Ecosystem services for sustainable development in La Prosperité, Suriname

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Summary

La Prosperité is an old colonial timber plantation in the rural district of Para in Suriname, which was purchased by a group of former plantation workers after the abolition of slavery. It is occupied by the small village of Bersaba which consists primarily of descendants of those who passed it on as heritage. One of these descendants and simultaneously heir is Guno C. Pocorni, the founder of Stichting Pocorni International, who has the ambition to focus and improve the future of this estate. The foundation is in search of sustainable opportunities, activities and mechanisms to utilise the capacity of its forest which should provide economic benefits to the community of Bersaba and allow for sustainable development of the forest whilst conserving its natural environment. No detailed information regarding the natural environment of La Prosperité is available, preventing sustainable and adequate development planning. Therefore, the objective of this research is to improve knowledge towards the ecological condition of La Prosperité and its ecosystem services, as well as identify suitable goods or services that can serve as a mechanism to support economic development in La Prosperité whilst conserving its natural surroundings.

The initial assessment was a literature study followed by plot-based forest inventories. A second assessment was carried out to identify ecosystem services and how they are utilised through observations, unstructured interviews and desk research. Feasibility analysis was carried out on the following three ecosystem goods and services 1) Payments for Environmental services, 2) Ecotourism and 3) Non-Timber Forest Products (NTFP's).
This included a market analysis to identify prospective ecosystem-based markets and their characteristics, complemented with a qualitative and quantitative analysis covering features and characteristics provided by the natural and non-natural environment, affecting the potential of capturing selected ecosystem services.

The research revealed that the natural environment of La Prosperité is subject to wet conditions in various degrees due to variations in the permeability of relatively poorly drained clayey schol soils. These differences are reflected in the four soil types identified which are swamp forest, marsh forest, creek forest and the permanently wet herbaceous swamp. Frequently found species in swamp forest such as *V. surinamensis* and *E. oleracea*, indicate a relatively species rich forest type and climax vegetation. Within marsh forest, tree and palm species related to high dryland forest (or rain forest) and savannah forests can be observed. Species of epiphytes and lianas are not uncommon, including tree species protected under Suriname law and all forest types show active regeneration.

The forests and water sources appear to provide the most important ecosystem services. Of the 26 identified ecosystem services, the majority appear under-utilized but two are promising ecosystem services which can be captured; *E. oleracea* and ecotourism.

The large forest area provides multiple NTFP's, some of which have market potential. The berries of *E. oleracea,* which are harvested and processed into Podosiri juice, are the most important and well known NTFP in Suriname. Prices and demand are increasing as Podosiri is becoming a popular 'superfood'. *E. oleracea* is the most abundant identified NTFP species in swamp forest and occurs in uniform patches. Although the size of these areas are uncertain and roughly estimated at 2-4 ha, this area could yield up to SRD 120.000 per year.

The natural environment of La Prosperité and its surrounding area provide multiple qualities that are key aspects in nature and rural tourism The location is attractive for this type of tourism as it offers unique cultural and natural attractions, is conveniently located and accessible with nearby airport and towns whilst still remaining exclusive from mainstream tourism. Furthermore it provides opportunities for self-guided nature walks and exploration through natural forest made possible from abandoned railway tracks.

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Acronyms and abbreviations

DBH Diameter at Breast Height
DBK Dienst Bodem Kartering
NTFP: Non-Timber Forest Products
NWFP: Non-Wood Forest Product

Figures and Tables

1 Introduction

Forests and other ecosystems provide a broad range of functions which, in turn, provide direct and indirect benefits, that are valued by humans. These are referred to as ecosystem goods and services, or ecosystem services in short and include for example maintenance of air quality and a favourable climate, but also bush meat, fruits, timber, minerals and recreational opportunities (de Groot, 2005). Development and economic growth however are inextricably linked with the conversion of natural ecosystems such as forests which can jeopardize the benefits they provide. Nearly one quarter of tropical rainforest worldwide has already been fragmented or converted by humans and an increase in demand of forest area and products is expected (Secretariat of the Convention on Biological Diversity, 2009). Luckily, worldwide interest to solve the problem between people's needs and conservation has increased significantly and the perception of forest as mainly a timber source has shifted towards a more multi-functional view (Secretariat of the Convention on Biological Diversity 2009).

The republic of Suriname is a country situated on the Northeast coast of South America and is part of the Amazon region. It is considered a territory with a high forest cover and low deforestation rate (Food and Agriculture Organisation, 2010; Ministry of Labour, Technological Development and Environment 2013a) with approximately 94% of the country still covered with natural tropical rain forest (Food and Agriculture Organisation, 2015). Suriname harbours a variety of ecosystems, including national capital and cultural heritage. These rich and divers ecosystems provide important goods and services which can generate income when sustainably managed (Government of the Republic of Suriname, 2015). Unfortunately, the economic value of Suriname's forest and its biodiversity remains largely unknown (Government of the Republic of Suriname, 2015). Forest functions and products other than wood are still under-valued (Milton, 2009) and its most abundant natural resource (forest) is considered under-utilized, (Bhairo-Marhé, Caldeira, Pigot & Ramautarsing, 2009).

New policies and development plans in Suriname take into account the importance of sustainable socio-economic development such as forest exploitation and the potential of mechanisms in order to conserve ecosystem services while contributing to the national economy (Government of the Republic of Suriname, 2012). Furthermore, the importance of scientifically determining the economical value of forests including its biodiversity has been recognised (Government of the Republic of Suriname, 2012) which can increase benefits deriving from forests while maintaining a healthy environment.

The rural district Para in northern Suriname is bordered by district Wanica in the North which is connected to the district of Paramaribo the Capital. Para, which connects these urban areas with the remote hinterland in the South is known for tourism, agricultural potential (Meredith, 2011) and its typical plantation culture which derives from colonial times. The first colonial plantations established in Suriname, were located on the old coastal plain, where Para is situated (van Dusseldorp, 1971; Stichting Plan Bureau Suriname, 2008).

One of such colonial plantations is La Prosperité, meaning prosperity in French. La Prosperité is one of several plantations that was purchased by a group of former plantation workers between 1880 and 1885, shortly after the abolition of slavery. These estates were bought on the condition that they should never to be sold. This heritage remains property of the group of relatives related to those who purchased it many years before. La Prosperité is a former timber plantation (Teenstra, 1835) and is covered with forest and fresh water swamps. In recent years, it has only been occupied by the villagers of Bersaba, a small community of descendants of those who purchased it originally. It is located within the borders of La Prosperité and is governed by a selected board, who represent the local community.

One of the descendants and also heir, is Guno C. Pocorni, the founder of Pocorni International Foundation, hereafter referred to as SPI. For more than 23 years, SPI has had the ambition to focus on and improve the future of those estates which belong to this group of families. The Foundation, in agreement with the plantation board, is in search for opportunities, activities, tools and mechanisms whereby services provided by the forest and its capacity are being utilized. La Prosperité currently has been designated as a pilot area for development purposes because of its convenient location, its forest landscape and adjacent community. Together with the plantation board and in cooperation with several Dutch Universities, SPI's future plans are currently being developed. The overall aim of SPI is to utilise the capacity of its forest via sustainable practices. These practices should provide economic benefits to the community of Bersaba and development to the forest of La Prosperité whilst conserving the natural environment, its resources and services.

Forest related businesses in ecotourism, payment for environmental services and collecting Non-Timber Forest Products, appears to be likely resources for increased public revenues in Suriname (Bhairo-Marhé et al., 2009). The potential of these mechanisms however, depend on many factors such as basic site characteristics, current condition of habitats or vegetation types and consequently, the delivered ecosystem services of a site (McCarthy & Morling, 2014).

Ecosystems and habitats of Suriname's lowlands have been comprehensively inventoried and mapped during the previous century (Ministry of Labour, Technological Development and Environment, 2013b). Much environmental data is available, however, unfortunately no detailed information of the natural environment of La Prosperité, its specific properties, condition and providing ecosystem services are currently at hand. The absence of detailed information of the natural environment, its ecosystem services and therefore its ecological and economic potential and value, prevents sustainable and adequate development planning. *''In order to reconcile landscape conservation with changing demands on land use and natural resources, it is essential that the ecological, socio-cultural and economic values of the landscape be fully taken into account in planning and decision-making''* (de Groot, 2005).

This report is compiled as a final BSc degree thesis in Forestry and Nature Management. The objective of this research is to improve knowledge towards the ecological condition of La Prosperité and its ecosystem services, as well as identify suitable goods or services that can serve as a mechanism to support economic development in La Prosperité whilst conserving its natural surroundings.

<u>Main research question:</u>

> What is the current ecological condition of the natural environment of La Prosperité and which ecosystem services can it provide to strengthen socio-economical development of La Prosperité

<u>Sub-questions:</u>

- What are the environmental properties of the study area regarding terrain characteristics and vegetation types?

- What are the ecosystem services provided by the vegetation types of La Prosperité and how are their benefits locally utilized?

- What are the most promising ecosystem services provided by La Prosperité that can be captured?

The outline of the report is as follows: Chapter 2 deals with the methods employed in this research. Chapter 3 addresses the characteristics of the natural environment. Chapter 4 provides the ecosystem services provided by the natural environment and addressed their means of local utilization, including anthropogenic factors. Chapter 5 addresses the feasibility analysis based on market characteristics and opportunities provided by the natural environment and non natural environment. Chapter 6 provides the discussion of the results, followed by Chapter 7 for conclusions and recommendations.

2 Methods

This chapter provides the methods employed during this research and a general description of the regional context of the study area (see Figure 1: Map of the study area). Methods are divided into three paragraphs, 2.1) Environmental assessment, 2.2) Ecosystem service assessment, and 2.3) Feasibility analysis. Each section provides the methods of a different subject, although some methods overlap. Methods are partly in line with required preliminary steps prior to ecosystem assessments and a rapid ecosystem assessments described by McCarthy and Morling (2014). They have been adapted to the objective of this research, its limited timeframe and are in line with the predetermined criteria set by the foundation regarding the current research and its results. The nine criteria points are provided below.

- Development activities implementable near the village of Bersaba
- Forest inventory of at least 50 ha near the village
- Mapping of wet and dry areas and providing environmental data for the local database
- Demand-orientated activities, preferably nationally and internationally orientated
- Revenues provided by the natural surroundings in near future
- Requiring low investment costs
- Conservation of the natural surrounding and its character
- Minimal impact on wildlife, biodiversity and standing trees
- Maintain confidentially regarding future plans and purpose of the research

The study area selected is located in La Prosperité, an old colonial plantation of 2200 hectares. Figure 1: Map of the study area and its surroundings, presents the regional context of the study area.

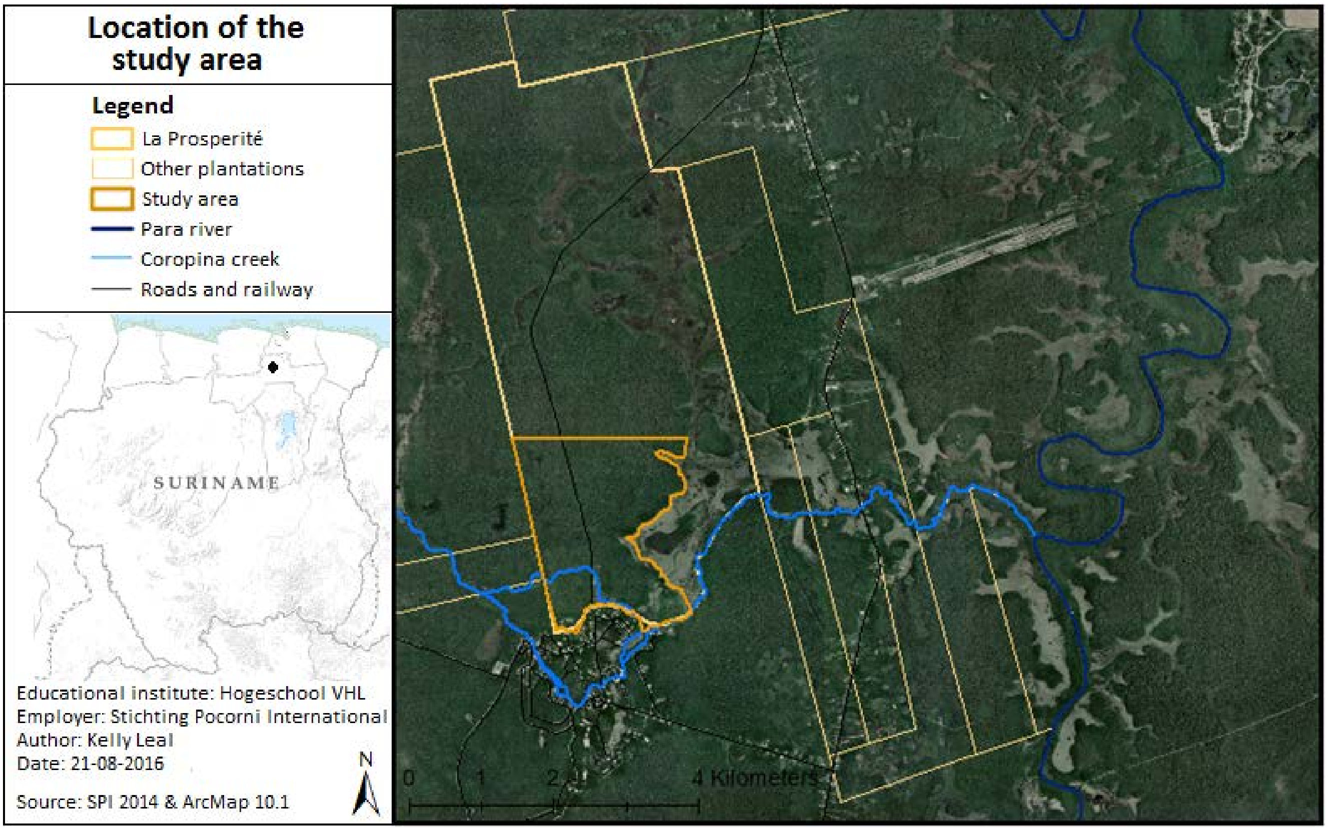

Figure 1: Map of the study area and its surroundings. Showing the boundaries of La Prosperité, the study area and those of surrounding plantations. The Coropina creek, the Para River and infrastructure is included.

This plantation is located in the Para district in Suriname, in northern South America between 5° and 6° N Latitude. The study site itself covers 455 of 2172 hectares of primarily forested area, which was chosen in agreement with SPI. The study area is located directly north of the community of Bersaba which is situated between plantation borders. The study site borders east along the Coropina creek and its grass swamp. The western border runs along the plantation of Vierkinderen and beyond the northern border, the forest of La Prosperité continues. Due to a long history of land division and insufficient contemporary data, legal boundaries of La Prosperité might differ from those which have been used for this research.

2.1 Environmental assessment

The environmental assessment provided comprehensive qualitative and quantitative information about the properties of the natural and semi-natural environment.

Literature study

This research required basis data on climate, geology, soil, vegetation types and their properties, botanical compositions, indicator species and hydrology. The majority of abiotic the data was gathered from previous environmental studies in northern Suriname. This included the *'Reconnaissance soil survey in Northern Surinam*' by Eyk (1957) and the '*Promotion of sustainable livelihood within the coastal zone of Suriname, with emphasis on Greater Paramaribo and the immediate region*' by Noordam (2007). The research in *´Verslag van de Semi-detail Bodemkartering Coropina Concentratiegebied 1, DBK Suriname´* by T. Edelman (1978) retrieved from the DBK in Suriname has served as main source for soil information and soil mapping. This research addresses soil mapping in an area of 8725 hectare which covered approximately 75% of La Prosperité and the entire area where this current research was conducted.

Vegetation type allocations on site and their hydrological and ecological properties were partly determined by considering the previous sources, including the forest type classifications as described by Jan Starke Opleiding en Onspanningscentrum (n.d.) in *´De ecologische context van duurzaam bosgebruik´*, the *´Interim Strategic Action Plan for the Forest Sector in Suriname 2009/2013´* by International Tropical Timber Organisation (2009) and '*Preliminary survey of the vegetation types of northern Suriname*' by Lindeman and Moolenaar (1959) which served as main source for comparison of forest characteristics. For botanical identification and nomenclature, '*Nuttige planten en sierplanten in Suriname' (Ostendorf & Stahel, 1962)* and '*Bomenboek voor Suriname'* (Lindeman & Mennega, 1963) were used as resources, complimented by '*The dictionary of trees*' (Grandtner & Chevrette, 2014) for determining botanical names.

Forest inventories

Forest inventories were conducted via plot inventories and general observations. These methods provided comparable quantitative and qualitative environmental data on forest types and their stand characteristics, botanical compositions, spatial structure, general hydrological characteristics, environmental condition and species richness. Inventories were conducted on foot, during the long dry season by a permanent field team, consisting of two students and a local resident who operated as vegetation specialist and a source of local knowledge. Three days were spend with qualified Surinamese tree botanists to enhance species identification. A Global Positioning System (GPS) was used for locating and storing geographical locations of plots centres, abrupt boundaries and transitions or other observed features. This included for example, anthropogenic elements such as residential areas, religious locations and infrastructure, which will be addressed in later in this chapter. Many small temporary paths were created, no permanent marks were made.

A brief pilot survey was conducted in order to obtain a general impression of vegetation types, forest properties, variables and indicator species and determine further classification methods and design. The herbaceous swamp in the east and its extension in the south-east were not included in further forest inventories. This also applies to the south-west area of the study area, occupied by agricultural plots and residential areas.

Final plot design, location and actual measurements were based on local circumstances, knowledge and objectives of this report. Approximate plot locations were pre-determined by the initial forest type zone map in where they were divided up. These zones include non-stratified areas and abnormalities. Although zoning was considered a principle method which was used, a small effort has been made to maintain an equal plot distribution, based on the surface of the study area. The selection of exact plot locations and allocation of the zones was continuously adapted to previously obtained plot information. Exact plot locations were further determined by the existing path structure, accessibility, time of day, existing plot distribution and forest guidance. To ensure random plot selection, a direction from a specific location within an allocated zone was chosen, with a distance varying between 20 and 200 m dependent on estimated zone size. For measurement, a GPS was used.

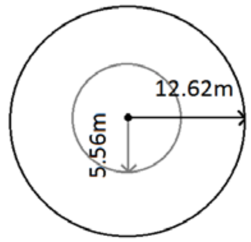

Figure 2: Shape and radius of the vegetation plots

A circular sample plot shape was chosen due to the size of the field team and time efficiency. Size and shape were based on tree data sampling methods by Keane (2006). Each main plot covered 500 m2 (12.62 m radius) with an equally shaped, yet, smaller sub-plot of 100 m2 (5.56 m radius) in the centre (see figure 2: Shape and radius of the vegetation plots).

Tree and palm measurements were performed and overall plot information was collected. Appendix 1 provides a field form used for obtaining information at tree and plot level, including the criteria used for forest type classification. Diameters of trees were measured at 1.30 m breast height (DBH) by using a diameter tape measure. Measured and counted trees and palms were identified, or were otherwise recorded as 'species x'.

Statistical analysis

Microsoft excel and Word were used to organize data obtained. Data of 52 plots were used, covering 2.6 ha which is 0.57% of the study area. Recorded tree and plot level data were digitalized and analysed separately according to main forest types. Plot and sub-plot data were converted to hectares and further calculations regarding forest and tree characteristics were made. The average number per hectare for the most frequently recorded palm and tree species per forest type was calculated. DBH sizes of trees per forest type were organized and four DBH size-classes were selected for trees ≥25cm DBH. As trees ≥10 and <25cm DBH were counted, these were, although their deviating range, included as separate interval class. Variations in characteristics between forest types in the study area were addressed and compared to relevant studies conducted in corresponding forest types. Species were screened for indicative properties regarding forest conditions and their protective status via IUCN red-list (International Union for the Conservation of Nature**,** n.d.) and Stichting voor Bosbeheer en Bostoezicht (n.d.). Calculations only included tree and palm species identified by the permanent forest guide. Species identified by qualified trees botanists were provided separately and listed as 'observed tree species'.

Mapping and image classification

Microsoft Excel and DNRGPS software was used to link GPS data and related field notes with ArcMap 10.1, a Geographical Information System software (GIS), to which data was converted. ArcMap 10.1 was used in order to analyse data, facilitate remote sensing and compile maps. It was used for geo-referencing and digitalizing an obtained soil map based on research conducted by Edelman (1978) and for compiling maps in the following phase.

Remote sensing has served as a mechanism to classify forest types, its spatial structure, land use and distinguishable forest type subdivisions by means of satellite imagery with support of verifiable ground truth data. Vegetation shape and size, land use, forest height, canopy size and canopy colour were used to further demarcate boundaries of main and sub-forest types and classify non-surveyed areas. Due to cloud cover in Landsat images, satellite imagery from Google Earth (Landsat 7) and ArcMap base map imagery were used.

2.2 Ecosystem service assessment

The ecosystem assessment enabled identification of ecosystem services in and means of local utilization.

Observations

Structured observations were made during the entire research phase to identify ecosystem services, including their means of local utilization. These observations were made in both the study area and the adjacent village. Inclusion of ecosystem services were primarily based on the primary ecosystem functions described by de Groot, Matthew, Wilson and Bouwmans (2002) in '*A typology for the classification, description and valuation of ecosystem functions, goods and services*' and de Groot (2005) in '*Function- analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes*'.

Interviews and desk research

Unstructured interviews were held with the forest guide during forest inventories and observations and with several local inhabitants active within or near the study area. Information obtained contributed to the identification of ecosystem services and the specific use for local utilisation. Questions generally included: 'what is used, why it is used, how it is used and where it is used'.

Information retrieved via interviews and the previous method of observations was complemented with desk research to specify benefits and details. Keywords used were: 'La Prosperité', 'Bersaba Kreek', 'Coropina Kreek'. Data were organisation according to de Groot et al., (2002) and de Groot (2005), provided with corresponding main vegetation types.

2.3 Feasibility analysis

The feasibility analysis explores and addresses the potential of 1) Payments for Ecosystem services, 2) Non-Timber Forest Products, and 3) ecotourism at market level and quantitative and qualitative scale.

Market analysis

Prospective ecosystem-based markets of Payments for Ecosystem services (PES), Non-Timber Forest Products (NTFP's) and ecotourism in Suriname were identified and their characteristics were explored. This included general market characteristics, monetary values and trends. The market for timber was not included. Important sources were: Government of the Republic of Suriname (2012), Stichting planbureau Suriname (2008), '*Global Forest Resource Assessment 2010, Country Report Suriname*' by Food and Agriculture Organisation (2010), de Wolf and van der Sluys (2010), Cymerys, Vogt and Borndizio (2011) in '*Fruit trees and useful plants in Amazonian life*', '*Commercial Non-Timber Forest Products of the Guiana Shield*' by Andel, MacKinven, & Bánki (2003), and Ostendorf and Stahel (1962) in '*Nuttige planten en sierplanten in Suriname*' to identify NTFP's. The following keywords have been used: 'PES Suriname', 'payments environmental services Suriname', 'payments ecosystem services Suriname' 'REDD Suriname' 'NTFP Suriname', 'Non Timber Forest Products Suriname', 'bos producten Suriname', 'tourism Suriname', ecotourism Suriname', 'tourism Para Suriname', 'prijzen resorts Para', 'prijzen recreatieoord Para' and 'tours Suriname'.

Qualitative and quantitative analysis

The potential of NTFP commercialization and ecotourism in La Prosperité were briefly assessed at quantitative or qualitative scale depending on their tangibility. Information derived from earlier retrieved primary and secondary data and newly obtained information.

The qualitative properties and benefits of La Prosperité regarding ecotourism were identified via brief observations in the village and direct surroundings and via desk research. Topics addressed were noteworthy village aspects and La Prosperité its location.

Marketable Non-Timber Forest Products identified in the study area were organized and quantified accordance to market potential and abundance in the study area. Quantification was expressed in standards from – to ++, with ++ being most abundant or marketable. Due to the multi-stemmed nature of the palm *Euterpe oleracea* and its potential as a NTFP, an additional measurement regarding stem frequency distribution was conducted in one particular area where this species appeared relatively uniform and well developed, meaning multi-stemmed with ≥ 2 stems of at least 10cm DBH. This was executed through sub-plot design in where all woody *E. oleracea* stems were measured in cm at DBH.

For both ecosystem services a brief overview of potential financial contribution was provided, based on newly obtained data and information obtained via the market analysis. The information retrieved under this chapter and prior information was incorporated in an overview dividing advantages and disadvantages.

3 Natural environmental

This chapter addresses environmental properties and situation at abiotic level (climate, geology soils and hydrology) and biotic level (vegetation types, stand characteristics, hydrology, environmental condition and species richness).

3.1 Geological properties and climate

According to the Köppen-Geiger Classification System, the location of La Prosperité in northern Suriname is an AF climate class, meaning Equatorial rainforest and fully humid (Kottek et al., 2006). The average daily temperature is 27.4° Celsius (Ministry of Labour, Technological Development and Environment, 2013a), the daily air humidity has an average of 80-90% (Nationaal Instituut voor Milieu en Ontwikkeling in Suriname, n.d.) and the annual rainfall is approximately 2210mm. Four seasons are distinguishable (Ministry of Labour, Technological Development and Environment, 2013a). There are two dry seasons (February-March and August-November) and two rain seasons (April-July and December-January) (Edelman, 1978) with the first rain season providing about 50-70% of the annual rainfall (Noordam, 2007). Shifts in seasons and changes in temperatures and precipitation do however occur (Nationaal Instituut voor Milieu en Ontwikkeling in Suriname, n.d. ; Noordam, 2007) and the El Nino phenomenon can be expect every 2-7 years (Noordam, 2007).

Suriname is part of the Guyana shield, of which approximately 85% consists of crystalline basement rock (Eyk, 1957). The entire Northern part of Suriname consists predominantly of marine sediments which increases in age whilst orientating southwards towards the hinterland (Noordam, 2007; Eyk, 1957). Whilst La Prosperité is located in the South of Para, it is situated on the old coastal plain and is part of the Coropina formation (Edelman, 1978), which consists of thick clay plates called 'schollen' (Eyk, 1957). It lies approximately 3 km from the Zanderij formation which consists of the oldest continental sediments (European Digital Archive of Soil Maps, n.d.), mainly in the form of sands (Eyk, 1957). Erosion of the sand and silty clays of the Coropina formation have created deep gullies in the landscape as well as shallower depressions where runoff is collected (Eyk, 1957), resulting in the formation of herbaceous and forest swamps. The deep gullies were covered by other marine sediments such as the Para Member (a typical stiff clay) and the Mara member (a peaty clay) (Post, 1996). Unlike the Para member, which can be found all over the district, the Mara member can only be found in the creek within the forest.

Three soil associations (commonly referred to as landscape elements) and four soil series have been distinguished in the study area based on a study conducted by T. Edelman (1978) Table 1 shows these associations and series, including their location and general characteristics. Appendix 2 Soil map, presents the soil map showing soil associations and soil series in the study area.

Table 1: Soil associations and series and their general characteristics

Soil association	Representative Soil Series	Location	Terrain	Important characteristics	Nature of Rock
River Levee Soils	Saramacca 1.2.1	Along the creek within the forest	High	Occasionally inundated Very poorly drained	Clay, peat, fine sand, coarse sand and shells
Schol Soils (Os)	Cassewinica 2.1.1	Along the railway and in the study area	High	Poorly drained Preferred for agriculture	Fine sand, silty clay, loam and clay
	Waycaribo 2.1.2	The majority of the study area	Middle	Very poorly drained	
Gully Swamp Soils (Og)	Complex of Arapappa and Berceba 1.2.5	In the herbaceous swamp	Middle & low	Frequently inundated	

The soils types identified in the study area are characterized by variations in relative elevation, drainage capacity, inundation intensity and contours such as depressions. According to Jan Starke Opleiding en Onspanningscentrum (n.d.), the (surface) water level in parts of the old coastal plain in the Para landscape have a fluctuations of either 0-2m and more or a maximum of 80cm depending on location.

3.2 Vegetation types and structure

Four different main vegetation types have been distinguished, namely: 1) swamp forest, 2) marsh forest, 3) creek forest, and 4) herbaceous swamp. The herbaceous swamp was not included in inventories except for area calculations and mapping. Of the three remaining vegetation types classified in the study area, swamp and marsh forest have been further subdivided into sub-forest types. Statistical analysis however, only included main forest types where a total of 52 plots were analysed. Table 2 provides several specific characteristics and area coverage in the study area for all main forest types and their subdivisions, including the number of plots established per main forest type. Appendix 3: Vegetation map, provides the main vegetation type map.

Table 2: Specific characteristics and area covered in hectare (ha) of the four main vegetation types and their subdivisions

Main vegetation type area in ha and plots per area	Sub forest types	Basic characteristics
Swamp forest 59.37 ha	Swamp forest	• Trees well represented • Pina palm (*Euterpe oleracea*) abundant
	Pina palm forest	• Trees less represented • *E. oleracea* uniform
Marsh forest 324.06 ha	Low marsh forest	• *E. oleracea* less represented • Maripa palm (*Maximiliana maripa*) less represented
	High marsh forest	• *M. maripa* and Paramakka (*Astrocaryum paramaca)* abundant • Agricultural activity and secondary forest
Creek forest 38.99 ha	-	• Understory and re-growth sparse • Palms absent
Herbaceous swamp (-) 32.31 ha	-	• Permanently wet • Trees absent and dominated by one single species

- **Swamp forests**

Swamp forests are locally referred to as *Lowland* or *Swamp* and as *Low swamp forest* or *High swamp forest* by Jan Starke Opleiding en Onspanningscentrum (n.d.) and are found on lower terrains in the study area. Approximately 60 ha of the study area was classified as swamp forest. Babun (*Virola surinamensis*) and foengoe (*Parinari campestris*) are the most frequently recorded tree species in swamp areas amongst trees of ≥25cm DBH with 11 and 16 trees on average per hectare respectively. Figure 3, shows the six most common tree species ≥25cm DBH in all forest types and their frequency in average per hectare. Considering palm species, pina (*E oleracea)* is most abundant in swamp forest with 455 clumps per hectare. Due to occasional patches of pure stands of *E. oleracea*, it was assigned as subdivision, with boundaries that are not clearly distinguishable through remote sensing. Figure 4, show the frequency distribution of all recorded palm species in the study area in average per hectare for all forest types. Swamp forests, with only 77 trees of ≥25 cm DBH on average per hectare, contain fewer trees compared to other forest types in the study area. Table 3 shows the general differences at plot and tree level, between all three forest types. This number is also lower than the average of 100-130 trees of ≥25 cm DBH per hectare in swamp forest, researched by Lindeman & Moolenaar (1959) in *Preliminary survey of the vegetation types of northern Suriname.* According to the same source, swamp forests have an average basal area of 13m2, while those in the study area have an average basal area of 8.45. The number of *E. oleracea* palms in the study area however is higher than the *E. oleracea* dominated forests in the estuary of the Amazon River, according to Cymerys et al. (2011), who counted between 300 and 400 adults per hectare including 800 juveniles.

With an average DBH of 36.3cm amongst trees ≥25cm DBH and an average canopy height of 21.9 m, trees in this forest type are somewhat wider and taller compared to other forest types in the study area. Swamp forests are generally at least 20 m in height with a range between 18 and 30 m (Lindeman & Moolenaar, 1959). Large trees have been observed occasionally, whereas very large or emergent trees of >30 m in height are less represented.

Details per hectare	**Swamp forest**	**Marsh forest**	**Creek forest**
Avg. No. trees ≥25cm DBH	77	103	128
Avg. No. trees <25cm DBH	380	459	733
Avg. basal area in m2	8.45	10.75	13.45
Avg. DBH ≥25cm	36.3	33.9	35.1
Max. DBH ≥25cm	75	102	65
Avg. canopy hgt. in m	21.9	21.5	20.7
Max. canopy hgt. in m	27	28	22
Min. canopy hgt. in m	16	15	19

Table 3 General differences between three forest types in average (avg.), height (hgt.) in metres (m) and number (No.) per hectare

The forest floor of swamp forests are generally covered with understory species such as grasses (*Poaceae*) and sedges (*Cyperaceae*), although not abundantly. Occasional patches of warimbo (*Ischnosiphon spp.*) can be found. The number of small trees (<10cm DBH) ranges from dense to almost absent. In areas where *E. oleracea* is strongly dominant, this palm forms nearly uniform stands. Here trees are sparse, crowns are small and the forest floor is free of understory species and covered wit dead palm leaves.

- **Marsh forest**

Marsh forests are locally referred to as *dryland*, as *High marsh forest* by Jan Starke Opleiding en Onspanningscentrum (n.d.) and *Seasonal swamp* by Lindeman and Moolenaar (1959). This forest types comprises 324 hectares, which is roughly 70% of the study area. Marsh forest is characterized by kopi (*Goupia glabra*) and manbarklak (*Eschweilera sp.*), which make up for 38% of all trees ≥25cm DBH recorded in marsh forest. Common palm species are paramakka (*Astrocaryum paramaca*) and maripa (*Maximiliana maripa*). *A. paramaca*, are frequently found in high dryland forest (Lindeman & Moolenaar, 1959) which does not occur in the study areas and *M. maripa* is generally absent in swamp forest (Eyk, 1957).

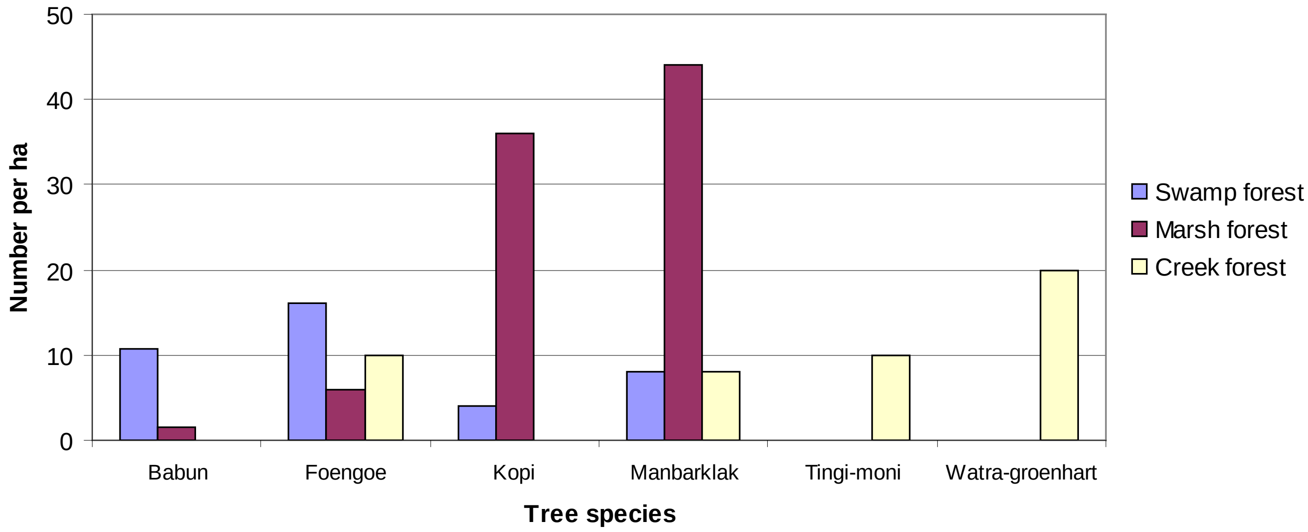

Figure 3: The frequency of the 6 most frequently recorded tree species in all forest types in average per hectare.
(V. surinamensis; P. campestris; G. glabra; Eschweilera sp.; Protium spp.; Tabebuia serratifolia)

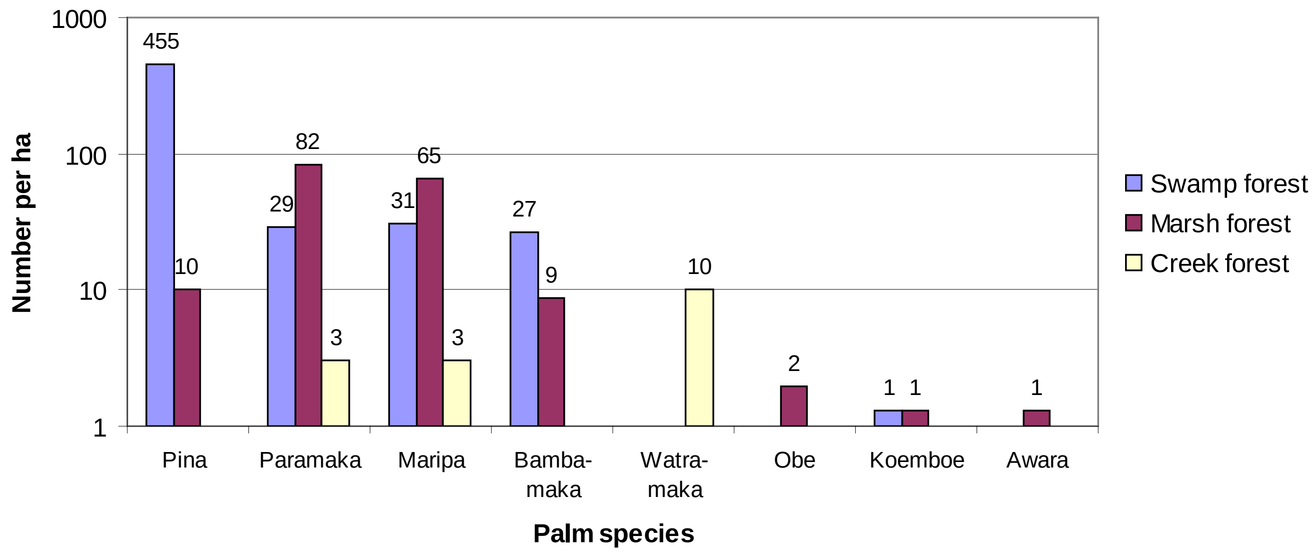

Figure 4: Average frequency distribution for all recorded palm species per hectare in all three forest types.
(E. oleracea; A. paramaca; M. maripa; Desmoncus sp.; Unknown; Elaeis sp.; Oenocarpus bacaba; Astrocaryum vulgare)

Marsh forest can be subdivided into high marsh forest and low marsh forest. Low marsh forest forms a zone between dryer terrain and swamp forest. In these areas swamp forest species are mixed with species occurring in high marsh forest. Due to locally better drainage conditions, high marsh forest is used for agriculture. In agricultural fields, which are small plots called ‘Kostgrondjes’, forest is cut down and burnt, to create fields to produce food crops. These traditional slash and burn practice have changed the characteristics of the forest. They have led to a variation of ages ranging from clear cut to young re-growth (kapoeweri forest), older secondary forest and intact or original high marsh forest. The location of these different structures including the remaining main forest types are presented in Appendix 4: Forest structure map. Figure 5: presents the indicator species used for forest type classification and visual indicators. Besides *E. oleracea*, *A. paramaca* and dominant DBH sizes, all indicators are visible both in the field as via image classification.

Main forest type indicator species:

- Swamp forest: *E. oleracea*
- Marsh forest: *M. maripa and A. paramaca*

Forest structure indicators:

- High marsh forest (Agricultural or abandoned plots and human habitation): Clear cut or small vegetation
- High marsh forest (Kapoeweri): Thin trees, small canopies at same height
- High marsh forest (Secondary forest): Medium canopies at various heights, >60% of trees ≥29cm DBH
- High marsh forest (Natural forest): Tall trees, dynamic and multicoloured canopies
- Low marsh or swamp forest: Less tall trees, dark and dynamic canopies
- Swamp forest: Less tall trees, small dark canopies

Kapoeweri forest is 5-15m tall and extremely densely covered with very thin trees. Common tree species in kapoeweri forest and young secondary forest are pinja (*Vismia spp.*), bospapaya (*Cecropia sp*.) and palulu (*Heliconia sp).* The latter occurs in disturbed well lit areas with excessive light, such as along the railway, where many were found. At heights of approximately 20 m, these areas are called older secondary forest. At this height, tree sizes vary more strongly, trees above 25cm DBH appear again and A*. maripa* returns to sight.

Figure 5: indicator species used for forest type classification and visual indicators.

The average frequency of trees ≥25cm DBH in marsh forest in general is 103 which stands between swamp and creek forest in the study area. This is just below the 108 trees per hectare ≥25cm DBH, recorded by Lindeman and Moolenaar (1959) in a forest roughly 13 km north of the study area, classified as marsh forest. The average basal area of marsh forest is 10.75 m2. The average height is 21.5 m, with a maximum of 28 m and a minimum of 15 m, due to measurements in secondary forest. According to Lindeman and Moolenaar (1959), the tree height of marsh forest ranges between 25-30 m, with a minimum height of 15 m. According to Food and Agriculture Organisation (n.d.) this is generally 15-20 m. Taller forests up to 28 m have been recorded and observed occasionally, including emergent trees of >35 m and trees with diameters >120 cm DBH. As a rule, canopies in these taller forests are large, colourful and dynamic and differ from the smaller crowned swamp forests. These areas however, appear to be rare in the South of the study area, close to the village, with the exception of a religious forest near the entrance of the forest.

A dense understory of trees (<10cm DBH) is generally common in marsh forest, comprising of shrubs, re-growth and small to medium-sized (spiny) palms. These densities can be very high in areas classified as low marsh forest and are generally less represented in areas where trees appear somewhat taller and forests are more open. *Cyperaceae* and *Poaceae* species are abundant in marsh forest and are mixed with a variety of herbs.

- **Creek forest**

Creek forest is a forested strip along the creek comprising 39 ha, accounting for less than 10% of the study area. With a few exceptions, it generally not classified as a separate forest type in the old coastal plain. Typical tree species found in this forest type are Tingi-moni (*Protium spp.*) and Watra groenhart (*Tabebuia serratifolia*) which were generally not recorded elsewhere among trees ≥25cm DBH. Watra-maka (Unknown) is the most frequently recorded palm species, although palm frequencies are remarkably low in creek forest and occasionally completely absent.

With an average of 128 trees ≥25 cm DBH and 733 trees <25 cm DBH, creek forest is considered the most dense forest type in the study area in both size-limits. Tree frequencies in creek forest resembles marsh forests and swamp forests argued by Lindeman and Moolenaar (1959) who found an average of 126 trees ≥25 cm DBH per hectare in marsh forest and 100-130 trees ≥25 cm DBH in swamp forest. The basal area of creek forest is noticeably higher than other forest types in the study area. With an average of 13.45 m2, this resembles those swamp forests as researched by Lindeman and Moolenaar (1959).

However, compared to the average basal area of 17.7 m2 in forests classified as marsh-creek, located east of the Suriname River (Lindeman & Moolenaar, 1959), the average basal area in creek forest in the study area is lower. Creek forest has a small range between minimum (19 m) and maximum canopy heights (22 m) and with an average height of 20.7 m, this forest type is lowest amongst others. Undergrowth is generally remarkably sparse and consists of thin patches of *Poaceae* and *Cyperaceae*. Medium to tall boesinasi (*Bromelia alta)* are found frequently reaching more than 2 m and are a typical savannah species (Lindeman & Moolenaar (1959). Along the lower slope near the waterline trees make place for a variety of shrubs and herbaceous species typical for permanent wet areas.

- **Herbaceous swamp**

The herbaceous swamp of the Coropina creek, also known as *fresh water grass swamp*- or *shrub swamp* (Jan Starke Opleiding en Onspanningscentrum, n.d.) is locater east of the study area and is a relatively large grass swamp. Within the southern part of the study area, this sharply bordered creek meanders through the forest, along dense tree and shrub boundaries. The large grass swamp is dominated by one or two species. According to Ouboter (1993), two species of *Gramineae* (*Poaceae*) and one species *Cyperaceae* are found. Trees or shrubs are rare along the large swamp area and are found solitarily. Permanent wet areas are often home to dense stands of moko moko (*Montrichardia arborescens*) both within the southern creek as within the large swamp. The creek within the forest consists of typical water plants such as pankoekoe (*Nympphaeaceae*) and *Poaceae* or *Cyperaceae* species are infrequent. Herbaceous vegetation of the large herbaceous swamp, east of the study area, is frequently burned during dry seasons when water levels are low. Due to the frequency and intensity of these fires, it maintains its open characteristics as trees are scarce in this area, whilst trees and shrubs with xeromorphic properties are plentiful in the creek area within the forest. The large open swamps somewhat resembles wet savannah, with infrequent dead trees still remaining.

Figure 6 shows a graph with the average size-class distribution of trees ≥10 cm DBH per hectare, in 5 size- class intervals for all forest types. The first class interval of 10-24 cm DBH contains remarkably high numbers of trees, compared to other size-class intervals. The difference between the number of trees in the first and second class is the lowest in marsh forest. Creek forest contains the largest number of trees per hectare in all class interval, except the 45-54 diameter class. In this same class, swamp forest contains the largest number of trees per hectare, while it generally scores low or average. All forest types show the typical reversed j-shape curve, however, creek forest has a noticeable peak in the highest class interval of ≥55 cm DBH.

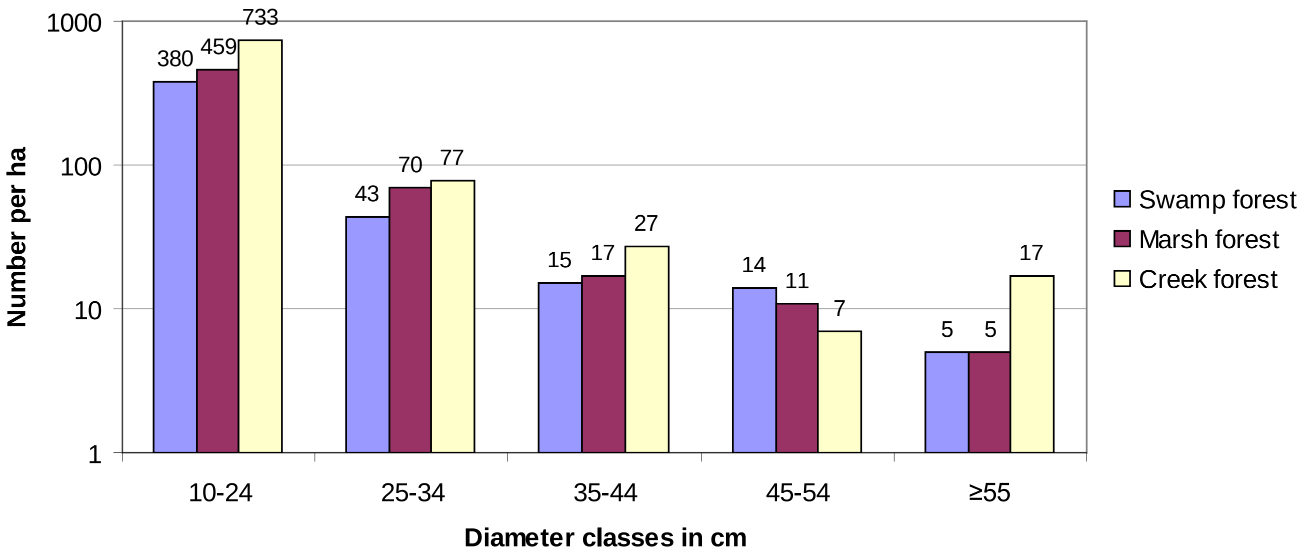

Figure 6: The average size-class distribution of trees ≥10cm DBH per hectare in 5 size- class intervals for all forest types.

3.3 Hydrology and forest types

Swamp forest are located on the lower terrains of the study area and are characterised by an abundance of *E. oleracea*. This palm species grows in areas where water is stagnant (Granville & Jean-Jacques, 1986) and indicates swamp soils (Eyk, 1957; Jan Starke Opleiding en Onspanningscentrum, n.d.). Swamp forest terrains are more frequently inundated and for long periods during rain seasons compared to other forest types and water levels are generally higher (Personal communication, 2014). Soils in these areas were still wet and muddy halfway during the long dry season. However, at the end on the long dry season surfaces appeared dry. Rugged soil are common and kawfoetoe structures, a typical water track pattern, have been observed frequently. This micro relief generally occurs in areas where *E. oleracea* palms are abundant.(Eyk, 1957) and is said to be related to inundation and microflora (van der Voorde, 1957). Natural water tracks are quite common and man-made trenches are sporadically found along marsh forest borders with depths over 100 cm. In areas where trees are generally plentiful these water tracks and especially kawfoetoe structures, appear less evident.

Marsh forest, located between swamp forest and high dry land forest, is found in periodically flooded areas (International Tropical Timber Organisation, 2009). It must be noted that high dry land forest did not occur within the borders of the study area. These terrains of marsh forest can somewhat resemble swamp forest, however water is less stagnant and inundation periods are shorter. According to Eyk (1957), areas where *M. maripa* is abundant, can be classified as marsh or dry land. If absent, then, with few exceptions, the forest can be classified as swamp.

Several moist top soils were observed during the first forest inventories, however, after few weeks these top soils appeared completely dry. Water tracks are generally not deep, nor frequent. Excessive water is drained after several days at most if rain intensity decreases (Personal communication, 2014). High marsh forest terrains have more favourable hydrological conditions compared to low marsh forests. This is caused by somewhat higher elevations, hardly noticeable in these flat terrains or permeability is better due to mixtures with coarse sand and deeper impermeable clay layers further from the surface. Botanical compositions are different compared to those in swamp forests or low marsh forest and species such as *A. paramaca, Eschweilera sp.* and *G. glabra* are abundant which are frequently found in high dry land forest (Food and Agriculture Organisation, n.d.). These permeable terrains which are favoured for agricultural practices are searched for by locals during the long rainy season. Nonetheless, although the higher terrains have the capability to remain dry, during heavy showers in the long rainy season, these terrains including the old railway can be temporarily flooded (Personal communication, 2014)

Creek forest is a forested strip subjected to fluctuation of water in the creek. It is somewhat tilted towards the creek or located just behind the slightly higher creek beds where they appear somewhat higher than adjacent forest types. They are approximately 10-100 m in width, depending on relative elevation and water level fluctuations. During rainy seasons this forest type is partially inundated and forms an extension of the creek itself while forests behind the creek bed channel excessive water towards the creek.

Estimations of averages and maximum water levels varied from 30 cm in general to 100 cm in the swamp areas, up to 50 cm on the old railway and marsh forest and up to 2 m within the herbaceous swamp and creek (Personal communication, 2014). According to some sources, infiltration rates of higher and dryer areas such as kostgrondjes and the old rail way, occur approximately one day after rain intensity decreases, although they can be temporarily flooded. Forests referred to as swamp or lowland are said to be inundated for the grater part of the rain seasons, especially the long rain season. Trenches along the old railway drain excessive water from the railway and village to either the creek or towards swamp forests (Personal communication, 2014).

Clear signs or permanent marks of maximum water levels have not been observed during this research. During research which took place in the majority of the long dry season, no flooded soils were encountered other than the creek itself. Towards the end of the long dry season, the creek in the forest had almost dried up completely, only leaving behind a few shallow pools where fish species would be trapped until the next rain and runoff. Figure 7: vegetation types and their hydrological properties presents a brief overview of the most important hydrological characteristics per forest type.

Figure 7: Vegetation types and their hydrological properties

Forest type	Basic characteristics
Swamp forest	• Water tracks quite common, trenches sporadically • Water levels higher than other forest types • Frequently inundated and water stagnant • Inundated for the grater part of the rain seasons • Muddy soils till the halfway of long dry season • Inundated up till 30-100 cm
Marsh forest	• Water tracks sporadically • Water less stagnant, inundation period shorter • Periodically flooded • Soils dry at beginning long dry season • Highest terrains temporarily flooded in the long rainy season • Inundated up to 50cm
Creek forest	• Along the herbaceous swamp • Forms an extension of the creek itself during rain season • Subjected to fluctuation of the creek
Herbaceous swamp and creek	• Permanently wet • Almost dry at end of long dry season • Water level fluctuations up to 2 m

3.4 Environmental condition and species richness

While the young coastal plain is home to rich herbaceous fresh water swamps, those swamps in the old coastal plain are generally species poor and often dominated by a singular species (Jan Starke Opleiding en Onspanningscentrum, n.d.). In the deeper swamps in the Para landscape, (with fluctuations between 0-2m or more) species poor forests occur. This poor composition has a typical light canopy with xenomorphic leaves, features shared amongst trees and shrubs directly along the swamp and creek. In shallower swamps with annual surface water fluctuations with a maximum of 80cm, two typical species compositions are often found (Jan Starke Opleiding en Onspanningscentrum, n.d.) of which the more species rich *V. surinamensis-Symphonia globulifera- E. oleracea forest,,* much resembles marsh forests and especially swamp forests found in the study area. This composition belongs to the high swamp forest type and indicate climax vegetation (Werger, 2011; Jan Starke Opleiding en Onspanningscentrum n.d.).

More towards the sandy dek-landscape of the Zanderij formation, the *V. surinamensis- S. globulifera- E. oleracea* forests are mixed with high dryland forest species (Jan Starke Opleiding en Onspanningscentrum, n.d.) and species found in the adjacent Savannah forest (Lindeman & Moolenaar, 1959). As a rule, high dryland forest, also referred to as rainforest, is very species rich (Jan Starke Opleiding en Onspanningscentrum, n.d.) and these forest are tall (up 25-30m) with scattered emergents over 45 m (Lindeman & Moolenaar, 1959).

Species found in high dryland forest have been recorded in the study area and trees conspicuous for their height can be observed especially within the village along the forest border. Heights over 30 m are not uncommon on these sandy soils and some are found somewhat solitary in backyards. Within the study area, emergent trees are relatively scarce. These trees such as kwatakama (*Parkia sp*.), wanakwari and wiswiskwari (*Vochysia spp*.) and gronfoeloe (*Qualea spp*.) are generally restricted to the north of the study area. Some high dryland forest species recorded in the study area are *Eschweilera sp.*, *Qualea spp.*, the palm *A. paramaca* and emergent species such as *Vochysia spp*. (Lindeman & Moolenaar, 1959). *G. glabra* is also common in high dryland forest, although according to the same source, this species has the highest frequency on silt clay soils of the Coropina formation. Species frequently found in savannah forests are *B. alta*, and tingi-moni (*Protium spp.*) (Lindeman & Moolenaar (1959). Another species is the Obé palm (*Elaeis sp*.), also referred to as oil palm. A few of these palms were encountered in the south of the study area. This species which does not fruit (Personal communication, 2014) belongs to *Savannah woods* or *Savannah forest* according to Eyk (1957) and Lindeman and Moolenaar (1959).

Lindeman and Moolenaar (1959) classify the area were La Prosperité is located as *Marsh forest* and its herbaceous swamp as *Swamp with herbs and shrubs*. The village is situated on an area classified as *High dryland forest* and south of La Prosperité, small areas of *open savannah and shrub savannah* can be found. Eyk (1957) argues that marsh forest on the dryland ''schollen'' or schol soils in the old sea clay landscape have not developed luxuriantly and that they contain high numbers of very thin trees, which therefore recall the aspect of a luxuriant savannah wood. However, forests on those scholl soils which are rich in coarse sand can be very luxurious (Eyk, 1957).

Both xeromorphic and hydrophytic properties can be observed amongst shrubs and trees in the study area. Trees with buttresses or stilt roots are rather common in all forest types and few large trees were observed with buttress roots of several meters long and at least 100 cm high near the base. Other features observed in the study area were species of epiphytes such as *Monstera oblique* (Dijk, 2010) and lianas. Lianas occur in all forest types, especially marsh forests. They are however not abundant and it appears that the amount and size increases northwards along with taller forests and wider trees. Relatively thick lianas (diameter of 20 cm or more) have been found reaching canopies of almost 30 m in height, hanging from large branches and entangling large trunks.

While the majority of undergrowth in the study area contained of *Poaceae* and *Cyperaceae*, other species such as warimbo (*Ischnosiphon spp.*) have been frequently encountered. At least two types of fern species were observed in small patches, however, they are scarce. In and around swamp forests where it merges into marsh forest, *Crinum sp.* occur. A variety of woody and herbaceous stemmed species up to 90cm cover the forest floor. This includes small species from the *Palmae* family, spiny palms (*Bactris sp.)* and other unidentified species.

It must be mentioned that *V. surinamensis* which has been recorded frequently, is a primary forest species which is globally threatened, yet, it is one of the most common tree species in the lowland of Suriname, typical for inundated and swamp forest (IUCN Red List). Furthermore, it is noteworthy to mention that of the eight tree species which are protected under Surinamese law (Stichting voor Bosbeheer en Bostoezicht, n.d.), three tree species were encountered in the study area. Two Tonka trees (*Dipteryx odorata*) were recorded of 35 and 50 cm DBH in marsh forest, 1 Hoepelhout (*Copaifera guianensis*) of 29cm DBH in creek forest and a Bolletri (*Manilkara bidentata*) of 46cm DBH in swamp forest. These species are protected due to overharvesting in the past. Many commercial tree species have been observed and recorded in the study area (Personal communication, 2014), however, no signs of timber harvest have been observed. All forest types and their DBH distribution showed a typical inverse “J” shaped curve, indicating that there is active regeneration and recruitment in the forest area.

A total of 514 trees ≥10cm DBH were recorded, which consisted of 35 different identified species. 229 individual trees ≥10cm DBH remained unidentified and another 8 palm species were identified of which one could not be properly named. Table 4 shows the number of recorded trees and palms in plots in all forest types, including the number of different unidentified species.

Table 4: The number of all recorded trees, including identified and unidentified species

	Swamp forest	Marsh forest	Creek forest	Total
Recorded trees	102	331	81	514
No. different identified tree species	17	21	10	35
No. unidentified tree species	40	166	23	229
No. different identified palm species	5	6	2	8
No. different unidentified palm species	-	-	1	1

Appendix 5: Vegetation list, shows all tree and palm species identified, it shows in which forest type they were recorded and it includes a separate list of trees which have only been observed. Compared to a research conducted by

Comparable information regarding number of trees and palms in the study area and that in similar forest types elsewhere is scarce while plenty can be found regarding commercial tree species. However, a research conducted by Andel (2003) in Guyana regarding species diversity in swamp forest, resulted in a total of 664 trees and palms ≥10cm DBH in one hectare of Manicole forest (a forest dominated by *E. oleracea*), represented by 30 different species. The total size of plots in swamp forest in the study area was 0.6 ha, in which 17 different tree and 6 palm species were identified. Many recorded palms however, and at least 3 palm species do not comply with size limits used by Andel (2003) and 40 individual trees in swamp forest remain unidentified

4 Ecosystem services in La Prosperité

This chapter provides an overview of the identified ecosystem serviced provided by the environment and the means of local utilization.

In general, forests serve as an important global regulating mechanism. Complex interactions between many factors determine global and local processes and conditions (de Groot et al., 2002). Climate factors such as rainfall and temperature and gas regulating processes such as carbon storage are several examples. The natural and semi-natural environment of La Prosperité and its ecosystem services contribute to these processes. Although all functions are interrelated and of major importance at global scale this research only addresses a small selection which are directly applicable to local conditions, easily observable and generally verifiable.

Table 5: Ecosystem functions and ecosystem services, provides the selection of nine processes or components with a range of goods and services per primary function, identified in the study area and its direct surroundings and includes the vegetation type(s) or other location delivering these ecosystem services.

Table 5: Ecosystem functions and ecosystem services (Source: de Groot et al., 2002; de Groot, 2005)

Primary functions	Processes and components	Ecosystem goods and services	Vegetation type(s) or other location
Regulating functions	Water regulation and supply	Drainage of swamp and marshland	Herbaceous swamp/creek
		Channelling of water	Herbaceous swamp/creek
		Drainage of excessive (waste) water village	Herbaceous swamp/creek
		Tourism	Herbaceous swamp/creek
		Important aquifer exploited by SWM	Herbaceous swamp/creek
		Transport	Herbaceous swamp/creek
Habitat functions	Refugium and nursery function	Mammals, fish and other fauna	All vegetation types
Production functions	Food	Game (Peccary, rabbits, birds)	All vegetation types
		Fish and caiman	Herbaceous swamp/creek
		Agricultural practices (kostgrondjes)	Marsh forest
	Ornamental resources	Aquarium fish in the past (aquaculture)	Herbaceous swamp/creek
		Song birds	Unknown
	Medicinal resources	Leaves	Marsh forest
		Resins	Unknown
	Minor timber products and timber	Fodder (leaves)	March forest
		Fuel wood	Unknown
Information functions	Spiritual information	Spiritual areas (Winti)	Marsh forest
	Historical information	Colonial village centre	Village
		The forest as colonial timber plantation	All forest types
		Old mango trees in the village	Village
		Old railway	All forest types
		Old drainage systems	All forest types
	Recreation and aesthetic information	Fresh black water creek	Herbaceous swamp/creek
		Accommodations	Village
		Aesthetic scenery herbaceous swamp	Herbaceous swamp/creek
		Enjoyment	Unknown

Water regulation and supply

Both water regulation and supply functions are of major importance to La Prosperité and its surroundings. The Coropina creek which channels water from large swamp and marsh areas, flows into the Para River. The swamps and rivers on the old coastal plain bordering the Zanderij formation, partially derive their input from groundwater inflow (Prado, 2013). The flow of the creek is important. Obstructions prevent efficient drainage from the village and aquatic ecosystems and tourism rely on balanced water systems. A few years ago the Coropina creek underwent maintenance. Vegetation was removed from within the creek and trees along the sides were felled to improve flow and maintain an open character (Personal communication, 2014).

In the past, recreational resorts in Para suffered shortage of surface water for tourism during holiday seasons. This was caused by to the absence of information on the connectivity of streams and other waterways and adaptations to natural watercourses either by natural circumstances or human interference (Stichting Planbureau Suriname, 2008). The creek is frequently used by tourists and occasionally used by locals. Reasons are fishing, bathing, hunting, other recreational purposes and as a means of transport. (Personal communication, 2014)

Both natural and man-made drainage systems have been observed in the area. Several artificial trenches derive from colonial times. Drainage systems in the forest have not been maintained for many years or even decades. The absence of periodical maintenance on drainage systems in the study area have led to occasional water flooding in the bordering plantation Vierkinderen (Personal communication, 2014), however along the railroad they appeared more deep and free of litter. Excavation of trenches in the village was observed, where periodical maintenance is common and excessive water from the village is drained towards the creek. Several relative shallow drainage systems (trenches) have been found between the creek and bordering residential areas. These trenches are used for waste water drainage from household equipment, such as washing machines (Personal communication, 2014).

La Prosperité is situated on a major fresh water aquifer named the Zanderij aquifer (Stichting Plan Bureau Suriname, 2008). This source is exploited by the Surinaamsche Waterleiding Maatschappij (SWM) at Republiek, near the main entrance of La Prosperité. It is the only outcropping aquifer and the only one receiving replenishment in Suriname (Prado, 2013). It facilitates piped water for the districts Paramaribo and Wanica. The water retaining layer lies very close to the surface (<20m) and a sealing clay layer is absent (Stichting Plan Bureau Suriname, 2008). This makes this reservoir very vulnerable. It is estimated that this reservoir has a life span at least 100 years unless contaminations occur (Stichting Plan Bureau Suriname, 2008).

Refugium

The different habitats and ecosystems of La Prosperité harbour a variety of botanical and animal species. Regarding wildlife, a separate list of identified wildlife during this research is included in Appendix 6: Identified wildlife. Various species of wildlife have been observed including large mammals such as golden-handed tamarind and Common squirrel monkeys which are both relatively common. Howler monkeys vocalisations have been observed and other species of monkeys have been encountered, however, identification was not possible. Tracks of wild boar have been observed occasionally and after sunset, many caiman can be seen in the creek, near the recreation area along the village. Large anacondas are not uncommon and the rare birds such as the Harpy eagle have been observed (Personal communication, 2016).

Food

Daily subsistence consumed by locals, generally derive from local and regional shops and markets. Some locals however, still use the forest and the creek as an additional food source and few hunting platforms have been observed. Frequently caught fish are Pataka (*Hoplias sp*.) and Walapa (*Hoplerythrinus sp*.), which, together with caiman (*Crocodylidae*), are considered good meat. Wild game such as Peccaries (*Tayassu sp*.), rabbits and forest birds are frequently hunted (Personal communication, 2014). Large groups of *Tayassu sp.* are known to have run through the village, disturbing its peace. Another food source derives from small agricultural areas within the forest, so called 'kostgrondjes'. Crops such as napi, casava, pom-tajer, bananas and ginger are produced. The forest itself provides many other products such as fruits from the Sekrepatu-kersi tree or boskers (*Eugenia omissa*) and the Pina and Koemboe palm (*E. oleracea*; *Oenocarpus bacába*) and other fruit bearing species. In La Prosperité, the collection of such forest products is minimal and less intensive than ever before (Personal communication, 2014).

Ornamental resources

The Coropina creek has been used in the past for breeding aquarium fish for trade (Personal communication, 2014). According to Mol (2012) in '*The fresh water fishes of Suriname'*, aquarium fish which have been imported from Brazil to Suriname, nowadays swim freely in areas such as the Coropina creek. Evidence of capturing wildlife was found in the form of a metal cage construction which appeared to be in poor condition and without bait. This was potentially used for capturing monkeys for trade or as someone's pet. A noteworthy phenomenon is the capturing of birds which are held as pet. Several local villagers keep birds, generally for their songs. This common phenomenon is seen in other parts of Suriname as well. Songbirds can be worth hundreds of Surinamese Dollars and are generally captured from the wild. Although capturing has not been observed, a variety of caged endemic songbirds in the village and beyond was noticed.

Medicinal resources

Many products in the forest can be used for medicinal purposes (Personal communication, 2014), however only few inhabitants have been observed collecting such goods. Examples are Anesi-wiwiri (*Piper sp.*) for baths and dried tree resin of the tingi-moni tree (*Protium spp.*). This substance which is called 'bush candle' can be lit and its aromatic smell is useful against mosquito's (Personal communication, 2014). Goods are sometimes used for own purposes, however, the majority is for local trade and medicinal products are sometimes collected to send to family members in the Netherlands (Personal communication, 2014). Other observed medicinal species as pointed out by the forest guide were dia-bita (*Lisianthus chelonoides*), malva (*Lippia alba*) and kamfer-bita (*Unxia camphorata*).

Minor timber products and timber

The collection of minor timber products such as fuel wood was not observed. Food preparation on small fuel wood however, has been noticed in the village on occasion. The source of these products however, remains unknown. The only minor timber product frequently used is fodder as fertilizer. This is converted to compost and applied around crops on agricultural plots (Personal communication, 2014). Timber harvesting or evidence of such activities has not been observed in the study area. However, commercial timber harvesting has occurred in the past, along the northern border of La Prosperité (Personal communication, 2014).

Spiritual information

Two important spiritual areas have been encountered during forest surveys. Both are located in the south of the study area, near the old railway. These areas are used by locals in as part of the traditional Winti religion. The first area of approximately 2 ha is rather isolated and accessible by a forest path leading from the railway. This area has not been observed and satellite images show an area with distinctive large colourful canopies with depth dynamic. This area which has been kept preserved due to its spiritual function, dates back from colonial times and consists of old, large trees (Personal communication, 2014). The second area is small and represents the location of a fallen tree. As this tree was spiritual, now the remains are being worshiped. Many offerings have been placed around its stump, consisting of bottles filled with alcoholic drinks and other beverages. These offerings can also be found in places in the village.

Historic information

La Prosperité was a timber plantation (Teenstra, 1835) also referred to as Porakko (Wekker, 1983). It was the last plantation along the Coropina creek accessible by tent boats in the dry season (Wekker, 1983). The digital collection of the Tropical Museum in The Netherlands (Tropen museum, n.d.) holds data of La Prosperité dating back to 1737. It states that Bersaba was build in 1858 on a donated piece of land were the Evangelical Brotherhood missionary post was established.

Multiple historical features, dating back to colonial times, have been preserved in La Prosperité. The small village comprises of only few roads, with a variety of traditional buildings. The original centre lies along the creek, next to the historical church and the vicarage. A monument near the creek carries the names of the former plantation workers who purchased La Prosperité, reminding locals of the past and their achievements. There are old mango trees scattered through the village (Personal communication, 2014.) and between 1904 and 1912 the railway was established connecting the north with the goldmines in the south. La Prosperité became a station, making it an important centre of the area.

Although the forest itself is of historical value, no historical elements were observed in the study area, except for the potential colonial drainage systems and more contemporary railway. Few Hevea trees (*Hevea brasiliensis*) have been observed along the railway, planted at times the railway was build (Personal communication, 2014). Those are however, not quite distinguishable from natural vegetation. Whether the old railway is considered historical or not remains debatable. The current sandy forest path sporadically shows remains of the old railway in the form of a few old nails and pieces of timber board. The bridge however is exposed track covered with few timber boards to improve access.

Recreation and aesthetic information

La Prosperité is a recreational resort, well known for its black freshwater creek (Stichting Plan Bureau Suriname, 2008). Hundreds of tourists have visited the Coropina creek in the village area during the project phase. Activities are mainly concentrated near the centre of the village next to the creek. Fees are charged for recreational activities depending on group size and means of transport. In the village, several accommodation services can be found. A variety of properties can be rented for overnight stays which is often done by young adults. Along the creek several shaded areas can be found for hammocks and as seating areas. Large crowds, noise and loud music near the creek or within holiday accommodations have been raised to be an issue and inconvenience for some villagers (Personal communication, 2014).

The forest area is generally not used for recreation purposes, except by locals. Some locals practicing agriculture in the forest have argued that their choice for such activities is recreational, and others admit they appreciate the tranquillity of the forest and enjoy hunting, fishing, bathing or visiting spiritual areas (Personal communication, 2014). The natural environment of the area and especially the creek and its herbaceous swamp provide aesthetic value. However, whether these values are appreciated by tourists or other local villagers, is unclear. Noteworthy is a residential areas observed in the South-east of the study area within the forest. This residential areas consist of a small tin house and claimed agricultural land. Furthermore, a small part of the old railway just north of the study area has been occupied and provided with a basic dwelling (Personal communication, 2014).

Although not all directly related to ecosystem services according to de Groot (2005), anthropogenic elements are separately included as carrier function, by de Groot (2002). Here they are provided separately. Appendix 7, provides an overview of the location of all anthropogenic elements observed and identified, in the study area. This includes the following features:

- Bridge
- Religious fallen tree
- Old railway
- Spiritual area
- Roads
- Agricultural plots
- Residential areas
- Coropina creek

-

5 Feasibility of ecosystem services

According to Bhairo-Marhé et al. (2009), Payments for Ecosystem Service (PES), ecotourism and Non-Timber Forest Products (NTFP's) are resources with potential to increase public revenues in Suriname. When regarding the environmental properties of La Prosperité and delivered ecosystem services, tourism is already an activity which is incorporated in the function of La Prosperité. La Prosperité is largely forested and water sources are an important aspect within its surroundings. The forest and their waterways provide important ecosystem services which are currently under-utilised by the community, and therefore exerting minimal stresses on these systems. Based on these findings, the potential of ecosystem-based markets regarding 1) Payments for Ecosystem Services, 2) ecotourism, and 3) Non-Timber Forest Products are addressed in the subsequent sections.

5.1 Ecosystem services and markets

This section provides a brief definition of the context of PES, ecotourism and NTFP's and provides an overview of their market characteristics and general trends.

Payments for Ecosystem Services

Payments for Ecosystem Services, also referred to as Payments for Environmental Services or PES in short, is a mechanism related to ecosystem services which puts value on natural resources as incentive for the protection of these resources (Rodriguez, Latawiec, Strassburg & Matt, 2012). It is often landowners or managers of an area who receive financial incentives for implementing conservation actions which otherwise would not have been adopted (Rodriguez et al., 2012). PES schemes generally include incentives related to water resources and carbon storage in forests. An example of carbon related schemes are REDD+ which stands for Reducing Emissions from Deforestation and Forest Degradation. REDD+ focuses on mitigating climate change through reducing emissions of greenhouse gasses via result-based payments.

According to Rodriguez et al. (2012), ''*Suriname is in an extraordinary position to benefit from incentives to conserve forest carbon and biodiversity*''. Due to Suriname's high forest cover and low deforestation rate the country may benefit from REDD+ funds which is expected to reach up to US$ 40 billion per year (Rodriguez et al., 2012). According to the same source, PES schemes related to water resources can be an interesting mechanism in Suriname, however, no information regarding these schemes is currently available.

In line with Suriname's strategy to pursue environmentally sustainable economic development, the government of Suriname has expressed its interest in payments for carbon storage such as REDD+ (Kuijk, 2012). In 2011 Suriname started preparing a national plan for measuring, monitoring and calculating carbon stock. According to Kuijk (2012), many developing countries such as Guyana and Suriname are preparing for REDD+ although the details of REDD+ programs are still a matter of international debate. While Suriname has taken steps towards more approaches to address climate changes issues, a REDD+ strategy does not yet exist (Kuijk, 2012). Due to the limited information about PES schemes in Suriname, this potential mechanism will not be further addressed.

Ecotourism market

Ecotourism can be a mechanism or an incentive for nature conservation while bringing economic value to natural and cultural resources. It can contribute to revenue rising, awareness raising, sustainable land management and it can strengthen cultural appreciation (Secretariat of the Convention on Biological Diversity, World Tourism Organization & United Nations Environment Programme, 2009). The term ecotourism can be considered both a tool for sustainable development based on principles and a form of nature-based tourism in the marketplace (Epler-Wood, 2002). The term therefore refers to both a concept under a set of principles and a specific market segment (Epler-Wood, 2002). Sustainable ecotourism in itself is rather broad and complex and many definitions can be found. Therefore instead of defining the concept, the principles of ecotourism are provided in Table 6: Ecotourism principles, as pointed out by Epler-Wood (2002) in "*Ecotourism: Principles, practices & policies for sustainability*''. As a segment in the marketplace, ecotourism is an industry advertised as being equivalent to nature tourism. In fact, ecotourism consists of the segments cultural, rural and nature tourism, although it is commonly advertised as being equivalent to nature tourism (Epler-Wood, 2002).

Table 6: Ecotourism principles

- Contributes to conservation of biodiversity
- Requires lowest possible consumption of non-renewable resources
- Sustains the well being of local people
- Is delivered primarily to small groups by small-scale businesses
- Stresses local participation, ownership and business opportunities, particularly for rural people
- Involves responsible action on the part of tourists and tourism industry
- Includes an interpretation / learning experience

Table 7: presents an overview of the market characteristics and trends of ecotourism, and to a certain extent tourism in general, mainly focussed at national and regional level. Appendix 8: Market characteristics of ecotourism, provides a more comprehensive description of the aspects included in this table.

Table 7: Market characteristics and trends of ecotourism

- Government plans to enhance the profitability of ecotourism in Suriname especially focussed on nature, culture, heritage and event tourism in rural areas and the hinterland
- Governmental plans include increasing the number of tourists and Suriname's popularity as destination
- There is hardly any data available regarding the ecotourism market in Suriname
- Suriname experienced a decline of tourists in the tourism sector
- Mass and mainstream tourism is in decline and there is a large international demand for special interest tourism
- Awareness of ecological issues, educational and aesthetic purposes, self-improvement and commitment to communities are important target-group characteristics
- Holidays with active and nature-orientated activities are becoming more popular
- Authentic and pristine surroundings are now highly appreciated
- The Para district is known for its recreational and holiday resorts and holds the most resorts in Suriname
- Between 2008 and 2016 the number of resorts in Para have more than doubled
- The number of visitors in Para have experienced an increase between 2008 and 2016
- Majority of resorts in Para offer natural or artificial swimming facilities with permanent holiday facilities which resembles rural-tourism
- Tours through nature offered by these resorts generally include self-guided tours in close proximity of facilities
- Only few resorts or locations offer guided nature-tours in Para
- The majority of guided tours in Para or urban areas provide day-tours including more than one destination
- Prices of day-tours and nature walks in Para or surrounding areas vary considerably and range somewhere between SRD 7,50 for a self-guided nature walks or SRD 15 for swimming fees up to € 39 for a half-day guided tour
- Guided tours more towards the hinterland are more expensive. Prices of € 45-85 and over are not uncommon

Non-Timber Forest Products

NTFP's are Non-Timber Forest Products, also referred to as Non Wood Forest Products (NWFP). These are products other than timber, such as fruits, medicinal plants, resins, small timber products and wildlife, deriving from natural environments. Table 8 presents an overview of the market characteristics and trends of Non-Timber Forest Products in Suriname and beyond, based on vegetal NTFP's only. Appendix 9: Market characteristics of NTFP's provides a more comprehensive description of the aspects included.

Table 8: Market characteristics and trends of NTFP's

- Government plans to increase benefits deriving from forests and enhance markets for forest products
- Government stresses the importance of vegetal species delivered by forests and their economical potential and value
- NTFP's are increasingly a source of income
- There is hardly any data available on the commercialisation of NTFP's in Suriname
- There appears to be a lively national market for forest products
- Some of the main commercial plant species are *Euterpe. oleracea, Maximiliana maripa and Astrocaryum vulgare*
- Some of the most expensive medicinal NTFP's found on the market in Suriname are *Parinari spp.* (182 US$/Kg) and *Copaifera guyanensis* (365 US$/Kg)
- Annual value of the domestic and export market for medicinal plants in Suriname is estimated at a US$ 1.5 million
- There is a lively market near Zanderij where NTFP's such as *M. maripa* and *A. vulgare* are sold
- *E. oleracea, M. maripa*, *A. vulgare* and *O. bacaba* are considered the most important edible NTFP's in Suriname
- There are food and cosmetic industries manufacturing NTFP's in Suriname
- Prices range from *C. guyanensis* oil (40-60 SRD/L), *A. maripa* oil (20-25 SRD/L) , *D. odorata* beans (30-60 SRD/L) and *E. oleracea* berries (50-200 SRD/50Kg)
- There is much data available regarding *E. oleracea* as juice (Podosiri)
- The juice produced with the berries of *E. oleracea* has received much attention the last few years and is produced intensively in Brazil, partially for export
- Podosiri is becoming more popular as a highly nutritious beverage and as 'super food'
- Prices of *E. oleracea* in brazil have experienced an increase due to large international demand
- Podosiri is probably the most well known and popular vegetal NTFP in Suriname
- Podosiri juice in Suriname is commercialized and in some places this palm has been cultivated
- The demand for *E. oleracea* in Suriname is increasing and prices and consumption are rising. Prices have almost doubled between 2008 and 2014
- Proposals for planting 5 billion *E. oleracea* palms in the Amazon estuary exist

5.2 Ecosystem services and their potential

This section provides an overview of the potential for ecotourism and NTFP commercialization in La Prosperité by outlining the advantages and disadvantages. This is partially based on the characteristics of the natural and semi-natural environment and its direct surroundings, including earlier addressed market characteristics. It also incorporates additional qualitative and quantitative information and addresses economic benefits and builds upon earlier obtained information which can influence the potential of these ecosystem services.

Ecotourism

Nature-based tourism and rural tourism as segments of ecotourism, appear to be promising ecosystem services for La Prosperité. Its natural surroundings and rural position offer multiple qualities that are in line with aspects important in ecotourism, nature-based tourism and rural tourism and which are in line with market trends. Table 9: Advantages of La Prosperité regarding ecotourism, provides an overview of contributing aspects towards nature-based ecotourism and rural tourism in La Prosperité. Besides these contributing aspects towards the potential of ecotourism segments, several other unfavourable aspects can affect its overall potential. These elements are presented in table 10: Disadvantages for Ecotourism. Appendix 10, provides a more comprehensive description of the aspects included in this table

Table 9: Advantages of La Prosperité regarding ecotourism

- Large forested area with multiple forest types in a natural and semi-natural environment
- Large meandering herbaceous swamp and creek along the eastern forest border and creek within the forest
- Swimmable waters during wet season and parts of the dry season
- Diversity of botanical species belonging to swamp, marsh and creek forest including high dryland forest
- Large and emergent trees observable, including large buttresses, epiphytes and lianas
- Globally threatened species (*V. surinamensis)* abundant, including other protected species
- No evidence of timber harvesting except for agricultural areas
- Environment home to a variety of wildlife, including large mammals and rare bird species
- Existence of traditional agricultural practices and hunting (culture-tourism)
- Variety of edible forest products and products with medicinal properties
- Existence of spiritual areas (sacred forest and sacred trees in the forest and within the village
- Historical value of the forest as colonial timber plantation and the railway through the forest
- Colonial village centre with several original buildings and buildings in traditional style
- Old mango trees within the village and a monument to remember former plantation workers
- Already a well known recreational resort in Suriname for its black fresh water creek
- Activities mainly concentrated in the village near the creek
- Facilities for overnight stays available in the village, including seating areas near the creek
- The forest area is generally not used for recreation purposes by tourists and villagers
- The creek and its scenic herbaceous swamp provide aesthetic value
- Easy forest access in the dry season
- Located in a rural region and a convenient position between urban and rural areas
- Close to the main airport, the Capital, and Zanderij
- Good connectivity, easily accessible from main road and a old railway leading to Onverwacht and Zanderij
- Regular public transportation in the village and frequently along Kennedy highway
- In close proximity of the Jan Starke Educational and Recreational Institute in Zanderij and other recreational resorts
- Typical plantation culture
- Active and nature-orientated activities received much attention
- Large international demand for active and nature-orientated activities (special interest tourism)
- High appreciation for authenticity, pristine surroundings, not massively visited by tourists
- Important elements are scenery, wildlife, wilderness setting, trekking and experiencing places.
- Bird, mammals and water resources are the most important ecotourism factors in tropical forests

Table 10: Disadvantages for Ecotourism

• Forest area subjected to flooding in various degrees during rainy seasons • Multiple secondary forest patches near the entrance and within the forest • Shortage of surface water in the past during holiday seasons • Waterways are part of the replenishable aquifer which is vulnerable to contamination • Slash and burn practices to create agricultural plots and maintain open herbaceous swamp • Capturing of wildlife and hunting • Commercial timber harvesting in the past along the northern border of La Prosperité • Poor state of the bridge providing access to the forest • Large crowds, noise and loud music have been argued to be an issue of concern • Burning of garbage is done regularly and roaming dogs can be aggressive • Feeling of tensions in the village, people tend to keep to themselves and minor drug related crime

La Prosperité's most noticeable natural features are its large forest area, the creek and large herbaceous swamp, which provide refuge to various wildlife, including monkeys and birds. The quiet and rural location of the forest provides an attractive opportunity for nature-orientated tourism, although wet conditions might limit the seasons in which the forest can be visited. The old railway, with its clear and open trail, provides a suitable track and therefore an opportunity for self-guided tours from La Prosperité to the neighbouring village of Onverwacht. These element are key in nature-tourism and are increasing in popularity amongst tourists. The majority of the forest appears natural and is generally not used for recreational purposes by tourists.

The creek and herbaceous swamp near the village centre, provide opportunities for swimming, canoeing and other water related activities, popular to nature tourism and rural tourism. Locations further along the creek are more suitable to tourists who enjoy a more tranquil setting further away from the village. Shortage of water during holiday seasons however, must be considered as not all seasons are suitable for such activities. The relatively close proximity of other resorts and cities allows for nature-orientated day-tours in La Prosperité to be combined with visits to surrounding areas. This is a common practice and is often offered by tour operators in Suriname, in collaboration with other nearby businesses. Nearby resorts and the Jan Starke Opleiding- en Onspanningscentrum can provide a variety of activities with en emphasis on education to benefit both tourists and businesses involved. The large size and variety within La Prosperité's forest provides an excellent business opportunity for nature tourism in the form of tracking and hiking, a business option currently not readily available in this area. Whether there is a demand for such activities in unclear as data regarding tourism in Suriname is limited.

Other aspects such as it convenient location and accessibility could make La Prosperité a centre for those who prefer rural, yet centralised areas to plan their journeys and tours from. The village offers a variety of holiday homes that can be rented and there is public transport towards the capital and airport, providing tourists with an easy commute to and from this area. It could be a quiet retreat and escape for urban nationals and for international arrivals arriving at the nearby airport.

The history of La Prosperité, which is reflected in its village centre with scattered old mango trees, might appeal to tourists searching for culture-based activities and heritage-related information. The history of the plantation and the village and what they have to offer are in line with the features and information searched for by this particular group. However, several unfavourable aspects in the village, such as its atmosphere, minor crime and waste management makes culture-tourism a less promising segment within ecotourism in the near future. When considering earlier addressed costs for nature-orientated activities and the nature of many activities, a guided day-tour organised in La Prosperité could generate at least € 40, compared to prices seen at Peperpot (for half a day). If tours would be offered to groups of 5-10 people, this could result in € 200-400 per day, which is SRD 12.600 on average, based on an exchange rate of € 1 – SRD 4.2.

Non-Timber Forest Products

The commercialization of NTFP's and in particular the berries of the *E. oleracea* palm appears to be a promising NTFP species for La Prosperité. It is considered the most well known and one of the most important vegetal NTFP in Suriname, which grows abundantly in the study area. Appendix 11, provides a brief overview of quantitative characteristics of identified vegetal NTFP's in La Prosperité and their market value. Furthermore, it addresses the abundance of *E. oleracea* in the study area compared to other areas where this palm flourishes. Table 11: Advantages of La Prosperité regarding NTFP commercialization provides an overview of contributing aspects of La Prosperité and the market characteristics of utilizing these NTFP's.

Table 11: Advantages of La Prosperité regarding NTFP commercialization

Advantages
• A variety of NTFP's provided by the forest of which several are commercial in Suriname • Two important commercial NTFP's that are most abundant (*E. oleracea and M. maripa*) • *E. oleracea* is the most abundant NTFP identified in swamp forest in the study area • Large area of swamp forest (95 ha) where this palm flourishes • Uniform patches of this palm can be found in swamp forest in proximity of Bersaba • *E. oleracea* is the most well known NTFP species in Suriname and is becoming more popular • There is much data available regarding *E. oleracea* and there is a high international demand • Prices for *E. oleracea* and its demand are rising in Suriname • Easy to process into Podosiri juice via simple machine • Revenues in the near future

Table 12: disadvantages of NTFP commercialisation

Disadvantages
• The total area coverage of uniform *E. oleraces* stands is unknown • Located in areas inundated during rainy seasons • Information of NTFP commercialization in Suriname is poor

E. oleracea is a marketable species in Suriname and the juice of *E. oleracea* is becoming more popular in Western countries. The demand and price of this particular juice in Suriname is increasing and *E. oleracea* is the most abundant NTFP species found in swamp forest within the study area, covering approximately 59 ha. A disadvantage of the berries of this palm is that they grow in an area which is inundated during the rainy season and that the total area coverage of uniform *E. oleracea* stands is unknown, however, it is estimated that they cover at least 2 hectares in total and probably more.

According to Cymerys et al. (2011), each fruiting palm clump can produce about 120 kg of fruit per year, depending on the amount of stems and overall management. In an area where palms are managed by pruning and thinning of vegetation around the clumps, one hectare of *E. oleracea* can produce 10.000-12.000 kg/ha/yr in terra firme and up to 15.000 kg/ha/yr in flooded forest (Cymerys et al., 2011). If an average of 15.000 kg/ha/yr is multiplied with the lower range of SRD 50 per 50 kg, argued by Esseboom (2013) , a modest 2 ha uniform area of this palm can yield up to SRD 30.000 per year. When the higher end of SRD 200 per kilo, argued by the same source is considered, the same area can yield up to SRD 120.000 per year.

6 Discussion

This Chapter discusses the methods and results provided in this report and the limitations to the research methods employed.

The first section of this report provides information in regards to the natural environment of La Prosperité. Some of the main finding in this section are that four vegetation types can be distinguished which is based on variations in inundation intensity and duration of the rather clayey soils, caused by variations in permeability. This is reflected in dispersed spatial patterns of these vegetation types and their specific species distribution, making La Prosperité a relatively species rich forest.

The identified vegetation types in the study area; swamp forest, marsh forest, creek forest and herbaceous swamp, all compose of species which are typical for, or even restricted to the concerned vegetation type. The most frequent trees and palm species in swamp forest for example are babun (*V. surinamensis*), foengoe (*P. campestris*) and Pina (*E. oleracea*), while kopi, manbarklak, mapira and paramakka are more dominant in marsh forest. These differentiations are largely based on research conducted by Eyk (1957) and Lindeman and Moolenaar (1959), who provide reliable and comparable data. Literature information obtained regarding local forest types and characteristic species however, often provide contradicting or overlapping information.

According to Food and Agriculture Organisation (n.d.) for example, palms such as *Maximiliana maripa*, *Euterpe oleracea* and *Astrocaryum paramaca* are well represented in marsh forest. These palm species indeed occur, varying in quantities, however, *E. oleracea* in the study area occurs mainly in swamp forest and to a lesser extent in marsh forest. Lindeman and Moolenaar (1959) however, argue that *A. paramaca Eschweilera sp.* and *G. glabra* are commonly found in high dryland forest, while this forest types has not been distinguished in the study area. An other example is ter Steege and Zondervan who argue that *G. glabra* and *P. campestris* are common species on old ridges on the old coastal plain (Coropina formation) and that *E. oleracea* is common in marsh forest. Kahn and Granville (1992) by contrast, who researched ecosystems in Amazonia, found that palms such as, *M. maripa* and *Astrocaryum sp*. were dominant in secondary un-flooded forest while forests dominated by *M. maripa* together with *E. oleracea* were encountered in periodically flooded soils. If *E. oleracea* was strongly dominant, this indicated seasonal or permanent swamp forest.

Based on these examples it can be concluded that the indicator species used for forest type classification are not necessarily restricted to one particular forest type. Furthermore, when considering that forest types are dispersed and that three forest types have been distinguished in a relatively small area, it might be possible that instead of three distinctive forest types, only two true forest types occur in the study area namely marsh forest and creek forest, each with subtle variations

In regards to this, the soil map does not necessarily correspond with the locations of the forest types. Furthermore, when comparing the soil map with the vegetation type map, the allocated swamp areas are located either west of the elevated railway or east of the railway where it is enclosed by higher terrain. As this restricts drainage towards the herbaceous swamp, soils remain longer inundated, explaining slightly wetter conditions at local scale. The forest type map is related to hydrological properties in the study area. The greater part of the forest area is classified as either seasonally flooded (swamp forest and creek forest) or temporarily inundated (marsh forest). This is related to small variations in depressions in the landscape, although the herbaceous swamp with the creek have a more distinctive boundary. Whilst allocated forest types in the study area leave room for debate, the vegetation type map does reflect the patterns of dryer and wetter soils found in the study area. Therefore, the forest type map continues to be a reliable tool to consider when determining wet or dryer areas.

A closer look at the data provides several other issues regarding forest types which should be considered. First of all, high dryland forests have soils with sandy properties making them highly permeable. The location of the village is classified as such and sandy soils can be found in proximity of La Prosperité. Although no forests in the study area are classified as high dryland forest, species indicating this forest types can be found. Some of these species are mentioned above, another example is emergent species such as *Vochysia spp*. (Lindeman & Moolenaar, 1959).

Areas resembling high dryland forest are scarce in the study area. Either because marsh forest is strongly dominant and sandy soils are scarce, or because agricultural plots and secondary forest prevent identification of relevant indicator species. Although secondary forests have been classified as high marsh forest, another possible explanation is that high marsh forest is actually high dryland forest and that low marsh forest is a mixture of marsh forest and high dryland forest. The low basal area of these locations would then not be related to the hydrology of these areas, but instead indicate large areas of secondary forest, where timber harvesting in the past has altered its characteristics severely. This possibility is supported by the fact that the religious forest in the south of the study area is distinctive compared to other forest, which could be the last remaining patch of intact high dryland forest in the study area.

Furthermore, the canopy structures of swamp forest (in case of low tree density) closely resemble secondary forest or kapoeweri where *M. maripa* is absent. Mapping of areas might therefore differ from actual circumstances. It is however common for swamp forest to be located within low marsh forest areas. Therefore, it is assumable that these swamp areas are zoned sufficiently. However, it is plausible that forests allocated as kapoeweri and secondary forest are actually swamp forests. Although swamp forest has been identified via small crowned canopies in combination with the distinctive colour of foengoe (*Parinari sp*.) (which was not observed in kapoeweri or secondary forest, at least not within recordable size), according to Edelman (1978) and Eyk (1957) however, *Parinari sp.* occurs both on swamps and dryer scholl soils. Furthermore, as this species is considered commercial (Tropenbos n.d.), its absence might be explained by previous timber harvesting, rather than dryer soil conditions.

Secondly, a remark that must be made is Eyk (1957), who mentions that marsh forest in general is rather species poor and can resemble a luxuriant savannah forest, meaning a generally low forest and many thin trees. More dynamics such as flooding intensity and duration could explain lower numbers and limited sizes (both in height and circumference), amongst trees. This is relatively common in swamp forest and marsh forest in the study area. However, as kapoeweri was distinguished due to its high number of very thin trees, these areas might have been classified incorrectly.

Lastly, high dryland forest, also referred to as tropical rain forest, is very rich in species, which could not compete with the species richness found in La Prosperité. However, considering that high dryland forest might occur in the study area, or at least marsh forest which resembles this rich forest type in several places, it can be concluded that this area is probably more species rich than the majority of marsh forests found on the Coropina formation. Additionally, species frequently found in savannah forest (such as *B. alta* and *Protium sp*.) also occur in other areas, (Lindeman & Moolenaar, 1959). Areas where they were observed are generally classified as creek forest, which raises the question whether this forest type has been properly classified.

The methods of data collecting have encountered several limitations. Firstly, the determination of tree and palm species and overall species richness is affected due to limitations in botanical knowledge during species identification. Statistical analysis regarding forest stands have only included species, identified by the permanent field guide. Therefore a separate list was included consisting of additional identified tree species by qualified tree botanists. These restrictions have prevented possible use of other indicator species for forest type classification and mapping. Furthermore, they might have prevented further comparison with forests in other areas and the identification of potentially marketable NTFP's, which will be addressed at the end of this Chapter. Additionally, tree measurements include trees >25 cm DBH and do not include individual tree heights. Using other size limits and including individual tree height can provided more comparable forest data. A significant amount of data regarding forest properties can be found, orientated at commercial timber species and forest, generally classified as high dryland forest.

Additionally, it is difficult to provide detailed information on water levels and hydrological properties, especially as the research was conducted in the long dry season. As hydrology was directly linked to species composition and overall forest type, no separate hydrology map is provided. In addition to this, hydrological information retrieved from local residents, vary significantly both in water level and in location of these areas. Hydrological information should therefore be interpreted carefully.

For the completion of maps, indicators were used, visible on satellite imagery. This image stratification has determined final zoning in non-surveyed areas. Plot data and descriptive field notes have been used and applied during map compilation, however, in case of any doubt, remote sensing eventually determined allocations. After maps were compiled, a majority analysis was done, to prevent highly fragmentised maps. It must be said that the study area has a very high small-scale variation in forest types, which further complicated mapping. This has resulted in overlap with other forest types or subdivisions, however, it must be considered that forest type boundaries are not distinct boundaries.

The second and subsequent chapters and sections of this report address the ecosystem services provided by La Prosperité, their local utilization, as well as market characteristics of three ecosystem services, their qualitative or quantitative properties and overall advantages and disadvantages. One of the main findings is that a variety of ecosystem services can be found in La Prosperité, providing important benefits to the local community, however not all ecosystem services are utilized to the same extent. Many are under-utilized, while others appear to be of greater significance. Based on local conditions of the natural environment of la Prosperité, a variety of ecosystem services appear promising such as its natural characteristics, provided NTFP’s and market characteristics, the utilization of berries of the *E. oleracea* palm and two segments of ecotourism (nature-tourism and rural tourism.

Ecosystem service assessment generally include a variety of methods to identify and value ecosystem services. Understanding the benefits provided by nature can help to increase awareness and support for conservation and improve decision-making processes (McCarthy & Morling, 2014). Several important aspects within these methods are identifying the quantity (by area) and the quality (condition) of the habitat concerned, identifying important ecosystem services, valuing these services in monetary terms and involving key stakeholders (McCarthy & Morling, 2014). Although this research does identify the quality of habitats (under environmental assessment) to a certain extent, it is unable to encompass a full ecosystem service assessment. It only addresses few aspects which all together are briefly addressed.

First of all, the ecosystem services that are identified and included are just a small selection of the broad variety of ecosystem services which are generally provided by forests and other ecosystems. It only includes those which are easy identifiable within or near the study area. However, these non-regarded ecosystem services are of equal importance. Thereby, involving key stakeholders when identifying ecosystem services and their value is an important aspect within an ecosystem service assessment. This however, was a limitation to the research. Only few locals have been approached for details regarding ecosystem services in La Prosperité, limiting the potential for identification of marketable ecosystem services and determination of local utilisation. Local involvement within this assessment can increase the reliability of obtained information, it could have influences the overall selection of NTFP’s and could have contributed towards the experienced constraints towards species identification.

Secondly, assigning a monetary value to ecosystem services can help to strengthen the case for conservation and it allows the benefits and costs to be expressed in comparable units. Generally, all identified ecosystem services are valued in an ecosystem service assessment, which can include a variety of value-based aspects to provide a reliable overview of the value of an area. In this research however, only the two predetermined ecosystem services (Ecotourism and *E. oleracea* as a NTFP) are briefly valued via the market-price method. It does not include market distortions such as fluctuations of prices over time or rate of exchange and only presents a brief and simple overview of potential financial returns. For both ecosystem services, prices_are based on a minimal amount of data. Furthermore, it excludes all costs related to required staff and salaries, facilities, machinery, season-bounded limitations and other financial aspects. However, although this data remains absent, it does provide a general overview of the economic potential related to these ecosystem services.

Two potential ecosystem services have been fully included in this assessment, which are related to NTFP's and ecotourism.The choice for *E. oleracea* as a NTFP is based on the fact that the fruits of this palm are considered the most important NTFP in Suriname and that its demand and prices are rising. This palm was recorded as being most abundant in swamp forest and more plentiful than other potential NTFP's in other forest types.
However, although *E. oleracea* is said to be the most abundant NTFP in swamp forest and that it contains higher densities then other potential NTFP's in other forest types, swamp forest is not the largest forest type in La Prosperité. In fact, *M. maripa* which is the second most abundant marketable NTFP species, is distributed over a larger area. However, due to the abundant information regarding *E. oleracea*, and the absence of market data regarding other NTFP's, it appears that this species indeed provides the most potential.

Another regard concerning this NTFP species is that measurements during main forest inventories only included stem heights, with size-limits that include juvenile, and thus non-fruiting palms. Although the recommendations in regard to this palm are partially based on the presence of uniform *E. oleracea* stands, it is important to consider that the calculated average of 455 *E. oleracea* stem not only contain adult fruiting palms. Furthermore, although it is estimated that at least 2-4 ha of these uniform *E. oleracea* stands can be observed in the study area, it is important to highlight the fact that patches can be small and that they are widely dispersed.

Presenting information and outcomes provides SPI a comprehensive description of the natural heritage provided by the natural environment site which might be representative for the entire environment of La Prosperité. It delivers an overview of the ecosystem services supported by the natural environment and includes a specific service which can be a successful contributor to socio-economic development.

Combined information may serve as linkage between economic development and nature conservation and can serve as base and as tool for further business planning and decision making. It can complement (current development plans)) or feasibility studies and project proposals, it can be used as base for future studies and for acquiring appropriate specialists and relations in the following phases and finally, it can serve as base for strengthening socio-economic development in La Prosperité/ additional information complements the recently established local database. And as solid information on the properties of heritage.

7 Conclusions and recommendations

The objective of this research was to improve knowledge towards the ecological condition of La Prosperité and its ecosystem services, as well as identify suitable goods or services that can serve as a mechanism to support economic development in La Prosperité whilst conserving its natural surroundings. In order to understand the ecological condition of the natural environment of this heritage, including its ecosystem services and further link this to La Prosperité's potential towards ecosystem-based mechanisms, further considerations must be made.

First of all, ecology in general is an interdisciplinary field in which many aspects and their mutual relations are included. In order to complement the knowledge towards the ecological condition of La Prosperité, further research would be desirable. Additional research could include for example identifying the indicative properties of non-regarded tree species in this research. This could further contribute to determining the overall species richness and thus its biodiversity of La Prosperité. Other examples include classification of botanical species in the herb strata, and botanical species found in canopy layers, including lianas and epiphytes. In addition, the relation amongst organisms can be regarded, in particular the interactions amongst species and microhabitats and the effects of intensifying forest-utilization towards these groups and areas.

Research towards the classification of botanical species and faunal species could be a basis for expanding the possibilities of ecosystem-based markets. For example, many vegetal species are considered a NTFP and are used for their medicinal properties. Investing in the classification of these species in combination with local knowledge regarding the properties of certain species, could open new markets beyond regional and national markets currently found in Suriname. In addition to this, thorough research of local fauna could be used to pick up on and promote key aspects, important in nature-based tourism. Including local knowledge in research could contribute to further identifying the properties, relations and ultimately, the potential of La Prosperité. Data regarding locations and previous harvest times indicate which areas are indeed secondary or primary forest and which species are desired as commercial timber. This could further be incorporated into future development plans.

When considering the selected ecosystem services regarding NTFP's and ecotourism, it would be recommended to further investigate their overall potential and constraints. This includes the localisation of *E. oleracea* patches and their total area coverage, quantifying mature and fruiting specimens, identifying local and regional markets regarding both berries and its juice and considering the possibilities regarding intensifying the productivity of this species in a sustainable way. In regards to nature based tourism and rural tourism, it would be worthwhile to identify the characteristics of tourism (reason for travel, duration, particular interests and nature of activities) in bordering recreational resorts and other resorts in Para. In addition to La Prosperité's wet conditions and related constraints, reliable information regarding maximum water levels can be obtained via brief forest inventories conducted during the long wet season. Likewise, solutions towards ensuring sufficient surface water during holiday seasons should be identified, in cooperation with bordering recreational resorts.

For both ecosystem services, an emphasis should be put on community involvement. It is highly recommended to explore the willingness of local inhabitants to contribute to and participate in such activities and ensure that local conditions are suitable for relevant activities. Furthermore, in order to include all aspects of ecosystem services, their way of utilization, constraints and potential, it is recommended that all ecosystem services are identified with help of the local community. Finally, it is of high importance that the risks and disadvantaged regarding environmental, socio-cultural and economical aspects provided by these prospective ecosystem services are identified before further plans are constructed. This should at east include potential risks related to affects on wildlife, traditional practices, legislation, product specific constraints and of course all the costs related to implementing these prospective services.

The prospects of capturing ecosystem services such as *E. oleracea* and nature-based tourism are hopeful. If further attention would be paid towards complementing useful, desirable and necessary information, these ecosystem services could be used as tool for sustainable development in La Prosperité.

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Appendix 1 Field form

Date:
Plot number:
GPS coordinates Lat/lon:

Remarks:

Overall plot information

- Forest type:
  (Dominant)
- General forest/canopy height in meters:

Main plot details

- DBH of trees ≥25cm DBH
- Vernacular names of recorded trees and palms
- Number of palms*, excluding *E. oleracea* clumps

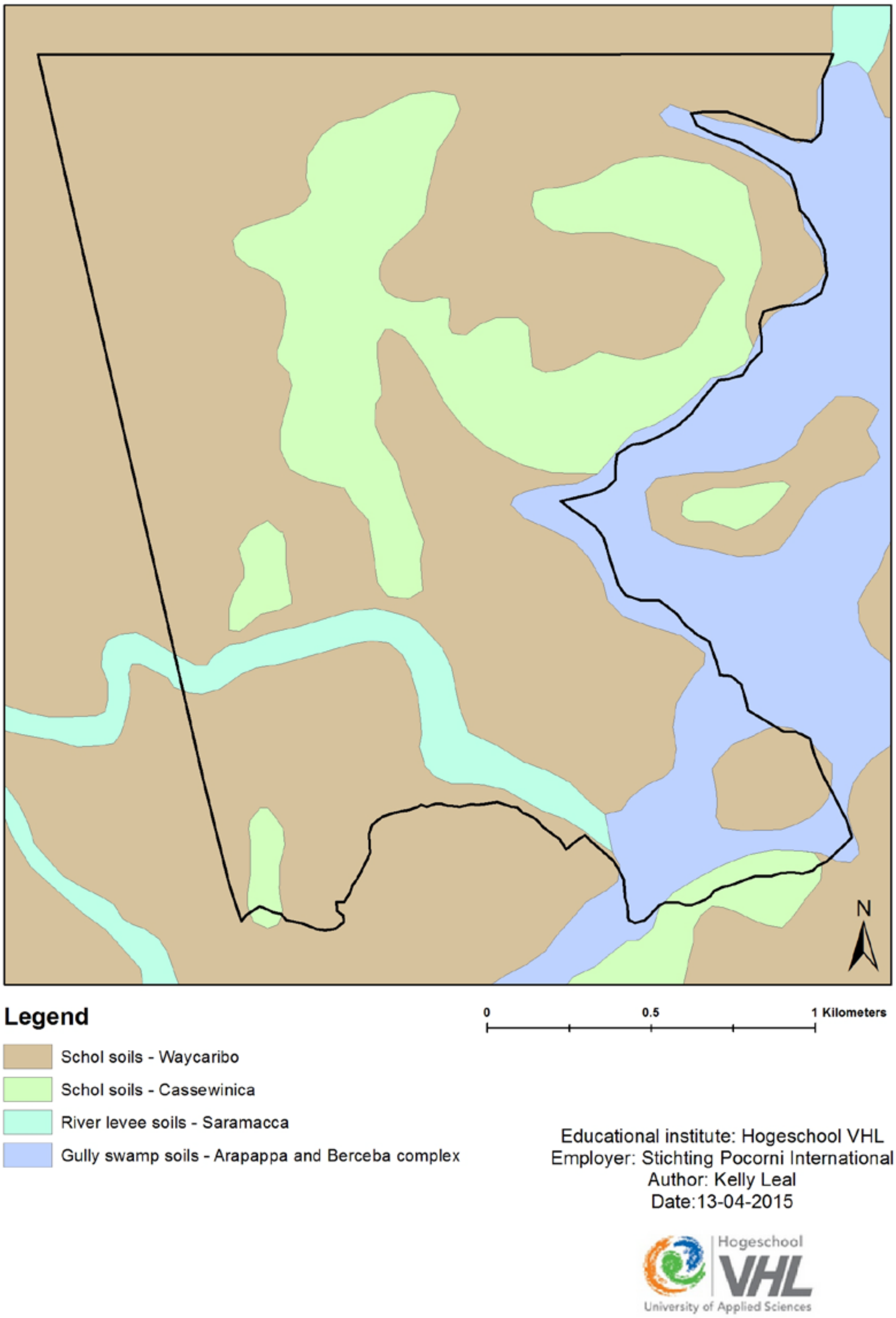
*: All palms 4 m except *A. paramaca*

Sub plot details

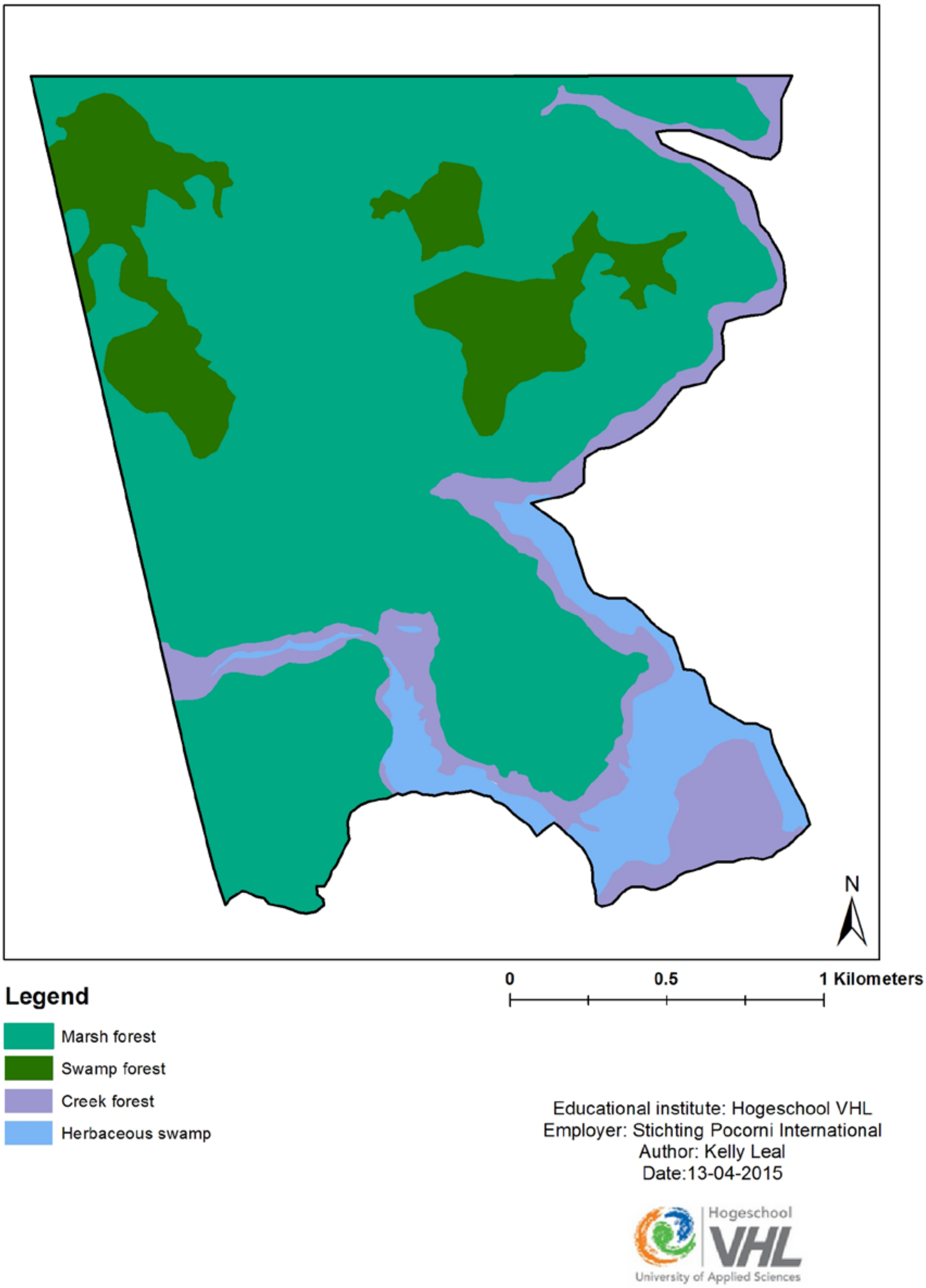
- Number of trees ≥10cm and <25cm DBH
- Vernacular names of recorded trees and palms
- Number of *E. oleracea* clumps*

*: Stem *E. oleracea* at least 4 m

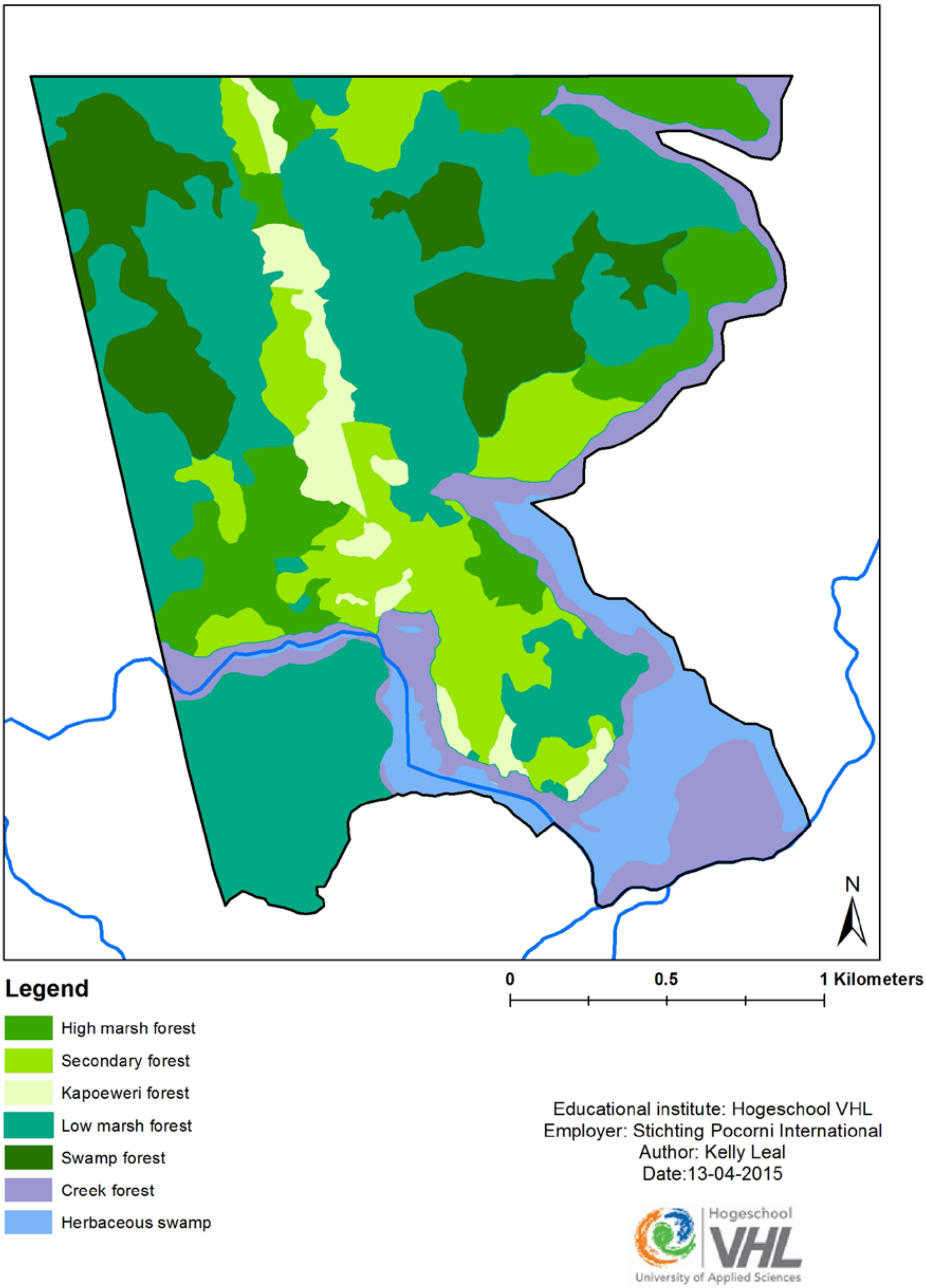
Appendix 2 Soil map



Appendix 3 Vegetation type map



Appendix 4 Forest structure map



Appendix 5 Vegetation list

Vernacular names	**Recorded trees** **Scientific names /botanical names**	Swamp	Marsh	Creek
Baboenhout (babun)	*Virola surinamensis*	X	X	
Bat-bat	*Ambelania acida*			X
Blakoma	*Diospyros guianensis*			X
Bolletri	*Manilkara bidentata*	X		
Boesikersi	*Eugenia coffeifolia*		X	
Bossapatile	Unknown	X		
Bradilifi	*Coccoloba spp.*		X	X
Foengoe	*Licania-Parinari spp.*	X	X	X
Gele kabbes	*Vatairea guianensis*	X	X	
Gronfoeloe	*Qualea spp.*	X	X	
Kabbes	*Leguminosae spp.*	X	X	
Kalebashout	*Citharexylum vitex spp.*	X	X	
Kandra-oedoe	*Isertia parviflora*		X	
Katankama	Unknown		X	
Gandoe (katjee)	*Swartzia panacoco*	X	X	X
Kopi	*Goupia glabra*	X	X	
Krabasi-oedoe	*Verbenaceae/ Labiatae spp.*		X	
Kwatakama	*Parkia spp.*		X	
Laagland mataki	*Symphonia spp.*	X		
Loksi	*Hymenaea courbaril*	X		
Loto-oedoe	*Miconia longifolia*	X	X	
Manbarklak (baicarachi)	*Eschweilera coriacea*	X	X	X
Mamadosu	*Duroia-Amaioua spp.*	X		
Mapa	*Macoubea guianensis*		X	X
Mesper	Unknown	X		
Morokobita	*Jacaranda obtusifolia*		X	
Paroedoe	*Aspidosperma excelsum*	X	X	
Pinja	*Vismia spp.*		X	
Skijt noto	Unknown			X
Tingi-moni	*Protium-Tetragastris spp.*	X	X	X
Tonka	*Dipteryx odorata*		X	
Wanakwari	*Vochysia tomentosa*	X	X	
Watra-groenhart	*Swietenia macrophylla*			X
Watra-gujaba	Unknown		X	
Watra-papa	Unknown			X
Witi-oedoe	*Tapirira guianensis*		X	

Vernacular names	**RECORDED PALMS** **Scientific names / botanical names**	Swamp	Marsh	Creek
Awara	*Astrocaryum vulgare*		X	
Bambamaka	*Desmoncu sp.*	X	X	X
Koemboe	*Oenocarpus bacaba*	X	X	
Maripa	*Maximiliana maripa*	X	X	X
Obé	*Elaeis sp.*		X	
Paramaka	*Astrocaryum paramaca*	X	X	
Pina palm (podosiri)	*Euterpe oleracea*	X	X	
Watra maka	Unknown			X

Vernacular names	**Encountered forest trees** **Scientific names / botanical names**	**S**	**M**	**C**
Agrobigi	*Unknown*		X	
Ajo-ajo	*Unknown*		X	
Anaura	*Couepia-Licania spp.*	X		
Awaristong	*Unknown*	X		
Barmani	*Unknown*		X	
Boesi tamalin	*Leguminosae spp.*		X	
Bos amandel	*Terminalia spp.*	X	X	
Bosmangrove	*Tovomita secunda*	X		
Botro-oedoe	*Chaunochiton kappleri*	X	X	X
Ceder	*Cedrela odorata*	X	X	
Gautri	*Sapindaceae/ Celastraceae spp.*		X	X
Gawetri	*Matayba-Toulicia spp.*		X	
Gele jakanta	*Hebepetalum humiriifolium*	X		
Goebaja	*Jacaranda copaia*		X	
Hoepelhout	*Sapindaceae/ Celastraceae spp.*			X
Hoogland anaula	*Couepia-Licania spp.*	X		
Hoogland panta	*Tabebuia spp.*		X	
Hoogland tafrabon	*Cordia spp.*	X		
Jakantra	*Unknown*		X	
Jakantra rode bast	*Dendrobangia boliviana*		X	
Jakantra witte bast	*Discophora guianensis*		X	
Kankan-oedoe	*Apeiba spp.*	X	X	
Konkon-oedoe	*Gustavia augusta*			
Kaneel-pisi	*Aniba-Licaria-Mezilaurus spp.*	X		
Kleinbladige rode kabbes	*Leguninosae spp.*		X	
Kokriki	*Ormosia cinerea*	X		
Kromanti kopi	*Aspidosperma album*	X		
Letterhout	*Brosimum guianense*		X	
Manretel	*Unknown*		X	
Masala-oedoe	Apeiba spp.		X	
Meli Sali	*Trichilia euneura*	X	X	
Merki-tiki	*Tabernaemontana spp.*		X	
Moloko bita	*Unknown*		X	
Oemanbarklak	*Lecythis corrugate*	X	X	
Okkerhout	*Sterculia pruriëns*			X
Paars ijzerhout	*Leguninosae spp.*		X	

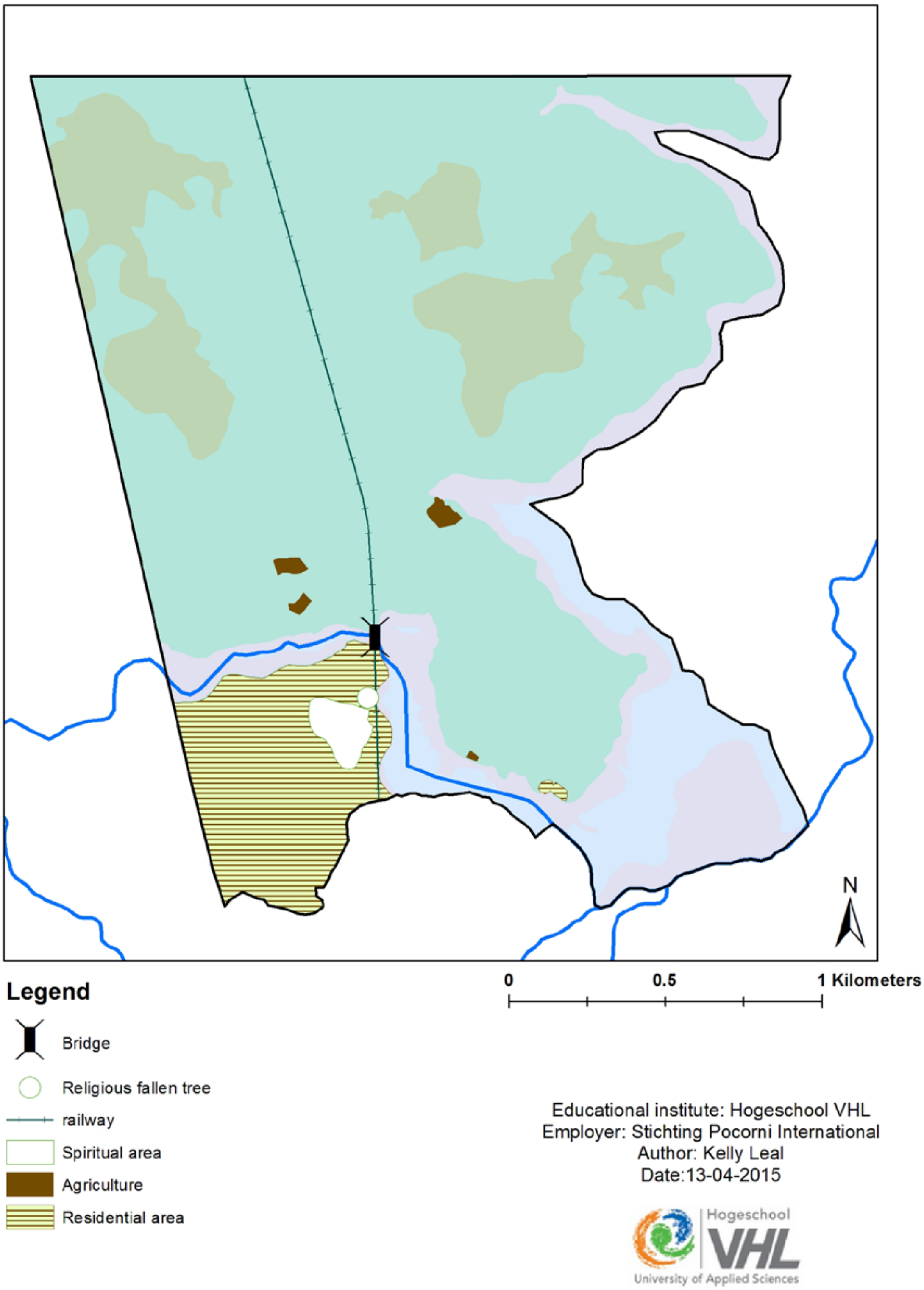
Pakoeli	*Platonia insignis*		X	
Pepre-oedoe	*Pera bicolour*		X	
Pikin-tiki	*Maprounea amazonica*			X
Prasara-oedoe	*Guapira spp.*	X		
Rode bast kwepi	*Licania spp.*		X	
Rode foengoe	*Parinari campestris*	X	X	
Rode jamboka	*Pouteria guianensis*	X		
Rode kabbes	*Andira spp.*		X	X
Slangenhout	*Loxopterygium sagotii*		X	
Sopo-oedoe	*Pithecellobium jupunba*	X		
Swamp foma	Unkown	X		
Swit bonkie	*Inga spp.*		X	
Tafrabon	*Cordia sericicalyx*		X	
Tamalin prokoni	*Enterolobium-Hydrochorea spp.*		X	
Tete-oedoe	*Eschweilera labriculata*	X	X	X
Treminalia	Unkown	X		X
Wiswiskwari	*Vochysia guianensis*	X	X	
Wit parelhout	*Aspidosperma marcgravianum*		X	
Zwart foengoe	*Licania micrantha*	X		
Zwarte pinto lokus	*Talisia pedicellaris*	X		

Vernacular names	**Encountered PALMS** **Scientific names / botanical names**	Swamp	Marsh	Creek
Boegroe-maka	*Astrocaryum sciophilum*	X		

Appendix 6 Identified wildlife

Birds	
Name English	Name scientific
Aracari sp.	*Pteroglossus sp.*
Black-capped donacobius	*Donacobius atricapilla*
Black-faced hawk	*Leucopternis melanops*
Black-collared hawk	*Busarellus nigricollis*
Blue-tailed emerald	*Chlorostilbon mellisugus*
Brown-throuted parakeet	*Aratinga pertinax*
Capuchin bird	*Perissocephalus tricolor*
Crested oropendola	*Psarocolius decumanus*
Great kiskadee	*Pitangus sulphuratus*
Greater ani	*Crotophaga major*
Green-tailed jamacar	*Galbula galbula*
Grey-breasted martin	*Progne chalybea*
Laughing falcon	*Herpetotheres cachinnans*
Ringed kingfisher	*Megaceryle torquata*
Road side hawk	*Buteo magnirostris*
Silver-beaked tanager	*Ramphocelus carbo*
Smooth billed ani	*Crotophaga ani*
Straight-billed woodcreeper	*Xiphorhynchus picus*
Striated heron	*Burorides striata*
Swallow tailed kite	*Elanoides forficatus*
Wattled jacana	*Jacana jacana*
White crowned manakin	*Pipra pipra*
Yellow-headed vulture	*Cathartes burrovianus or Cathartes melambrotus*
Reptiles	
Name English	Name scientific
Aquatic Coral snake	*Micrurus surinamensis*
Caiman sp.	*Crocodylidae sp.*
Tegu (Sapakara)	*Tupinambis sp.*
Fer-de-Lance	*Bothrops atrox*
Fish	
Name English	Name scientific
Haimara (Pataka)	*Hoplias sp.*
Unknown (Walapa)	*Hoplerythrinus sp.*
Mammals	
Name English	Name scientific
Capuchin monkey	*Saimiri sciureus*
Howler monkey	*Alouatta sp.*
Midas tamarin	*Saguinus midas*

Appendix 7 Anthropogenic map



Appendix 8 Market characteristics of ecotourism

According to the government of Suriname, structural steps will be taken to transform nature-based tourism into a profitable industry in the coming years, specifically focused on nature, culture, heritage and event tourism in the hinterland and surrounding districts (Government of the Republic of Suriname, 2012). Several steps included in the policy priorities are: adaptation of the current visa policy, improving image, branding and the quality of current services. Other focus points within this sector is raising awareness, research and innovation and including statistical records into national data. Suriname plans to increase the number of tourists visiting the country in the coming years which will generate income and contribute to the national economy. It provides job opportunities and will increase the popularity of this destination (Government of the Republic of Suriname, 2012).

There is hardly any data available on the ecotourism market in Suriname, however it is estimated that sustainable nature-tourism contributes 1% to GDP in Suriname (Plouvier, Gomes, Verweij & Verlinden, 2012) When including the general tourism sector, foreign tourist arrivals in 2015 was estimated at 227.699 with 36% of tourists having a destinations as hotels, guest housing or lodges. The majority of this group came from South America and particularly brazil and Western Europe (Surinametours, 2015). While there was a statistical increase in annual visitors arriving in Suriname over the last few years, Suriname experienced a decline of tourists in the tourism sector. Unfortunately, there is little known about exact destinations and reason for travel.

When observing current trends and key aspects regarding tourism, there is a desire to move away from mass, mainstream experiences and travel models and there is a large international demand for special interest tourism. Target group characteristics for this type of tourism are: awareness of ecological issues, educational and aesthetic purposes, self-improvement and commitment to communities (Government of the Republic of Suriname, 2012)

Holidays with active nature-orientated activities are on the rise and common beach holidays make place for more active and nature-orientated activities. It are the authentic, pristine surroundings which are now highly appreciated, those not massively visited by tourists (Government of the Republic of Suriname, 2012). Important factors are scenery, wildlife and wilderness setting and trekking and experiencing places (Epler-Wood, 2002). Water and wildlife are key elements in ecotourism and special interest tourism and birds is a special group within special interest tourism that encourages millions of tourist to travel to destinations all over the world.

When observing tourism in Para, a variety of resorts can be found. The Para district is known for its recreational and holiday resorts and holds the most resorts in Suriname. While their were 16 resorts in Para in 2008 (Stichting Planbureau Suriname, 2008), currently Para holds 35 resorts (Starnieuws, 2016a). La Prosperité is already a popular and well known resort because of the recreational fresh water creeks with black water and provides a variety of holiday accommodations. It belonged to the top 5 most visited resorts in Para in 2008, when approximately 5000 visitors annually visited these Para resorts within peak seasons. Peak season is in March – April and August – September (Stichting Planbureau Suriname, 2008). This number is currently estimated at tens of thousands every day on weekends (Starnieuws, 2016b).

When utilising an online travel magazine to compare recreational resorts in the proximity of La Prosperité, Para and surrounds, the majority of these recommended (recreational) resorts attract tourists with swimming facilities. These swimming facilities are either natural or artificial and sandy beaches with basic or luxurious cabins are often grouped in a village setting (Suriname Hotspots, n.d.). The locations are generally advertised as being located in a natural undisturbed setting or pristine forest, although many tend to be located in modified environments. This style of vacation could be classified as rural tourism. Only few of these recreational resorts offer nature walks, which generally include short self-guided walks in proximity of the facilities.

When considering a vacation which includes the opportunity of nature-orientated guided day-tours in or near Para, only few tour operators, such as ´Jenny tours´, or 'Orangetours', appear to provide this. An example is a visit to babunhol which costs €75 (Jenny tours, n.d.). Day-tours are often combined with other activities such as visits to colonial plantations, visits to markets or historical buildings in the Capital, swimming or spotting wildlife (Jenny tours, n.d.;Orange, n.d.). When considering nature tours in Suriname, prices vary considerably depending on the type of activities and location. For example, in Peperpot, an old colonial coffee plantation close to the capital, entree fees for a self-guided nature walk trough conservation forest on their private estate of 700 ha, ranges from SRD 7.50 to SRD 10 (Suriname123, n.d.). Guided nature tours in Peperpot cost € 39 for half a day, which includes a visit to the coffee factory. This is located on the same property and minimal group-size is four people. Prices of nature walks more orientated towards the hinterland are higher and prices of €45-85 and over are not uncommon (Suriname123, n.d.).

Table 13: Prices Colakreek

Activity/facility	**SRD**
Adult day recreation (swimming)	15
Pick nick table	42,50
Open hut with 4 hammocks	85
Holiday home	515

Source: Mets Travel & Tours (n.d.).

Table: 13 Prices Colakreek, presents an overview of costs related to activities and facilities of a resort in proximity of La Prosperité well known for its swimming facilities. Prices are based on 1 day (or 1 overnight) and averages of prices for weekdays and weekends.

Appendix 9 Market characteristics of NTFP’s

When regarding national programmes or objectives related to the national forestry strategy, Suriname plans to enhance the social and economical values and livelihood benefits from forests and will make forestry a more economically viable option via the contribution of markets for forest products and services (Government of Suriname & Food and Agriculture Organisation, 2011). In *Ontwikkelingsplan 2012-2016* by the Government of the Republic of Suriname (2012), it states that the economical value of forests should be determined and it stresses the importance of botanical species delivered by forests and their economical potential and value. Although NTFP’s are regarded an important resource contributing to economic development, no concrete policies, plans or objectives about this sector can be found. However, although NTFP’s are often utilized for subsistence needs, they are increasingly also as source of income (Bhairo-Marhé et al., 2009).

According to Food and Agriculture Organisation (2010) “*There is very little published information available about current NTFP commercialisation in Suriname, with the exception of animal exports. Except for wildlife, Suriname does not appear in export statistics of NTFP’s*”. However, according to the same source, there appears to be a lively national market for forest products, with some of the main commercial plant species being *Euterpe. oleracea, Maximiliana maripa, Astrocaryum vulgare* and *Oenocarpus bacaba.*

Of all the botanical species identified during forest surveys, many can be considered a Non Timber forest Product (NTFP) of some sort. According to Andel et al. (2003) in ‘*Commercial Non-Timber Forest Products of the Guiana Shield*’ local indigenous people consider 65-90% of plant species found in the Guiana shield useful. Many species have specific uses such as edible, medicinal or ornamental and some of them can be found in the main market in Paramaribo. Some of the most expensive medicinal plant products found in markets in Paramaribo which have been recorded or observed in the study area are presented in Table 14: Most expensive Vegetal NTFP’s in Suriname

Table 14: Most expensive Vegetal NTFP’s in Suriname

Local name	Botanical name	Price US$/Kg	Part used / form
Astrocaryum sciophilum	Boegroemaka	91	Seeds
Astrocaryum vulgare	Awara	91	Oil (from seeds)
*Copaifera guyanensis**	*Hoepelhout*	365	Resin
*Dipteryx odorata**	*Tonka*	154	Oil (from seeds)
Ormosia cinerea	*Kokriki*	61	Seeds
Parinari spp & Licania sp	*Foengoe*	182	Fibre

* Species protected under Surinamese law. *Source: Andel, Behari-Ramdas, Havinga & Groenendijk (2007).*

The annual value of the domestic market and export market for medicinal plants in Suriname is estimated at a total of US$ 1.5 million of which a substantial volume of medicinal plants are exported to the Netherlands (Andel et al., 2007). Considering edible NTFP’s, there is a lively market near Zanderij where *M. maripa* and *A. vulgare* are sold (Andel et al., 2003).Of the NTFP’s recorded in the study area, the most important ones in Suriname are *E. oleracea, M. maripa* and *A. vulgare* and to some extent *O. bacaba* (Andel et al., 2003; Food and Agriculture Organisation, 2010). A variety of cosmetic and food industries can be found in Suriname using NTFP’s for manufacturing products which are sold nationally under a brand name or trade name. In these industries, the following NTFP’s are most common as raw material: *A. vulgare*, *C. guyanensis*, *Attalea maripa*, *E. oleracea* and *D. odorata*. Prices range from *C. guyanensis* oil (40-60 SRD/L), *A. maripa* oil (20-25 SRD/L) , *D. odorata* beans (30-60 SRD/L) and *E. oleracea* berries (50-200 SRD/50Kg) (Esseboom, 2013).

Although reliable data regarding NTFP’s in Suriname remains scarce and generally absent, the data available regarding *E. oleracea* as Podosiri juice and as a medicinal component is plentiful. The juice produced with the berries of *E. oleracea* has received much attention the last few years. In Brazil, *E. oleracea* is produced intensively for national uses and export towards countries such as America and in Europe (de Wolf & van der

Sluys, 2010). The juice is becoming more popular as a highly nutritious beverage (de Wolf & van der Sluys, 2010) and as ‘Super food’ (Cymerys et al., 2011). The product is available in many forms, including capsules and tablets (Mormon, n.d.). Regarding the product in pill or supplements form related to health benefits, a 60-capsule container can reach very high prices of US$50 (Cymerys et al., 2011).

In Belém, Brazil, a 14kg basket of berries was sold for US$1 – US$5, while in 2008 the same amount was sold for US$30. This increase was caused by growing international and national markets (Cymerys et al., 2011). In the same region, consumption has risen from 90.000 L per day at the end of 1980, to about 400.000 litres a day at the end of 1990. In 2006, more than 101.000 tonnes of fruit were sold in Brazil, for a value of US$47 million, which excluded regional production (Cymerys et al., 2011)

Podosiri juice is probably the most well known and popular vegetal NTFP in the country (Andel et al., 2003). The juice in Suriname is commercialized and in some places this palm has been cultivated. Marowijne is the most important district for production of Podosiri (de Wolf & van der Sluys, 2010; Mormon, n.d.). From here, the processed products are transported to Paramaribo and French Guyana, where they are sold on markets. The demand for *E. oleracea* is increasing (Weinstein & Moegenburg, 2014) and prices and consumption are rising (Cymerys et al., 2011; Mormon, n.d.). In Suriname, the prices of 0.5 litre of juice has risen from SRD 5-10 in 2008 to SRD 10-15 between 2013 and 2014 (Mormon n.d.). In Suriname, the current annual consumption of *E. oleracea* juice is estimated at 1.9 million litre of pulp for the Marowijne district and Paramaribo, while the demand requests twice this amount (Mormon, n.d.). While the market for *E. oleracea* juice have greatly expanded, as have strategies regarding its production. Weinstein and Moegenburg (2014) mention that proposals for planting 5 billion *E. oleracea* palms in the Amazon estuary already exists and the Brazilian government has developed cultivars to maximize productivity (Mormon, n.d.)

Appendix 10 Ecotourism and La Prosperité

Bersaba is a relatively small village with a spirit of typical plantation culture, comprising of few hundred inhabitants (Personal communication, 2014). Many inhabitants are descendants from those who purchased La Prosperité many years ago, however, divers newcomers have settled in the village via rentable plots of land (Personal communication, 2014). Within the village there is a mixture of traditional and modern life, which is reflected in lifestyle and property design. Both small basic tin houses and timber structures in traditional style are mixed with large modern and concrete properties. Although garbage is collected regularly, burning of garbage is done regularly, producing a smell. Many dogs roam around the village and are sometimes aggressive. Different religions (Winti and EBG) are being practiced in various degrees and both the forest and church are still used for spiritual and religious purposes. There appears to be conflicting ideas amongst different groups or cultures leading to a feeling of tension amongst residents. Potential factors are poverty, the variation in lifestyle and the division of cultural practices and beliefs. People tend to keep to themselves and minor drug related crime such as theft, are not uncommon.

La Prosperité is located in a rural district, 3 km west of the Kennedy highway which connects the urban north with the rural south and the hinterland. It lies between the capital Paramaribo in the north (at about 35 km distance) and the main Johan Adolf Pengel airport in Zanderij (at approximately 5 km south). This main airport facilitates international and intercontinental flights. The main town of the Para district is Onverwacht which is accessible by the Kennedy highway as well as the old railway. The railway however, is barely used, although occasionally by cyclists or scooters. La Prosperité is easily accessible from the Kennedy highway and there is regular public transport on this road. Public transport within the village is infrequent and occurs at set times, twice a day. La Prosperité lies in close proximity to the Jan Starke Opleidings en Ontspanningscentrum, a recreational and educational institute in Zanderij. This area and other bordering resort such as Cola creek, Republiek and Vierkinderen are accessible on foot.

Appendix 11 NTFP’s and La Prosperité

Of all the identified and recorded botanical species during forest inventories, 13 have been considered a NTFP. These species are presented in Table 15: Recorded vegetal NTFP’s in the study area. Quantification is expressed in standards from – to ++, with ++ being most abundant or marketable. Of these products, *E. oleracea* appears the most promising NTFP provided by La Prosperité. This is based on its marketable value and earlier retrieved market data, its abundance compared to other areas where densities of this palm have been studied and its abundance compared to other recorded NTFP’s in the study area.

Table 15: Recorded vegetal NTFP’s in the study area. Valuing commercial value and availability in the study area at High++, Medium+ and Low-.

Species name	Marketable	Availability in study area
Astrocaryum paramaca (paramakka)	-	++
Astrocaryum vulgare (awara)	++	-
Copaifera guyanensis (hoepelhout)	+	-
Dipteryx odorata (tonka)	+	-
Eugenia sp. (*boskers*)	-	-
Euterpe oleracea (pina)	++	++
Goupia glabra (kopi)	-	++
Maximiliana maripa (maripa)	++	++
Oenocarpus bacaba (koemboe)	+	-
Parinari spp. (foengoe)	+	++
Protium spp. (tingi-moni)	-	+
Virola surinamensis) (babun)	-	++
Ormosia cinerea (kokriki)	-	-

Sources: Andel et al. (2003); Andel et al. (2007); Food and Agriculture Organisation (2010); Esseboom (2013)

Although an average of 455 *E. oleracea* clumps or individual stems per hectare were recorded in swamp forest during forest inventories, relatively high densities of *E. oleracea* have been observed occasionally, in relatively small areas or ‘patches’. Here this palm appeared rather well developed, meaning, multi-stemmed and containing stems of at least 10 cm DBH. An additional measurement within such area was performed via sub-plot design during forest inventories. Figure 16 shows the size-class distribution of woody *E. oleracea* stems deriving from this measurement, based on an average of 1100 clumps per hectare.

In Manicole forests in Guyana, (a synonym for swamp forests dominated by *E. oleracea*), average densities of 124 stems with a DBH of 10 cm or more in one hectare have been recorded (Andel, 2003). According to Cymerys et al. (2011), unmanaged flooded forest of *E. oleracea* in the estuary of the Amazon river showed numbers between 300 and 400 adult ‘trees’ per hectare, including 800 juveniles. Height or size-limits were not reported. A remarkable fact is that according to the same source, more intensively managed forests of *E. oleracea* in that same area can produce densities of 100-200 clumps per hectare and even 1200 clumps per hectare if soils are fertile.

Compared to the average stem and clump densities of *E. oleracea* found in Guyana and in the Amazon estuary where they grow on unfertile soil, the calculated average number of stems >10 cm DBH in patches in the study area are significantly higher. Compared to managed forests of *E. oleracea* on fertile soil, calculated average densities in the study area are somewhat lower with a moderate difference of less than 8%.

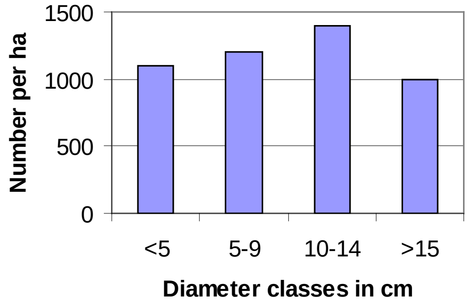


Figure 16: The average size-class distribution of 4800 Pina palm stems (E. oleracea) based on average 1100 clumps per hectare

It must be mentioned that these occasionally observed dense patches of *E. oleracea* in the study area appear to cover relatively small areas, ranging from several dozen to several hundred square meters. These patches are non-detectible through satellite imagery, however, as these areas are not uncommon, their total area can easily cover 2-4 ha or more in swamp forest in the study area.