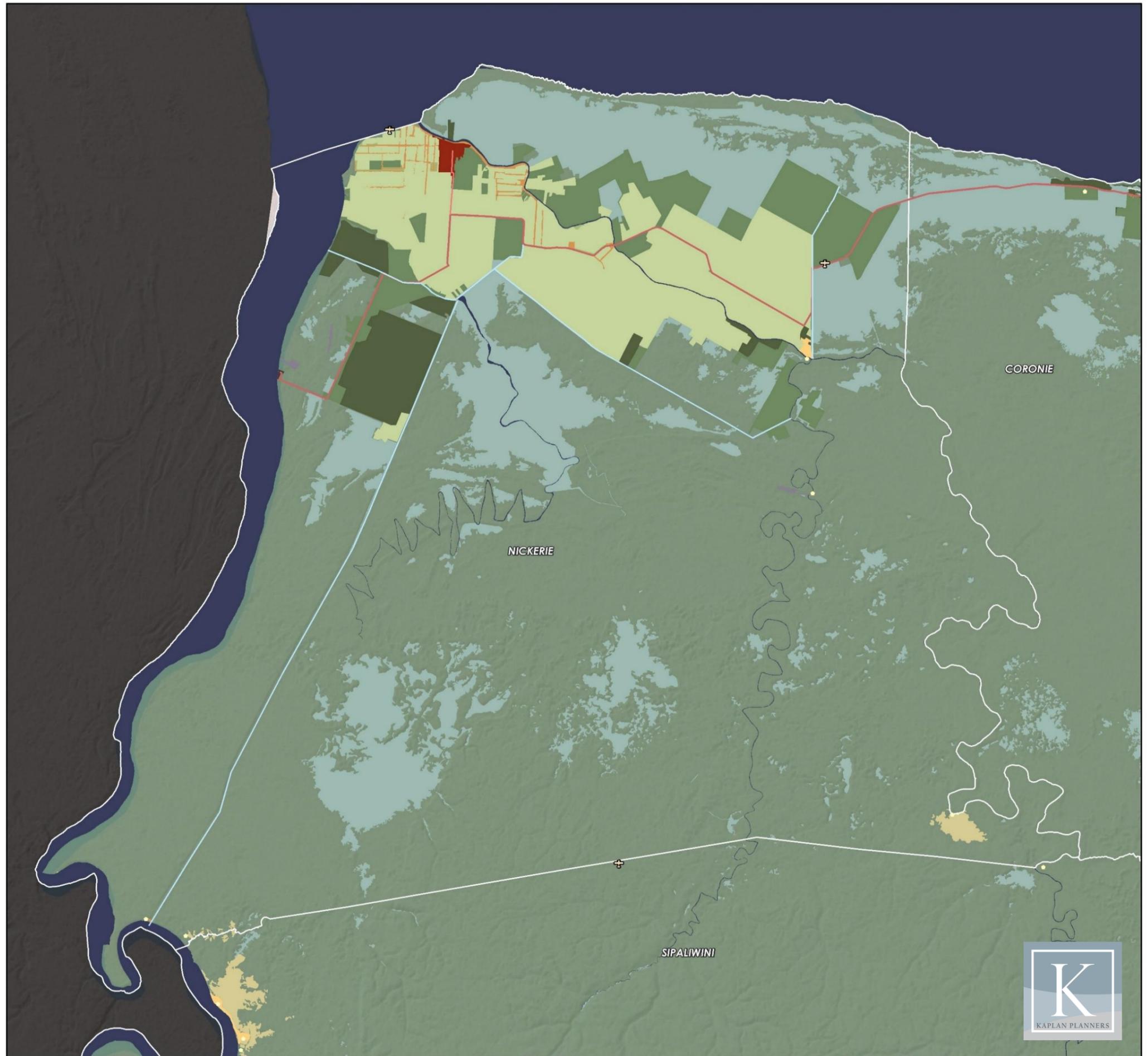
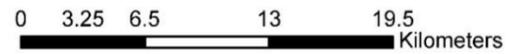
Canals	Woodlanding
Primary Road	Brokopondo Lake
Secondary Road	Dam\Dike
Infrastructure Sites	Mining
Dam\Dike	Gold
Airport	Oil
Airstrip	Bauxite
Built Area	Building Material
Industrial	Unclassified Mine
Urban	Abandoned Mine
Sub Urban	Human Forest
Rural	Shifting Cultivation
Town	Forest Plantation
Village	Natural Non Forest
Agriculture	River
Large Scale	Open Swamp (N)
Small Scale	Savannah
Small Scale\Abandoned (A)	Rock
Abandoned (A)\Pasture	Natural Forest
Infrastructure	Undisturbed Forest
Airport	Abandoned (B)
Port	



LAND USE MAP

NICKERIE DISTRICT

- | | |
|-----------------------------|---------------------------|
| Canals | Woodlanding |
| Primary Road | Brokopondo Lake |
| Secondary Road | Dam/Dike |
| Infrastructure Sites | Mining |
| Dam/Dike | Gold |
| Airport | Oil |
| Airstrip | Bauxite |
| Built Area | Building Material |
| Industrial | Unclassified Mine |
| Urban | Abandoned Mine |
| Sub Urban | Human Forest |
| Rural | Shifting Cultivation |
| Town | Forest Plantation |
| Village | Natural Non Forest |
| Agriculture | River |
| Large Scale | Open Swamp (N) |
| Small Scale | Savannah |
| Small Scale/Abandoned (A) | Rock |
| Abandoned (A)/Pasture | Natural Forest |
| Infrastructure | Undisturbed Forest |
| Airport | Abandoned (B) |
| Port | |



LAND USE MAP

CORONIE DISTRICT

Canals	Woodlanding
Primary Road	Brokopondo Lake
Secondary Road	Dam/Dike
Infrastructure Sites	Mining
Dam/Dike	Gold
Airport	Oil
Airstrip	Bauxite
Built Area	Building Material
Industrial	Unclassified Mine
Urban	Abandoned Mine
Sub Urban	Human Forest
Rural	Shifting Cultivation
Town	Forest Plantation
Village	Natural Non Forest
Agriculture	River
Large Scale	Open Swamp (N)
Small Scale	Savannah
Small Scale/Abandoned (A)	Rock
Abandoned (A)/Pasture	Natural Forest
Infrastructure	Undisturbed Forest
Airport	Abandoned (B)
Port	



LAND USE MAP

SARAMACCA DISTRICT

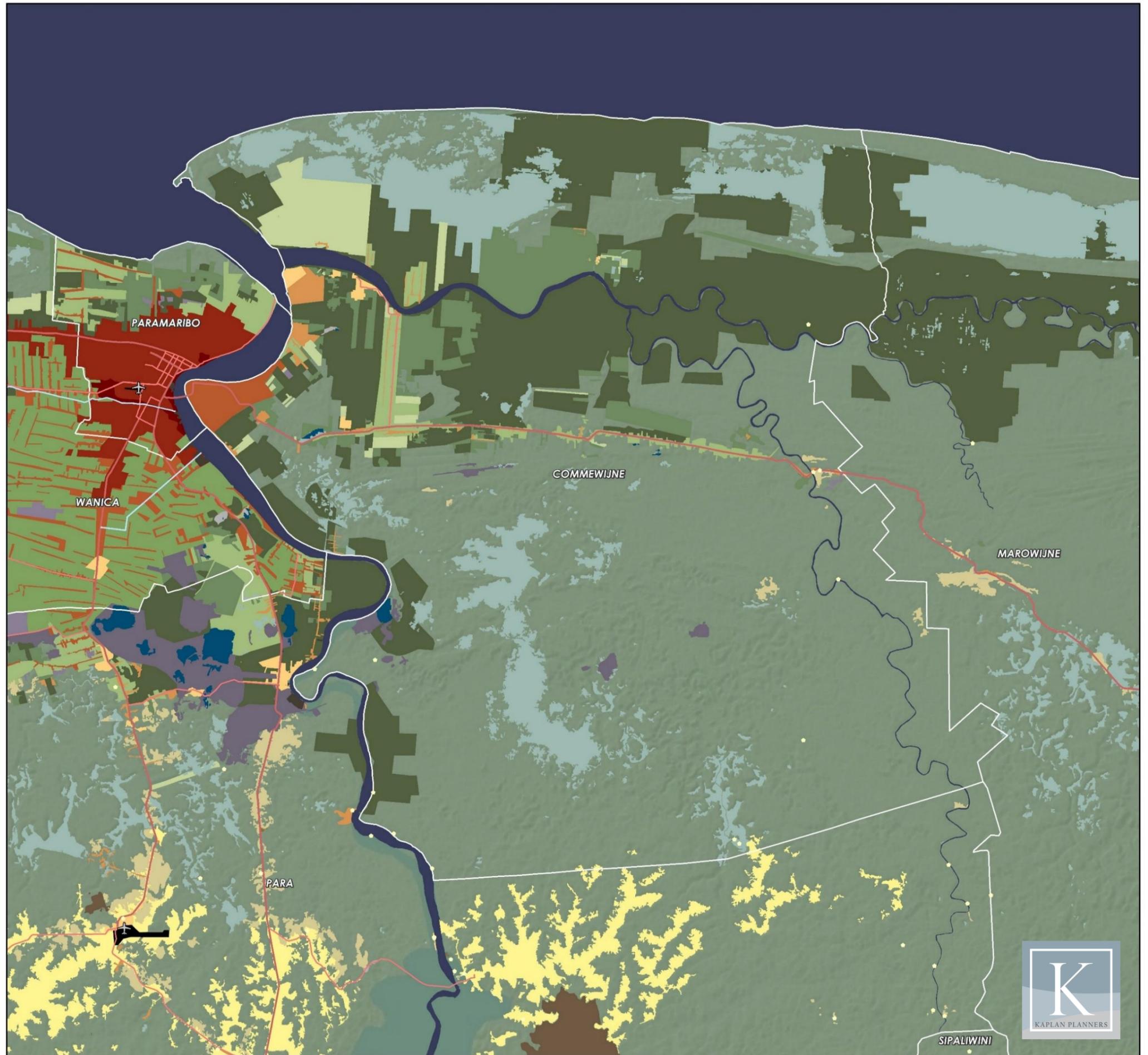
Canals	Woodlanding
Primary Road	Brokopondo Lake
Secondary Road	Dam/Dike
Infrastructure Sites	Mining
Dam/Dike	Gold
Airport	Oil
Airstrip	Bauxite
Built Area	Building Material
Industrial	Unclassified Mine
Urban	Abandoned Mine
Sub Urban	Human Forest
Rural	Shifting Cultivation
Town	Forest Plantation
Village	Natural Non Forest
Agriculture	River
Large Scale	Open Swamp (N)
Small Scale	Savannah
Small Scale/Abandoned (A)	Rock
Abandoned (A)/Pasture	Natural Forest
Infrastructure	Undisturbed Forest
Airport	Abandoned (B)
Port	



LAND USE MAP

COMMEWIJNE DISTRICT

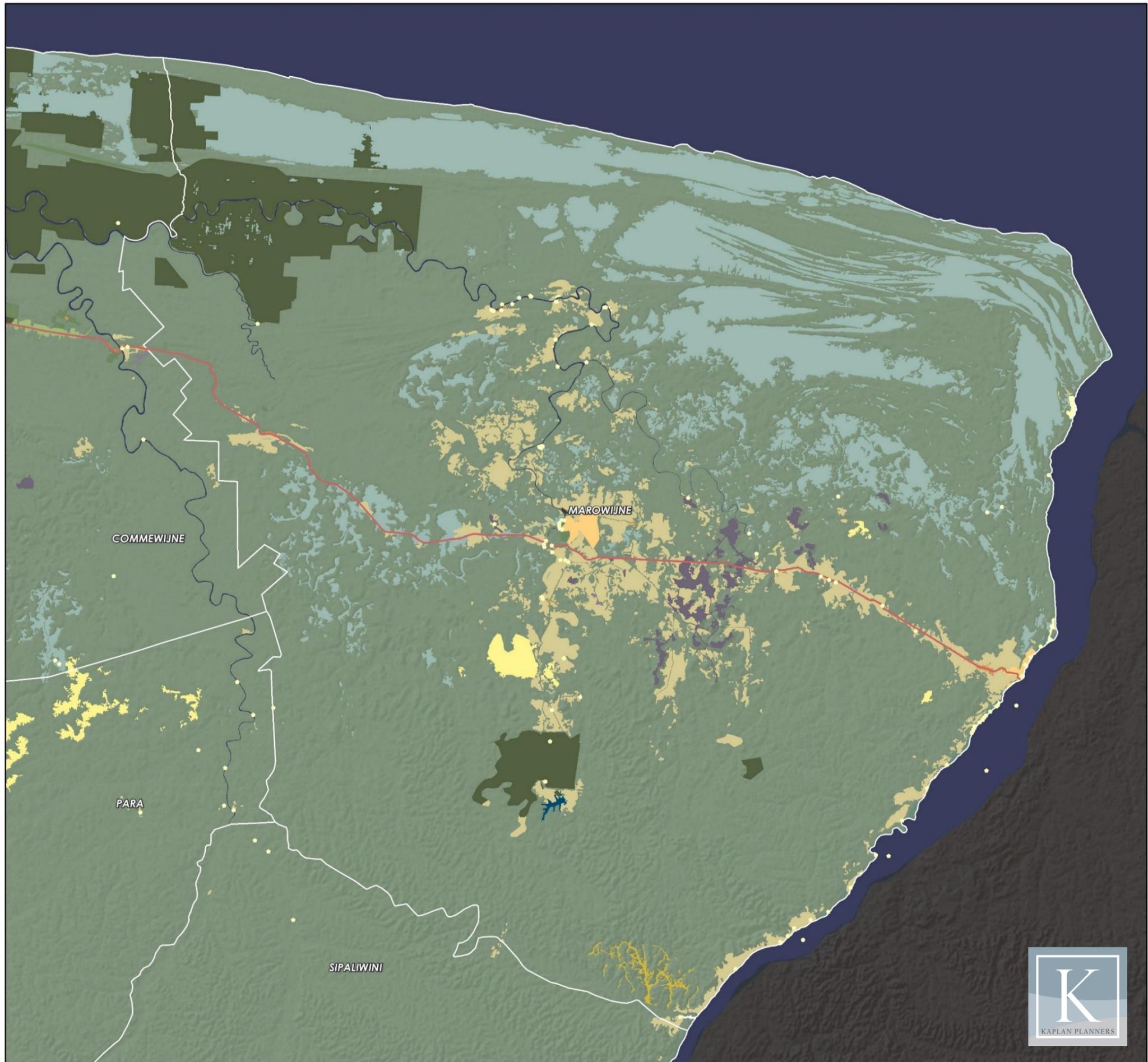
Canals	Woodlanding
Primary Road	Brokopondo Lake
Secondary Road	Dam/Dike
Infrastructure Sites	Mining
Dam/Dike	Gold
Airport	Oil
Airstrip	Bauxite
Built Area	Building Material
Industrial	Unclassified Mine
Urban	Abandoned Mine
Sub Urban	Human Forest
Rural	Shifting Cultivation
Town	Forest Plantation
Village	Natural Non Forest
Agriculture	River
Large Scale	Open Swamp (N)
Small Scale	Savannah
Small Scale/Abandoned (A)	Rock
Abandoned (A)/Pasture	Natural Forest
Infrastructure	Undisturbed Forest
Airport	Abandoned (B)
Port	



LAND USE MAP

MAROWIJNE DISTRICT

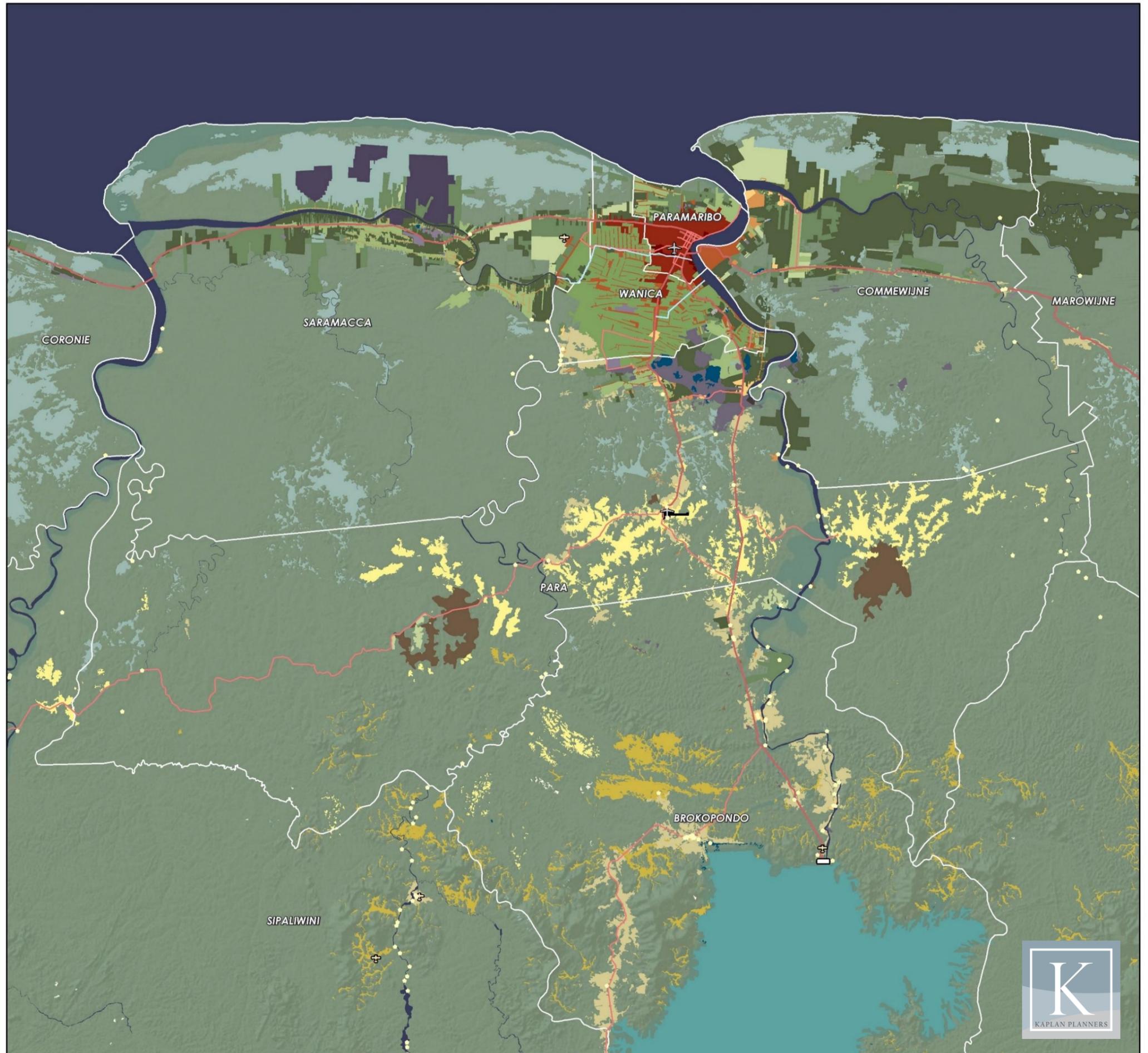
- | | |
|-----------------------------|---------------------------|
| Canals | Woodlanding |
| Primary Road | Brokopondo Lake |
| Secondary Road | Dam\Dike |
| Infrastructure Sites | Mining |
| Dam\Dike | Gold |
| Airport | Oil |
| Airstrip | Bauxite |
| Built Area | Building Material |
| Industrial | Unclassified Mine |
| Urban | Abandoned Mine |
| Sub Urban | Human Forest |
| Rural | Shifting Cultivation |
| Town | Forest Plantation |
| Village | Natural Non Forest |
| Agriculture | River |
| Large Scale | Open Swamp (N) |
| Small Scale | Savannah |
| Small Scale\Abandoned (A) | Rock |
| Abandoned (A)\Pasture | Natural Forest |
| Infrastructure | Undisturbed Forest |
| Airport | Abandoned (B) |
| Port | |



LAND USE MAP

PARA DISTRICT

Canals	Woodlanding
Primary Road	Brokopondo Lake
Secondary Road	Dam/Dike
Infrastructure Sites	Mining
Dam/Dike	Gold
Airport	Oil
Airstrip	Bauxite
Built Area	Building Material
Industrial	Unclassified Mine
Urban	Abandoned Mine
Sub Urban	Human Forest
Rural	Shifting Cultivation
Town	Forest Plantation
Village	Natural Non Forest
Agriculture	River
Large Scale	Open Swamp (N)
Small Scale	Savannah
Small Scale/Abandoned (A)	Rock
Abandoned (A)/Pasture	Natural Forest
Infrastructure	Undisturbed Forest
Airport	Abandoned (B)
Port	

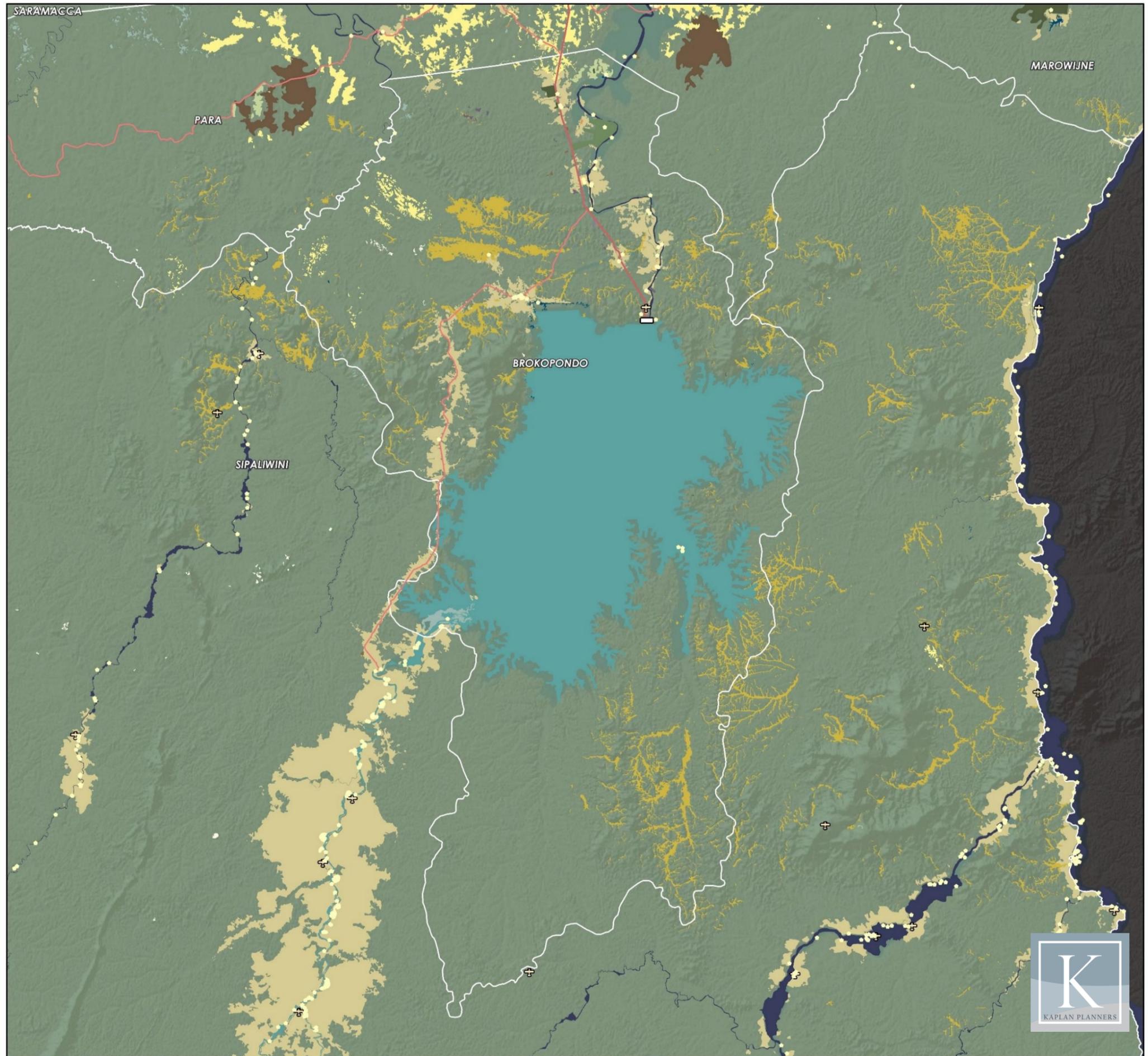


LAND USE MAP

BROKOPONDO DISTRICT

- | | |
|-----------------------------|---------------------------|
| Canals | Woodlanding |
| Primary Road | Brokopondo Lake |
| Secondary Road | Dam\Dike |
| Infrastructure Sites | Mining |
| Dam\Dike | Gold |
| Airport | Oil |
| Airstrip | Bauxite |
| Built Area | Building Material |
| Industrial | Unclassified Mine |
| Urban | Abandoned Mine |
| Sub Urban | Human Forest |
| Rural | Shifting Cultivation |
| Town | Forest Plantation |
| Village | Natural Non Forest |
| Agriculture | River |
| Large Scale | Open Swamp (N) |
| Small Scale | Savannah |
| Small Scale\Abandoned (A) | Rock |
| Abandoned (A)\Pasture | Natural Forest |
| Infrastructure | Undisturbed Forest |
| Airport | Abandoned (B) |
| Port | |

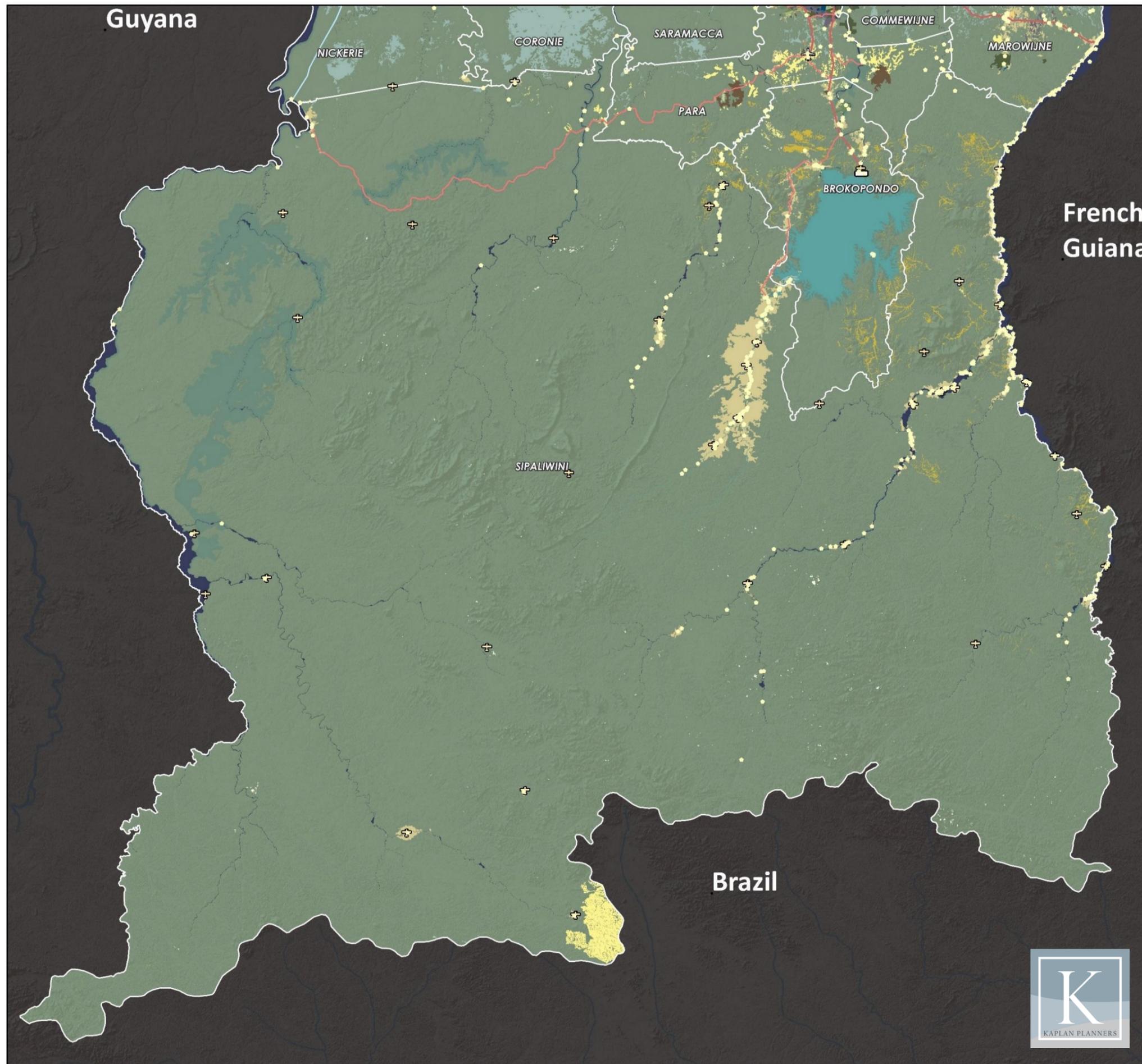
0 5 10 20 30 Kilometers



LAND USE MAP

SIPALIWINI DISTRICT

- | | |
|-----------------------------|---------------------------|
| Canals | Woodlanding |
| Primary Road | Brokopondo Lake |
| Secondary Road | Dam\Dike |
| Infrastructure Sites | Mining |
| Dam\Dike | Gold |
| Airport | Oil |
| Airstrip | Bauxite |
| Built Area | Building Material |
| Industrial | Unclassified Mine |
| Urban | Abandoned Mine |
| Sub Urban | Human Forest |
| Rural | Shifting Cultivation |
| Town | Forest Plantation |
| Village | Natural Non Forest |
| Agriculture | River |
| Large Scale | Open Swamp (N) |
| Small Scale | Savannah |
| Small Scale\Abandoned (A) | Rock |
| Abandoned (A)\Pasture | Natural Forest |
| Infrastructure | Undisturbed Forest |
| Airport | Abandoned (B) |
| Port | |



An aerial photograph showing a vast rural landscape. The foreground and middle ground are dominated by a grid of agricultural fields, some green and some yellowish-brown, separated by narrow roads and ditches. A small village with numerous houses and buildings is visible in the lower right quadrant. The background shows a wide expanse of fields stretching towards a distant horizon under a clear blue sky.

Division 3

Roadmap

BACKGROUND

INTRODUCTION

The Roadmap is a proposed approach for development, conservation and management of land resources in Suriname. It is intended to provide policy makers in Suriname with guidelines, intended to optimally prepare for the challenges posed by the Rio Conventions. The means proposed in the Roadmap are designed to tackle the threats posed by climate change, conserve biological diversity and protect land from erosion and degradation.

The starting point for the Roadmap (Land Designation Map) is the Land Use Map, which provides a **description** of the given physical condition, the use of the resource of land and space at a certain point in time. The Roadmap, in turn, presents an **idea**, a planning concept, recommendations and designations of areas for various purposes. The Roadmap seeks to change the current status in the best interest of the public.

PRINCIPLES

The Roadmap is guided by the following leading principles: concentration of development efforts in defined centers and routes or in proximity to them; saturation, rehabilitation and contiguous development.

Concentrating development efforts in defined centers and routes or in proximity to them has several important advantages:

1. Concentrated development efforts will prevent scattered development in open and natural areas. This course of action will assist in preserving natural resources, protecting biological diversity, and mitigating the greenhouse effect, by leaving most of the forests unharmed.
2. Concentrating efforts in defined focal points will lead to a more efficient and economically correct use of resources, will facilitate quick change, and will enable monitoring and control over the system.
3. Concentrated development enables good connectivity, accessibility to all settlements on main roads, with a better affinity between each another.

GUIDELINES

In order to promote a policy of saturation, rehabilitation and contiguous development, the Roadmap aims to focus efforts on areas that have already been developed. This is to be achieved by several methods:

1. Saturation of built areas, restoration and condensing in the cities, especially in Paramaribo, should be preferred over sprawling at the expense of agricultural and natural areas around it.
2. Urban and rural development (beyond the aforementioned saturation) should always be contiguous - or at least in close proximity - to existing built areas. The establishment of new development foci, distant from existing ones, would lead to pavement of roads, installation of infrastructure, disrupting and disconnecting natural areas.

3. Renewal of the agricultural activity in the abandoned agricultural areas should be prioritized over the preparation of new cultivation areas, the latter reducing the natural forest area.
4. Maximum utilization of mining material in active quarries (mainly the gold in the many abandoned quarries), before opening new quarries.
5. Restoration of abandoned quarry areas (mainly bauxite), and diversion of industry and infrastructure to their perimeter.
6. Expansion of existing roads instead of construction of new ones in natural areas.

As a rule, the Roadmap aims at maximizing intensive development in the existing development centers, prioritizing it above the expansion beyond the boundaries of the defined development areas.

DIVISION TO GROUPS: DEVELOPMENT AND CONSERVATION

The Roadmap creates spatial zoning on the national level based on the Separation Principle, according to which the area is divided into two main groups, each one determining in advance the various types of development.

1. **Development Oriented Areas** - preselected areas, designated for dense and structured development, including settlements, agriculture, industry, etc. The Roadmap designates some of the quarries for development-oriented rehabilitation – mostly the bauxite quarries in Para and Marowijne. These are large quarries, in which large areas were heavily transformed and disrupted.
2. **Conservation Oriented Areas** - areas which will be preserved as natural open spaces with various levels of protection and preservation. The Roadmap designates a part of the quarries for conservation-oriented rehabilitation and return to the natural status – mostly gold quarries in Marowijne, Brokopondo and Para, and the petroleum fields in Saramacca.

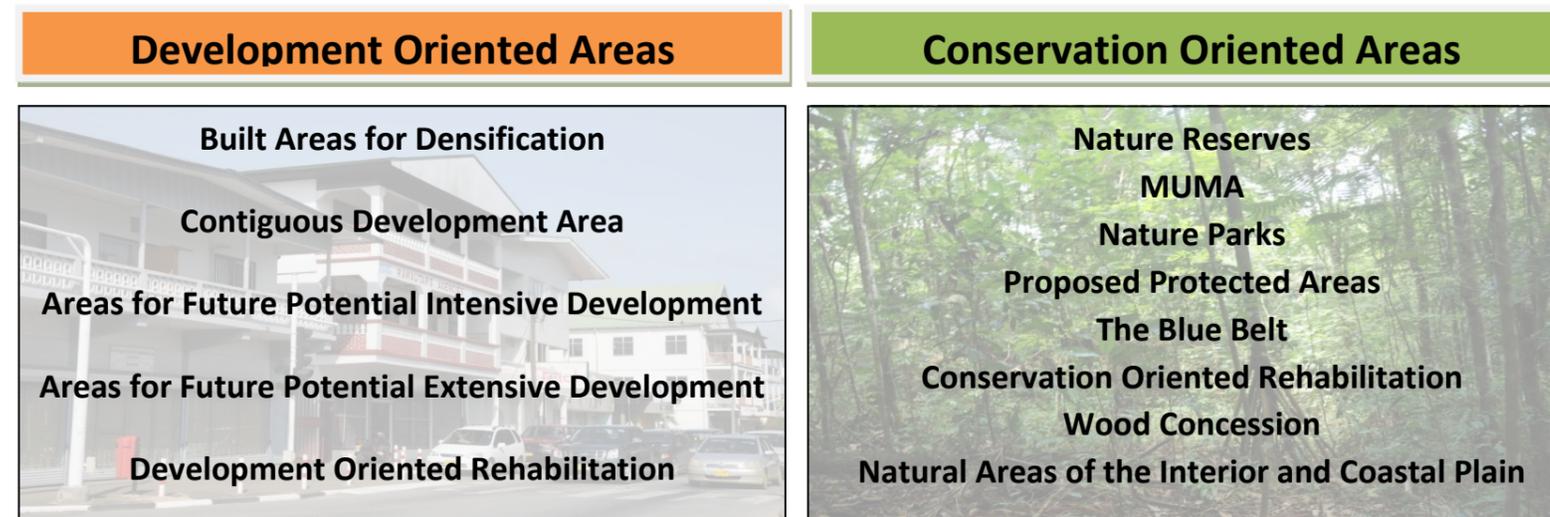


Figure 4: Classification of the Roadmap's land designations into two main categories: development and conservation.

THE SEPARATION PRINCIPLE

Separation between development areas and conservation areas is a central principle of the sustainable development as it is expressed in the CCCD project. Uncontrolled sprawling of development into open areas - natural or agricultural - would disrupt the integrity of the ecosystem, sever and harm biodiversity. Additionally, supplemental development of settlements outwards would weaken the settlements themselves. For example, the weakening of central Paramaribo is already apparent, in the form of removal of commercial areas from the city centre, development of new neighborhoods outside the city, etc. All of those affect the city's strength in its economic, social and cultural life, weakening its function as a metropolitan centre. A well-organized development, with predefined boundaries, is preferable to a dispersed and loosely organized development.

DEVELOPMENT ORIENTED AREAS

The Roadmap defines different types of development, in accordance with the unique conditions and needs of Suriname, outlining land designations for future use: development of the residential sector, settlement expansions in proximity to existing settlements, expansion of cultivated plots towards abandoned plots - usually attached to active plots - use of existing quarries with depleted material, and more. Below is a detailed description of each of the land designations and classifications.

This classification includes all forms of development: residential areas, infrastructure, industry, employment, agriculture, tourism, mines, etc. The Roadmap directs these uses to their most appropriate locations.



Built Areas for Densification

The core zones for development consist of the towns and cities of Suriname. The Roadmap aims to concentrate development inside these settlements. The recommendations include the intensification and saturation of density and the infill of existing built areas, such as abandoned buildings, as well as empty lots in Paramaribo, which currently have little functionality. The proposed planning outline additionally includes substantial additional construction and the introduction of mixed uses - mainly into the historic core - and development of public transportation routes. All of these measures could bring forth urban renewal and prosperity, as well as prevent sprawling and the depletion of surrounding natural and agricultural areas.



Contiguous Development Area

Zones mostly including the perimeter of existing settlements. It is proposed that urban development will spread to these areas, creating consecutive areas of development, with existing built areas and infrastructure. A prominent example is found in the Wanica district, where future development should focus on the area around the current route, connecting Paramaribo and Lelydorp, to the surrounding suburban neighborhoods. It should be stressed that the "Contiguous Development Area" is a search area for potential spaces for urban spreading. **It is not intended to be fully developed.** In New Nickerie, development should occur to the south of the existing city, in Mungo and Albina circulating around the town, and so on.



Areas for Future Potential Intensive Development

Areas where potential extensive developments should be located, in a systematic, thoroughly planned fashion. This designation is relevant for the northern parts of Suriname, where settlements are denser and activity is carried out on a large scale, across significant areas. These areas were chosen and outlined to answer for future needs, should the areas adjacent to existing uses be exhausted. It is not intended to outline recommended areas for the present or near future. The Roadmap aims to direct policy makers to focus on those potential areas for intensive uses such as urban

development, agriculture, metropolitan parks, employment and industrial zones, service and logistic centers, as well as recreation and tourism areas. These areas are proposed as a boundary for future development, since they are expected to provide for the development needs of Suriname, and there is no reason to disrupt natural areas found outside of them. The zones of potential development have been located mostly along the two main roads of Suriname - from Albina to New Nickerie, on the East-West Connection, and from Paramaribo to Pokigron, on the North-South Connection.



Areas for Future Potential Extensive Development

Throughout the Interior, there are dozens of community settlements, mostly along the Marowijne River, the Suriname River, the Saramacca River and the main streams. The surrounding area is used for the communities' livelihood, in the form of shifting cultivation, as hunting and fishing areas, and producing wood for local use from the forest, as well as additional forest products. The Roadmap accurately identifies the settlement points at the Interior, and the living areas surrounding them, as well as a shell area for potentially additional spatial development.

These areas will serve for development purposes, for existence and livelihood of the communities in the Interior. The development form will be based on traditional activities, enhanced by advanced technology and methods. The activities in the areas dedicated for livelihood purposes will be a combination of nature tourism, lodging centers and tourism routes in the natural area. Development will also focus on promotion of shifting

cultivation through new technologies - irrigation, fertilization, etc. The goal is to concentrate and reduce the processing cycles of the area, thereby minimizing the area of forest affected. Trees will be used for local consumption, natural pasture integrated into the forest and production of forest products without harming the forest itself - products such as cosmetics, medicine, art, solar energy farms, etc.



Development Oriented Rehabilitation

Open and abandoned mines, which are located close to major roads and existing settlements, can be rehabilitated in a development-oriented manner and integrated into areas peripheral to settlements. These are usually small quarries along streams, where the environmental disruption is relatively of little significance. The introduction of industry, tourism or infrastructure could prevent impact on untouched natural areas. Additionally, this effort could contribute to a systematic rehabilitation of the damaged areas, clearing the worst impacts on the landscape.

The most prominent example of this type is the abandoned bauxite mines in the south of Wanica, on the Para district border. These cover an area of over 3,000 hectares and lie at the heart of the national development zone and along the main roads. This area is currently unused. Following rehabilitation, the area can instead play a productive economic role and contribute to the development of the entire region. The heavy industry causing severe environmental damage in Paramaribo would be replaced by a large "industrial park", located in the quarry rehabilitation zone.

CONSERVATION ORIENTED AREAS

This group consists of areas with a high natural value and, in fact, most of Suriname's open land. In the Land Use Map, these are the forest areas - mostly rainforests, savannah, swamp and grassland, bare mountain ranges, rivers etc. From a national perspective, this group can be divided into three main sub-groups:



Nature Reserves

Areas currently under legal protection by the Surinamese government. These areas outline ecosystems and habitats of specific species, where human activity is limited and regulated according to the laws of Suriname. The Roadmap has taken the nature reserves as an existing condition in the mapping process, adapting them with no changes.



MUMA

Multiple-Use Management Areas (MUMA) are defined in Suriname as locations where economic activity is allowed, so long as it does not disrupt certain terms regarding environmental protection. MUMA are outlined mostly on the coast of Suriname, where commercial maritime activities take place in close proximity of the mangroves streak. As is the case with the Nature Reserves, The Roadmap has fully adopted the MUMA principle and geographical outlines.



Nature Parks

Nature parks are defined as natural areas where recreational uses of land are allowed, as these are considered extensive purposes, causing minimal effects to the environment. The Roadmap has adopted this designation into its own.



Proposed Protected Areas

The Proposed Protected Areas are delineations of sensitive natural ecosystems and habitats whose legal acknowledgement as protected areas is pending. Due to the initial recognition of the area as vulnerable and of significant natural value, the Roadmap has kept the outlines of the proposed areas in its mapping process.



The Blue Belt

The areas to the north of the main rivers of Suriname and south of the coastline, north of the large cities and towns, are to be marked for conservation and extremely limited development. These areas include a mangrove streak in front of the coast, swamps and lakes, all of which form a natural protection from sea level rise. It would further prevent and regulate flooding and sea water intrusion into the development streak, the settlements and infrastructure along the coast in the north of the country. The natural mangrove forest protective barriers, securing the ground from erosion, must be rehabilitated in places where the streak has been damaged (Paramaribo and Coronie), helping to ameliorate the land loss and contribute to biological diversity. Human development should be done in a manner that is careful and limited to sensitive ecotourism, fisheries and nature-related activities. Existing agriculture, infrastructure and housing should be gradually relocated to protected areas further from the coast, in dialogue with the local communities.

It should be noted that the areas covered by the Blue Belt in the Roadmap, are currently under the protection of the MUMA outlines. The current proposal seeks to: 1. Extend the protected area to places where MUMA is not present, e.g. north Paramaribo and east Marowijne. 2. To strengthen restrictions and prevent multi-purpose use previously permitted by MUMA, mainly restrictions on development of settlements and agriculture areas.



Conservation Oriented Rehabilitation

Quarries in which the material was completely extracted, and have reached the end of their activity, in the natural areas of Suriname, will be transformed back into the natural status. This is true in regards to the gold quarries in Marowijne, Brokopondo and Para, spread across large areas, disrupting the natural land and disconnecting the forest's consecutiveness. This is also true regarding the petroleum production fields in Saramacca.

The Roadmap recommends to take compulsory measures to make operating companies to complete extraction from the quarries before the quarry is shut down and new quarries are opened. After extraction is complete, the operating company will be obligated to fully rehabilitate the quarry, including the removal of all polluting substances, cover of the quarry with fertile soil and encouragement of restoration of the natural forest, including - among other measures – plantation of trees.

Wood Concession

Concession areas are delineated within the natural forest. In the concession framework, guidelines and restrictions were set concerning the scope of woodcutting, methods of wood-cutting and transportation, periodic division over the years and affinity to communities. Although there is an element of development present, the main function of the concession area is practically that of a natural forest. Note that since many concession areas overlap other protected areas, they were not included in the map and SHP files of the Roadmap.



Natural Areas of the Interior and Coastal Plain

The interior areas of Suriname, primarily south of the development belt, should remain largely in their natural state. The Interior consists of multiple diverse landscapes and habitats, only some of which are currently represented in natural reserves. The paradigmatic example is the central reserve, while drainage basements in the Marowijne and Corantijn Rivers, and no rich and unique flora and fauna are represented at all. The small communities existing in the Interior presently practice a sustainable lifestyle, which needs to be provided with proper conditions to continue. The development of heavy infrastructure or new urban communities in this area is not recommended. Such attempts would be economically inefficient and have little effect in promoting development, while greatly undermining the goals of the Rio Conventions by exposing vast areas of natural forest to exploitation. The natural areas include the largest forested area in Suriname and one of the biggest and best-preserved tropical forests in the world. Local improvements in services such as education and health, as well as limited sustainable investments in sectors such as high-end ecotourism and scientific research, can generate incomes and improvements to the quality of life without causing harm to the natural conditions and the area's ecological sensitivity.

PLANNING MAPS - 'ROADMAP'

ROADMAP

NATIONAL PLANNING LAYOUT

LEGEND

Development

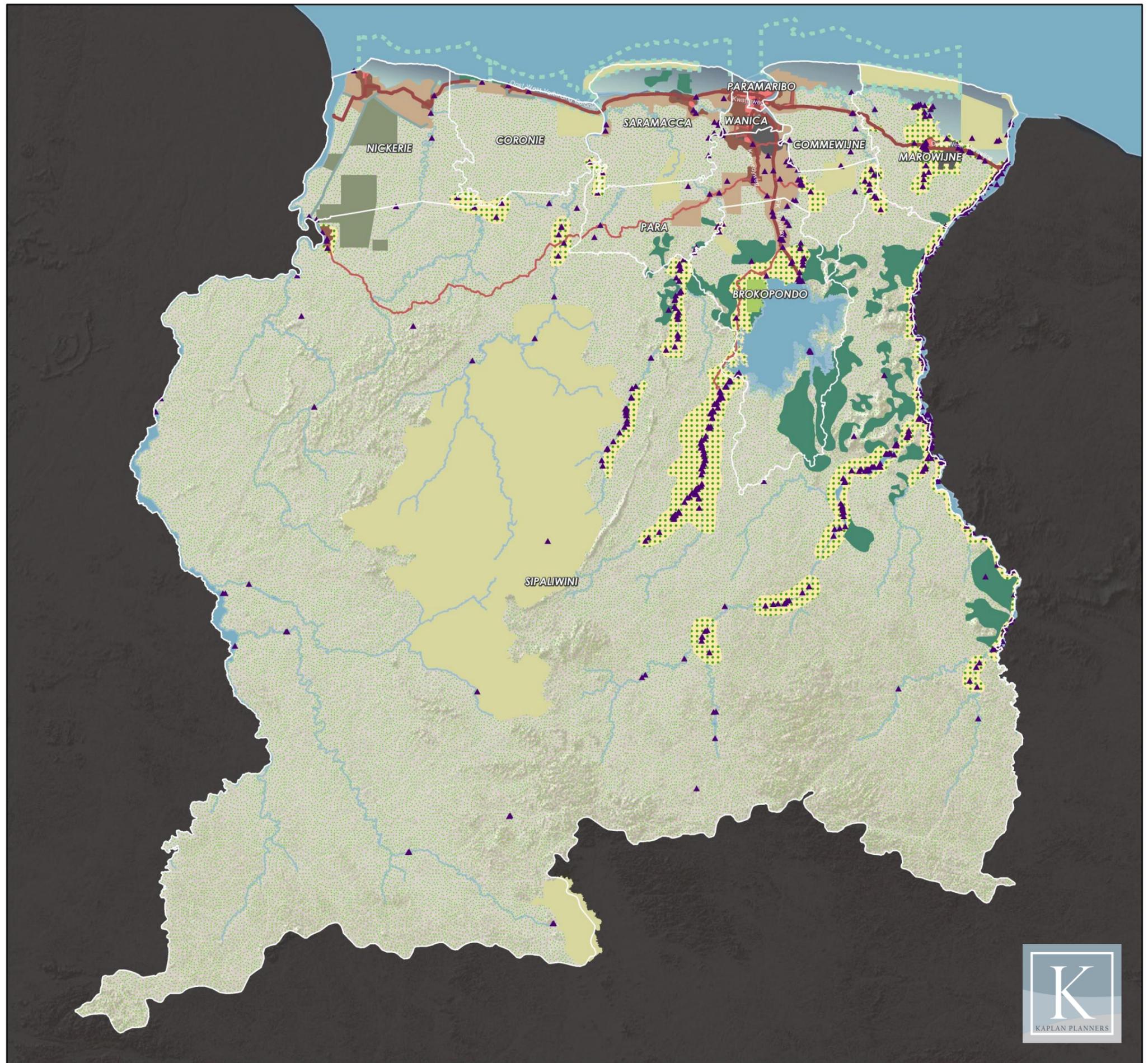
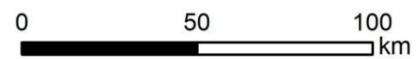
- Built Area for Densification
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
- Area for Future Potential Extensive Development
- Development Oriented Rehabilitation
- Canals

Conservation

- Protected Area
- MUMA - Multiple Use Management Area
- Naturel Park
- Proposed Protected Area
- Blue Belt
- Nature Oriented Rehabilitation
- Bodies of Water
- Natural Areas of the Interior and Coastal Plain

Roads

- Primary Road
- Secondary Road
- Settlement



ROADMAP

PARAMARIBO DISTRICT

LEGEND

Built Areas

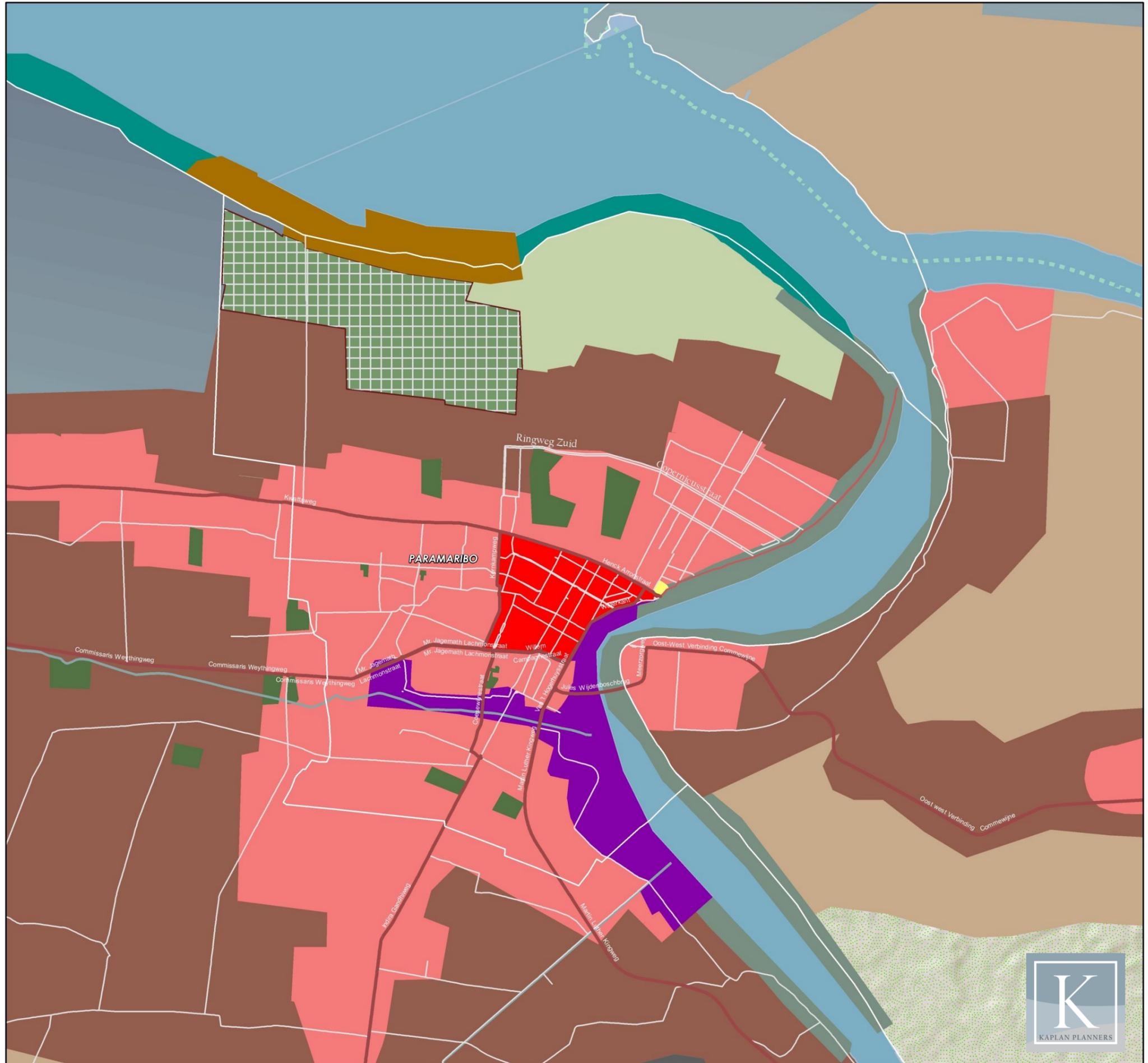
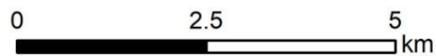
- Historic City Center
- Built Area for Densification
- Light Industry and Employment
- Development Oriented Rehabilitation
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
- Settlement
- Canals

Conservation

- MUMA - Multiple Use Management Area
- Blue Belt
- Preserved Natural Area
- Riverfront Green Promenade
- Urban Park
- Park Palmentuin
- Muddy Area for Rehabilitation
- Mangrove Conservation and Rehabilitation
- Rural Area - Cessation and Rehabilitation
- Bodies of Water
- Natural Areas of the Interior and Coastal Plain

Roads

- Primary Road
- Secondary Road
- Local Roads



ROADMAP

WANICA DISTRICT

LEGEND

Built Areas

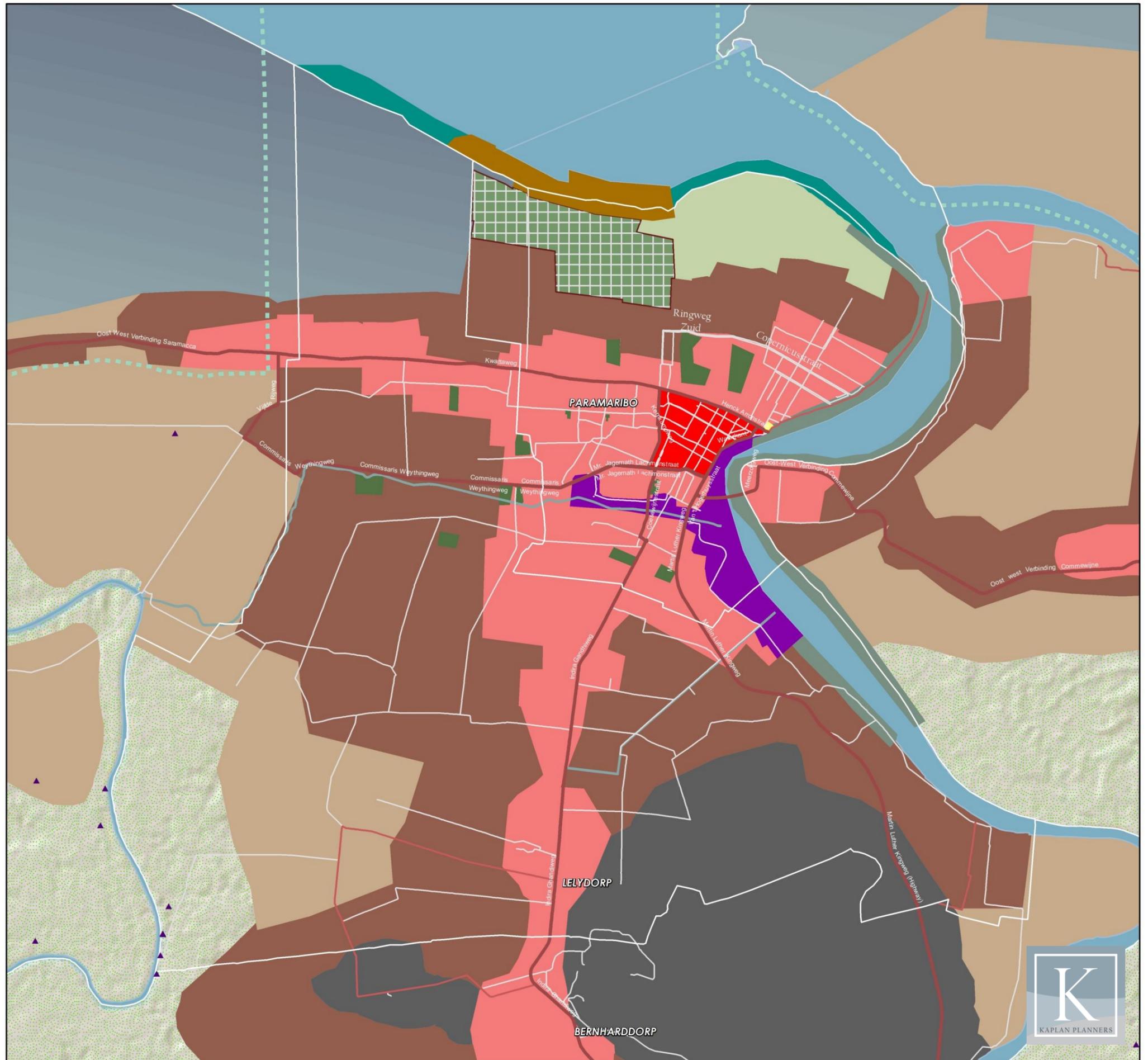
- Historic City Center
- Built Area for Densification
- Light Industry and Employment
- Development Oriented Rehabilitation
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
- Settlement
- Canals

Conservation

- MUMA - Multiple Use Management Area
- Blue Belt
- Preserved Natural Area
- Riverfront Green Promenade
- Urban Park
- Park Palmentuin
- Muddy Area for Rehabilitation
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- Rural Area - Cessation and Rehabilitation
- Bodies of Water
- Natural Areas of the Interior and Coastal Plain

Roads

- Primary Road
- Secondary Road
- Local Roads



ROADMAP

NICKERIE DISTRICT

LEGEND

Development

- Built Area for Intensification
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
- Area for Future Potential Extensive Development

Conservation

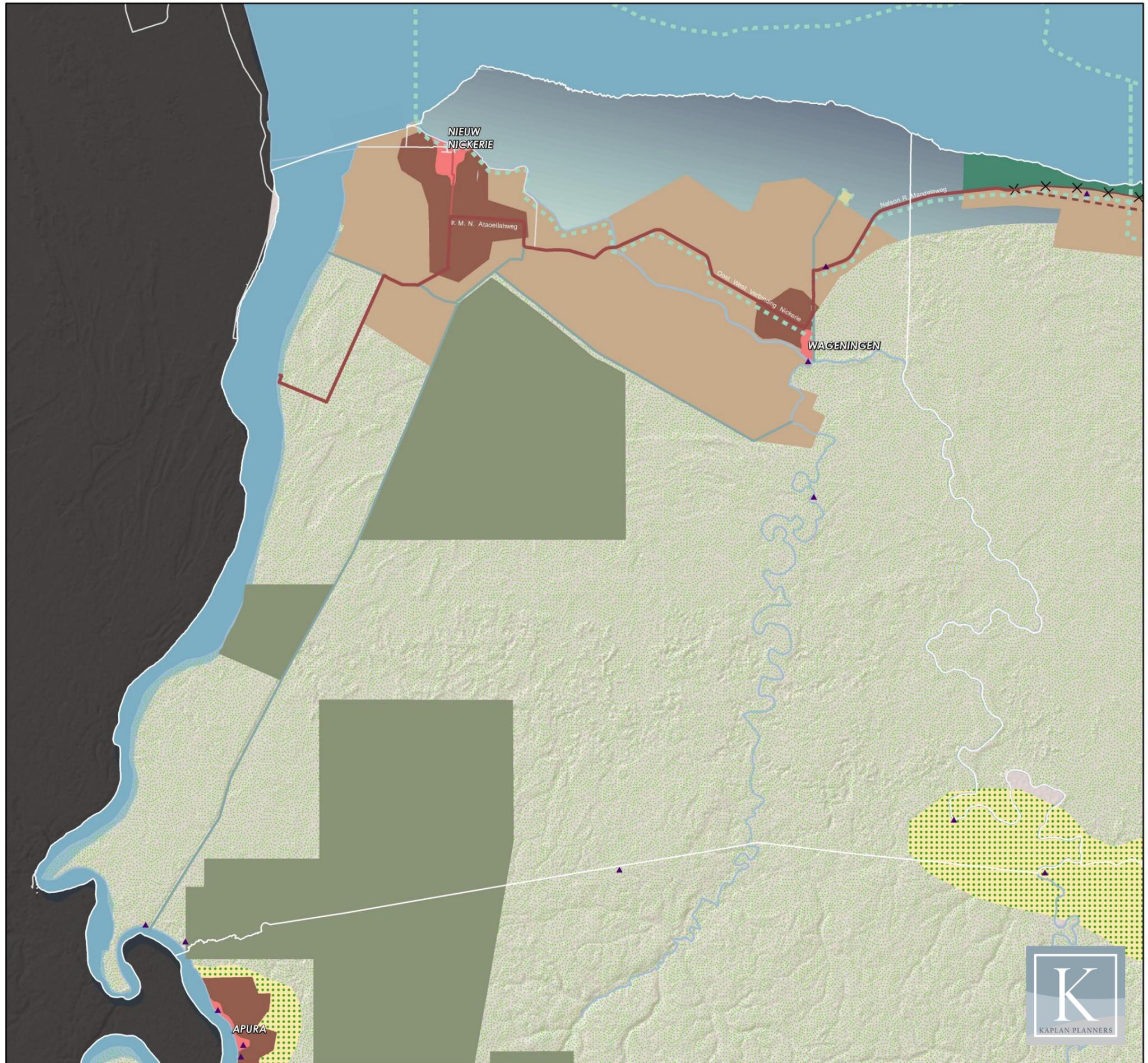
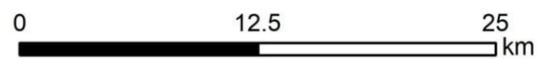
- MUMA - Multiple Use Management Area
- Protected Area
- Proposed Protected Area
- Blue Belt
- Nature Oriented Rehabilitation
- Bodies of Water
- Natural Areas of the Interior and Coastal Plain

Roads

- Proposed for Removal
- Proposed New Road
- Primary Road
- Secondary Road
- Local Roads

Other

- Settlement
- Canals



ROADMAP

CORONIE DISTRICT

LEGEND

Development

- Built Area for Densification
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
- Area for Future Potential Extensive Development

Conservation

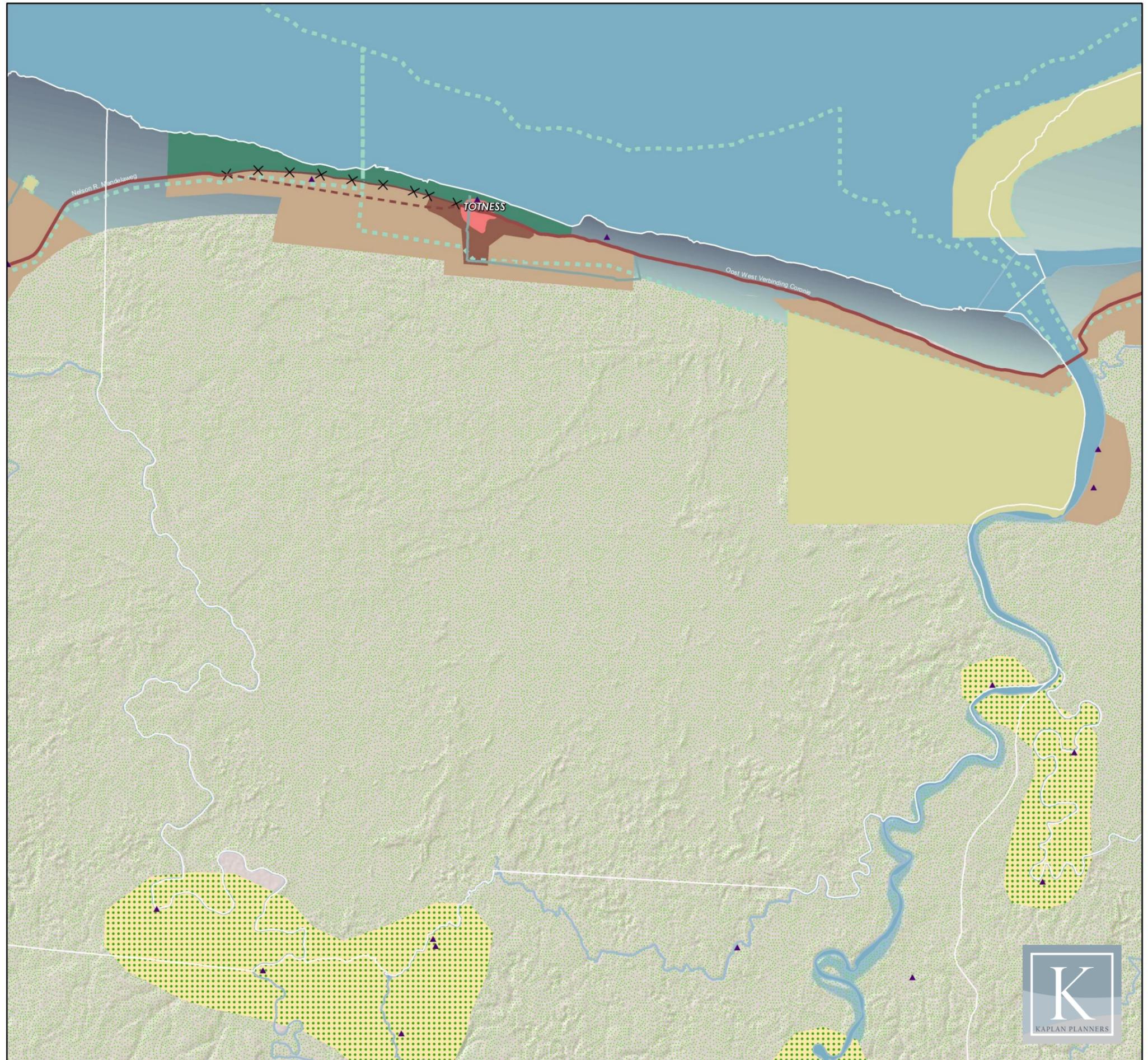
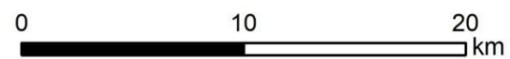
- MUMA - Multiple Use Management Area
- Protected Area
- Blue Belt
- Nature Oriented Rehabilitation
- Bodies of Water
- Natural Areas of the Interior and Coastal Plain

Roads

- Proposed for Removal
- Proposed New Road
- Primary Road
- Local Roads

Other

- Settlement
- Canals



ROADMAP

SARAMACCA DISTRICT

LEGEND

Development

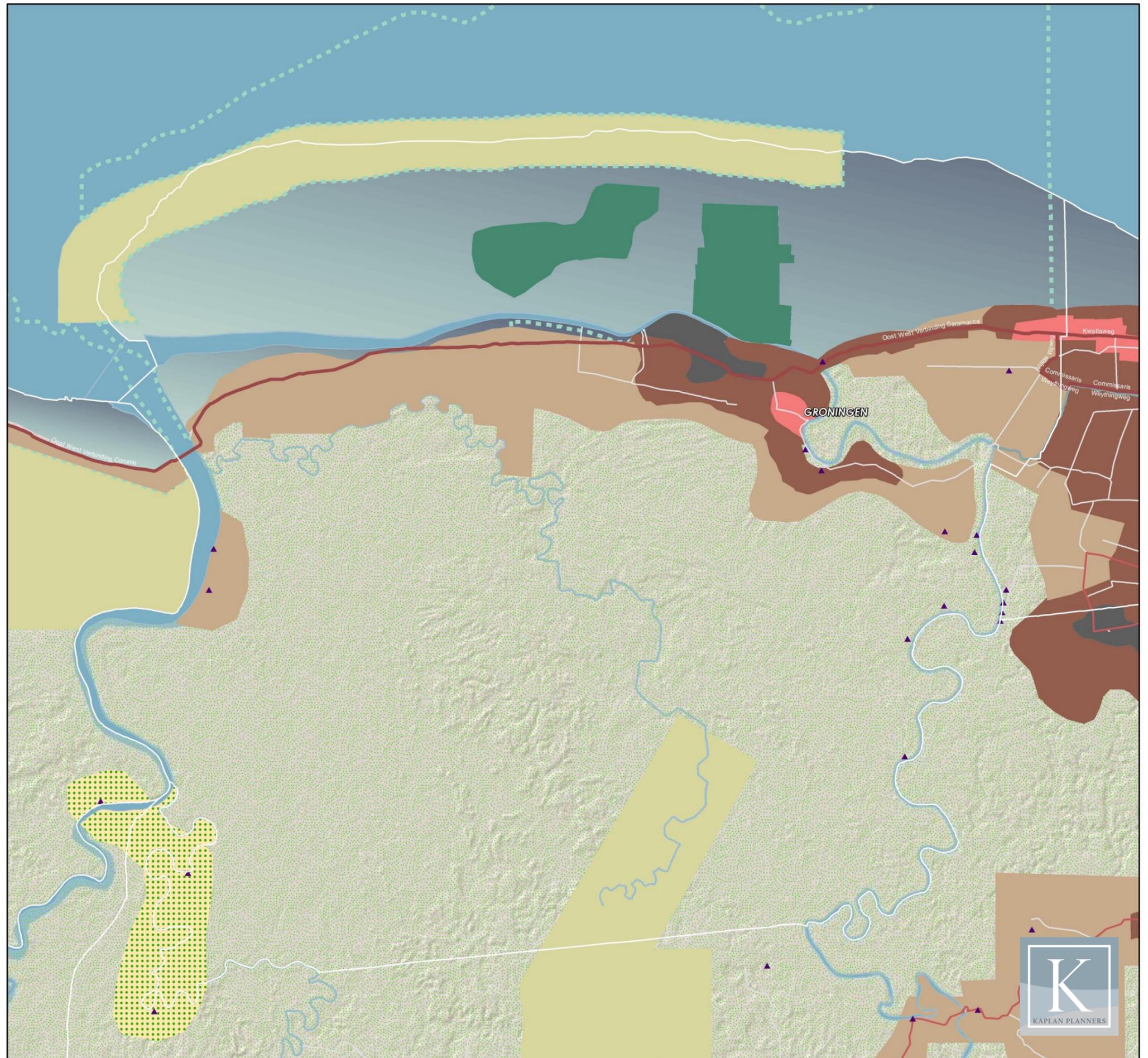
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- Canals

Conservation

- Protected Area
- MUMA - Multiple Use Management Area
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- Bodies of Water
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Roads

- Primary Road
- Secondary Road
- Local Roads
- Settlement



ROADMAP

COMMEWIJNE DISTRICT

LEGEND

Built Areas

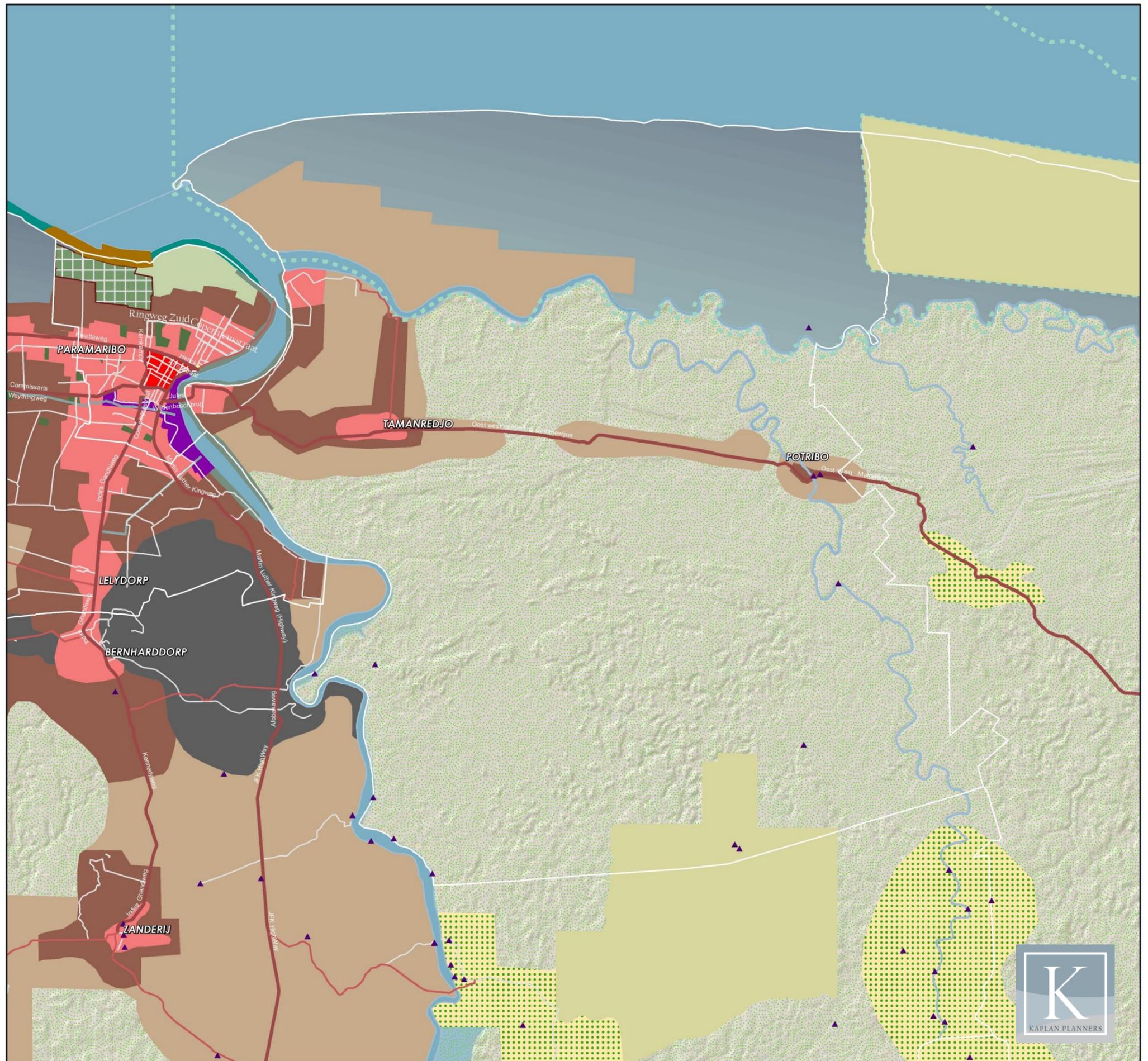
- Historic City Center
- Built Area for Densification
- Light Industry and Employment
- Development Oriented Rehabilitation
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
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- Canals

Conservation

- MUMA - Multiple Use Management Area
- Protected Area
- Blue Belt
- Preserved Natural Area
- Riverfront Green Promenade
- Urban Park
- Park Palmentuin
- Muddy Area for Rehabilitation
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- Natural Areas of the Interior and Coastal Plain

Roads

- Primary Road
- Secondary Road
- Local Roads



ROADMAP

MAROWIJNE DISTRICT

LEGEND

Development

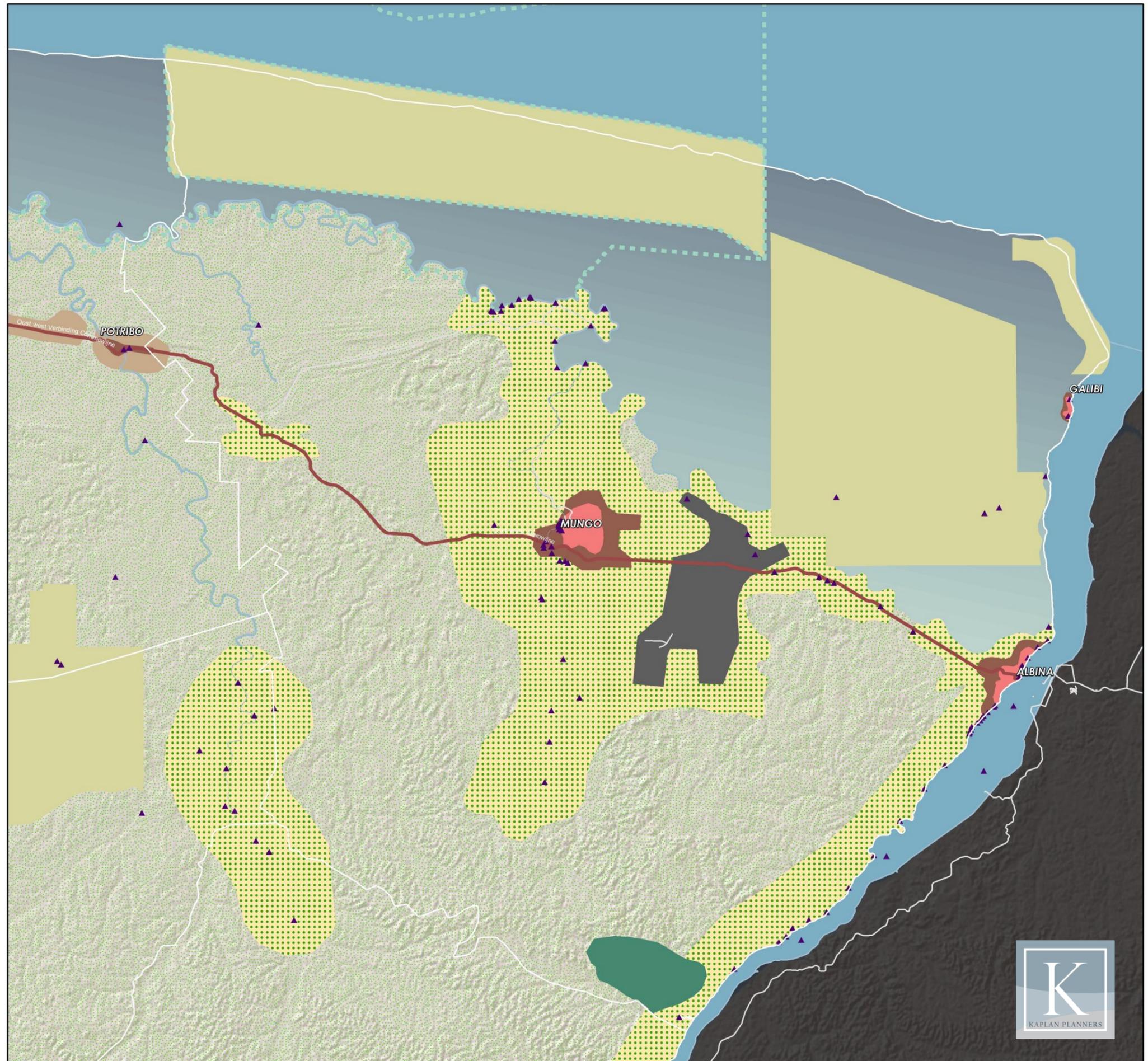
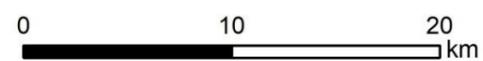
-  Built Area for Densification
-  Contiguous Development Area
-  Area for Future Potential Intensive Development (agriculture, recreation...)
-  Area for Future Potential Extensive Development
-  Development Oriented Rehabilitation

Conservation

-  Protected Area
-  MUMA - Multiple Use Management Area
-  Blue Belt
-  Nature Oriented Rehabilitation
-  Bodies of Water
-  Natural Areas of the Interior and Coastal Plain

Roads

-  Primary Road
-  Local Roads
-  Settlement



ROADMAP

PARA DISTRICT

LEGEND

Development

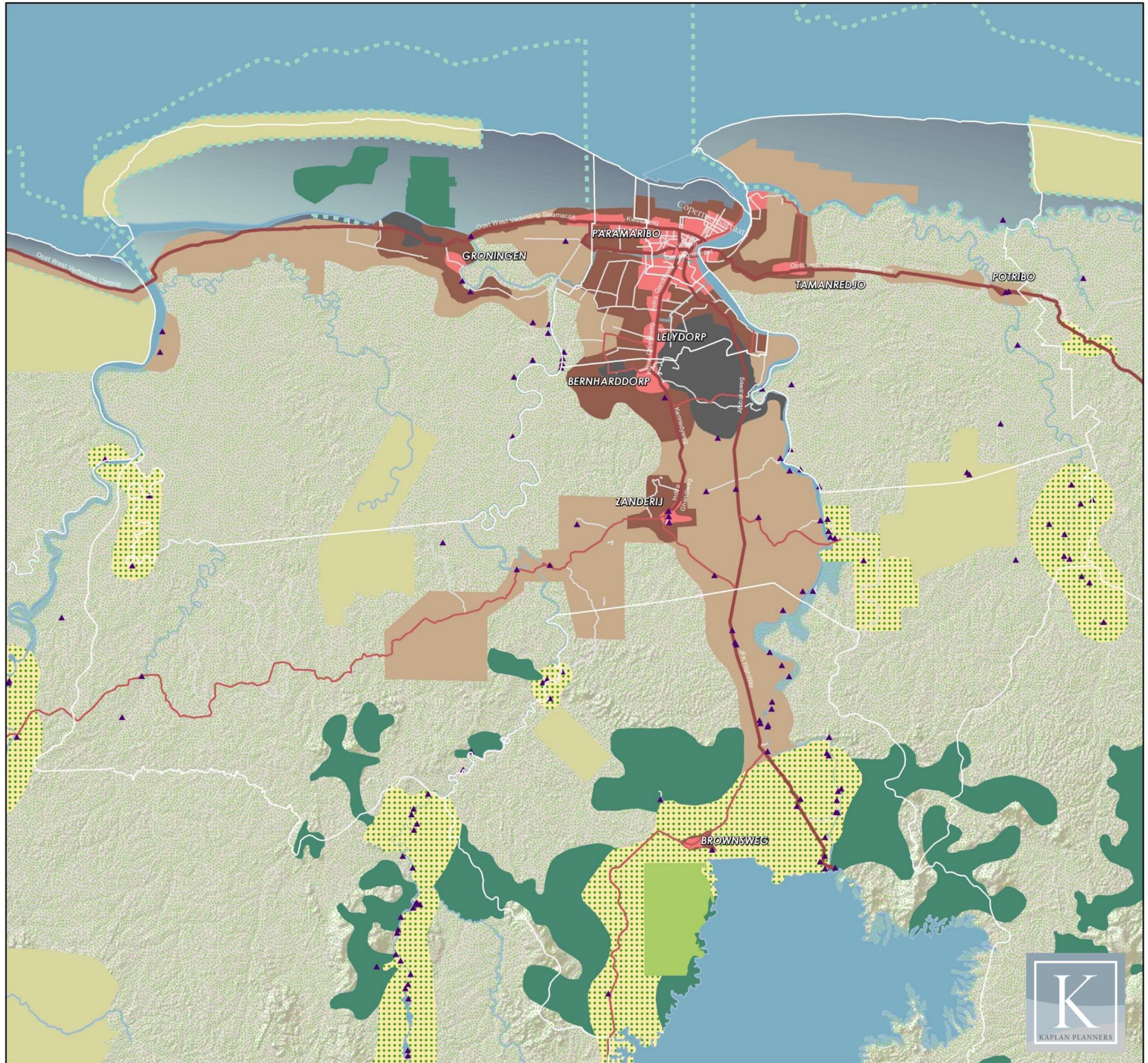
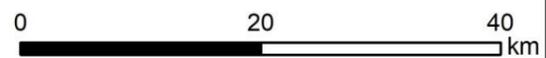
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- Contiguous Development Area
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- Canals

Conservation

- Protected Area
- MUMA - Multiple Use Management Area
- Naturel Park
- Blue Belt
- Nature Oriented Rehabilitation
- Bodies of Water
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Roads

- Primary Road
- Secondary Road
- Local Roads
- Settlement



ROADMAP

BROKOPONDO DISTRICT

LEGEND

Development

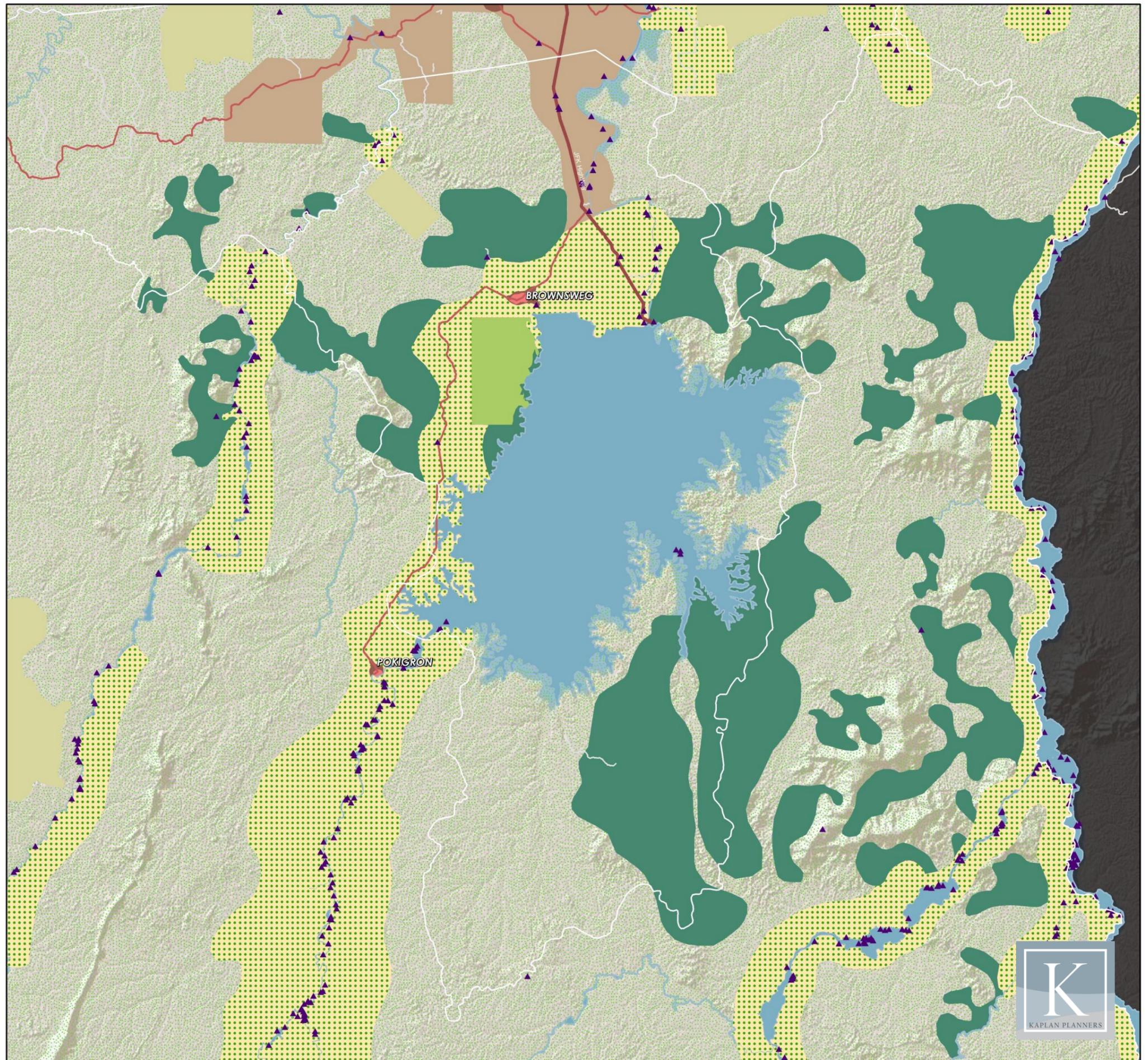
- Built Area for Densification
- Contiguous Development Area
- Area for Future Potential Intensive Development (agriculture, recreation...)
- Area for Future Potential Extensive Development

Conservation

- Protected Area
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- Nature Oriented Rehabilitation
- Bodies of Water
- Natural Areas of the Interior and Coastal Plain

Roads

- Primary Road
- Secondary Road
- Local Roads
- Settlement



ROADMAP

SIPALIWINI DISTRICT

LEGEND

Development

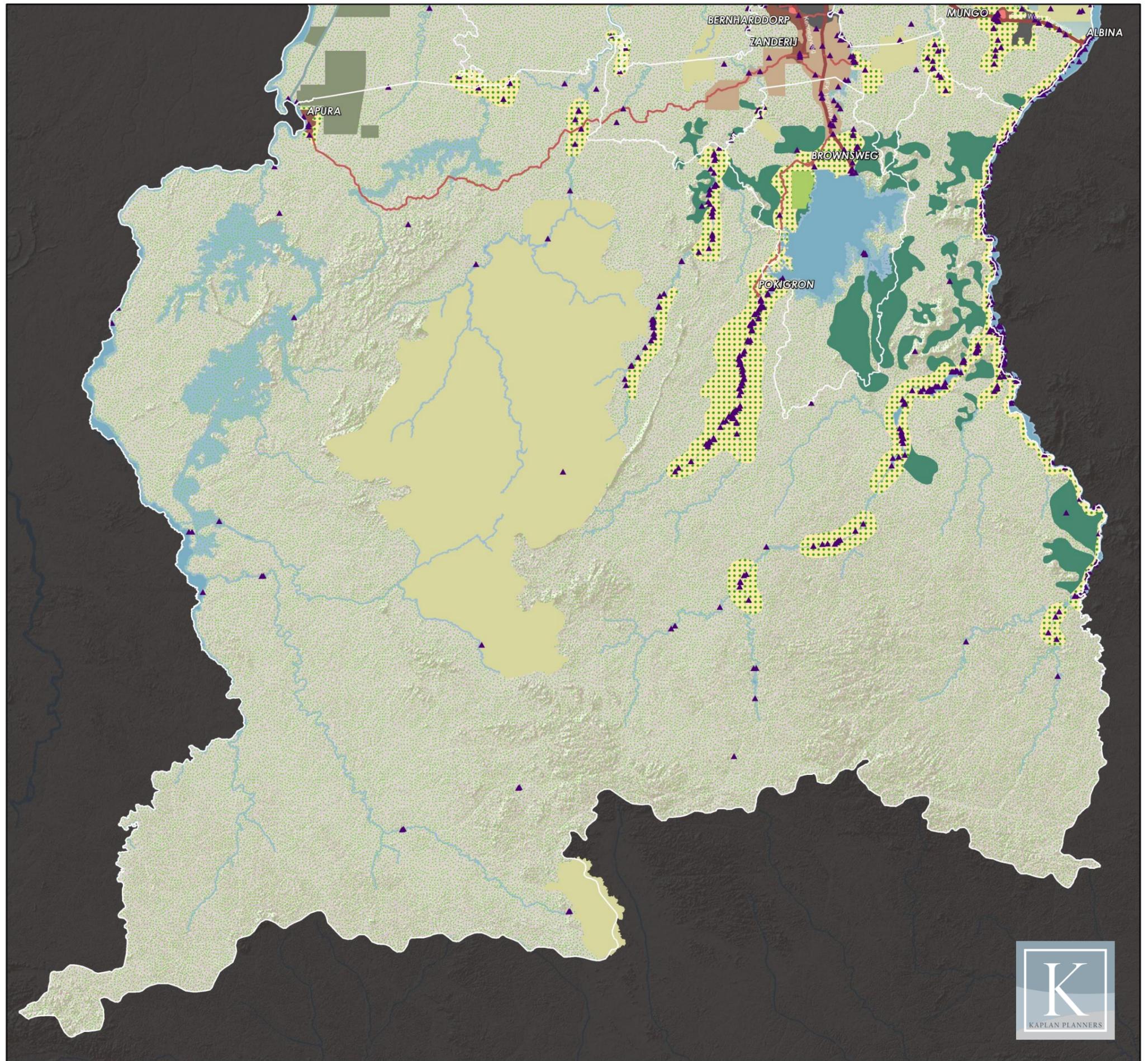
- Built Area for Densification
- Contiguous Development Area
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- Canals

Conservation

- Protected Area
- Naturel Park
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Roads

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- Secondary Road
- Settlement



Division 4

Recommendations for The Expansion Of Nature Reserves

SURINAME

CROSS-CUTTING CAPACITY
DEVELOPMENT PROJECT

C C C D

ENVIRONMENTAL PLANNING ATLAS

RECOMMENDATIONS FOR THE EXPANSION OF NATURE RESERVES

The Importance of Nature Reserves

Nature reserves are meant to protect biodiversity. Assuming that the reserve area will always be limited in size and subject to development pressures, careful, precise and effective allocation of the nature reserve area will be required to achieve conservation goals. In the professional literature, there are many different expressions of the functions of a nature reserve, among them:

1. Preservation of areas where the greatest biodiversity values exist.
2. Conservation of endemic species, and endangered species.
3. Representation of many habitats and ecosystems.
4. Maintaining large and continuous areas.
5. Creation of ecological corridors.
6. Integration of community and society values into nature reserves.

The Current Condition in Suriname

Suriname has three types of protected areas:

1. Multiple-Use Management Areas (MUMAs), in which economic activities are allowed as long as specific protection elements are not threatened.
2. Nature Parks, in which light forms of exploitation - mainly recreation - are allowed.
3. Nature Reserves, in which species or ecosystems are protected and human activities, are limited.

Site Name	Marine or terrestrial	Total terrestrial area (ha)
Nature Reserve		
Boven-Coesewijne Nature Reserve	Terrestrial	27,000
Brinckheuvel Nature Reserve	Terrestrial	6,000
Central Suriname Nature Reserve	Terrestrial	1,592,000
Copi Nature Reserve	Terrestrial	28,000
Coppename Monding Nature Reserve	Both	12,000
Galibi Nature Reserve	Both	4,000
Hertenrits Nature Reserve	Terrestrial	100
Peruvia Nature Reserve	Terrestrial	31,000
Sipaliwini Nature Reserve	Terrestrial	100,000
Wane Kreek Nature Reserve	Terrestrial	45,000
Wia-Wia Nature Reserve	Both	36,000
Nature Park		
	Terrestrial	12200
Multiple-Use Management Area (MUMA)		
	Both	67900
	Both	27200
	Both	88400
	Both	61500
Total		2,138,300

Action Plan

A view of the Suriname nature reserve map shows that the reserves are concentrated in certain areas, especially in the mountainous area and the shoreline. Many areas, landscape units, and ecological units are not represented at all.

In the framework of the CCCD project, the expansion of nature reserves and the establishment of new nature reserves are proposed, so that there will be maximum representation for each of the main landscape units and for each of the country's habitats.

The optimal way to determine a nature reserve area is according to the following principles:

1. Providing representation for each of the landscape units, expressed by physical characteristics and in the distribution of vegetation.
2. Outlining the reserves consecutively, so that vast, continuous and undisturbed areas will be created by human infrastructure and activity.
3. Creation of connectivity of protected areas, as an ecological corridor between the country - with the neighbors of Suriname - Brazil, Guyana, French Guiana.

The proposal before us presents four types of protected areas:

New Nature Reserves: Expanding existing nature reserves and offering new nature reserves that represent the unique habitats of Suriname.

The Blue Belt: Full protection for the sensitive area in the north of the country, which is locked between the rivers flowing westward and the beaches.

Nature Park: An additional nature park is offered on the Brownsweg Park, at the starting point for the intensive tourism upstream of the Suriname River, to showcase the entire life of nature, culture and way of life in the local communities.

1	Large is preferred than small. There will be more species at equilibrium in a larger reserve, and a lower extinction rate.	
2	One large area, preferably over a number of small spaces In terms of biodiversity, and the transition of species in space	
3	Clumped is better than dispersed, To enable the passage of species between different reserves in order to maintain genetic variability.	
4	Ecological corridors provide effective dispersal habitat for various species, maintain demographic and thus genetic interaction between populations, and provide landscape features with other, indirect benefits.	
5	Round rather than ellipse - reduces edge effect and makes the center of the reserve less accessible	
6	Bio-Diversity - wide as possible, creating inter-species relations and a healthy functional ecosystem.	
7	As far as possible from human activity - Creating a buffer of an area without activity and development will protect the ecosystem and prevent leakage of development or its	

Table 1: Nature Reserves of Suriname, Names and size in hectare

Areas for natural rehabilitation: In the areas of the abandoned gold quarries: optimal exhaustion of the material existing in the quarries, and after extraction - rehabilitation and restoration to the natural state.

Reasons for the location of the proposed reserves:

1. Southern reserve - an ecological corridor that creates a trans-continental connection with nature reserves in the Guianas and northern Brazil.
2. Western Reserve - represents the landscape units and habitats along the Corantijn River.
3. The eastern reserve - together with the rehabilitation areas provides representation to the landscape units and habitats up the Marowijne River.
4. Reserve in the coastal plain area - which includes the Nickerie swamp and the adjacent landscape units to the south.

The framework creates a suitable response to the representation of the different landscape units in Suriname and the varied habitats in Suriname. The proposed nature reserves are located on several main continuous routes, creating a connection and continuity:

- Along the coastal plain, using the blue strip and the continuity of existing reserves south of it.
- On a north-south axis, along the central nature reserve and its continuation to the south.
- The east-west axis, by the intercontinental ecological corridor.
- Local representation of the Corantijn and Marianne river basins. The reserves are attached to rivers and support the ecological corridor along the river.

The new proposals do not include permanent communities (except for four communities) in their territory, so that predictable conflicts are avoided. In any case, the program calls for encouraging the traditional activities of the communities in the forest, and for creating a fruitful and mutual coexistence between the activities of the communities and the prosperity and health of the forest.

PRESERVATION AND NATURE REHABILITATION MAP
NATIONAL EXTENT

Existing Protected Areas

-  MUMA
-  Protected
-  Proposed
-  Nature Park

CCCD Proposed Areas

-  Blue Belt
-  Nature Reserve
-  National Park
-  Nature Oriented Rehabilitation

Other

-  Rural Community Development
-  landscape Units

