ECOSYSTEM AND COMMUNITY BASED MODEL FOR ZONATION IN NINO KONIS SANTANA NATIONAL PARK, TIMOR-LESTE

RAIMUNDO MAU

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STATEMENT

I, Raimundo Mau, hereby stated that this thesis entitled:

ECOSYSTEM AND COMMUNITY BASED MODEL FOR ZONATION IN NINO KONIS SANTANA NATIONAL PARK, TIMOR-LESTE

Is a result of my own work under the supervision of advisory board during the period of March until October 2010 and that it has not been published ever. The content of this thesis has been examined by the advisory board and external examiner.

Bogor, December 2010

Raimundo Mau
G051088021

ABSTRACT

RAIMUNDO MAU. 'Ecosystem and Community Based Model for Zonation in Nino Konis Santana National Park, Timor-Leste'. Under supervision of HARTRISARI HARDJOMIDJOJO and GATOT H. PRAMONO

In order to contribute management purposes of Nino Konis Santana National Park, an ecosystem and community based model for zonation has designed. The study is carried out focused on data exploration of the potentials assets of ecological, physics and social economic factors as basis in designing zonation. Zonation scheme was done systematically by conduct several stages of processes such as assessment on High Conservation Values Areas (HCVAs), delineation of Priorities Conservation Areas (PCAs) and evaluation of social economic of the community in six villages covered. Assessment of HCVA occurrence is based on several maps such as Land Cover, Digital Terrain Model, IUCN Listed Species and Social Economic Characteristics. Land cover map classified based on Landsat TM5 acquired November 2006, Digital Terrain Model analysis by generated slopes and elevation maps based on the United State Geology and Survey-Shuttle Radar Thematic Mapping points data. Social economic data analyzed is focused on the pressures by population density and household activities in gathering forests products.

Integration of several method analyses has used such as satellite imagery processing, surfaces analysis and spatial analysis. The product of study is the Biosphere Reserves Zonation model for terrestrial part of Nino Konis Santana National Park. Coverage area designed are Core Areas 180.90 km^2 (26.7%), Buffer Zones 215.3 km^2 (32.9%) and Transition Areas 279.8 km^2 (40.46%). Core Areas is consists of PCA-1 Jaco Island, Tutuala Beach and Adjacent Forests, Paitchao Mountain Range and Lore Reserve Forests, dominantly distributed in villages such Lore I and Tutuala. Buffer Zones is consists of PCA-2 Forests Habitat Corridor, PCA-3 Iralalaro and Numunira Lake, PCA-3 Oaoloho Swamp Forest and PCA-4 North Dry Lowland Forests. Buffer zones mainly distributed in Mehara and Muapitine villages. Transition Areas is consists of areas that have not sufficient data to extract the conservation values that might exist.

Key words: Nino Konis Santana, Timor-Leste, Conservation, National Park

ABSTRAK

RAIMUNDO MAU. Ekosistem dan Komunitas Model untuk Zonasi pada Taman Nasional Nino Konis Santana, Timor-Leste. Dibawah bimbingan dari HARTRISARI HARDJOMIDJOJO dan GATOT H. PRAMONO

Dalam rangka menyumbangkan ide untuk pengambilan keputusan dalam pengelolaan taman nasional Nino Konis Santana di Timor-Leste, melalui penelitian itu telah dihasilkan sebuah model yang berbasis pendekatan ekosistem dan komunitas. Model ini terbangun sebagai satu-kesatuan dari data spatial nilai ekologi fisik dan sosial ekonomi kebudayaan masyarakat setempat. Data analisa menghasilkan empat type prioritas konservasi areas (PCAs). Analisa dilaksanakan dengan menggunakan data spatial berupa Peta Penutupan Lahan, Peta Permukaan Bumi, Peta Penyebaran Burung Penting, Peta Klaim Tradisional Lahan oleh Ratu dan Peta Sosial Ekonomi Karakteristik. Sosial ekonomi analysis di titikberatkan pada pengolahan data survey nasional pertanian, yakni tingkat kepadatan penduduk dan ketergantungan pada hasil hutan. Petatradisional klaim kepemilikan lahan dibangun sebagai hasil survey lapangan.

Pemodelan ekosistem yang diperggunakan dalam penelitian ini mengadopsi pemodelan universal dan merupakan kombinasi dari beberapa teknik data analisa seperti dalam identifikasi area-area bernilai konservasi tinggi. Delineasi prioritas area untuk konservasi dilaksanakan berpatokan pada panduan internasional yang telah diintegrasikan dengan regulasi dalam negeri dan atau regional. Sistem zonasi yang diperggunakan mengikuti konsep *Biosphere Reserves*. Zona Inti meliputi 180.90 km^2 atau 26.7%, Zona Penyangga meliputi 215.3 km^2 atau 32. 9% dan Zona Transisi meliputi 279.8 km^2 atau 40.46%. Masing-masing zona memiliki tingkat resiko sosial ekonomi yang berbeda, demikian juga dengan alternatif penatagunaannya yang berbeda pula. Zona inti terdiri dari beberapa prioritas area seperti Pulau Jaco, Kelompok Hutan Pantai Tutuala, Hutan di Pegunungan Paitchao dan sekitarnya and Hutan Primer Dataran Rendah di Lore I. Zona Penyangga terdiri dari PCA-2 Rimba, PCA-3 Danau Iralalaro dan Numunira, PCA-3 Hutan Rawa Oaoloho dan PCA-4 Hutan Dataran Rendah di Pantai Utara. Sedangkan area yang tidak teridentifikasi adanya nilai-nilai konservasi diperuntukkan bagi pengembangan infrastruktur dan sektor pertanian.

Kata Kunci: Nino Konis Santana, Timor-Leste, Konservasi, Taman Nasional

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SUMMARY

RAIMUNDO MAU. 'Ecosystem and Community Based Model for Zonation in Nino Konis Santana National Park, Timor-Leste'. Under supervision of HARTRISARI HARDJOMIDJOJO and GATOT H. PRAMONO

Nino Konis Santana National Park is the first national park that was declared by Timor-Leste Government on August 2008. Aims is to i) Protect and conserve nationally and globally important natural and cultural values, ii) Contribute to the achievement of sustainable livelihoods for local communities, iii) Establish the first protected area in Timor-Leste's world-class protected area system, iv) Increase awareness of conservation and the sustainable management of biodiversity and natural resources, v) Ensure the active participation of and foster ownership by the communities in the protected area, and vi) Manage the NKSNP as an internationally recognized protected area where the traditional interactions of people and nature are maintained in a way that protects the environment.

In order to contribute the management of Nino Konis Santana National Park, a spatial management zoning has modeled throughout this study which is based on ecosystem and community approach. The study is carry out on identification and mapping the potentials assets of ecological as threatened factors and characterization of social economic of community as affecting factors.

Approach in this research has follows universal human-ecosystems models. Integration of several models were used, mainly play by spatial analysis tools such in assessments of high conservation values areas (HCVAs), delineation of priorities conservation areas by considering the national and regional law and regulation. Several maps for Nino Konis Santana National Park have generated in order to fill the minimum spatial data required for analysis. Those maps are including Zonation Map, Land Cover Map, Digital Terrain Model, Important Bird Habitat, Traditional Forest Land Claim and Population Density Map and Household Forests Activities Map.

Ecological factors identified classed into each Priority Conservation Areas (PCAs), four PCAs has produced, PCA-1 occupied 26.44% consist of Jaco Island, Tutuala Beach and Adjacent Forest, Paitchao Mountain Range and Lore Reserve. PCA-2 occupied 15.13% consists of forests areas that functions as habitat corridors to connect Paitchao Mountain Range and Tutuala to the Lore Reserve Forest. PCA-3 occupied 2.22% inland and 5% of Marine Part, consist of Iralalaro Lake, Numunira-Utchanira Lake, Oaoloho Swamp Forest and shallow water of north coast. PCA-4 occupied 13.55%, covered forest communities of Socoloho, north dry lowland forest along Com-Mehara Beach. Forests community in this area has basic function for drink water to the community in Com, Poros and Mehara because there is spring water existed on hilly part.

Social economic factors analyzed by explored descriptive public data available, such forest activities and population density, while traditional land claim is carry out during the field work. Converting descriptive data into spatial

format through raster weights method, thence overlay spatial to spatial between threatened factors and affecting factors to come up with a new characteristic raster. Analyzing of social economic components is aim to characterized its pressures to the conservation areas, this done by given scores to measure the pressures. Data analysis of population density and forests household pressures to conservation areas thence produced information of pressures level of each PCA in every village.

In order to ensure the active participation of and foster ownership by the communities in the protected area a coarse map of Traditional Land Claim by community were generated. The proposed national park is, for Fataluku society, a wholly local preserve and the vital inheritance of their ancestors. Map were divided a zone for traditional land claim based on fieldwork of geo-positioning of boundary amount Ratu. Seven zones has divided are Ilha de Jaco, Paitchao, Praia do Norte, Praia do Sol, Lore, Lagoa Iralalaro and Plateau.

Traditionally, forests of PCA-1 Lore is claim by Ratu Naza, Ratu Pitileti, Ratu Chailoro as dominant Ratu and many small area claim by others with their sacral sites which regularly visited. Praia do Sol (North Coast) of national park where is categorized into buffer areas of PCA-4 within Com Village are claim and dominated by Kati Ratu, Conu Ratu, Keberesi Ratu, Lavera Ratu, and many others Ratu that claimed pieces of land. While PCA-4 where as part of Mehara Village from coast to the terrestrial are claimed and dominated by Home Ratu, Ma'assipanu Ratu, Pair Ratu, Iuru Ratu, Luturenu Ratu, Macapairanu Ratu, Puitical Ratu, Ma'avari Ratu, Keriseni Ratu and Ilivali Ratu. PCA-3 Numunira-Utchanira Lake is claim by Kati Ratu. PCA-3 Iralalaro Lake is claim by Latuloho Ratu, Ma'assipanu Ratu and Solor Ratu. Several Ratu name listed claimed the areas. At Poros Village part of Mehara Village is claimed by Nari Ratu, Letimece Ratu and Comocho Ratu. Mehara and Louiquero hamlet is claimed by Pair Ratu, Pairu Ratu, Latuloho Ratu and Chailoro Ratu.

A set of criteria has set-up in order to end up a final zonation based on ecological values and social economic characteristics. *A core area* is ecologically it must be represented at least one components of PCA-1 of Endangered, Threatened and Endemic Species, it is covered all land cover class within slope $\geq$ 16 % and elevation $\geq$ 600 m and embedded features, including primary forest communities, dense lowland tropical evergreen forest, dry and moist deciduous forest, mangrove forests and suite of coastal strand communities, The covered areas of PCA-1 must be greatest and dominant than others PCAs surrounded, no settlements located within it and a non built up areas and very limited of human activities and existed traditional farming within it must be excluded to a permanent farmland. *A buffer zone* is ecologically it must be represent at least one component of either PCA-2, PCA-3, PCA-4, the covered areas must be greatest than non priority conservation areas, no settlement located within it and a non built up areas and only limited traditional agriculture practices by local communities allowed for existing opened areas and not permitted to expanded. *A transition areas* is ecologically it might not represented any of HCVAs, The covered areas are dominantly by agriculture land, non productive dry land and non productive wetland, rural settlements and it can be a built up areas.

Product of this study by applied the set-up criteria is a model of zonation for terrestrial part of NKSNP by adopted the universal UNESCO Biosphere Reserve Concept. Coverage area zones designed are Core Areas is occupied 180.90 km^2 (26.7%), Buffer Zones are occupied 215.3 km^2 (32.9%) and Transition Areas is 279.8 km^2 (40.46%). Core Areas is consists of PCA-1 Jaco Island, Tutuala Beach and Adjacent Forests, Paitchao Mountain Range and Lore Reserve Forests. Buffer Zones is consists of PCA-2 Forests Habitat Corridor, PCA-3 Iralalaro and Numunira Lake, PCA-3 Oaoloho Swamp Forest and PCA-4 North Dry Lowland Forests. While the Transition Areas are consists of the areas that has not sufficient data to explore the conservation values that might existed.

Based on zones designed, several points have recommended. They are such as i) determine zones boundary in the field and demarcate it by conduct a consensus with representation of Traditional Leader, Ratu Entity as representation of community, ii) ground based details mapping of traditional land claim to foster the community ownership, iii) mapping of south coastal marine habitat from Valu Beach to Lore Beach to completed the coastal marine data and iv) establish community board at each village to accumulate and ensure the active participatory of community.

Key words: Nino Konis Santana, Timor-Leste, Conservation, National Park

ECOSYSTEM AND COMMUNITY BASED MODEL FOR ZONATION IN NINO KONIS SANTANA NATIONAL PARK, TIMOR-LESTE

RAIMUNDO MAU

A thesis submitted for the degree Master of Science in Information Technology for Natural Resources Management Program Study

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The External Examiner: Dr. Ir. Ricky Avenzora, M.Sc.F

Research Title   : Ecosystem and Community Based Model for Zonation
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Student Name   : Raimundo Mau

Student ID   : G051088021

Study Program   : Master of Science in Information Technology for
                      Natural Resources Management

Approved by,

Advisory Board

Dr. Ir. Hartrisari Hardjomidjojo, DEA   Dr. Gatot H. Pramono
            Supervisor   Co-Supervisor

Endorsed by,

Program Coordinator   Dean of the Graduate School

Dr. Ir. Hartrisari Hardjomidjojo, DEA.   Prof. Dr. Ir. Khairil A. Notodiputro, MS.

Date of Examination: Date of Graduation:

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Hopefully, results of this research that presents here would be provided a valuable contribution for many readers. *God Bless Us…*

CURRICULUM VITAE

The Author was born in Atsabe, Ermera Timor-Leste on 31st August 1971, child of couple Domingos Sigamau and Elsa Fatima. He was finished his Forestry Senior High School (SKMA) Kadipaten in Majalengka, 1991 and Undergraduate Degree in Social-Economic of Agriculture in Universitas Timor-Timur (UNTIM), in Kupang, 2000.

Since 2001 used to work with the Ministry of Agriculture, Forestry and Fisheries of the Democratic Republic of Timor-Leste under Division of Agro-Meteorology and Agricultural Land Use (ALGIS). In order to improve human resources within the ministry, He was recommended to pursuing his MS Degree in Information Technology for Natural Resources Management Program Study of IPB Bogor, 2008-2010. His final project for thesis is entitled *Ecosystem and Community Based Model for Zonation in Nino Konis Santana National Park, Timor-Leste.*

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I.   INTRODUCTION

1.1   Background

Nino Konis Santana National Park (NKSNP) is the only one of the world class protection area that existed under Timor-Leste jurisdiction. It is a lived-in protected area which covered six villages and home of more than 12,000 peoples. About 87.7% of household's main economic activity is owned food crops and livestock farming (NASS 2007). The actual community condition is poor and highly dependency on the exploitation of forests resources.

As a new national park that has just been declared by the government on 1st August 2008, there are many challenges that experiencing. One of these challenge that faced by national park authority is since its declaration till nowadays has not established yet a zonation to address a proper management. A clear zonation necessary to be establish early in order to reach the aims of establishment the national park, which underlined by the Ministry of Agriculture Forestry and Fisheries as national park authority. These are such i) to protect and conserve important natural and cultural values, ii) to contribute to the achievement of sustainable livelihoods for local communities, iii) to establish the first protected area in Timor-Leste's world-class protected area system, iv) to increase awareness of conservation and the sustainable management of biodiversity and natural resources, v) to ensure the active participation of and foster ownership by the communities in the protected area, and vi) Manage the NKSNP as an internationally recognized protected area where the traditional interactions of people and nature are maintained in a way that protects the environment (MAFP, 2006).

Throughout this study has designed a concept of zoning management that provides a useful idea to support national park authority. This study was done focused on exploration of the spatial data on forests and wetlands areas as part of living and non living elements of ecosystem within national park. Characterization of forests and wetlands ecosystem was using combination of image processing technique and field work. Through image processing were detected the forest

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cover distribution and general wetlands distribution within the national park area. Terrain models such elevation and slopes generated based on height points of USGS SRTM data. Fieldwork and literature study enrich the basic data that required for designing the zoning system for the national park. Spatial distribution of threatened species of trees and bird generated based on previous study; this is done by conduct spatial analysis in the mapping processes. These ecological and biophysics data are used as criteria in the rapid assessment of high values conservation areas that occurred within the study area. The HCVAs identified are as basis in delineation of priority areas to be conserved. Priority conservation areas which have bio-centric functions then assigned as Core Area, while the anthropocentric assigned as buffer zones.

It is important to note that a degradation and change of ecosystems are something that unavoidable, since human and nature are interacted each other. Socio-economic factors such population density and household forests activities considered as affecting factor to conservation priorities areas in processes of designing the zonation. As human well being is improved time to time, increasing population density, physical development such settlements are such factors that enforce on the loosing of biodiversity.

Several points of recommendation have formulated based on ecological, physics and social economic factors were analyzed related to the management zoning system for NKSNP. Rest expectation that the model of zoning system that designed throughout of this research would contribute the national park authority in order to decide suitable development strategies for national park based on its zoning.

1.2   Problem Statement

As stated above that one of the challenge that facing by national park authority is the need of a management zoning. With the word "zonation" would used to define the different partitioning of the territory in areas; each area has different criteria. To this end, in supporting planning for management of the national park, a model of zonation absolutely need and must be designed. Throughout this study which based on ecosystem and community approach has

produced a zonation map and its management needed. The approach were done by integrated the Remote Sensing and GIS Technology application in the assessments of high values of conservation areas as ecological factors and population density and household forests products gathering, both as affecting factors that given pressure to conservation areas.

1.3 Goals and Objectives

The goal of this research is to design a model of zonation for Nino Konis Santana National Park (NKSNP). To this end, research activities were focused on exploratory of four main aspects such as:

1. To assess the values of conservation areas
2. To evaluate the related socio-economic factors villagers dynamics to the natural resources
3. To assess the traditional land claimed by the community.
4. To design the better zonation of the NKSNP

While, at least the objectives of the study is to get better management process, approach, as well as the management efficiency, effectiveness and results. For further hope, it is useful for reaching a better conservation actions and example through the national park best learnt.

1.4 Scopes of Analysis

Considered to the challenges in this study, data analysis just limited only several points such follows:

1. Biophysics factors focused on forested lands and wet lands of terrestrial park of NKSNP
2. Household forests activities analysis conducts by downscale NASS 2007 Lautem District to six villages within study area
3. Population density analyzed by explored the GPS Waypoints of TL Housing and Population Census 2004 with required field data updated
4. Rapid ground based survey for traditional land claim in a very short time period, this reduced the accuracy of the traditional land claim map produced

5. FSC Toolkit Landscape Level in considering to Timor-Leste Forestry Law (Draft) used to carried out a preliminary assessment the occurrence of high conservation values areas and delineated the priorities conservation areas

1.5 Outputs

Product of this research is a Biosphere Reserves (BRs) Zonation Map, which is designed as functions of ecological, bio-physics and socio-economic variables. Several related map also produced in first stage in data preparation. These are such as land cover map, terrain model map, IUCN protected species map and Socio-economic pattern map. Zones established expected to be greatly facilitate planning, thoughtful development, ecosystem preservation activities within given location through the determination of the protected area boundaries. The end of analysis has provided management needs for each zone based on actual condition of ecological factors within each conservation areas that formed the zones. Zonation map that produced, it might be also useful as draft for community consultation and consensus in order to establish zones boundary perimeters and demarcation.

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II. LITERATURE REVIEW

2.1 Ecosystem

An ecosystem or ecological system as a basic to the conservation of natural resources, its sustain life on biosphere, provided ecological services through cleaning up and absorption of pollution, protecting coastline, supplying wildness food from fish to bush meat, conserving genetic resources for crops, maintain soil and hydrology, these are only a few kinds of ecosystems function that existed. Its play crucial roles on human survive and prosperity, forest stimulates local rainfall and prevents erosion and soil loss, coral reef and mangrove protected coast from abrasion and guard sea level rise.

Busby in Skidmore, 2003 emphasized that Article 2 of the *Convention on Biological Diversity* (CBD), specifies the ecosystems as a dynamic complex of plant, animal, and microorganism communities and their living and non living environment interacting as a functional unit. Moreover, for the convention uses on conservation biological diversity purposes state that biological diversity means the variability among living organism from all sources including, inter alia terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Horizon and Peace (2001) underlined three major ecosystems types, those are; i*) Forest Ecosystems, ii) Freshwater Ecosystems and iii) Marine Ecosystems*. Forest is the largest planet reservoir of biological diversity, containing an estimated half of whole the world's plant and animal species. Furthermore, they emphasized that forest ecosystems also play crucial and vital role in maintaining ecological services such as the water and carbon cycles, by storing carbon, conserving soils, and generating rainfall. In the freshwater ecosystems, wetland is transitional lands between terrestrial and aquatic system, where the water table is usually at or near surface or the lands is covered by shallow water (Turner, 1998 in Winpenny, 1991). Wetland can be a permanent or temporary or seasonal with static or flowing water which may fresh, brackish or salt. RAMSAR Convention underlined that wetlands area are swamp forest, brackish, peat areas, or other

natural and or human made water bodies that are flooded with fresh brackish or salt water including marine waters whose depth is not more than six meter during low tide and are located within wetlands. Commonly know that two types of wetlands, natural and artificial. Natural wetlands consist of mangrove, peat swamp, freshwater swamp, sea-grass, coral reefs and lakes, while artificial wetlands are paddy field, fishpond and freshwater pond.

2.2   National Park

A national park is a reserve of natural or semi-natural land, declared or owned by a government, set aside for human recreation and enjoyment, animal and environmental protection and restricted from most development. In 1969 the IUCN (International Union for the Conservation of Nature and Natural Resources) declared a national park to be a relatively large area with particular defining characteristics. A national park was deemed to be a place:

- with one or several ecosystems not materially altered by human exploitation and occupation, where plant and animal species, geomorphological sites and habitats are of special scientific, educative and recreative interest or which contain a natural landscape of great beauty.
- the highest competent authority of the country has taken steps to prevent or eliminate as soon as possible exploitation or occupation in the whole area and to enforce effectively the respect of ecological, geomorphological or aesthetic features which have led to its establishment.
- visitors are allowed to enter, under special conditions, for inspirational, educative, cultural and recreative purposes.

In 1971 those criteria were further expanded upon leading to more clear and defined benchmarks to evaluate a national park. These include:
- a minimum size of 1,000 hectares within zones in which protection of nature takes precedence
- statutory legal protection
- a budget and staff sufficient to provide sufficient effective protection
- prohibition of exploitation of natural resources (including the development of dams) qualified by such activities as sport, fishing, the need for management, facilities, etc.

2.3 Socio-Economic Factors

Pressures on forests, included high population growth rates, has increased demands on land for farms, particularly in industrial enterprise based on natural resources such as timber and pulp industry while in developing countries demands on fuel wood and charcoal is recognized as the most timber cutting. Piecemeal forest removal has also fragmented forest regions, which has a disproportionate effect on species diversity by limiting the ecosystems ability to recover from catastrophes such as fires and reducing species mobility.

Complex socio economic pressure has caused degradation of ecosystems. Deforestation has multiple causes with the particular mix of causes varying from place to place. Kaimowitz & Angelsen (1998) revised several models of deforestation; i) direct agents and the underlying causes. Physical environment, agricultural price, timber price, wages and off farm employment, agricultural input price, technology, accessibility, property regime and strategic behavior are part of the direct agents. However, choices between the conservation and restoration of ecosystems and the continuation and expansion of human activities have to be made in the recognition of conflicts between the expansion of certain human activities and the continued provision of valued ecosystem goods and services. In making these choices, the economic values of ecosystem goods and services should be assessed and compared with the economic values of activities that may compromise them.

Human activities are the proximate direct affect the environment and thus constitute proximate sources of changes (Turner et al, 1990). Interms the change in land cover as biophysical attributes of the earth's surface and land use as human purpose or intends applied activities that directly alter the physical environment. It might be interpreted as more immediate, direct factors, which originate from land use and directly impact upon forest cover. Land cover changes create conversion of forest to other cover types, with further environmental consequences that may ultimately feedback to affect land use.

Mangrove swamps, sea-grass beds, salt marshes and coral reefs are all examples of marine and coastal environments which are very important in sustaining human life, but which are in serious decline at global level. Human

have damaged wetlands by damming and canalizing rivers, converting floodplains to aquaculture, planting trees on bogs area that must be prevented from progressing, draining marshes for agriculture, forestry and urban development instead leaved it as originate for waterlogged area. Historically, agricultural activities has taken places as one of the most caused of damaged on wetlands including traditional wet pastures, drained to provided croplands.

2.4 Biosphere Reserve Concept

Biosphere reserve concept and its applications are described in a statutory framework know as *Seville Strategy*. A comparison of some key principles of the ecosystem approach and the Seville Strategy provided some evidence of the corresponding objectives between ecosystem approach and biosphere reserve.

Table 1 Ecosystem Approach and Biosphere Reserve Concept

Ecosystems Approach	Biosphere Reserve
The objectives of management of land, water, and living resources are a matter of societal choice	All local authorities have to be consulted and approve the nomination; the management of a biosphere reserve should be promoted as a part with society as a whole
Management should be decentralized to the lowest appropriate level	Support and involvement of local people has to be secured for the definition and implementation of management policy.
Ecosystems must be managed within the limits of their functioning	Biosphere resources should be extended to take into account fragmented habitats, threatened ecosystems and vulnerable environments.
The ecosystems approach should seek the appropriate balance between, and integration of conservation and use of biological diversity	Biosphere reserve constitute a tools for the conservation of biological diversity and the sustainable use of its components
The ecosystems approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices	Information should flow freely among all concerned; the role of traditional knowledge in sustainable development should be recognized and encouraged
The ecosystems approach should involve all relevant sectors of society and scientific disciplines	All interested groups should be brought together in a partnership approach to biosphere reserves

Source: Man and Biosphere, 2002.

2.5 Biological Indicator

Biological indicators are species used to monitor the health of an environment or ecosystem. They are any biological species or group of species whose function, population, or status can be used to determine ecosystem or environmental integrity. An example of such a group is the copepods and other small water crustaceans present in many water bodies. Such organisms are monitored for changes (biochemical, physiological, or behavioral) that may indicate a problem within their ecosystem. Bioindicator can tell us about the cumulative effects of different pollutants in the ecosystem and about how long a problem may have been present, which physical and chemical testing cannot (http://en.wikipedia.org/wiki/Bioindicator).

Bird's data point that recorded during 2003-2004 in Timor-Leste by Colin Trainor including those that recording within national park could be used also as indicator of the ecosystem that existed. Information on each GPS points are included the habitat types such as forests and woodland, river estuary, beach and lake. This task carried out by using Spatial Analysis to maps the distribution of those species.

2.6 Imagery Interpretations

A valuable tool in the identification and characterization existed ecosystems and related land cover types are remote sensor technologies. These technologies measures and store the characteristics of variables of interest or related surrogate variables in a permanent record. They allow the collection of data over large areas in a relative short period as compared to 100% field sampling of the ecosystem.

A goal of the use of imagery is to provide better information on land covers as they are base to delineate the real-time features as part of ecosystems. It is desirable to utilize aerial photo and remote sensor data in combination with GIS technology to address these ecosystems and facilitate analyses. In particular, people wish to work on: a) better methods of collecting field data with in-situ and remote sensor measurements; and b) integration of sensor data of varying resolutions for input into Geographic Information Systems (Lyon, 2005).

Field et al., 1990; Jensen et al., 1992; Lunette and Balogh, 1999 (Lyon, 2005), emphasized that of the wetland ecosystems and the exposure of stressors on wetlands or adjacent ecosystems can best be met by an analysis of multiple sources of remote and in situ sensor data, GIS Databases, and models of wetland and water resource characteristics. Monitoring experiments require good quality data for initialization of the system and real-time delivery of data.

2.7 Spatial Data Analysis and Spatial modeling

Spatial data analytical techniques and spatial models can perform functions which, in the main, current GIS lack, but which are important for the sorts of question that decision makers in private and public organizations are interested in. (Manfred M. Fischer et al. 1996).

A model is an abstraction or simplification of reality (Odum 1975; Jeffers 1978; Duerr *et al.* 1979). When models are applied to the environment, it is anticipated that insights about the physical, biological or socio-economic system may be derived. Models may also allow prediction and simulation of future conditions, both in space and in time. The reason to build models is to understand, and ultimately manage, a sustainable system.

2.8 Previous Study

There are several study was done previously during preparation proposed national park that used as referenced for this research. Those are such as Vegetation and Flora Survey (Northern Territory Herbarium), Preliminary Inventory (the Ministry of Agriculture and Fisheries), Important Birds Areas (Colin Trainor) and Fataluku Forest Tenure (Andrew Mc William).

2.8.1 *Flora and Vegetation Survey*

In 2006, a survey of flora and vegetation for the proposed national park was conducted during the preparation of declaration of Nino Konis Santana National Park, in cooperation of the Ministry of Agriculture and Fisheries Timor-Leste, Birdlife International and Northern Territory Herbarium. Approximately 730 plant species are recorded for the proposed Jaco–Tutuala–Lore National Park

with 391 taxa (54%) presently identified to species level. Three IUCN Red List Species for Timor-Leste & Indonesia were recorded in the Park (*Intsia bijuga, Pterocarpus indicus, Santalum album*). Additional species that may be threatened include *Antiaris toxicaria, Neoalsomitra podagrica, Carallia brachiata* and *Eleocharis geniculata.* The area also contains significant populations of *Cycas rumphii* a taxon listed by IUCN as Near Threatened (Cowie, 2006).

In the previous year, a preliminary survey also carried out by the Ministry of Agriculture. Survey were conducted using tracking method at several point such as in Jaco Island (3 tracks), Paitchao Mountain Range (8 tracks) and Lore Reserve (4 tracks). Data that were recorded is the occurrence of tree species along tracking line and surrounding (approximately 200 meters on left and right). Statistical processes of this survey have indicated the distribution of four IUCN species within proposed national park. *Intsia bijuga*, *Pterocarpus indicus, Anthiaris toxicaria* and *Elaeocarpus arnhemicus* dominantly found in Paitchao Mountain Range Forest and Tutuala beach and adjacent forests (Santana F, 2005 unpublished report).

2.8.2   *Important Bird Areas*

Three important bird areas are existed within national park area. They are such as TL06 Lore, TL07 Mount Paitchao and Lake Iralalaro and TL08 Jaco Island. TL06 Lore is located about 40 km south of Lospalos. Twenty-four restricted-range species have been recorded, including the Endangered Timor Green-pigeon, and the Critically Endangered Yellow-crested Cockatoo also occurs there (FAO/UNDP 1982, Ora 2000, Trainor *et al*. 2004).

TL07 Mount Paitchao and Lake Iralalaro located 22 km to Malahara from Lospalos. Twenty-four restricted-range species have been recorded in this IBA, including the Endangered Timor-Pigeon, and the Critically Endangered Yellow-crested Cockatoo occurs. TL08 Jaco Island is a small island dominated by tropical dry deciduous forests, coastal strand vegetation, beaches and rock platforms in the far east of Timor-Leste. According to Thompson *et al*. 1974, Trainor *et al*. 2004 in Trainor et al. 2007, eight restricted-range species have been recorded in this IBA.

2.8.3   *Fataluku Forests Tenure*

Andrew McWilliams, Australian Anthropology Senior Researcher was carried out a study on the Fataluku Forests Tenure in the Proposed Nino Konis Santana National Park. A long ignored and subsumed within government regulations, customary tenures and local claims of Fataluku-speaking populations to the forestry zone remain substantially intact. The present of national park status in this region should foster the traditional owner right. However, since Portuguese period there is no legal document such map to describe the ownership even amount community they know their boundary of land claim in the field.

A detail GIS based survey in future is highly needed to mapping the traditional claim in the national park areas. During field work, were carried out a geo-positioning on land boundary amount community claim related to forests tenure in Fataluku customary. A coarse map has produced and divided the national park into seven zones.

2.9 The declaration of Nino Konis Santana National Park

Ecologically, there are five important biodiversity areas that combined in the national park status. They are such i) Lore Reserve Forests, ii) Mount Paichao Range, iii) Lake Iralalaro, iv) Jaco Island and v)Tutuala Beach and Adjacent Forest.

Lore Reserve Forest was gazette as a Forest Reserve by the Portuguese Government in 1967, and proposed by FAO/UNDP in 1982 as Wildlife Sanctuary, according to Trainor et.al (2007). Mount Paitchao and Lake Iralalaro sites was proposed as a Wildlife Sanctuary by FAO/UNDP (1982) with a suggestion that these sites might be combined with Lore and Jaco Island and considered for National Park status. The combination of these sites was gazette as a Nature Reserve (SK Menhut No. 672/Kpts-II/1996) according to Ora, 2000 in Trainor *et al.* 2007. In 2000 when the country under United Nations Transition Administration, these areas was recognized by UNTAET as protected Wild Area under Regulation Number 2000/19 which by later, on 1st August 2008 has just been declared by the Government of Timor-Leste as Nino Konis Santana National Park under Government Regulation Number 8/2007.

III. METHODOLOGY OF RESEARCH

3.1 Time and Location

Research was conducted between March and October 2010. It consists of process develop method, analysis and reporting. Laboratory work was accomplish at MIT IPB Research Laboratory, while field works such gathering additional updated data related to method developed took place at Nino Konis Santana National Park, Timor-Leste.
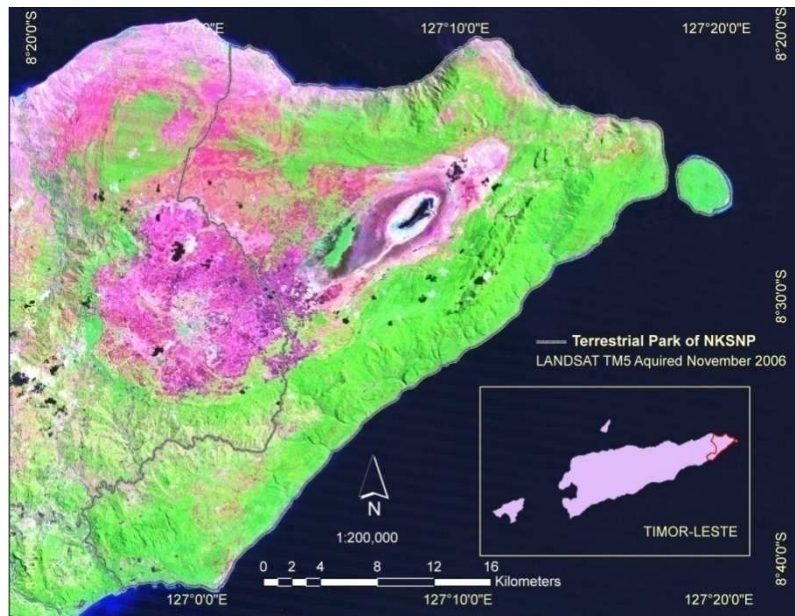
Figure 1   Map area of study

Administratively, NKSNP is located at Lautem District, the Democratic Republic of Timor-Leste. It's covered six villages' areas, such Com, Bauro, Mehara, Tutuala, Muapitine and Lore I. It's lied at coordinates -8° 16' 48'' to -8° 43' 48'' S and 126° 55' 12'' to 127° 23' 24'' E. The total area is 1,231.34 km^2, divided into terrestrial part (677 km^2) and marine part (554 km^2).

3.2   Data and Tools

In order to fulfill the data required for purposes analysis, an assessment was done on July to September 2009 to explore the ready available data. This

work done focused on exploratory of the previous documents during preparation for proposed the national park, share amount GIS Users.

Geographically, Timor-Leste located at UTM Grid Zone 51S and 52S, and the study area is located at UTM zone 52S. There is no national datum standard setup yet. But, GIS users used the UTM Zone 51S to project the country. A personal GIS Geodatabase for internal storage and also to perform the integrity of spatial data by conduct basic corrections on the topology errors and re-project the spatial reference, since there were un-uniform spatial references on spatial data have collected.

Table 2   List of vector, raster and descriptive data used

Data	Format	Custodian/Author	Date
Administration Boundary	Shapefile	ALGIS-MAF	2001
National Park Boundary	Shapefile	ALGIS-MAF	2003
Land Cover	Shapefile		2006
Dwelling Occupations	Shapefile	ND of Statictics of TL	2004
Coastal and Marine Habitat	Shapefile	ALGIS-MAF	2007
Landsat TM 5	TIFF	ALGIS-MAF	2006
Topographic Map, 25k	JPEG	Bakosurtanal, INA	1993
Aerial Orthophoto	ECW	ND of Land and Property	2003
SRTM	HGT	USGS	
Trees Species Distribution	Descriptive	Ian Cowie	2005
Important Birds Area	Shapefile	Colin Trainor	2003-2004
Lautem NASS	Descriptive	MAF	2007

Table 3   List of hardware and software used

Items	Basic Functions	Remarks
PC Dell Latitude	Removable PC	Intel ® Core™2CPU 1.83GHz 1.5GB
Handheld GPS	GCPs	ALGIS Properties
ArcGIS 9.2	Spatial data processes	ALGIS Licensed (ESRI®SS and 3D Analysis)
ER MAPPER 6.4	Image Processes	MIT-IPB Licensed
Global Mapper 9	Spatial data processes	ALGIS Licensed
MS Office 2007	Report Writing	ALGIS Licensed

3.3 Research Framework

In order to reach objective of the research, a framework has designed to accumulate flows of thinking (Figure 2). There are three major essential variables in designing the zoning, such as ecology, physics and social economic. Research activity covered investigation, analysis processes, option evaluation or synthesis and the recommendation of to support the decision.

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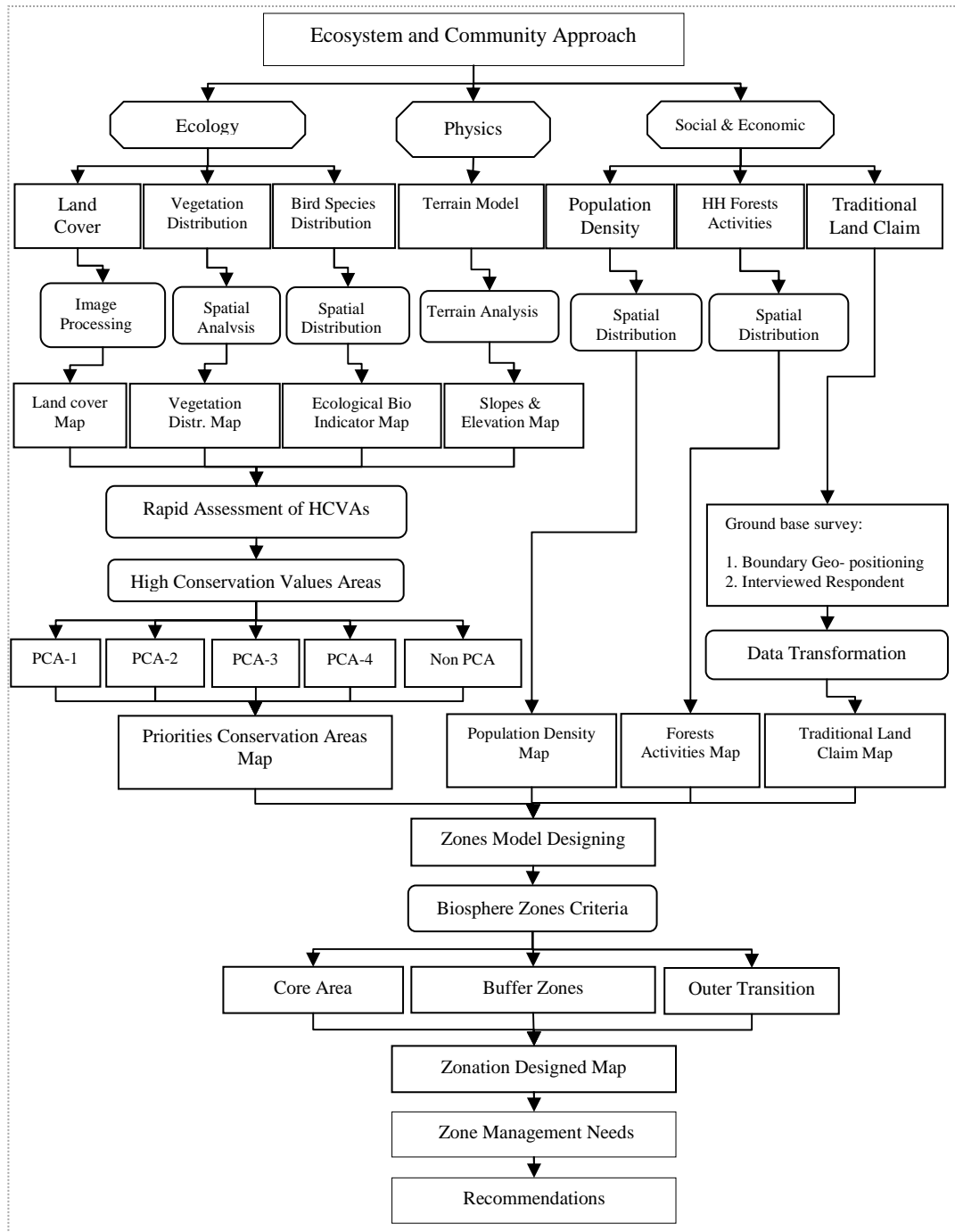
Figure 2   Research Framework

3.4   Data Preparation

Spatial data generated is ecology, physics and social economic. Ecological data such land cover, distribution of endangered species of trees and bird. Physics data is the digital terrain model such as elevation and slopes. Non spatial data is the social economic data that indicated as major issues which have potential

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impact to the conservation areas, such as population density, household forest activities and traditional forests land claim by community. Traditional forest land claim map is generated by assessing the traditional boundary in the field, using GPS device. This data layer provided information like distribution of Ratu Forest Claim in national park that must be taking into account when making a management decision. Even this right is not recognized yet under government low, but considering the aims of establishment of the national park is to conserve the community rights of land. Results of data preparation are described followed.

3.4.1 *Terrain Model*

Terrains model such slope and elevation generated using height points derived from USGS SRTM. First process is to crops the points of area of interest. This done using Global Mapper Program thence exported as text file with spatial resolution has resample the original resolution from 90 m x 90 m. Height point data (X, Y, and Z) that has geo-referenced thence interpolate to produce Triangular Irregular Network (TIN) as raster dataset to generate elevation and slope map. The use of height points data are given are smooth result in surfaces analysis but its less accurate at coast area.

Slopes classes derived from GTOPO30 data (EROS Data Centre, 1998) the Global Agro-Ecological Zones Study, Food and Agriculture Organization of the United Nations (FAO), Land and Water Development Division (AGL) with the collaboration of the International Institute for Applied Systems Analysis (IIASA), 2000.

Surfaces data analysis resulted about 88.19% of terrestrial park are flat (slopes <8%) and 11.81% other are with slope hilly to mountainous (slopes >8%). In table 4, showed the percentage of area based on slopes class in Nino Konis Santana National Park.

Table 4   Slope classes distribution

Slopes	0-2	2-5	5-8	8-16	16-30	30-45	>45
Area (km^2)	364.4	163.3	69.8	56.4	18.4	3.7	1.6
% of Area	53.78	24.1	10.3	8.32	2.72	0.55	0.24

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Surfaces data analysis also produced elevation map for study area, as list in table 5 that the area is almost 94% dominated with elevation range between 0-500 meters, while areas above 500 meters to 925 meters only 6%. Elevation Map has indicated that within area of study are less than 2000 m. The highest point only 925 m and its meaning no area fit to the HCVA 1.1 protected places with elevation > 2000 m.
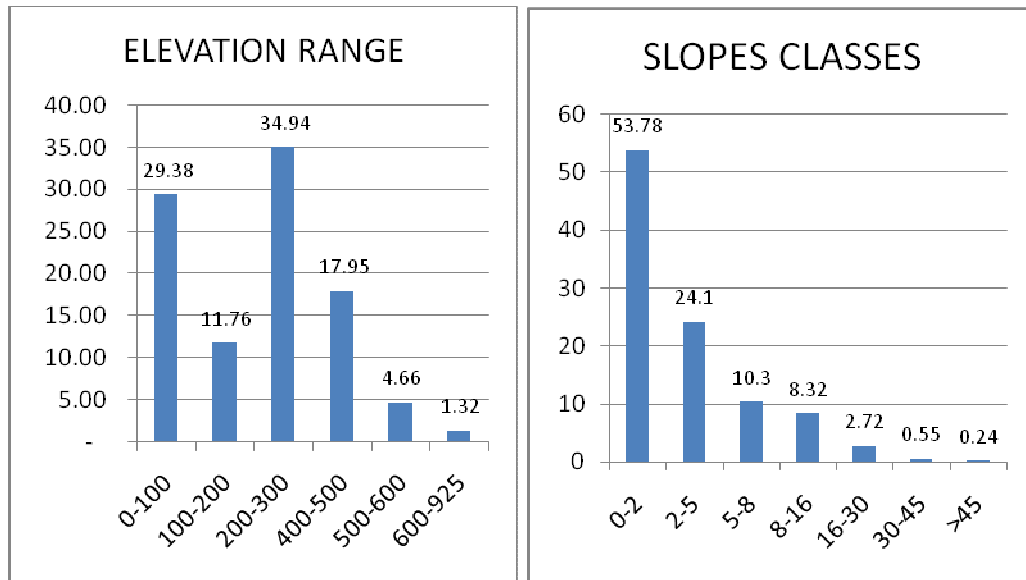
Figure 3   Percentage areas of elevation and slopes distribution within national park

Table 5   Elevation classes distribution

Elevation (m)	0-100	100-200	200-300	400-500	500-600	600-925	Total
Area (km^2)	198.98	79.64	236.64	121.59	31.54	8.91	677.30
% of Area	29.38	11.76	34.94	17.95	4.66	1.32	100.00

3.4.2   *Land Cover Classification*

Land cover map generated by interpreted Landsat TM 5 Satellite Imagery acquired November 2006. Unsupervised classification method done using the ER Mapper 6.4 version. The reason of choosing this temporal imagery is that during 2006 there were the periods of preparation till the declaration of the Nino Konis Santana National Park. The normal image processing applied such as preparation image, enhancement and classification. Improvement of land cover map done by re-digit the features based on visual interpretation of color aerial photo data 2003. Ground Control Points checked conducted at several site during field work between April and May 2010.

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Land cover classification has produced information on percentage of covered area of the Terrestrial Park by each of land cover category. There are four categories such, Agriculture Land, Forested Land, Non Productive Dryland, Non Productive Wetland and Water Bodies. Agriculture Land covered 63.89 km^2 or 9.44% and consisting of four classes such as Food Crops Arable (49.76 km^2 or 7.35%), Rice Field (2.91 km^2 or 0.43%) and Smallholder Crops (11.22 km^2 or 1.66%). Forested Land is general forests class, covered 340.55 km^2 or 50.28%. Non Productive Dryland covered 242.86 km^2 or 35.86% and consisting of three classes such as Bareland (29.85 km^2 or 4.41%), Grassland (73.71 km^2 or 10.88) and Woodland (139.3 km^2 or 20.57). Non Productive Wetland such shrubs covered 27.35 km^2 or 3.51%. Rural Settlements such Village and Mixed Garden are covered 6.69 km^2 or 0.99%. Waterbodies such Lake is covered 1.49 km^2 or 0.22%.
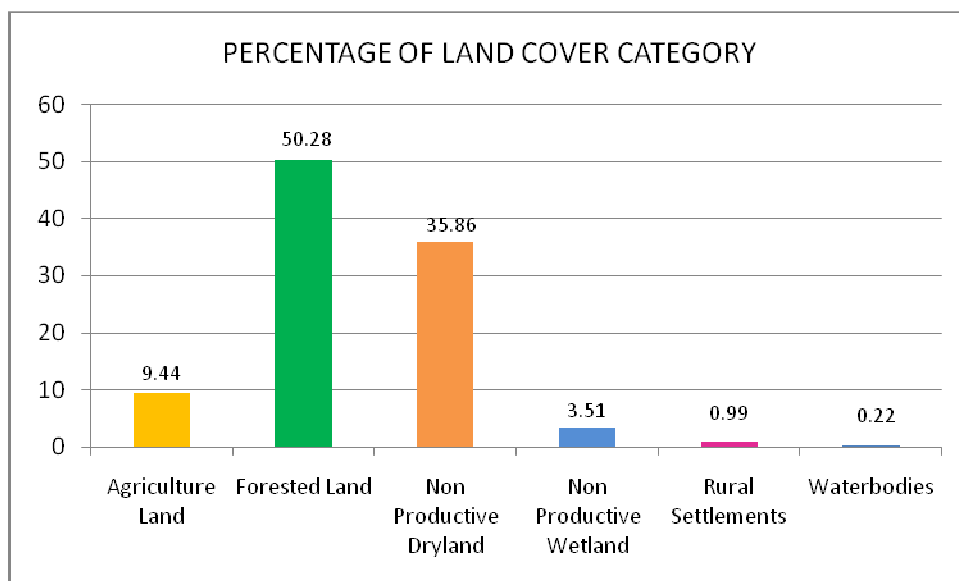
Figure 4 Distribution covered area by each land cover class.

Table 6   Percentage of land covers classes divided per category

Category	Class	Area (km^2)	% of Area
	Food Crops Arable	49.76	7.35
Agriculture Land	Ricefield	2.91	0.43
	Smallholder Crops	11.22	1.66
	Total Agriculture Land	63.89	9.44
Forested Land	Forests	340.55	50.28
	Bareland	29.85	4.41
Non Productive Dryland	Grassland	73.71	10.88
	Woodland	139.3	20.57
	Total Non Productive Dryland	242.86	35.86
Non Productive Wetland	Shurbs	23.75	3.51
Rural Settlements	Village and Mixed Gradens	6.69	0.99
Waterbodies	Lake	1.49	0.22
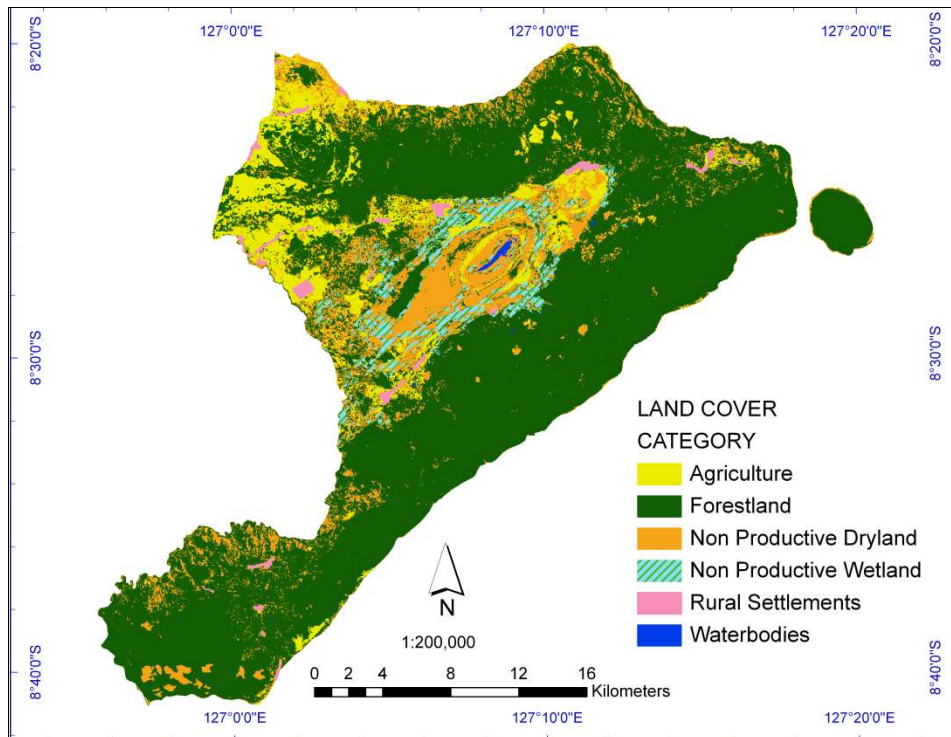
Figure 5   Land cover classification based on Satellite Imagery Landsat TM5 Nov 2006

3.4.3 *Important Bird Areas*

Nationally, identified 3 out 15 Timor-Leste Important Bird Areas (IBAs) existed within national park, TL06 Lore, TL07 Mount Paitchao and Iralalaro Lake, and TL08 Jaco Island. The globally threatened bird species occurred in Timor-Leste only 4 species, the cockatoo, Timor Imperial Pigeon, Timor Green

Pigeon and Wetar Ground dove. Only two of these the cockatoo and green pigeon occur in the Nat Park. All Globally Near threatened birds – about 15 species (Colin Trainor, Pers. Comm. December 2010).

Colin Trainor on 2003 has listed almost birds' species and collected its geo-positioning by using GPS device and data stored in tabular format. Through spatial data analysis has modeled a mostly good quality habitat of birds within national park. Distribution sites of birds developed aims to indicate areas that need to be considering as habitat of endangered, threatened, near threatened and restricted range Timor Birds to fulfill the High Conservation Values Assessments.

The distribution sites were generated by sum together all number recorded of GPS points in a particular site and processed by inverse distance weighted (IDW) method of spatial analysis. Based on exploratory of tabular data has classified twelve different sites based on the abundance species birds recorded. Referred to Figure 6, those sites are such as: Less abundance areas (A), Malahara Woodland (B), Iralalaro Lake (C), Veihoorana Lake-Ooaloho Swamp (D), Assalaino Woodland (E), Com Beach (F), Numunira Lake (G), Vero River Estuary (H), Namaluto River Estuary (I), Masici Beach (J) and Cece Beach (K). In the spatial birds distribution several species that have same position of Latitude and Longitude were grouped to avoid coincident of spatial data analysis.
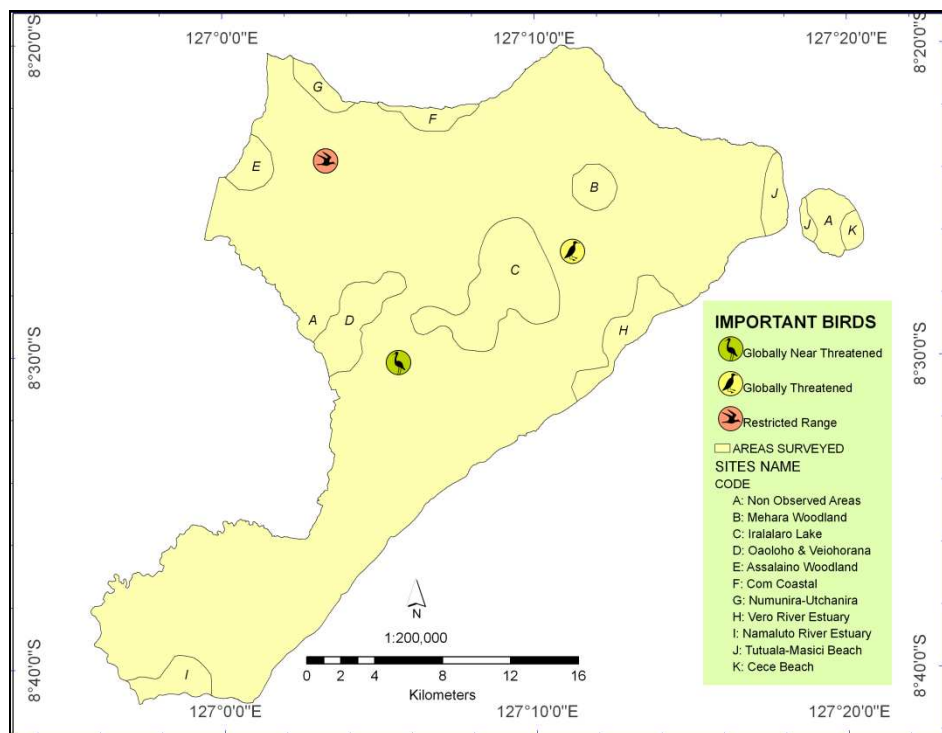
Figure 6   Spatial distribution sites in bird survey, interpolated by inverse distance weighted.

3.4.4   *Threatened Trees Species Distribution*

The aim of plant species distribution mapping is to identify species that threatened under IUCN List. Preliminary survey during the preparation of the declaration of the national park that was conducted in 2005 by Fernando Santana, was implemented transect data record within three target protected areas such Jaco, Paitchao-Tutuala and Lore Reserve. Survey was applied transect line by observing within radius 200 meters from estimated track line at three different area, Jaco Tutuala and Lore. Data recorded is number of trees species that counted along the track line and stored as tabular format. Statistical data processing is applied to identify dominants tree species, endangered, near threatened, threatened and red list species that must be considered as high values forest that would be protected.

Table 7   IUCN protected trees species recorded within several points on surveyed

Local Name	Scientific Name	Family	Paitchao	Jaco	Lore	IUCN
Aina	Pterocarpus indicus	Fabaceae	465	5	105	Red List
Aibesi	Intsia bijuga	Fabaceae	128	0	29	Red List
Aimanuhirus	Anthiaris toxicaria	Moraceae	43	0	9	Red List
Valuvalur	Elaeocarpus arnhemicus	Elaocarpaceae	16	7	0	Threatened

Note: Data in Paitchao, Jaco and Lore are numbers of frequency counted

Unfortunately data was recorded without geo-positions marking, and it's difficult to plot into spatial distribution. Through this data processes discovered the trends of trees that most frequent. Table and figure below are described IUCN protected plants species frequency counted by transect of Tutuala Forest, Jaco Forest and Lore Forest. Appears that Tutuala Forest is the most high frequents of four protected species, while Jaco only recorded two protected species with less number and Lore Forest with three protected species on IUCN Red List on *Pterocarpus indicus, Intsia bijuga, Anthiaris toxicaria* and no record for *Elaocarpaceae*. The endemic Indonesia and Timor-Leste, *Pterocarpus indicus* is highly frequented and follow by *Intsia bijuga.*
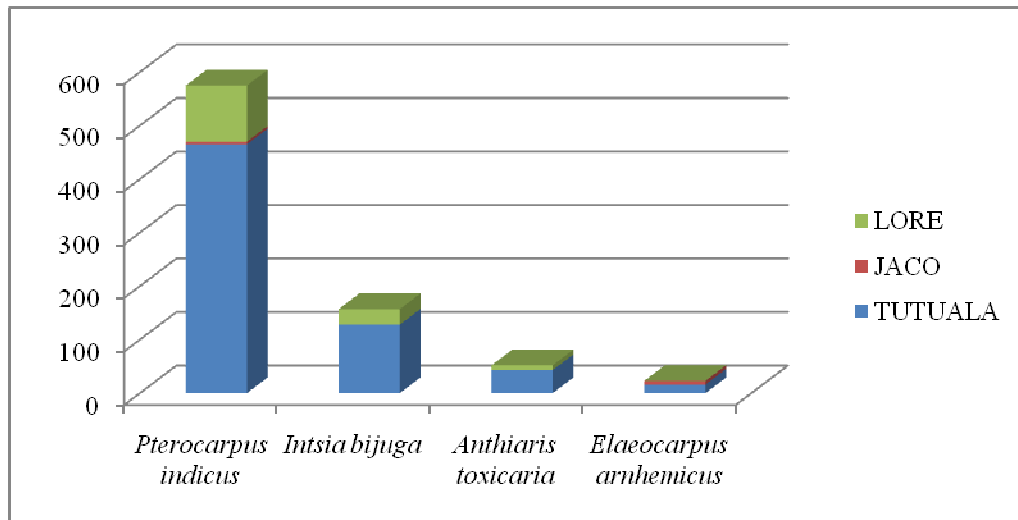
Figure 7   Dominant trees species listed in IUCN as protected species

3.4.5 *Social Economic Factors*

Since there were no public data available for household income and village revenue social economic data analysis considered only to two available data, such population density and forests activities by households. Forests activities are explored from Nacional Agriculture Sample Survey 2007. While number of population counted from each attribute of GPS Waypoints of Timor-Leste Census of Population and Housing 2004 and were upgraded during the fieldwork. Each of points was recorded attributed by number of family members. Analysis of social economic factors as state in methodology are by converting available descriptive data into spatial standard in order to have a spatial format which able to overlay to each other layers.

This study determined that the conservation components are as critical factors against social economic   components as affecting factors.   Social economic factors as criterion, in defining each preference rank following formula-(1). Social-economic data available in tabular format and up to district level only. Social-economic data are explored from Nacional Agriculture Sample Survey 2007, such percentage of household members in forest activities for accessing forest product. There is no significant statistics formula available, but to support data analysis has establish a simple method calculation as below.

$$V_i = C_i/100 * \sum HH \tag{1}$$

Where;

V_i is Village i (HH/Village)

C_i is Criterion under consideration (%) and

$\sum HH$ is Total Household (HH/Village)

Once attributes for each village of those social economic data has inputted, its store in different class and format of data. Before converted into raster grid format, must be done normalization of attributes. Normalization method adopted here is range 0-1. That's mean 'zero' is the lower perform and 'one' is the high perform. Malczewski (1999), there are many methods to standardized criterion map, and one of the ways is by using linear scale transformation. Benefit criterion is used as new values in which the highest score (score = 1) represent the better performance, and contrary (score = 0) is worst performance. Standardization of attribute done follows the Benefit Criterion Equation below.

$$X'_{ij} = \frac{X_{ij}}{X_i^{\ max}} \tag{2}$$

Where;

X'_{ij} = standardized score for the ith object (alternative) and the jth attribute

X_{ij} = the row score

$X_i^{\ max}$ = the maximum score for the jth attribute

A simplest method of rank order established to given the weights to social economic components based on attributes of data embedded. Weighting is aim to convert the descriptive data format into spatial data format.

Table 8 Score in Weighted Overlay Process for Social-Economic Factors

Score	1	2	3	4	5
Mean	Very Low	Low	Medium	High	Very High

Scoring Basis are the spatial attributes of each raster layer which reclass using Natural Break (Jenk) Method, scale 1-5 by 1. Classes are based on natural groupings inherent in the data. ArcMap identifies break points by picking the

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class breaks that best group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values (ArcMap ESRI Tutorial). Raster layers of each social economic criterion such population density and Household Forests Activities in the zonation scheme analysis done through weighted overlay of referred layers.

3.4.5.1 *Population Density*

Population pressure is the social factors that might affects conservation areas. A high population number are would give high pressure to conservation areas. During field work data updated, indicated that 12.716 peoples are lived within national park areas. All six villages covered within national park are categorized as rural villages. Statistics data processed has produced a population density map for six villages of area study. Furthermore analysis is the density population attributes have been normalized within new values range from 0-1 (Low-High). Normalized weight values thence to re-evaluate in classes within scale 1 to 5 by 1 based on ArcMap Natural Break (Jenks). Classes generated are based on natural groupings inherent in the data. ArcMap identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values.

Population density in Com is 29.51person/km^2 and Muapitine is 27.41person/km^2 and placed both villages at 'higher' and 'high' pressure to conservation areas. It occurred because in the areas with high people would require more land expansion for agriculture. Lore I and Tutuala, both villages have rank as village with 'medium' pressure to conservation areas. Mehara and Bauro are villages with 'lower' and 'low' population pressure to conservation areas. Average population density within national park area is 20.92person/km^2 (See Table 9 and Figure 8).

Table 9   Population distribution and density per village

Village	Area (km^2)	HH[1]	No Pop [2]	Pop Den[3]	Score	Pressure
Mehara	189.91	454	2,063	10.86	1	Very Low
Bauro	98.94	518	1,750	17.69	2	Low
Lore I	133.26	640	2,722	20.43	3	Medium
Tutuala	119.19	625	2,342	19.65	3	Medium
Muapitine	75.97	408	2,082	27.41	4	High
Com	59.53	354	1,757	29.51	5	Very High
Total	676.80	2,999	12,716	20.92		

Notes:1) households, 2) Number of Population, 3) Population Density
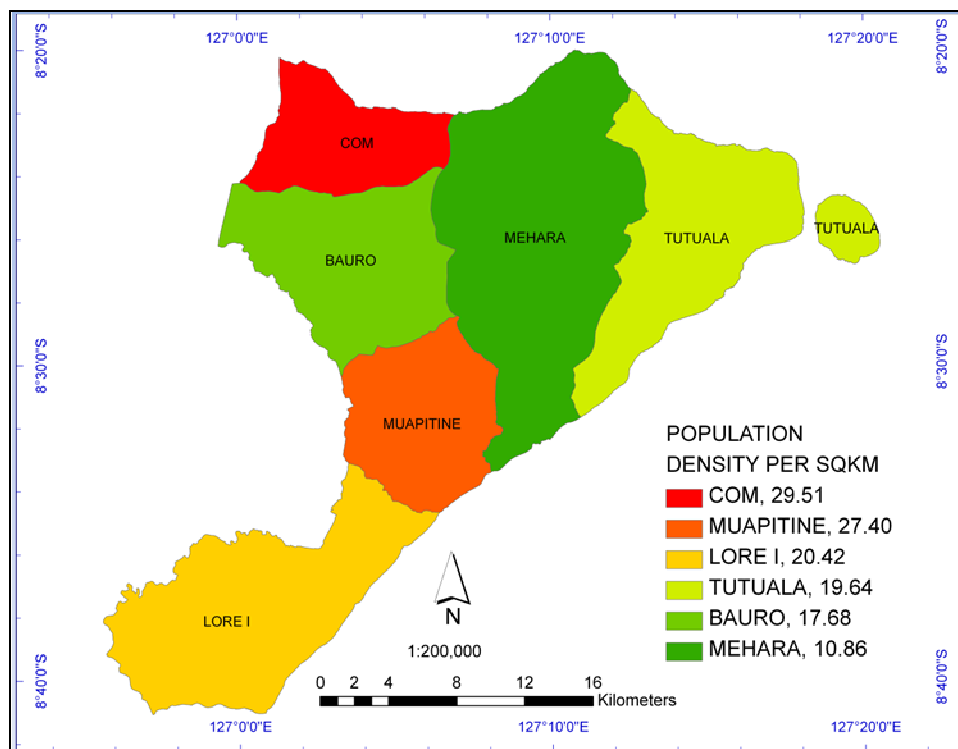
Figure 8   Spatial distribution population densities per village

3.4.5.2 *Household Forest Activities*

Household forests activities analysis just considered the major purposes that was carry out during NASS 2007 such firewood (36.7%), building materials (48.6%) and Food (13.4%).   Followed method analysis in formula 1 of methodology thence downscale it into household at village level for area of study, average values of all forests gathering purposes by households thence used in further analysis. Table 10 showed the average of number households in each village where gathered forests products for firewood, building materials and food.

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Data analysis on number of household gathered forests products resulted that Com, Mehara and Muapitine Village are 'low' number. Tutuala and Bauro are 'medium' number of households and only Lore I that are high number of households in gathering forests products.
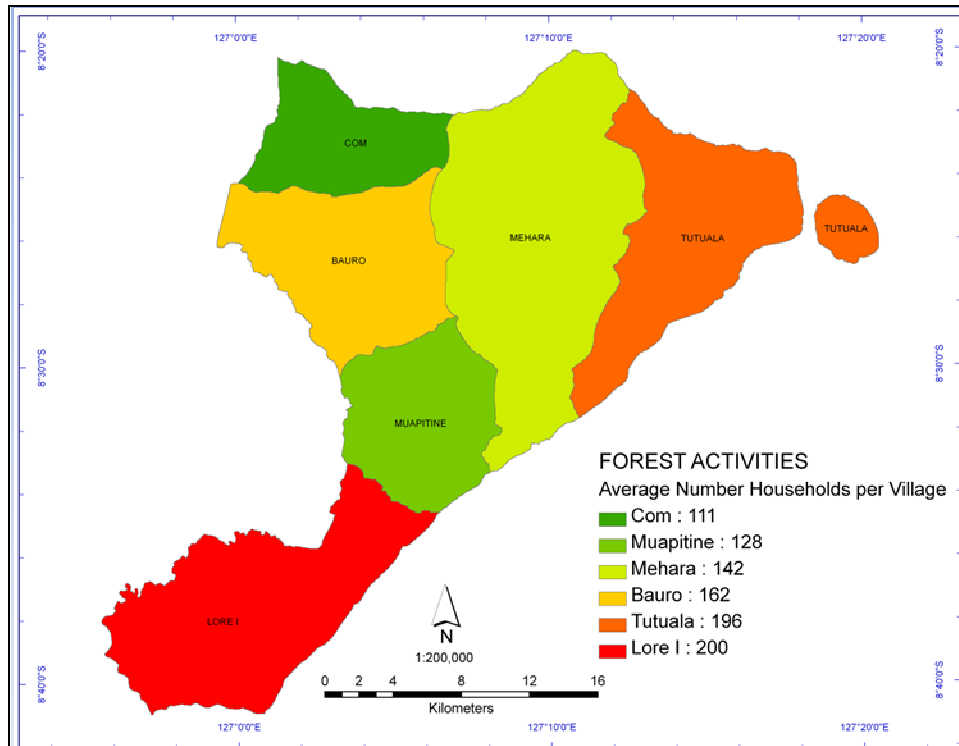
Figure 9   Spatial distribution households in forests activities per village

Table 10   Purposes of forest activities by households per village

Village	HH[1]	FW [2]	BM [3]	Food	Average HH	Score	Pressure
Com	354	130	155	47	111	1	Low
Muapitine	408	150	179	55	128	2	Low
Mehara	454	167	199	61	142	2	Low
Bauro	518	190	227	69	162	3	Medium
Tutuala	625	229	274	84	196	3	Medium
Lore I	640	235	280	86	200	4	High
Total	2,999	1,101	1,314	402			

Notes: 1) Number of Households, 2) Firewood, 3) Building Materials

3.4.5.3   *Traditional Land Claim*

The aims of mapping of community forests land claim are to ensure the active participation of and foster ownership by the communities in the protected area. The proposed national park is, for Fataluku society, a wholly local preserve

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and the vital inheritance of their ancestors. Product of this assessment is Community Traditional Land Claim.

During field work, 34 respondents were interviewed for their opinion and perspectives on forests use that claim by each of group of family which called Ratu. The respondents were interviewed are youth, oldest, women, professionals and government officer. The most respondent are addressed within the national park area, and them that selected in the interviewed processed are the oldest first, because the reason is that the oldest man considering know the historic of the land and forest tenure claimed by each Ratu including give an indication regarded to boundary amount Ratu land. The interview method is recording documents, since many of oldest were will only able to speak in local language (Fataluku). The recorded interviewed data then analysis through re-interpretation through translation into Tetum, the national language. Several principals' points were concluded as issues that need further treatments, such as:

1. Traditionally the whole part of Terrestrial Park were divided into pieces of land that belonging to the each group of Ratu as it's already exist for long time in the pass. That's mean that every management zone will encompasses Ratu land.

2. Regarded to the park management, basically community is having positive responds by wishing to participate at the whole conservation areas. Community asked for defining the definitive boundary of land to emphasize these areas which is allowed and restricted or limited accessed only.

3. Capacity building for youth within Sucos of park area by establish training center for foreign language and touristic techniques and guides.

4. Incentives for communities group in providing capitals for small entrepreneurs, livestock feeding, and agriculture tools such hand tractor. That expected will changed the community attitude from swidden agriculture to intensive farmers at a permanent site. Small entrepreneurs focused on women empowering to provide opportunity for women contribute better earn for household needs.

5. Develops potential sites on tourism that ecologically. The eco-tourism concept is suitable to adopt in the development of tourism side in the national park. Since all features in the park land is claimed traditionally by Ratu group, the management of tourism sites is should be by the Ratu owner and under Park Authority monitoring.

Boundary land between Ratu traditionally demarcated and the point of place considered and believed to be sacral. Marked that used is consist of a wood as pole and constructed surrounded with stones. Each of Ratu has theirs different type of wood, motives and meaning. Those demarcated points are also considered as sacral sites that necessarily the owners will do rituals ceremony (Figure 10).

Figure 10 Example of traditional boundary marker amount Ratu claim

The Main points during field work in assessments of the traditional forest use and land tenure was to collect much more coordinates points using GPS device, and mapped as much as possible the Ratu boundary. Position data that was collected are consists of descriptive information and the coordinates taken using handheld GPS Garmin with accuracy on the Estimation Position Error (EPE <10 meter). The descriptive information that gathered through respondent's interview is the name of places/locality which is considered as boundary amount Ratu area. Unfortunately, not all places were marked in GPS device for geo-positioning, considering to the limitation of time and supports.
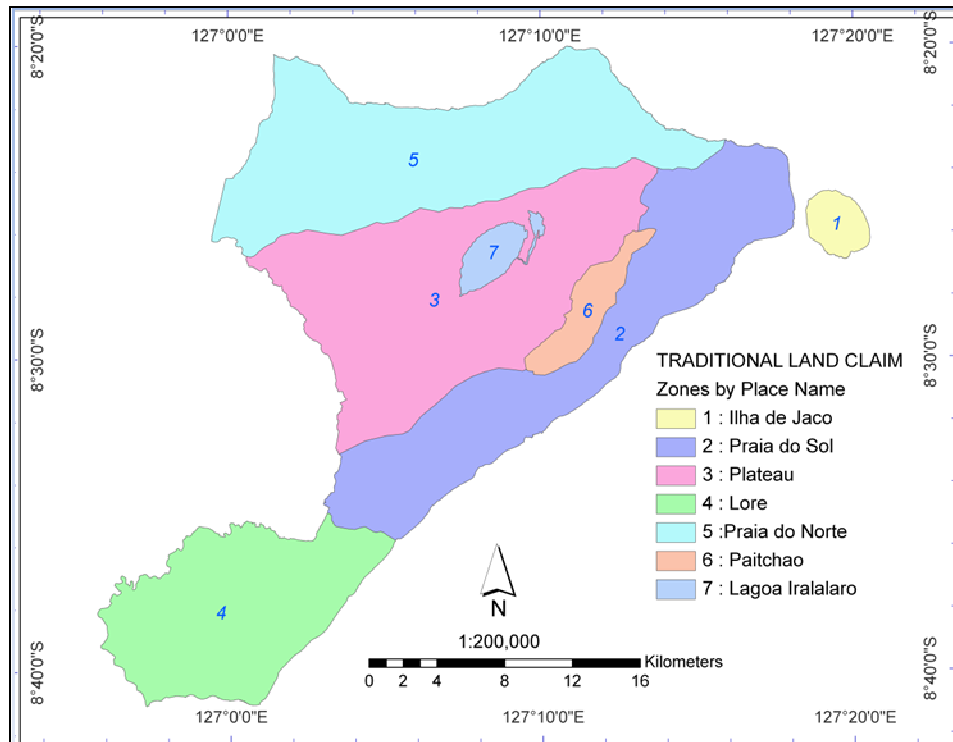
Figure 11   Zone of traditional land claim by communities.

Table 11   Estimated areas of each zone of traditional land claim

Place Name	Jaco	Praia do Sol	Plateau	Lore	Praia do Norte	Paitchao	Iralalaro
Zone	1	2	3	4	5	6	7
Area (km^2)	11	158.11		118	180.53	158.11	11.25

It's crowded in the field to clearly carry out geo-positioning work to record the exactly position of boundary amount Ratu forest land claim, since there was not available any previous maps and others documents related to forest land claim by Ratu. The terrestrial part of national park has classified into seven different zones, in order to draw a general Ratu forested land claim. They are such Ilha Jaco, Praia do Norte, Praia do Sol, Lore, Lagoa Iralalaro, Plateau and Paitchao. Jaco Island, during respondents interviewed facts that traditionally own by Ratu Tutuala and Ratu Jenilai. Two points boundary was recorded, Inik-kaile and Masici. In other version of source Tutuala Ratu claimed that the Island is belonging to Tutuala Ratu only. The seventh zones divided based on the preliminary information that was gained during the field work. Furthermore, for management strategies planning a worst map have drawn to plot the distribution

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of Ratu forested land claim within the conservation areas by grouping into zone. It's recommended for future survey to complete the Ratu forest land claim map.

Every Ratu zones areas are encompasses the priorities conservation areas except the Plateau zone that has not identified high conservation values and it's automatically became transition zone. During the field work has assessed almost the Ratu name and their distribution forest area claim by locality, only small boundary that was marked using GPS device (Ratu name listed in appendix).

3.5 Zonation Scheme

In this study, zones designed based on the PCAs delineated through HCVAs preliminary assessment. The national park is adopted IUCN Category V, which is not compatible to have a core area in the management purposes. This mean that all PCAs delineated to be managed as buffer zones only if referred to the IUCN Category V, but in case of the NKSNP, for national interest in conservation of biological diversity, it is necessary to manage a part of PCAs as core of ecosystem. The PCA-1 on protected places defined to be managing as core area within NKSNP. This is aim constituted area that devoted to long-term protection, according to the conservation objectives of the biosphere reserve and of sufficient size to meet these objectives.

Non PCA-1 such PCA-2, PCA-3, and PCA-4 assigned as buffer zones which surrounded the core area. A *buffer zone or zones* clearly identified and surrounding or contagious to the core area or areas, where only activities compatible with the conservation objectives can take place, aims to ameliorate external pressures. In other words buffers zones defined as areas adjacent to protected areas, on which land use is partially restricted to give an added layer of protection to the protected area itself while provided values benefits to rural neighboring communities (Wells and Brandon 1993). However, that there are few studies that test the effectiveness of buffer zones, and most of those have focused on the socio-economic as opposed to the ecological buffering functions.

The rest areas that do not have high conservation values thence become transition area. Transition area where sustainable resource management practices are promoted and developed, transition area as a linkages to maintain connectivity

between these core units need to be established or strengthened. *An outer transition area* where sustainable resource management practices are promoted and developed, transition area as a linkages to maintain connectivity between these core units need to be established or strengthened. The concept of connectivity refers to how the spatial arrangement and the quality of the elements in the landscape affect the movement of organisms among habitat patches (Bennet, 2003).

The patches areas either it is fulfill the criteria as core or buffer but it is distributed separately in a small size then considered to belonging the main zone surrounded, for example that an area that has values as core area but it is only a small in size and located surrounded buffer then it would be grouped as buffer zone (Figure 12).
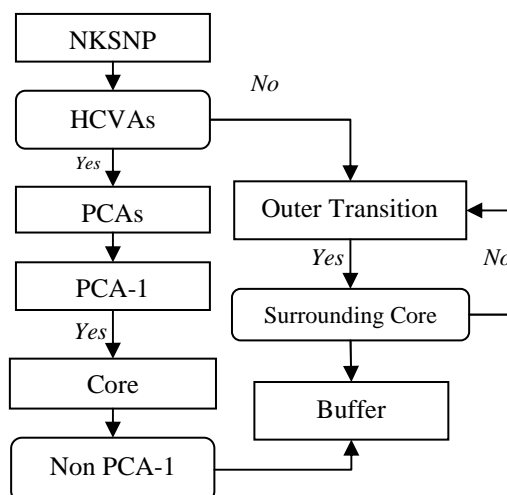
Figure 12   Flows in building zonation for NKSNP adopting the Biosphere Reserve Zones (Herwinda 2006, modified).

3.5.1 *Rapid Assessment of High Conservation Values Areas*

High conservation values areas (HCVAs) consists of broad category which is internationally known as protected forests, wildlife habitat, vulnerable ecosystem, areas with functions to support fundamentals of live system, and areas that considered have traditional identity. Considering the components for each category, slopes and elevation are use to determine the protected forests; forests cover and forests areas as function for wildlife habitat; wetland is the critical

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ecosystem; aquifer, watershed and aqua-culture sources are areas with live support system; and historical sites are areas as traditional identity.

Table 12 HCVAs and its elements used in assessment of existing conservation values within national park (FSC Toolkit, Adjusted)

HCVA Types	Elements
HCVA 1: Globally, regionally or nationally significant concentrations of biodiversity values	1. Forest with elevation ≥ 2000m 2. Forest with slope ≥40% 3. Threatened and Endangered 4. Endemic Species 5. Critical temporal use
HCVA-2 Globally, regionally or nationally significant large landscape level forests	1. Forest Cover ≥50 Ha (0.5 km²) 2. Primary Forest Communities 3. Secondary Deciduous Forest
HCVA-3. Forest areas that are in or contain rare, threatened or endangered ecosystems	Natural wetlands (lake, lake floodplain, reef, mangrove, shoal/marine water ≤ 6m, swamp)
HCVA-4. Forest areas that provide basic services of nature in critical situations	1. Water sources and buffer 2. Forest in priority watershed 3. Aquaculture resources
HCVA-5. Forest areas fundamentally meeting the basic needs of local communities	Forest areas critically important to supply drink water for community
HCVA-6. Forest areas critical to local communities' traditional cultural identity	Temple and spiritual site

Internationally, there is six types of HCVAs, the idea of was developed by the Forest Stewardship Council (FSC) and first published in 1999. Since Timor-Leste has no particular HCVAs yet, the preliminary assessment of HCVAs in this study is mainly based on Indonesia HCVA Toolkit with small adjustment to the Timor-Leste Forest Regulation Draft. Assessment mainly based on the information that generated for this study such as slopes and elevation map, land cover map, IUCN Protected Species in flora and fauna.

3.5.2 *Delineation of Priorities Conservation Areas*

Priorities conservation areas is product of assessment of high conservation values areas. Table 13 concluded the associated FSC toolkit, regional and national law and regulation that used to identify the high conservation values which existed within the study area. There are several legal based that integrated with FSC toolkit and RAMSAR Convention to perform the biophysical factor analysis,

such as: i) UNTAET Reg.2000/19 (On Protected Places); ii) Timor-Leste Draft Forest Management Decree; iii) Timor-Leste Decree-Law No. 6/2004 (General Bases of the Legal Regime for the Management and Regulation of Fisheries and Aquaculture) and iv) Indonesian Law on Protected Area Management. Analysis of bio-physic within HCVAs components then produced the priorities conservation areas (PCAs) to be used in zoning design and options in evaluation. The analysis performed the high conservation values areas components and legal basis in determining the protected places in Timor-Leste.

Table 13 Bio-physical analysis to delineate the priorities conservation areas

HCVA Type	PCA Type
HCVA 1: Globally, regionally or nationally significant concentrations of biodiversity values	PCA-1
HCVA-2 Globally, regionally or nationally significant large landscape level forests	PCA-2
HCVA-3. Forest areas that are in or contain rare, threatened or endangered ecosystems	PCA-3
HCVA-4. Forest areas that provide basic services of nature in critical situations	PCA-4
HCVA-5. Forest areas fundamentally meeting the basic needs of local communities	PCA-5
HCVA-6. Forest areas critical to local communities' traditional cultural identity	PCA-6

Core areas within NKSNP are the protected places as described in the UNTAET Regulation 19/2000. Except Jaco Island that have clear land boundary, Tutuala Beach and Adjacent Forest and Paitchao Mountain Range has not defined yet the areas boundary as state in UNTAET Regulation. A criterion has established in this study to define an estimated area of Paitchao Mountain Range and Tutuala Beach and Adjacent Forest to meet the regulation referred.

Table 14   Criteria used in delineation PCA-1 of Lore, Paitchao and Tutuala Forest Areas in zonation scheme for core areas

Criteria	Places Name	Parameters
• All land cover class within slope ≥ 16 % and elevation ≥ 600 m and surrounding	Paitchao Mountain Range	• Land cover map • Terrain model map (slopes and elevation)
• Primary Forest Communities and surrounding • Vero River Estuary as concentration of bird species	Tutuala Beach Forest	• Land cover map • Bird habitat map • Vegetation Information
• Natural Vegetation • Between Paitchao - Lore Reserve (Cowie,	Forest Habitat Corridors	

2006).		
• Dense lowland tropical evergreen forest, dry and moist deciduous forest, mangrove forests and suite of coastal strand communities (Cowie, 2006).	Lore-Reserve	• Land cover map • Bird habitat map • Vegetation Information

IV.   RESULTS AND DISCUSSION

4.1   Ecological Values Assessments

The aim of this study as state previously is to build a zoning model for Nino Konis Santana National Park base ecosystem and community approach. To end this, a systematic way has done during the study. They are such as i) rapid assessment of HCVAs, ii) delineation of priorities conservation areas, iii) designing the zones and iv) option evaluation base on social-economic factors. Analysis results of these stages are based on ecological, physics and social economic data that has prepared. The processes and results of analysis in each stage are described bellows, respectively.

4.1.1. *Assessment of High Conservation Values Areas*

The preliminary assessment is the simple approach to see if HCVAs are likely to occur or not. This acts as a coarse filter, to rapidly exclude all those forests that definitely do not contain HCVAs, and to identify forests that do potentially contain specific HCVAs. Preliminary assessments in this research are utilizing several parameters, such as Land Cover, Slope, Elevation, Important Birds, Distribution of IUCN protected trees, Coastal Habitat and Culture Values Sites. These maps are generated in the ecological data preparation phase.

Assessment has resulted four high conservation value areas were existed in NKSNP during this study. They are such HCVA 1.1 Protected Places, HCVA 2.1 Forests Corridors, HCVA 3 Natural Wetland and HCVA 4.1 Unique Source for Drink Water. While HCVA 5 and HCVA 6 has no enough data to explored. HCVA-1 occurred four times, Jaco Island, Tutuala Beach and Adjacent Forest, Paitchao mountain Range and Lore Reserve. HCVA 2 occurred 1 times, Corridor Forest, forests communities that cover which connecting the Tutuala-Paitchao

Forest and Lore Reserve Forest. HCVA 3 occurred 5 times, such as Numunira Lake, Iralalaro Lake, Oaoloho Swamp Forest and North Coastal Habitat. HCVA-4 occurred once only at North Dry Lowland Forest. Based on this rapid assessment only four out of six HCVAs identified presents within Nino Konis Santana National Park (see check list in table 15).

Table 15 Check list in identifying high conservation values forests areas

HCVA Elements	Present or Absent	Source of Information
HCVA-1:		
1. Forest with elevation ≥ 2000m	Absent	Elevation Map
2. Forest with slope ≥40%	Present	Slope Map
3. Threatened and Endangered	Present	IUCN Species List
4. Endemic Species	Present	IUCN Species List
5. Critical temporal use	Absent	Data not available
HCVA-2:		
1. Forest Cover ≥50 Ha (0.5 km^2)	Present	Land cover map
2. Primary Forest Communities		
3. Secondary Deciduous Forest		
HCVA-3:		
Natural wetlands (lake, lake floodplain, reef, mangrove, shoal/marine water ≤ 6m, swamp)	Present	Land cover map
HCVA-4:		
Water sources and buffer	Present	Land cover map
Forest in priority watershed		
Aquaculture resources		
HCVA-5:		
Forest areas critically important to supply drink water for community	Present	Land cover map
HCVA-6:		
Temple and spiritual site	Absent	Not suficient data to delineate the HCVA-6

4.1.2. *Delineation of Priorities Conservation Areas*

Priority Conservation Areas, as drawn in the zonation scheme, delineated based on HCVAs identified and considering to the regional and national regulation in the protected areas. These HCVAs that assessed such as HCVA-1 assigned as PCA-1, while HCVA-2, HCVA-3, HCVA-5 are assigned as PCA-2, PCA-3 and PCA-4.While non PCA automatically become transition areas. Compare to terrestrial part, data analysis resulted that PCA-1 occupied 26.69%,

PCA-2 occupied 15.13%, PCA-4 occupied 13.55% and PCA-3 occupied 2.22% inland and 5% of Marine Part. Mehara Village is the one that covered by all PCA. Bauro and Com are not covered by PCA-1, Lore I and Muapitine is not covered by PCA-3 and PCA-4, and Tutuala is not covered by PCA-3. All villages in different size have covered also non PCAs areas. Table 16 is the distribution of PCA and Non PCA delineated base on HCVA identified and has overlaid by village boundary.

Table 16   Distribution of PCAs and Non PCAs covered in each village

Village/PCAs	PCA-1	PCA-2	PCA-3[*)]	PCA-4	Non PCAs
Bauro	-	-	3.84	7.97	87.12
Com	-	-	0.02	18.99	40.34
Lore I	57.12	30.95	-	-	44.78
Mehara	30.52	27.50	11.26	56.70	64.83
Muapitine	4.64	41.36	-	-	29.96
Tutuala	88.50	2.58	-	14.09	13.80
Total	180.78	102.40	15.11	97.76	279.82

[PCA-3]) excluded the shallow water
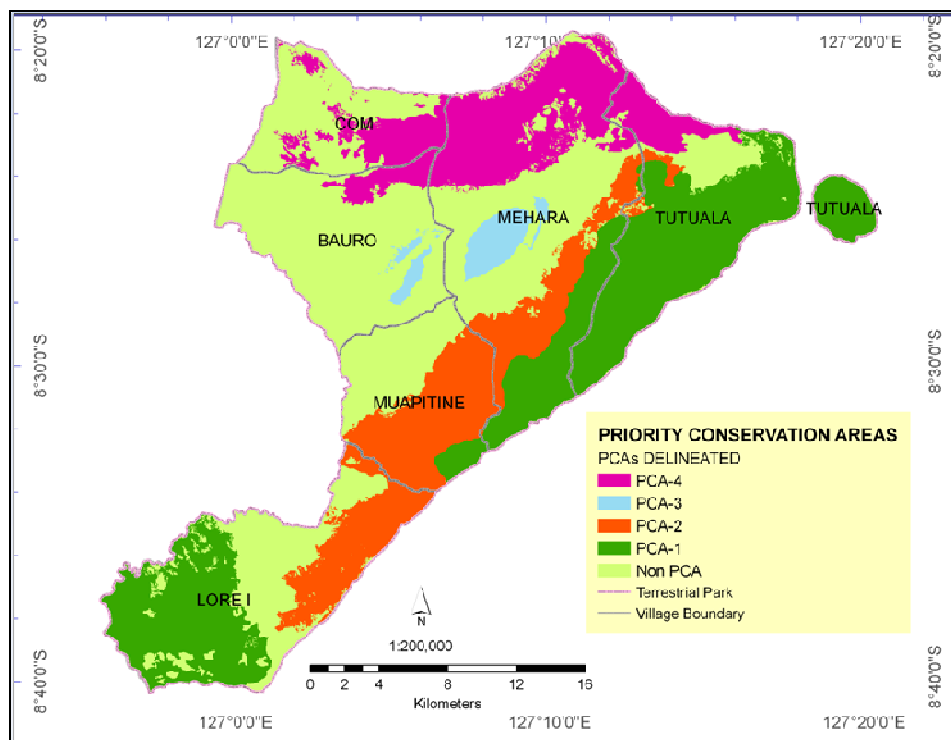
Figure 13   Priorities Conservation Areas delineated based on HCVAs, PCA-4 (purple), PCA-3 (blue), PCA-2 (orange) and PCA-1 (green).

4.1.1.1 *Priority Conservation Areas-1*

Priority Conservation Areas-1 in Figure 13 (dark green color) consists of four areas, such as i) Jaco Island, ii) Tutuala Beach and Adjacent Forest, iii) Paitchao Mountain Range and iv) Lore Reserve Forest.

Areas that considered as Priority Conservation Areas-1 are areas which globally, regionally or nationally significant concentrations of biodiversity values. These areas might be nationally defined by law as protected areas, concentration area for Threatened and Endangered Species, Endemic Species and or Critical temporal use. Biophysics data analysis indicated that PCA-1 is covered 180.78 km^2 or 26.69% of terrestrial park.

Table 17   Percentage areas of Priority Conservation Areas-1

Components	Area (km^2)	Areas (%)
Jaco Island	11.10	1.64
Tutuala Beach and Adjacent Forest	82.40	12.17
Paitchao Mountain Range	30.15	4.45
Lore Reserve	57.12	8.43
Total	180.78	26.69

4.1.1.1.1 *Jaco Island*

Jaco Island is a most eastern tip of Timor Island that under Timor-Leste sovereign. It's a non populated island with size 11.1 km^2. The area covered by 9.8 km^2 of unfragmented tropical dry deciduous forest. During preliminary vegetation inventory using tracking line method listed 2 IUCN Threatened and Red List Species of at least 31 species identified that growth in the Jaco Island.

Table 18   Protected plants species recorded in Jaco Island

Local Name	Scientific Name	Family	Freq.	IUCN
Valurvalur	Elaeocarpus amhemicus	Elaocarpaceae	7	Threatened
Aina	Pterocarpus indicus	Fabaceae	5	Red List

Data explored from Santana F, 2005

Jaco Island also significant habitat for Timorese Deer (*Cervus Timoresnsis),* they could survived without freshwater, since there is not freshwater

available in the Island. The white sands where surrounded the island is the nesting of Near Threatened Green Sea Turtle (*Chelonia mydas*). Jaco Island is habitat of water birds, which some are categorized as Near Threatened and Restricted Range species. At least seven bird species was recorded with GPS device tools by Colin during 2003-2004 in two sites, Cece Beach and Masici Beach.

Conservation issues that was discover is plastics rubbish a long of the beach, harvested mostly of Green Sea Turtle and its eggs by local communities. No data recorded forest degradation in Jaco Island.

Table 19   Important birds recorded in Jaco Island

Species	Location	Abundance
Actitus hypoleucos	Masici Beach, Cece Beach	3
Ardea purpurea	Masici Beach	1
Arenaria interpres	Masici Beach	8
Charadrius mongolus	Masici Beach	6
Egretta sacra	Masici Beach, Cece Beach	9
Heteroscelus brevipes	Masici Beach, Cece Beach	6
Numenius phaeopus	Masici Beach	18
Pluvialis squatarola	Masici Beach	5
Sterna bergii	Masici Beach	1
Tringa stagnatilis	Masici Beach	1

Data explorer from GPS points by Colin Trainor, 2003-2004

4.1.1.1.2 *Paitchao Mountain Range and Tutuala Beach Forest*

The highest altitude within NKSNP is only 925 meters above sea level at Paitchao Mountain. Paitchao Mountain Range is slope ≥ 16 % and elevation ≥ 600 m and surrounding features, approximately the land area is 3,073.11 Ha, with 24.79 km^2 dense forest communities. While Tutuala Beach and Adjacent Forest is covered of 83.93 km^2 lands which are 73.56 km^2 are dense natural forest. Referred to Cowie, 2006 the dense forest covered Paitchao Mountain Range narrow to the south coast is the primary deciduous forest communities that ever growth in Timor Island. Forest in both areas also has significant functions for watershed catchment, western part of Paitchao Mountain Range critical for Iralalaro catchments, while the eastern and beach lowland forest are functions as forest catchments for Vero River. Vero River is a permanent water river with length 9.7 km lied to south coast.   Spatial analysis data on bird's distribution indicated

that the estuary of Vero River and Valu Beach also one sites of important bird's concentration within NKSNP.

Table 20   IUCN protected birds recorded in Paitchao-Tutuala Forest

Species	Location	Abdnce	IUCN
Ardea sumatrana	7.5 km southeast Malahara	3	Near Threatened
Esacus neglectus	Vero River Estuary	1	Near Threatened
Charadrius peronii	Vero River Estuary	8	Near Threatened
Esacus neglectus	Helipuna Beach, Vero Estuary	5	Near Threatened

Data explorer from GPS points by Colin Trainor, 2003-2004

Statistics data analysis on vegetation preliminary survey indicated that one native threatened species and three IUCN Red List species that were recorded in along tracking line in Paitchao and Tutuala Beach Forest area.

Table 21 IUCN Protected plants recorded in Paitchao-Tutuala Forest

Local Name	Scientific Name	Family	Freq.	IUCN
Aina	Pterocarpus indicus	Fabaceae	465	Red List
Aibesi	Intsia bijuga	Fabaceae	128	Red List
Aimanuhirus	Anthiaris toxicaria	Moraceae	43	Red List
Valuvalur	Elaeocarpus arnhemicus	Elaocarpaceae	16	Threatened

Data explored from Santana F, 2005

4.1.1.1.3 *Lore Reserve Forest*

Land cover data analysis which base on Landsat TM5 acquired on November 2006 resulted that Lore Reserve Forest is occupied approximately 57.24 km^2 or 46.65 km^2. Referred to Cowie (2006) the dense forest remaining here is natural lowland tropical evergreen forest, dry and moist deciduous forest, mangrove forests and suite of coastal strand communities.

Namaluto River is a priority watershed that have direct boundary to national park but it is excluded the national park. Lore Reserve Forest is geographically covered into Namaluto water catchment area. At the down streams, at Namaluto estuary recorded several Near Threatened Water-birds such *Charadrius peronii, Ardea sumatrana, Esacus neglectus, and Anhinga melanogaster.*

Table 22 IUCN protected birds recorded in Lore Reserve

Species	Abudance	IUCN
Ardea sumatrana	5	Near Threatened
Anhinga melanogaster	1	Near Threatened
Charadrius peronii	4	Near Threatened
Esacus neglectus	2	Near Threatened

During preliminary potential survey found frequency of trees counted dominated by five species such *Pometia pinnata, Pterosperum acerifolium, Haplolopus floribundus, Intsia bijuga*, and *Canarium sp*, there is also indicated that at least 3 trees species that IUCN categorized as Red List and Threatened Species.

Table 23 IUCN protected Plants Species recorded in Lore Reserve

Local Name	Scientific Name	Family	Freq.	IUCN
Aina	Pterocarpus Indicus	Fabaceae	105	Red List
Aibesi	Intsia bijuga	Fabaceae	29	Red List
Aimanuhirus	Anthiaris toxicaria	Moraceae	9	Threatened

Data explored from Santana F, 2005

4.1.1.2 *Priority Conservation Areas-2*

Priorities Conservation Areas-2 (brown color in Figure 13), is globally, regionally or nationally significant large landscape level forests. This part of the HCVA definition aims to identify those forests that contain viable populations of most if not all naturally occurring species. It also includes forests that contain important sub-populations of very wide-ranging species even though the sub-populations may not in themselves be viable in the long term. It includes forests where ecological processes and ecosystem functioning are wholly or relatively unaffected by recent human activities. Such forests are necessarily large (tens of thousands of hectares).

Table 24 Percentage of Priority Conservation Areas-2

PCA-2	Component	Area (km^2)	% Area
	Forest Habitat Corridor	102.45	15.13
Total		102.45	15.13

Priorities Conservation Areas-2 identified in NKSNP is a forest community between Paitchao Mountain Range and Lore Reserve. It's occupied 102.45 km^2 or 15.13% forested land. It is needed to consider this forests area as habitat corridors that connecting Paitchao Mountain Range and Lore Reserve and Paitchao Mountain Range and North Dry Low Land Forest. It's also significant forest for watersheds catchment such Urunami Catchments consists of several permanent major rivers, such as Namao River, Lapalapa River and Urunami River. Corridor forest play important functions in wilderness movement such birds and mammals from and to Paitchao Mountain Range, Vero River Estuary, Valu Beach, Iralalaro Lake Birds Site, and Lore Reserve Forest, Com Beach, Numunira Lake and surrounded areas.

Swidden and slash burn agriculture and illegal logging are major issue in forest degradation. Re-allocated to a permanent agriculture land for agro-diversity along major roads or permanent agriculture land would be help decreasing the cutting trees for cropping.

4.1.1.3 *Priority Conservation Areas-3*

Priority Conservation Areas-3 (Blue color in figure 13), is derived from forest areas that are in or contain rare, threatened or endangered ecosystems, such as natural wetlands. Natural wetlands referred here is lake, Lake Floodplain, reef, mangrove, shoal/marine water $\leq$ 6m, and swamp areas. Biophysics data analysis indicated that within NKSNP area existed four areas that considered as natural wetlands, respectively, Numunira Lake, Iralalaro Lake, Oaoloho Swamp Forest and North Coastal Habitat.

Ecological data analysis indicated that within study areas only 27.65 km^2 of natural wetlands. Those key sites are Numunira Lake, Iralalaro Lake, Swamp Forest and North Coastal Habitat, which are only 2.22% of Lake and Swamp and 5.0% of Coastal Habitat, in total PCA-3 within NKSNP is 7.22%. Lakes and

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Swamp Forest and Mud Reef are also indicated as mostly area concentration of important waterbirds.

Table 25 Percentage of natural wetlands that form PCA-3

Components	Area (km^2)	% of Area	
		Lake-Swamp	Coastal
Numunira Lake	0.02	0.002	-
Iralalaro Lake	11.24	1.659	-
Swamp Forest	3.81	0.562	-
North Coastal	12.58		5.0
Total	27.65	2.22	7.2

4.1.1.3.1 *Numunira-Utchanira Lake*

Small saltwater lakes west of Com Village only approximately 100 meters from Com Beach and only 50 meters from main roads Lautem-Com. There are three separate water bodies that permanently in the year. Those are namely, Numunira1 (0.586 Ha), Numunira2 (0.716 Ha) and Utchanira (0.318 Ha) with salt water because it's closer to the sea.

During 2003-2004 Colin Trainor were recorded abundance of birds that present at savanna woodland and Lake, such as *Actitus hypoleucos, Ardea purpurea, Butorides striatus, Dupetor flavicollis, Egretta sacra, Nycticorax caledonicus, Phalacrocorax melanoleucos,* and *Tachybaptus ruficollis.* Numunira-Utchanira Lake need to considered as one priorities conservation areas within national park because it's surrounded by significant water birds habitat such savanna woodland, beach and saline mudflat.

4.1.1.3.2 *Iralalaro Lake*

Iralalaro Lake is one of fresh water ecosystem in the national park area, its lied at Lospalos plateau and this is remain as one of the biggest lake in Timor Island. Time series data of 1993, 2003 and 2007 data analysis indicated that water level of lake itself differentially depends to the seasons and rainfall. At 1993 the Lake was flooded up to 10.74 km^2, at 2003 water level flooded up to 46.24 km^2 wide while at May 2007, it's lowering till 1.6 km^2 only. Lake surrounded by

floodplain covered by grass and shrubs, and just few hundred meters to south is Oaoloho swamp forest. The Lake is consisting of two parts, such Lonina and Acakaranu. Lonina is the main canal and Acakaranu the small canal. At both canal intersections, Irasequiro River flows out to the end point which water flows underground at Paitchao Mountain. Iralalaro Lake, Irasequiro River and Oaoloho Swamp Forest form a habitat for water birds. Trainor was recorded more than 50 Restricted Range water birds which some of species are IUCN listed as threatened and near threatened species. Others wildlife that exists in Iralalaro Lake is Crocodiles. Local people have believed and placed Crocodiles as sacral reptile and it's fully protected. Crocodiles found around Lonina main canal, Acakaranu and some points along Irasequiro River (5.2 km length) the flow out River of Iralalaro Lake which runs southwards into the Paitchao range where it drains into a sink hole, then reappear to the south of the range near sea level. A new endemic fish species also found in Iralalaro Lake, *Craterocephalus laisapi* (MAFP, 2006).

Main issues during field work are that future use of Iralalaro water for agricultural irrigation around Lake Floodplain in order to empower self food surrounding community, while keep maintaining biological diversity that embedded to Iralalaro Lake. Touristic purposes might be promoted within eco-tourism concept, such for birds watching.

4.1.1.3.3 *Oaoloho Swamp Forest*

It's about 3.81 km^2 of dense swamp forest community that international and national significance for wetland ecosystem. It's located south of Iralalaro Lake at Oaoloho Hamlet, this forest land categorized into natural wetland. Spatial Analysis on sites concentration of birds indicated that Oaoloho Swamp Forest and closer wet spot such Veihoorana woodland is significant habitat for waterbirds and also this area is still within Iralalaro Lake Range of birds.

4.1.1.3.4 *Coastal Habitat*

The coastline of NKSNP is encompasses about 111 km length or 15.88% of national coastline, included Jaco Island, see table 26. Data that available for coastal habitat is the north coast or 57.83% of park coast, while 42.17% at southern part are not identified yet. North Coast of Timor-Leste is highly valued

for its contribution to local livelihoods, particularly through ecotourism and fisheries-based activities especially the coastal areas of NKSNP.

Table 26   Coastal line in national park

Coast Part	Habitat Data	Length (km)	% of Coastline	
			NKSNP	National
Jaco Island	Available	12.92	11.62	1.85
North Coast	Available	51.38	46.21	7.34
South Coast	Not Available	46.89	42.17	6.70
Total		111.19		15.88

There is no broad-scale habitat mapping currently exists for this region. An initial survey, Timor-Leste Marine and Coastal Habitat Mapping was done to carry out a broadscale map as base for coastal-marine conservation, planning, and regional sustainable development. Data derived indicated that it's about 12.58 km^2 of coastal resources existed at the north coast of national park, commencing from Com Beach till Hilapuna Beach including Jaco Island. There are six differences class was classified such Bare Areas, Coral Dominated Fore-Reef and Escarpment, Coral Dominated Reef Flat, Dense Seagrass and Open Reef Flat and Sparse Seagrass. Overall coastal resources are dominated by Coral Dominated Fore-Reef, 38.88% while the smallest class is Bare Areas such Beaches, Salt Flats and River Channels (4.01%).

Table 27   North coastal habitat on natural wetland

Class	Code	Hectares	% Area
Bare Areas : Beaches, Salt Flats and River Channels	SF	50.48	4.01
Coral Dominated Fore-Reef and Escarpment	FRC	489.09	38.88
Coral Dominated Reef Flat	RFC	84.53	6.72
Dense Seagrass Covered Reef Flat	RFSH	116.64	9.27
Mixed Coral, Seagrass and Open Reef Flat	RFM	186.85	14.85
Sparse Seagrass Covered Reef Flat	RFSL	330.44	26.27
	Total	1,258.03	

Derived from TLCHHM, Guy Bogs. *et. al,* 2009

4.1.1.4 *Priority Conservation Areas-4*

Priorities Conservation Areas-4 (purple color in figure 13), is forest areas that have values forest areas that provide basic services of nature in critical situations, such as forests critical to water catchments, forests critical to erosion control, and forests providing barriers to destructive fire. Ecological data analysis was not sufficient to do exploratory more to indicate the forest areas that have values to meet HCV4. Nevertheless, during field work was collected several spring water that vitals to community surrounded the north dry lowland forest. Based on very limited data required, there is only one element of HCVA-4 that drawn in CPA delineation, such Forest Critical for Drink Water for several hamlets around north coast.

Northern side of these forest areas is critical for spring water such Katam Spring which is significant for community at Com Village, and Sicara Hamlet. At hilly part (>500 m elevation) of this forests area are critically for watershed catchment of Iralalaro Lake also critical for several spring water that supplied drink water for community at several hamlets such Poros, Comocho, Bauro, Mehara, Ioro and Chailoro.

Within this forest area at Assalaino woodland, indicated as bird concentration sites. Data ever recorded in 2003 placed Assalaino woodland as second higher birds concentration after Iralalaro Lake.

Main issues are swidden and slash-burn agriculture, illegal logging and small scale of hunting. It's recommended for future inventory to discover much species and valuable values within Socoloho forest area. This forest area surrounded by bareland, woodland and fragmented coconut plantation. Reforestation with Near Threatened and Threatened Species is surround area is recommended. Comparing two series datasets on forest cover, Topographic Map 1993 and Landsat TM5 2006 interpretation indicated that forest land at north coast covered by dry lowland sparse forest was 106.14 km^2 (1993) and decrease to 91.78 km^2 (2006). It's mean that within 13 years forests area approximately 14.36 km^2 has loss.

Table 28   Percentage areas of Priorities Conservation Areas-4

Component	Areas (km2)	Areas (%)
Forests Critical for Drink Water	91.78	13.55
Total PCA-4	91.78	13.55

4.1.1.5 *Non Priority Conservation Areas*

Referred to zonation building scheme, areas which were identified has no conservation values that meet the criteria of FSC HCVAs Toolkit would considered as transition areas. A Transition Areas is area/areas where sustainable resource management practices are promoted and developed. Transition area as a linkage to maintain connectivity between these core units need to be established or strengthened. The concept of connectivity refers to how the spatial arrangement and the quality of the elements in the landscape affect the movement of organisms among habitat patches (Bennet, 2003).

Assessments of High Conservation Values Areas within national park area has resulted four different HCVAs as base in determine core area and buffer zone. Regarded to zones designs emphasized that areas those identified have high conservation values thence given priority to conserve, while the rest areas that has not data to indicated any values as state in FSC Toolkits would become transition areas under Biosphere Reserve Zonation Concept. Transition Areas are approximately covered 40.46% of Terrestrial Park (lemongrass color in figure 13). Even have no high conservation values that identified within areas that categorized as transition areas, the transition areas are play important functions in maintain connectivity core and buffer area on movements of organism.

There is four category of general land cover of transition areas such as agriculture land, non productive dryland, non productive wetland and rural settlements. Agriculture land, approximately 58 km^2 of land, it is form of smallholder state crops such coconut plantation, rice field, dryland arable and swidden agricultural practices. Bauro, Com and Mehara these villages are with dominant by slopes < 8 percent and are suitable as agriculture land. Tutuala, Lore I and Muapitine Villages are villages where having less agriculture land. During fieldwork, observed that land areas which categorized into dryland are areas that used as swidden agriculture practices. This means villages have less permanent agricultural land but the dwellers also own crops by doing agriculture practices

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within areas that supposed not allowed. Spatial distribution analysis indicated many of swidden spots are distributed within core area and buffer zones. Its needed approach to keep natural recovery by prohibited continuation swidden agriculture within core area and buffer zones.

Dominant land cover in Transition Area is Non Productive Dryland. It's covered about 186 km^2 of transition areas, form of grassland, woodland and bareland. Swidden agriculture practices has experience since long period, this is causes loss of forest and transforms it to woodland.

Table 29 Land cover in transition areas per village

Village	Agri.Lands	Drylands	Wetlands	Settlements	Total Areas
Com	14.75	24.90	0.00	0.96	40.61
Bauro	25.61	53.46	6.38	2.08	87.53
Mehara	12.11	35.43	11.62	1.48	60.64
Tutuala	1.24	10.63	0.03	0.64	12.54
Lore I	0.49	41.74	0.00	0.66	42.89
Muapitine	4.06	20.39	4.79	0.78	30.02
Total Areas	58.26	186.55	22.81	6.60	274.22
% of Areas	21.24	68.03	8.32	2.41	100.00

Wetlands are form of weds and bogs, wet spots distribution mainly surrounding of Lakes. Grazing is important in agriculture, in which domestic livestock are used to convert grass and other forage into meat, milk and other products. Its present inundated grassland at Iralalaro Lake Floodplain in very good condition. This area is traditionally used as grazing for cattle, buffaloes and horses.

During field work were assessed also number of livestock per villages. Grasslands areas distribution dominantly surrounded Iralalaro Lake floodplain. It's covered of Mehara, Bauro and Muapitine villages. Domestics' animals such Buffaloes, Cattle and Horse are dominantly grassing. Goat are mainly in beach area such Com and Lore I villages. Pork and Chicken are distributed almost in villages.

Table 30 Livestock distribution per village

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Village	Buffaloes	Cattle	Horse	Goat	Sheep	Pork	Chicken	Duck
Bauro	1028	736	103	711	0	911	602	0
Muapitine	115	56	43	15	0	126	704	0
Mehara	1784	620	157	185	10	1985	1987	0
Tutuala	359	538	38	288	0	1166	2062	0
Com	318	279	70	1892	25	115	270	0
Lore 1	180	375	167	479	0	2225	1377	45

Horses are mainly used in farmer's activity such for transportation and Buffalos are used as tools in land preparation. Livestock distribution in table 30 showed that all villages are having animals that feed grass and lower plants. This means that a management planning also required allocating a grassing zone to avoid the negative impacts to the conservation areas. Its future need to have deeply study on transition areas within NKSNP since the function of transition areas here is to eliminate the pressure that might potential occurred and destroy the Cora Areas and Buffer Zones.

4.2 Social Economic Characteristics

Technically, evaluation of social economic pressure is done in raster-vector processes by combine population density data layer and forests activities with priorities conservation areas. Product of evaluation to priorities conservation areas would provide information of social-economic pressure level to priorities conservation areas. This information is one of the factors that would be used as base of ecosystem approach to defined proper management zoning for national park with social-economic characteristics in each village.

4.2.1 Population Density

Evaluation of population density and priority conservation areas done by summed values of population density as social data layer and priorities conservation areas map as others data layer, both are in raster datasets. Aggregation of population density layer and conservation areas layer conducted in order to produce information of the level of pressures by population density by scoring. Aggregation procedure is following ArcGIS Model Builder in weighted sum processes. This process would overlays both raster multiplying each by their

given weight and summing them together and this would produce new raster dataset as aggregation of population density values and zonation values.

Population pressure to each zones of is presented in Table 31 and Figure 15 below, while the data processing is showing in figure 14. The first raster is PCAs layer, consists of PCA-1, Non PCA-1 and Non PCA. Through normalization weight (0-1) then the PCA raster has normalized based on its attributes. PCA-1 the raster values is 1.0000, Non PCA-1 raster values is 0.66666 and Non PCA raster values is 0.33333. The second raster is population density, which is have cells values 0.3681906 (very low), 0.597687 (low), 0.664339 (medium), 0.691494 (high) and 1.0000 (very high). These values were generated through normalized the values of population density of each village. The sum weighted processes done using ArcGIS tools by multiplying each other by their given weighted (using default 1). The cells values of raster sum results of PCAs-Population density thence re-classes into five level, such as 0.701439 (very low), 1.032191 (low), 1.367737 (medium), 1.593031 (high) and 1.928577 (very high).

In raster processes, the first output is in floating data format. Required next step is by reclassify the number of classes thence saved it as integer data format. Method of re-classified is using natural break method (called also Jenks). Number of re-classes using here is five classes same as scoring basis that used in characterization of social economic values as stated in methodology of this research. The new raster that produced as output of weighted processes thence converted into vector format for vectorization processes such as calculating distribution areas per PCA of each village.

Table 31   Population pressure scores in each village

PCA/Village	Bauro	Com	Lore I	Tutuala	Mehara	Muapitine
PCA1	-	-	5	5	3	5
Non PCA1	3	5	4	4	2	5
Non PCAs	2	5	3	3	1	4
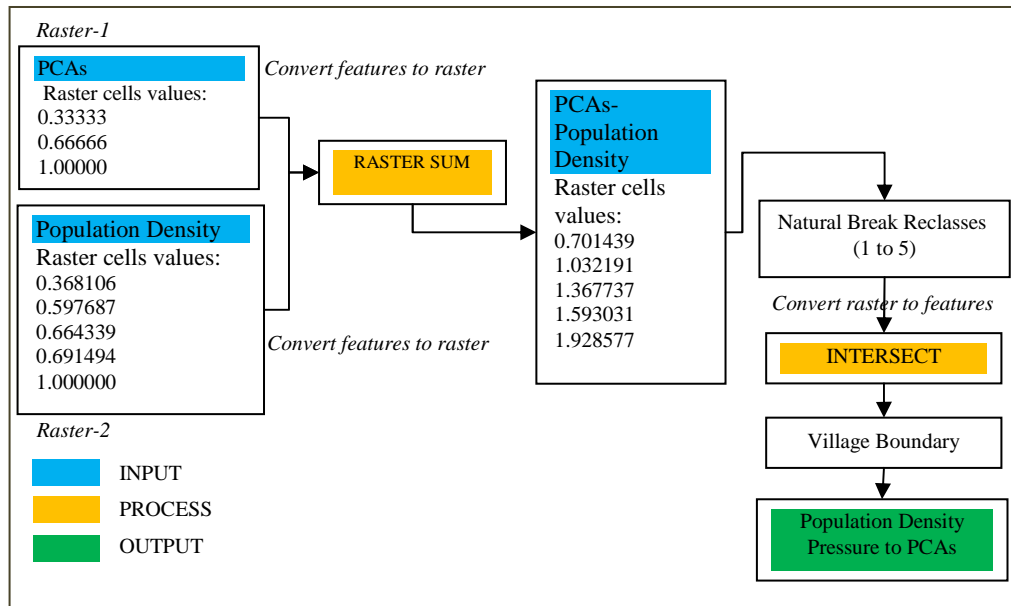
Figure 14 Rasterization processes in analyzing population pressure to the conservation areas
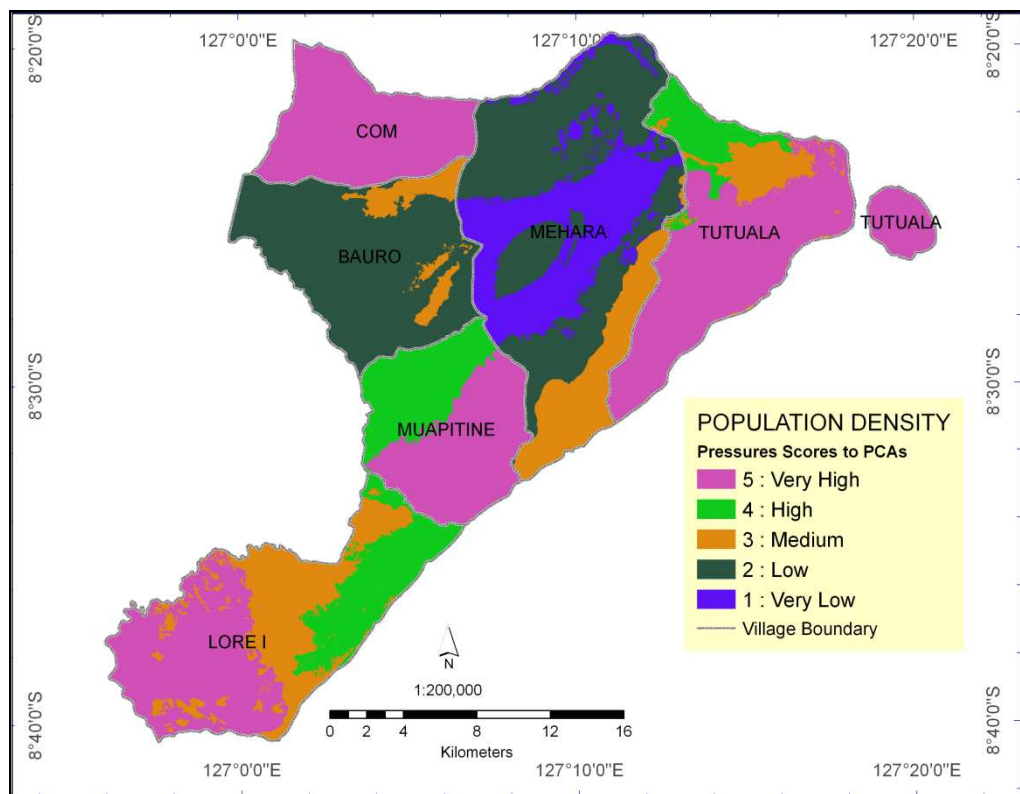
Figure 15 Spatial distributions pressure of population density to PCAs per village

4.2.2 Household Forests Activities

In order to characterize the pressure that might occur to conservation areas by household's activities in gathering forests products, two layers raster datasets

were combined. First is the village characteristic in gathering forests products and second is the distribution of priorities conservation areas that form zonation within each village area. Combination done by summed the given weight of each raster layer (using default weighted given is 1). This process would overlays both raster multiplying each by their given weight and summing them together and this would produce new raster dataset as aggregation of population density values and priorities conservation areas values.

Household forests activity pressure to each zones of is presented in Table 32 and Figure 17 below, while the data processing is showing in figure 16. The first raster is PCAs layer, consists of PCA-1, Non PCA-1 and Non PCA. Through normalization weight (0-1) then the PCA raster has normalized based on its attributes. PCA-1 the raster values is 1.0000, Non PCA-1 raster values is 0.66666 and Non PCA raster values is 0.33333. This layer is the same layer that using in population density analysis. The second raster is household forests activities, which is have cells values 0.555 (very low), 0.638438 (low), 0.709707 (medium), 0.808789 (high) and 1.0000 (very high).

These values were generated through normalized the values of population density of each village. The sum weighted processes done using ArcGIS tools by multiplying each other by their given weighted (using default weighted given is 1). The cells values of weighted sum results of PCAs-Population density thence re-classes into five level, such as 1.040319 (very low), 1.218359 (low), 1.474564 (medium), 1.709056 (high) and 2.0000 (very high).

In raster processes, the first output is in floating data format. Required next step is by reclassify the number of classes thence saved it as integer data format. Method of re-classified is using natural break method (called also Jenks). Number of re-classes using here is five classes same as scoring basis that used in characterization of social economic values as stated in methodology of this research. New raster that produced as output of weighted processes thence converted into vector format for vectorization processes such as calculating distribution areas per PCA of each village.

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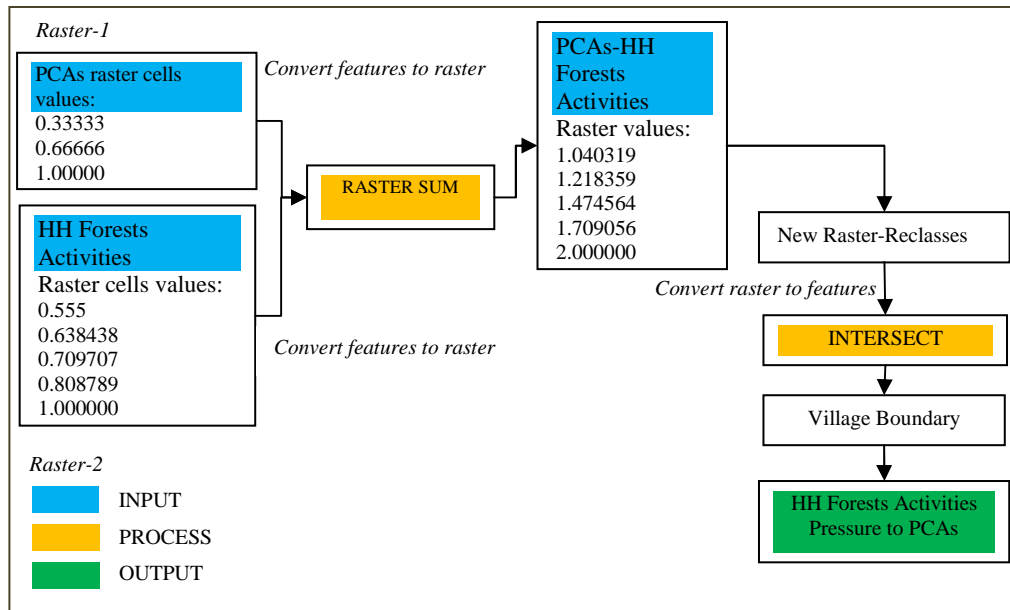
Figure 16 Rasterization processes in analyzing the household forests activities pressure to the conservation areas
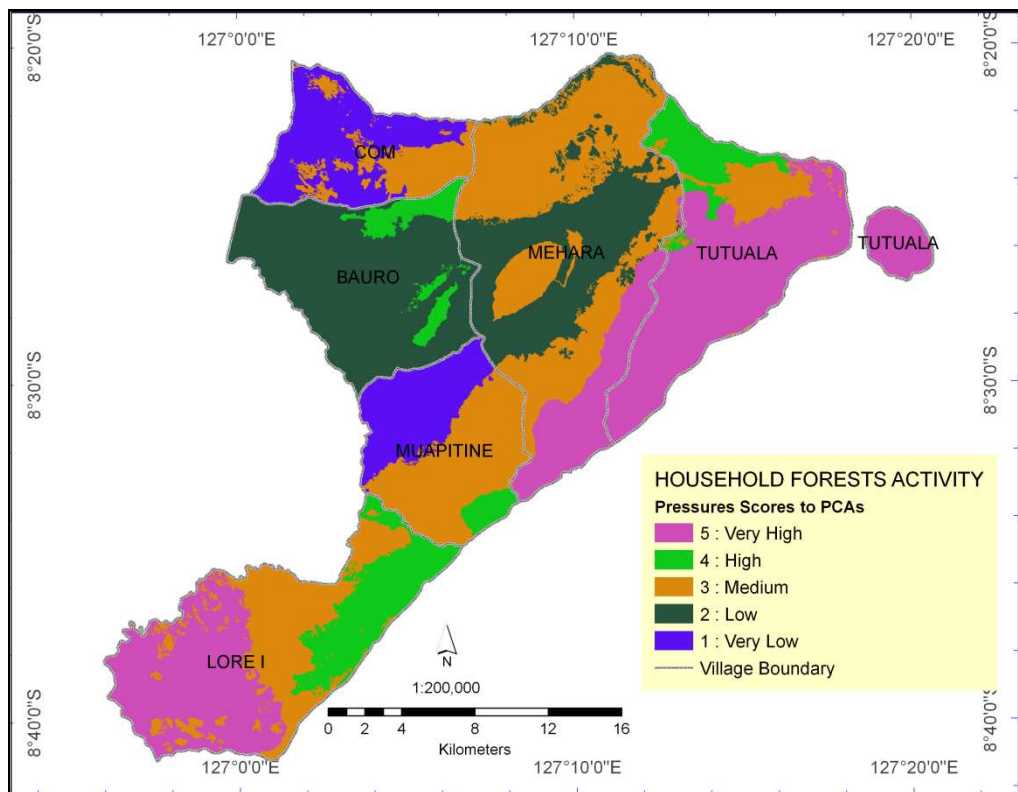
Figure 17 Spatial distributions the pressure of household forests activities to PCAs per village

Table 32 Household forests activities score scored in each village per zone

PCA/Village	Bauro	Com	Lore I	Tutuala	Mehara	Muapitine
PCA1	-	-	5	5	5	4
Non PCA1	5	2	5	5	4	3
Non PCAs	4	1	4	4	3	2

Notes: 1: very low, 2: low, 3: medium, 4: high and 5: very high

4.2.3   *Traditional Land Claim*

Evaluation of traditional land claim is aim to produce a map of zonation with considering to the traditional land claim by community within national park. Seventh polygon area where drawn to grouped numbers of community claimed into a zone by places, since there were the field work not detailed in geo-positioning of each Ratu land boundary. Table 33 and Figure 18 are described the covered areas classified in zone scheme that encompasses the Ratu Zones.
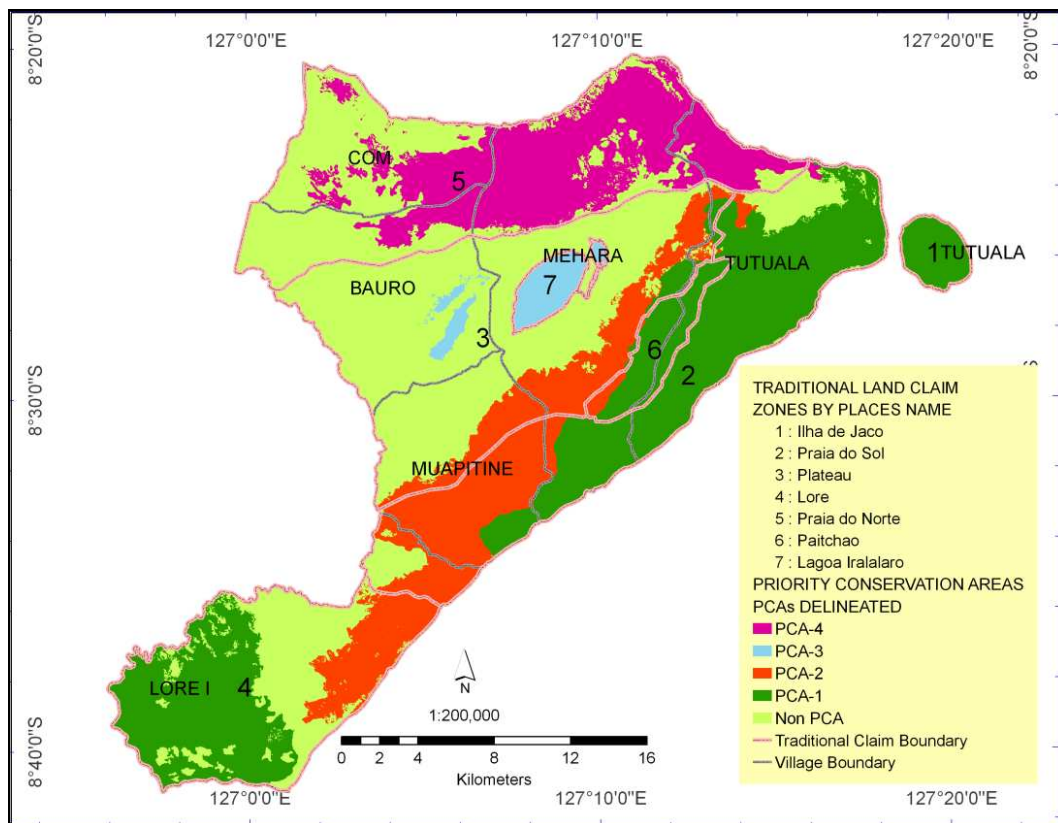
Figure 18 Traditional land claim zones areas based on places name.

Table 33   Estimated areas in traditional land claim by community

PCA/Ratu Area	Ilha de Jaco	Prai Sol	Plateau	Lore	Praia Norte	Paitchao	Iralalaro
PCA1	11.09	90.36	5.12	57.14	-	17.13	-
Non PCA1	-	44.08	39.29	21.37	97.30	2.07	11.24
Non PCAs	-	16.36	141.58	38.99	82.85	-	-
Total	11.09	150.80	185.99	117.50	180.15	19.20	11.24

Ilha Jaco (Jaco Island) is claimed by Tutuala Ratu and Jenilai Ratu. Valu beach which located within core area linkage Tutuala and Jaco Island it is highly having ecotourism potential and by far recognized as one of beach to be beside Jaco Island Beach also claimed by Tutuala Ratu and Jenilai Ratu and many others Ratu that grouped in Praia do Sol (south coast) of the national park. This is encompasses along the Core Area of PCA-1 Tutuala Beach and adjacent forest and Buffer Zones of PCA-2 Forest Corridors within Tutuala, Mehara and Muapitine Village and ended at the boundary of Muapitine Village at south coast.

Paitchao Mt. Range claim by Paitchao Ratu, Latuloho Ratu, Sepe Ratu, Serelau Ratu, Vacumura Ratu as dominant Ratu and many small pieces forest uses claim by other Ratu. Survey on farming area identification within national park area has mapped a distribution of farming spots that need to controlled for not expand the farming area rather than the existed spot. An agreement need to underline with community in order to prevent the land expansion for agricultural purposes within Core Areas.

Forests of PCA-1 Lore is claim by Ratu Naza, Ratu Pitileti, Ratu Chailoro as dominant Ratu and many small area claim by others with their sacral sites which regularly visited. Restoration of natural forests cover in areas designated as forest reserve and boundary perimeter demarcation, incentives to improve community livelihood, re-located swidden farming within protected area to the surrounded artery roads and road infrastructure development are highly recommend.

Praia do Sol (North Coast) of national park where is categorized into buffer areas of PCA-4 within Com Village are claim and dominated by Kati Ratu, Conu Ratu, Keberesi Ratu, Lavera Ratu, and many others Ratu that claimed pieces of land. While PCA-4 where as part of Mehara Village from coast to the terrestrial are claimed and dominated by Home Ratu, Ma'assipanu Ratu, Pair Ratu, Iuru Ratu, Luturenu Ratu, Macapairanu Ratu, Puitical Ratu, Ma'avari Ratu,

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Keriseni Ratu and Ilivali Ratu. Cultural values that existed in north coast are Batu Makassar which is located within Kati Ratu area, Lohomata and Muapusu Lama. Hilly areas of Com Village are claimed and dominated by Kati Ratu, Asatupa Ratu and Luturenu Ratu.

PCA-3 Numunira-Utchanira Lake is claim by Kati Ratu. Main issues are swidden agriculture practices, illegal logging, and wilderness hunting. Rehabilitation of North Dry Lowland Forest and Forest corridors would restore ecosystem functions within national park. Improving livelihood would decrease the forest dependency. Developments of ecotourism potentials such watch birds at Iralalaro Lake and Numunira Lake and eco-cultural sites such Batu Makassar and Camatara Ancestor are in Com Village. White sands at Com resort beach are need to develop under eco-tourism concept. Traditionally PCA-3 Iralalaro Lake is claim by Latuloho Ratu, Ma'assipanu Ratu and Solor Ratu.

4.3   Zonation Scheme

Analysis on high conservation values components produced different type of Priorities Conservation Areas that ecologically these conservation priority areas thence furthermore considered as based in establishing zonation depends on functions of each priority area and the social-economic factors that might affected it of each village. Some of villages may present by all zones category, while the others village may only one or two part of zones occurred.

4.3.1   *Criteria in Zonation Scheme*

A set of criteria to make the final zonation is described in table 36. These criteria defined based on the distribution of priorities conservation areas and the social economic characteristics. In order to build zonation scheme as functions of ecology, biophysics and social-economic factors, the distribution of ecological assessment and social-economic characteristics to the priorities conservation areas within each unit village are presented in table 34 and table 35.

As stated in the framework of this research which is zoning as function of ecological values, physics and social economic factors, thence the national park would be divided into administratively management zoning by considered the

village as unit of community structure that form the whole areas of the Nino Konis Santana National. Traditional Land Claim by community has setup as 'medium' pressure to the all of village. This is more considered as not a 'pressure' but more as local perspectives in the use of forests resources within study area. Based on fieldwork has concluded that mostly community having good willingness to the present of national park.

Table 34   Distribution zones within village based of priorities conservation areas based on ecological analysis

Villages	Present of area (%)			Dominant Areas	BRs Zones
	PCA1	Non PCA1	Non PCAs		
Bauro	0.00	5.49	31.16	Non PCAs	Transition
Com	0.00	8.83	14.35	Non PCAs	Transition
Lore I	31.60	14.38	16.01	PCA-1	Core
Tutuala	48.95	7.74	4.94	PCA-1	Core
Mehara	16.88	44.34	22.83	Non PCA-1	Buffer
Muapitine	2.57	19.21	10.71	Non PCA-1	Buffer

Table 35   Determination of zones by combining the ecological assessment and social-economic components of each village

Villages	Scores of the social economic pressured to PCAs									Average Scores	Presents of conservation areas	Decision Zone
	Population Density			HH Forests Activities			Trad. Land Claim					
	PCA1	Non PCA1	Non PCAs	PCA1	Non PCA1	Non PCAs	PCA1	Non PCA1	Non PCAs			
Bauro	0	3	2	0	5	4	0	3	3	2.2	Low	Transition
Com	0	5	5	0	2	1	0	3	3	2.1	Low	Transition
Lore I	5	4	3	5	5	4	3	3	3	3.9	High	Core
Tutuala	5	4	3	5	5	4	3	3	3	3.9	High	Core
Mehara	3	2	1	5	5	3	3	3	3	3.1	Medium	Buffer
Muapitine	5	5	4	4	3	2	3	3	3	3.0	Medium	Buffer

PCA-1 is dominantly distributed in Tutuala and Lore I Villages, PCA-2, PCA-3 and PCA-4 (Non PCA-1) are distributed in all villages but dominantly located within Mehara and Muapitine Villages, while Non PCAS areas are distributed mainly within Bauro and Com Village.

The social economic pressures based on scored in table 35, it's consists of scores to the PCA-1, Non PCA-1 and Non PCAs. Average scores of Bauro and Com Villages is 2.2 and 2.1 respectively and category as 'low' pressure, this values occurred because the existing conservation areas within both villages are low and placed both villages as transition areas. Mehara and Muapitine Villages are on 'medium' average scores, 3.0 and 3.1respectively and placed both villages

as buffer zones. The dominant area covered by PCA-1 which is become core areas are distributed within Tutuala and Lore I, this condition placed both villages as core areas. Average scores of social economic pressures occurred in Tutuala and Lore I Villages is 3.9 and categorized as 'high' pressure. High pressure category of both villages happened because of the population density and households number in both villages higher compared the others villages and also within both villages existed high conservation values areas as core of ecosystem.

Table 36 Criteria in designing zonation for NKSNP

Zones	Criteria

BRs Core Areas	1. Ecologically, it must be represented:
	   a. at least belongs to the one components of PCA-1; such as protected areas, endangered, threatened and endemic species
	   b. It is a zone that represents uniquely ecosystem that globally have significant biodiversity values for Timor-Leste
	   c. It is including primary forest communities, dense lowland tropical evergreen forest, dry and moist deciduous forest, mangrove forests and suite of coastal strand communities
	2. Physically it covered all land cover classes within:
	   a. slopes ≥ 16 %
	   b. elevation ≥ 600 meters above sea level
	3. Institutionaly can be:
	   a. areas that defined by national law as protected areas
	4. Socio economic and culture can be:
	   a. consist of the heritage sites that have significant high historical values
	   b. consist of environment inscribed with complex and layered social meanings and memories

BRs Buffer Zones	1. Ecologically it must be represent:
	   a. at least one component of either PCA-2 Forests Habitat Corridors, PCA-3 Natural Wetland and PCA-4 Forests critical for community daily need such drink water
	   b. Zones that serves as protection or buffer to the core areas
	2. Physically it can be including :
	   a. Non forest cover classes surounded to core areas (grassland, woodland

	and savannah that funcitons as habitat of important bio indicator)
	3. Institutionaly can included:
	a. Areas that defined by national law as areas that might have potential functions to maintain the core ares
	4. Socio economic and culture can be:
	a. Areas that traditionaly belongs to traditional claim but the community agree to managed is as buffer zones
	b. Areas that seasonaly used by community for culture and customary activity which have values as culture identity
BRs Transition Areas	1. Ecologically:
	a. it might not represented any of PCAs
	b. It might included areas that are dominantly covered by agriculture land, non productive dry land and non productive wetland
	c. Areas that have connecting functions to the core and buffer zones
	2. Physically:
	a. It is dominantly a rural settlements and mixed home garden
	b. It can be a built up areas
	c. It is not a industrial zone
	3. Socio economic and culture it can be:
	a. Areas that have potential to developed as main economic activity to improve community livelihood
	b. Areas that considered as human center activity in socio economic and culture that have uniqueness values as part of national park

4.3.2 *Zones Designed*

Base on zonation scheme and criteria in delineation the zonation as stated in table 36 and the delineation of priorities conservation areas, then PCA-1 assigned as Core Area of the zonation. Non PCA-1 such as PCA-2, PCA-3 and PCA-4 assigned as Buffer Zones and Non PCAs are considered as Transition Area. Figure 19 is map zones produced based on ecological and physics, which is composed of Core Area (Red) is occupied 180.78 km^2 (26.70%), Buffer Zones (Yellow) is occupied 215.27 km^2 (31.80%) and Transition Areas (Green) is occupied 279.83 km^2 (41.33%).
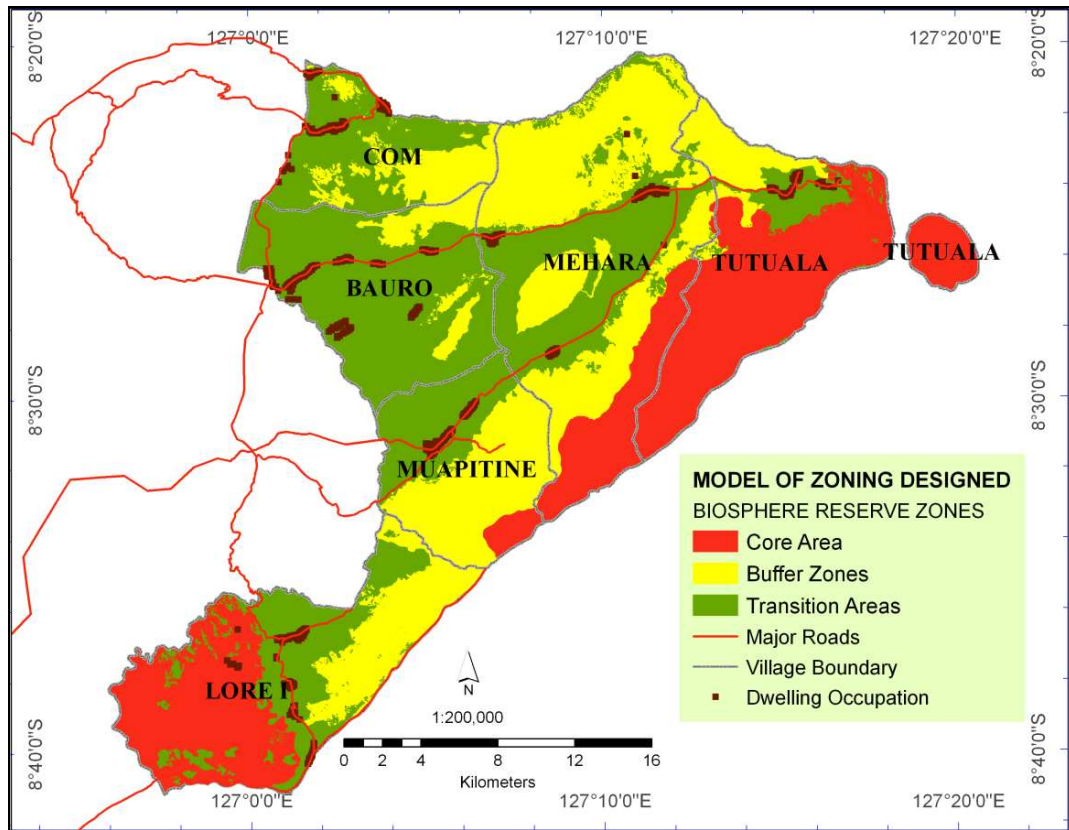
Figure 19 Zonation Map. Designed by adopted Biosphere Reserves Zones, Core Areas (red), Buffer Zones (yellow) and Transition Areas (lemongrass green)

Core Area distributed at four villages except Bauro and Com Villages, while buffer zones and transition areas are distributed variously in all villages. Distribution each zones covered within each village are as presented in table 37.

(Area in km²)

Table 37 Zones areas distribution per village

Zone/Village	Bauro	Com	Lore I	Tutuala	Mehara	Muapitine	Total	% Areas
Core	0	0	57.12	88.5	30.52	4.64	180.78	26.70
Buffer	11.81	19.01	30.96	16.67	95.46	41.36	215.27	31.80
Transition	87.12	40.34	44.78	13.8	63.83	29.96	279.83	41.33

4.3.2.1 *Core Areas*

Core areas are dominantly distributed in Lore I and Tutuala Villages. Core Areas in Tutuala Village is occupied land area of 88.61 km² (48.95%), it's included PCA-1 Jaco Island, PCA-1 Tutuala Beach and Adjacent Forest and PCA-1 Paitchao Mt. Range. In Lore I Village, Core Areas is occupied the PCA-1 Lore

Reserve Forests, 57.12 km^2 (31.60%). The present of Core Area in Muapitine is only 2.57%. While in Mehara Village 16.88%, the areas is a part of PCA-1 Paitchao Mountain Range that administratively belonging into Mehara and Muapitine Village.

4.3.2.2 *Buffer Zones*

Buffer zones within Mehara Village are occupied 44.34%. The areas composed of PCA-3 Iralalaro Lake, a part of PCA-4 North Dry lowland Forest and PCA-2 Forests Corridors which encompasses Mehara Village. Buffer zones are dominantly distributed in Muapitine and Mehara Villages.

Muapitine Village also dominated by Buffer Zones, its occupied 19.21%. The area covered is a part of PCA-2 Forests Habitat Corridors that encompasses this village. Tutuala Village, the buffer zone is covered land area of 16.69 km^2 (7.74%). In this area are existed several culture site such Ilikere-kere Jasa Kovaca, Ilikere-kere Tutuala, Leneara and Pantai Jono.

Buffer zones that located within Com Village covered areas such PCA-3 Numunira-Utchanira Lake and PCA-4 North Dry Lowland Forest. Buffer Zones in Com are 19 km^2 (8.83%). Conservation areas category as buffer zones in Bauro Village is included PCA-3 Oaoloho Swamp Forest and a part of PCA-4 North Dry Lowland Forest.

4.3.2.3 *Transition Areas*

Non priority conservation areas as stated in sub topics 4.1.1.5 that considered as transition areas are distributed variously in all villages. The dominantly transition areas is occurred in Bauro and Com Villages. Presents of the transition areas in four others villages are remained small.

In Bauro Village, transition areas is occupied 87.14 km^2 (31.16%), covered by non productive dryland (53.46 km^2), non productive wetland (6.38 km^2) and agriculture land (25.61 km^2), while the rest is mixed of villages and home garden. In Com Village, transition areas occupied 40.40 km^2 (14.35%). Areas are covered by agriculture land (14.75 km^2) and non productive dryland (24.90 km^2).

Lore I village is occupied 16.01% of transition areas and covered by non productive dryland (41.74 km^2) agriculture land and rural settlements occupied the rest of transition areas. Transition areas in Muapitine is occupied 10.71%, the areas are covered by non productive dryland (20.39 km^2), non productive wetland (4.79 km^2) and agriculture land (4.06 km^2).

Transition areas in Tutuala Village is only 4.94% are mainly dominated by settlement and dryland arable land, its occupied 13.87 km^2. Transition area within Tutuala Village is covered by non productive dryland (10.61 km^2), and smalls agriculture land, mixed rural settlements and home garden.

Transition areas within Mehara Village are occupied 63.90 km^2 (22.83%), occupied by Non Productive Dryland (35.43 km^2), Non Productive Wetland (11.62 km^2) and Agriculture Land (12.11 km^2). Intensive development on transition areas such community forest expected would be decrease the pressure to buffer zones.

4.3.3 *Management Needs*

There are two temporal management needs that has formulated through this research. Management needed is consists of important points for long-term period, while the specific management actions are such kinds of activities that necessarily to carry out within short-medium term in order to restore the ecosystem functions and services, such as described in table 38.

Table 38   Zones management needs proposed for NKSNP

Zones	Management Needs
BRs Core Areas	1. It is necessary to re-allocated existed swidden agriculture within PCA-1 into a permanent farmland 2. To maintain Namaluto and Vero River Estuary as bird's good bird habitat 3. To be fully protected the natural forests communities at all PCA-1 by controlled illegal logging 4. To be established Forest Guardian Check Points at several key sites such as intersection Com Village, Intersection Chai-Lore, Intersection Bauro-Assalaino and Outer point at Iliomar Sub District 5. To be establish beach-keeper to safeguard and controlled the activity at shallow water along coastal line Com-Jaco-Lore 6. It's management directions is for protection and securing, research and development, science and education 7. It must be considered as no take zone 8. It must be directly managing by the National Directorate of Forestry as National Park

		Authority under the Ministry of Agriculture and Fisheries in collaboration with local communities
BRs Buffer Zones	1.	It is necessary to manage swidden farming spot within conservation areas such as into to a permanent agriculture land. Proposed to re-allocate them along artery roads where the technical assistant is easy to deliver
	2.	Make buffer the inner swidden within buffer zones
	3.	It is necessary to maintain natural succession of PCA-2 by controlled illegal logging and limit the agriculture expansion
	4.	To maintain wetland ecosystem of PCA-3 Iralalaro Lake as important bird's good habitat
	5.	To maintain PCA-3 Oaoloho and Veihoorana wetlands and Assalaino woodlands as bird's good habitat
	6.	To rehabilitate forest areas of PCA-4 to support Katam, Sicara and surrounding springs
	7.	To maintain the wetland ecosystem of Numunira-Utchanira Lake and surrounding forests
	8.	Management directions such as research, eco-tourism tracking, natural resources used by local communities allowed under sustainable uses way
	9.	It must be directly managing by the National Directorate of Forestry as National Park Authority under the Ministry of Agriculture and Fisheries in collaboration government tourism offices and local communities
BRs Transition Areas	1.	Intense development in communication and educational, transportation and infrastructures development to improve community livelihood
	2.	Intense development of livestock related activities at Mehara, Bauro and Muapitine Villages
	3.	To fosters fisheries related activities at Lore I, Tutuala and Com Villages
	4.	Developed Com Beach Resort under eco-tourism principles
	5.	Developed Culture Tourism Batumakassar and Camatara
	6.	Intense development to dryland agriculture land at transition areas that having slopes <8%
	7.	Promote home industry activities and providing incentive for household keeper in order to empowering women active participation
	8.	It can be managing by inter governments sectors under coordination of National Park Authority and in collaboration with local communities

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V.   CONCLUSIONS AND RECOMMENDATIONS

5.1   Conclusions

Based on results of data analysis on ecological, physical and social economic factors in designing zonation for Nino Konis Santana National Park, the conclusions of this research are as follows:

1. PCA-1 Lore Reserve Forests, PCA-1 Jaco Island, PCA-1 Tutuala Beach and Adjacent Forest and PCA-1 Paitchao Mountain Range in total areas 180.78 km^2 to be managed as Core Areas

2. PCA-2 Forests Habitat Corridors, PCA-3 Iralalaro Lake, PCA-3 Numunira-Utchanira Lake, PCA-3 Oaoloho Swamp Forest and PCA-4 North Dry Lowland Forests in total areas 215.34 km^2 to be manage as Buffer Zones

3. Non identified PCA where occupied 279.79 km^2 which distributed in all villages of terrestrial park to be manage as Transition Areas to maintain the linkages functions

4. Core Area within NKSNP is necessary for national biodiversity conservation, this is an unique IUCN Category V management principles for Nino Konis Santana National Park

5. Based on zones distribution and social-economic pressures distribution have identified the dominant zones within each village, Lore I and Tutuala as core villages, Mehara and Muapitine to be treat as buffer zones villages while Bauro and Com to be treat as transition areas villages.

6. Traditionally, the whole part of Terrestrial Park were divided into pieces of land that belonging to the each group of Ratu as it's already exist for long time in the pass. That's mean that every management action has to involved community as the real manager of the land of national park.

5.2   Recommendations

Study on ecosystem and community based model for zonation in Nino Konis Santana National Park has formulated several points of recommendations to National Park Authority such as follows:

1. To fully restricted exploration of timber within forests communities that covered in core areas and buffer zones

2. Foster community forestry in each village, especially in transition villages such as Bauro and Com. This aims to reduce pressures to core areas and buffer zones

3. Determine zones boundary in the field and demarcate it by conduct a consensus with representation of Traditional Leader, Ratu Entity as representation of community

4. Conduct further ground based details mapping of traditional land claim to foster the community ownership

5. In addressing the management needed to be treating Tutuala and Lore I as core area villages, Muapitine and Mehara as buffer zones villages and Bauro and Com as transition areas villages.

6. Intensive agro-diversity development planning for Iralalaro Plateau for livestock sector specially cattle feeding in order to increase household earns

7. Develop an agro-diversity surrounded artery roads with slopes < 8% along Thcino-Lori, Trisula-Tutuala and Vaialovaia-Assalaino

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APPENDICES

Appendix 1   GCPs Tracking on Assessment of High Conservation Areas

GCPs Tracking on High Conservation Values Areas Assessment on NKSNP TL (April-May 2010)

Items	Target	Qty	Length	Data recorded	Potential_development
GCPs Tracking	1. Iralalaro Lake	6	25.03 km	Birds, mamal, vegetation	Birds watch
on Wetlands Areas	2. Vero River	1	12 km	Birds, mamal, vegetation	Priority Watershed
	3. Com Coastal1	1	7 Km	Birds, mamal, vegetation	
GCPs Tracking	3. Jaco Island	3		Birds, mamal, vegetation	Protected Forest
on Forests Areas	4. Paitchau Mt. Range	8		Birds, mamal, vegetation	Protected Forest
	5. Lore Reserve	4		Birds, mamal, vegetation	Protected Forest
	6. Com Coastal1	1	7 km	Birds, mamal, vegetation	Culture Ecotourism
	7. Com Coastal2	2	4 km	Birds, mamal, vegetation	Culture Ecotourism
	8. Vaialovaia	1	6 km	Birds, mamal, vegetation	
	9. Numunira Lake	1	4 km	Birds, mamal, vegetation	
	10. Trisula-Tutuala	1	14 km	Vegetation	Food Crops
	11. Chai-Lori	1	8 km	Birds, Vegetation	Food Crops
	12. Lori-Molavai	1	6 km	Birds, Vegetation	Ecotourism, Foodcrops
GCPs Tracking	13. Ilikerekere Tutuala	1	2 km	Birds, mamal, vegetation	Culture Ecotourism
on Culture Sites	14. Ilikerekere Kovaca	1	3.5 km	Birds, mamal, vegetation	Culture Ecotourism
	15.Tutuhara	1	0.2 km	Birds, mamal, vegetation	Culture Ecotourism
	16. Leneara	1	1 km	Birds, mamal, vegetation	Culture Ecotourism
	17. Pantai Jono	1	2.7 km	Birds, mamal, vegetation	Culture Ecotourism
	18. Lori-Namalutu	1	4 km	Birds, Vegetation	Protected Forest
Traditional Landuse Claim Assessments					
1. GCPs on Coastal Area	1. Vecasurver-Mehara	1			
	2. Jaco Island	1			
	3. Com Coastal	2			
2. Terrestrial					
3. Interviewed	Oldest, Traditional Leaders, Administratos, Gov. Officers, Park Authority, NGOs			34 Audio recorded	

Appendix 2   Ground Control Points, Thcino-Lori

Ground Controls Points, Tchino-Lori 28 April 2010

IDEN	LAT	LONG	VEGETATION
1	-8.59023	126.99875	Pandan, Bamboo, Cromoline
2	-8.59023	126.99875	Pandan, Bamboo, Cromoline
3	-8.59522	126.99959	Pandan, Bamboo, Cromoline
4	-8.60296	127.00273	Pandan, Bamboo, Pinang, Teak, Cromoline
5	-8.60296	127.00273	coconut, Pandan, Bamboo, Pinang, Peterocarpus, Cromoline
6	-8.60892	127.00172	coconut, Bamboo, Peterocarpus, Cromoline
7	-8.61083	127.00434	Coconut, Bamboo
8	-8.61120	127.00699	Coconut, Banana, Bamboo, Santalum, Cromoline
9	-8.61750	127.01086	Cromoline, Santalum
10	-8.61716	127.00851	Cromoline, Santalum
11	-8.61913	127.00793	Bamboo, Corn
12	-8.60221	127.00765	Teak, Kesambi, Santalum
13	-8.62313	127.00968	Teak, Kesambi, Santalum
14	-8.62596	127.00972	Coconut, Bamboo, Santalum, Cromoline
15	-8.62957	127.00939	Teak, Pterocarpus
16	-8.65146	127.00363	Mangrove, Palm, Santalum
17	-8.68425	127.01013	Mangrove
18	-8.68129	127.00374	Mangrove
19	-8.67601	126.98835	Mangrove
20	-8.67972	126.98715	Mangrove
21	-8.67810	126.98755	Corn
22	-8.67987	126.99271	Corn
23	-8.68154	126.99719	Mangrove
24	-8.68135	127.01533	Palm, White Sands

Appendix 3   Ground Control Points, Sapuru-East Com Beach

Ground Control Points, East of Com Beach, April 2010

IDENT	LAT	LONG	VEGETATION
1	-8.36356835	127.06332534	Coconut, Ete Kararoko (ficus), Food Crops
2	-8.36409875	127.06409144	Coconut, Ete Kararoko (ficus), Scheleisera oleosa, Food Crops
3	-8.36443319	127.06496350	Coconut, palm, Scheleisera oleosa, Food Crops
4	-8.36454685	127.06558384	Coastal Forest
5	-8.36420235	127.06614442	Coastal Forest
6	-8.36497097	127.06668489	Coastal Forest
7	-8.36522721	127.06696099	Pterocarpus, Coastal Forest
8	-8.36599734	127.06746063	Pterocarpus, Coastal Forest
9	-8.36680359	127.06852036	Coastal Forest
10	-8.36718371	127.06935184	Coconut-Food Crops Area
11	-8.36723275	127.07051014	Coconut-Food Crops Area
12	-8.36707014	127.07164203	Coastal Forest
13	-8.36695941	127.07271600	Ete Tara
14	-8.36632582	127.07362519	Tamarindus, Pterocarpus, Coastal Forest
15	-8.36568084	127.07422751	Tamarindus, Pterocarpus, Sirsak, Verua, Coastal Forest
16	-8.36564697	127.07519772	Tamarindus, Pterocarpus, Coastal Forest
17	-8.36520776	127.07643061	Tamarindus, Pterocarpus, Coastal Forest
18	-8.36535285	127.07733653	Pterocarpus, Etepiti, Kapulaya,Coastal Forest
19	-8.36531815	127.07867386	Coastal Forest
20	-8.36502478	127.07960953	Mangrove
21	-8.36482546	127.08065199	Mangrove
22	-8.36460426	127.08244924	Mangrove
23	-8.36449170	127.08292742	Mangrove
24	-8.36471382	127.08423475	Mangrove
25	-8.36541127	127.08565741	Coastal Forest
26	-8.36562962	127.08608463	Coastal Forest
27	-8.36662288	127.08762196	Coastal Forest
28	-8.36667937	127.08858755	Coastal Forest
29	-8.36680753	127.08963102	Tamarindus, Coastal Forest
30	-8.36704709	127.09103004	Coastal Forest
31	-8.36703837	127.09212011	Coastal Forest
32	-8.36696075	127.09398173	Coastal Forest
33	-8.36716452	127.09533649	Coastal Forest
34	-8.36736451	127.09636940	Pandan, Coastal Forest
35	-8.36676504	127.09673661	Coastal Forest
36	-8.36673754	127.09673334	Coastal Forest
37	-8.36707626	127.09847225	Alavaluru, Pterocarpus. Coastal Forest
38	-8.36720458	127.09890090	Coastal Forest
39	-8.36700107	127.09990639	Coastal Forest
40	-8.36708539	127.09994218	Coastal Forest

IDENT	LAT	LONG	VEGETATION
41	-8.36728069	127.10150206	Coastal Forest
42	-8.36727868	127.10187765	Coastal Forest
43	-8.36746451	127.10275456	Coastal Forest
44	-8.36804353	127.10454485	Coastal Forest
45	-8.36799843	127.10516956	Coastal Forest
46	-8.36794613	127.10679665	Coastal Forest
47	-8.36823665	127.10889615	Coastal Forest
48	-8.36834234	127.10970165	Etepiti, Coastal Forest
49	-8.36776785	127.11201665	Mangrove, Coastal Forest
50	-8.36775611	127.11291620	Coastal Forest
51	-8.36813497	127.11536530	Coastal Forest
52	-8.36858944	127.11663684	Mangrove, Pterocarpus, Coastal Forest
53	-8.36817755	127.11718527	Coastal Forest
54	-8.36751890	127.11805766	Coastal Forest
55	-8.36734146	127.11986069	Coastal Forest
56	-8.36761890	127.12012866	Coastal Forest
57	-8.36820438	127.12224936	Coastal Forest
58	-8.36809860	127.12253619	Coastal Forest
59	-8.36725144	127.12299879	Coastal Forest
60	-8.36616875	127.12614032	Primary Forest-Dense
61	-8.36604696	127.12709360	Primary Forest-Dense
62	-8.36585166	127.12847167	Primary Forest-Dense
63	-8.36426756	127.06456083	Woodland Sparse

Appendix 4   Ground Control Points on Com Beach-Fauna

COM GCPs, FAUNA, April 2010

IDENT	LAT	LONG	FAUNA
1	-8.36356835	127.06332534	Koikoi
2	-8.36409875	127.06409144	Koikoi
5	-8.36420235	127.06614442	Merpati Hutan
6	-8.36497097	127.06668489	Merpati Hutan
7	-8.36522721	127.06696099	Caukorokoro
8	-8.36599734	127.06746063	Merpati Hutan
10	-8.36718371	127.06935184	Koikoi, Merpati Hutan
11	-8.36723275	127.07051014	Merpati Hutan
12	-8.36707014	127.07164203	Merpati Hutan
13	-8.36695941	127.07271600	Koikoi, Merpati Hutan, Vacupolokua
14	-8.36632582	127.07362519	Koikoi, Mepati Hutan
15	-8.36568084	127.07422751	Koikoi, Merpati Hutan
16	-8.36564697	127.07519772	Koikoi, Merpati Hutan
17	-8.36520776	127.07643061	Merpati Hutan
18	-8.36535285	127.07733653	Koikoi,
19	-8.36531815	127.07867386	Koikoi, Merpati Hutan
24	-8.36471382	127.08423475	Momoraku (birds)
25	-8.36541127	127.08565741	Momoraku
26	-8.36562962	127.08608463	Volokoa (birds)
27	-8.36662288	127.08762196	Merpati Hutan, Koikoi
28	-8.36667937	127.08858755	Merpati Hutan, Ayam Hutan
29	-8.36680753	127.08963102	Merpati Hutan
30	-8.36704709	127.09103004	Delimuhan Zamrud
31	-8.36703837	127.09212011	Merpati Hutan, Koikoi
32	-8.36696075	127.09398173	Merpati Hutan
36	-8.36673754	127.09673334	Merpati Hutan
38	-8.36720458	127.09890090	Olokoa (birds), Macaca
39	-8.36700107	127.09990639	Merpati Hutan, Koikoi
40	-8.36708539	127.09994218	Cervus Timorenses, Merpati Hutan, Kuskus, Koikoi
41	-8.36728069	127.10150206	Merpati Hutan, Koikoi
44	-8.36804353	127.10454485	Macaca
48	-8.36834234	127.10970165	Valura (birds)
52	-8.36858944	127.11663684	Kuskus, Koikoi, Macaca
53	-8.36817755	127.11718527	Koikoi

Appendix 5   Ground Control Points on Numunira Lake-Flora

GCPs NUMUNIRA LAKE SURROUNDED, April 2010

HM	LAT	LONG	FLORA1	FLORA2	FLORA3
1	-8.35573738	127.056706	Tamarindus Indica	semak	
2	-8.35647189	127.0562265	Tamarindus Indica	semak	rumput
3	-8.35731343	127.055815	semak	pohon elefiti	srikaya
4	-8.35792934	127.0563005	semak	Tamarindus Indica	rumput
5	-8.35862679	127.0567441	pohon cenupeleku	rumput	
6	-8.35938452	127.0568087	pohon elepiti	Tamarindus Indica	
7	-8.35989104	127.056099	tamarindus Indica	pohon lontar	
8	-8.36015347	127.0553063	pohon lontar	pohon kaipupu	
9	-8.3607439	127.0546989	pohon beringin	pohon jeruk	pohon kelapa
10	-8.36124815	127.0540787	pohon elepiti	semak	pohon kelapa
11	-8.36178686	127.053509	ilalang	semak	pohon lontar
12	-8.36237803	127.0527867	semak	kebun pisang	pohon beringin
13	-8.36276058	127.0522238	tamarindus Indica	pohon suka-suka	
14	-8.36332007	127.0518792	semak	pohon beringin	tamarindus indica
15	-8.36338352	127.0507563	semak		
16	-8.36282244	127.0503714	pohon beringin	pohon kelapa	pohon lontar
17	-8.36252958	127.0495498	pohon sukun	phon beringin	pohon lontar
18	-8.36224853	127.0486323	pohon lontar	semak	
19	-8.36125578	127.0479366	pohon lontar	semak	
20	-8.36018926	127.0477799	kebun lontar	semak	
21	-8.35934043	127.0473098	semak	tamarindus Indica	
22	-8.35856418	127.0467857	semak	tamarindus Indica	
23	-8.35806688	127.0464604	semak	pohon mutu-mutu	
24	-8.35724437	127.0465902	tamarindus Indica	Tamarindus Indica	
25	-8.35646334	127.0462889	pohon mutu-mutu	Tamarindus Indica	
26	-8.35560378	127.0466842	tanaman tara	pohon cipileku	
27	-8.35515124	127.04767	pohon kapulai	semak	pohon mutu-mutu
28	-8.35535157	127.0483746	pohon mutu-mutu	semak	tamarindus indica
29	-8.35610476	127.0482978	tamarindus Indica	pohon jaha	
30	-8.35688705	127.04823	pohon mutu-mutu	pohon kararoko	
31	-8.35678328	127.0490256	Tamarindus Indica	pohon jaha	
32	-8.35593428	127.049467	pohon jaha	semak	
33	-8.35508075	127.0493507	pohon ketapang	semak	
34	-8.35447356	127.0494317	pohon cipileku	pohon kaitemoru	pohon acaete
35	-8.35441732	127.0502583	semak	pohon cipileku	pohon acaete
36	-8.35402077	127.0505245	semak	pohon cipileku	pohon mutu-mutu
37	-8.35370326	127.0503227	Tamarindus Indica	semak	
38	-8.35310413	127.0502351	rumput	kaktus	
39	-8.35266944	127.05013	pohon kaitemoru	semak	
40	-8.35244137	127.0505304	Tamarindus Indica	pohon cipileku	
41	-8.35184852	127.0508547	pohon beringin	Tamarindus indica	

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Appendix 6   Ground Control Points on Numunira Lake-Fauna

NUMUNIRA GCPs, FAUNA, April 2010

HM	LAT	LONG	FAUNA1	FAUNA2	FAUNA3	FAUNA4	FAUNA5
1	-8.35573738	127.056706	Br.tekukur	Br.Sikatan Belang	Br.kehicap kecamata		
2	-8.35647189	127.0562265	Br.cekakak kalung coklat	Br.cikrak kutub	Br.Cekakak Sungai	Kupu-kupu	
3	-8.35731343	127.055815	Br.cekakak kalung coklat	Br.Sikatan Belang	Br.Cekakak Sungai		
4	-8.35792934	127.0563005	Br.tekukur	Br.decu timor	Br.Cikukua Timor	Br.Cikukua tanduk	Br.cabai lombok
5	-8.35862679	127.0567441	Br.cikukua Timor	Br.meliphaga dada lurik			
6	-8.35938452	127.0568087	Br.Decu timor	Br.cikukua timor			
7	-8.35989104	127.056099	Br.Merpati hutan metalik	Br.walik putih	Br.opior Timor		
8	-8.36015347	127.0553063	Br.opior Timor	Br.kipasan dada hitam			
9	-8.3607439	127.0546989	Br.kipasan dada hitam	Br.Cikukua timor	Br.myzomela Timor	Kupu-kupu	serangga
10	-8.36124815	127.0540787	kupu-kupu putih	belalang			
11	-8.36178686	127.053509	Br.srigunting wallaceae	Br.Gagak kampung	Br.Cikukua tanduk	Br.Cabai lombok	
12	-8.36237803	127.0527867	Br.meliphaga dada lurik	Br.cabai Gunung	Br.walik putih	Br.paok la"us	Br.sikatan belang
13	-8.36276058	127.0522238	Br.cabai gunung	Br.walik putih			
14	-8.36332007	127.0518792	Tawon merah	kupu-kupu Biru	Br.meliphaga dada lurik	Br.Alla waluru	
15	-8.36338352	127.0507563	Br.Cikukua Timor	Br.walik putih	Br.paok la"us		
16	-8.36282244	127.0503714	Br.Bubut Timor				
17	-8.36252958	127.0495498	Br.paok La"us	Br.cikukua tanduk	Br.cabai lombok	kerbau/katak	Br.meliphaga dada lurik
18	-8.36224853	127.0486323	Br.sikatan belang				
19	-8.36125578	127.0479366	Br.Gagak kampung				
20	-8.36018926	127.0477799	Br.walik putih	Br.pauk la"us			
21	-8.35934043	127.0473098	Br.delimukan zamrud	ayam hutan	Br.remetuk timor	Br.popo	
22	-8.35856418	127.0467857	Br.cikrak kutub	Br.decu belang	Br.popo	Br.Kipasan dada hitam	
23	-8.35806688	127.0464604	Br.sikatan paruh lebar	Br.Sikatan Belang			
24	-8.35724437	127.0465902	Br.Decu belang	Br.cekakak kalung coklat	Rusa		
25	-8.35646334	127.0462889	Br.cekakak kalung coklat	Br.Decu coklat	Rusa		
26	-8.35560378	127.0466842	Br.srigunting wallacea	Br.cikrak kutub			
27	-8.35515124	127.04767	Br.tekukur	Br.Decu timor	Br.Remetuk timor		
28	-8.35535157	127.0483746	Br.tekukur	Br.Myzomela Timor			
29	-8.35610476	127.0482978	Br.tekukur	Br.meliphaga dada lurik	Br.Decu belang		
30	-8.35688705	127.04823	Br.meliphaga dada lurik	Br.decu belang	Br.tekukur		
31	-8.35678328	127.0490256	Merpati hutan	Br.tekukur			
32	-8.35593428	127.049467	Br.sikatan belang	Br.kehicap kecamata	kupu-kupu kuning	rusa	Merpati hutan
33	-8.35508075	127.0493507	Merpati hutan				
34	-8.35447356	127.0494317	Br.kehicap kacamata	kupu-kupu putih			
35	-8.35441732	127.0502583	Br.sikatan belang				
36	-8.35402077	127.0505245	Br.Decu belang	Br.cekakak kalung coklat	Br.tekukur		
37	-8.35370326	127.0503227	Br.Decu belang	Br.tekukur			
38	-8.35310413	127.0502351	Br.kuntul karang				
39	-8.35266944	127.05013	Br.cikukua Timor	Br.kacamata Gunung	Br.opior Timor		
40	-8.35244137	127.0505304	Br.kacamata gunung				
41	-8.35184852	127.0508547	Br.cikukua Timor				

Appendix 7   Ground Control Points on Numunira Lake Landscape

NUMUNIRA LANDSCAPE, GCPs April 2010

| HM	LAT	LONG	DAYA TARIK
1	-8.35573738	127.056706	Lanskap hutan primer
2	-8.35647189	127.0562265	Lanskap hutan primer
3	-8.35731343	127.055815	Lanskap hutan primer
4	-8.35792934	127.0563005	Lanskap hutan primer
5	-8.35862679	127.0567441	Lanskap pantai
6	-8.35938452	127.0568087	Lanskap pantai
7	-8.35989104	127.056099	Lanskap hutan primer
8	-8.36015347	127.0553063	Lanskap hutan primer
9	-8.3607439	127.0546989	Lanskap perkampungan lama
10	-8.36124815	127.0540787	Padang ilalang
11	-8.36178686	127.053509	Lanskap hutan primer
12	-8.36237803	127.0527867	tempat keramat
13	-8.36276058	127.0522238	tempat keramat
14	-8.36332007	127.0518792	lanskap alam
15	-8.36338352	127.0507563	hamparan batu karang
16	-8.36282244	127.0503714	hamparan batu karang
17	-8.36252958	127.0495498	tempat pengambilan tuak mutin
18	-8.36224853	127.0486323	Lanskap hutan primer
19	-8.36125578	127.0479366	Lanskap hutan primer
20	-8.36018926	127.0477799	hamparan batu karang
21	-8.35934043	127.0473098	hamparan batu karang
22	-8.35856418	127.0467857	hamparan batu karang
23	-8.35806688	127.0464604	Puncak lanskap alam
24	-8.35724437	127.0465902	Puncak lanskap alam
25	-8.35646334	127.0462889	Puncak lanskap alam
26	-8.35560378	127.0466842	jalan bekas romusa
27	-8.35515124	127.04767	jalan bekas romusa
28	-8.35535157	127.0483746	jalan bekas romusa
29	-8.35610476	127.0482978	Danau I Umunira
30	-8.35688705	127.04823	Danau II Umunira
38	-8.35310413	127.0502351	Danau III Ucanira

Appendix 8   Vegetation Survey Jaco Island, Paitchao and Lore (Santana, F 2005)

Site	Local Name	Scientific Name	Family Name	Freq.	IUCN
Jaco	Paaraku	Flueggea sp	Phyllanthaceae	345	
Jaco	Puamimiraka	Algaia rufa	Meliaceae	282	
Jaco	Aitanu	Mimusops elengi	Sapotaceae	182	
Jaco	Aifaulor	Pterospermum acerifolium	Sterculiceae	113	
Jaco	Helo	Dalbergia timorense	Fabaceae	95	
Jaco	Aidak	Schleichera oleosa Merr	Sapindaceae	89	
Jaco	Ailokfuik	Cryptocaria sp	Lauraceae	49	
Jaco	Variasa	Planchonella sp	Sapotaceae	47	
Jaco	Hali	Ficus sp	Moraceae	42	
Jaco	Aikamelimane	Exocarpus latifolius	Santalaceae	33	
Jaco	Ailenok	Grewia breviflora	Tiliaceae	32	
Jaco	Huho	Vitex acuminata	Verbenaceae	31	
Jaco	Laihere	Adenanthera pavonina	Mimosaceae	14	
Jaco	Aikakumakaas	Aidia cochinchinensis	Rubiaceae	14	
Jaco	Lesumalik	Morinda tinctoria	Rubiaceae	10	
Jaco	Paiakelekele	Xylosma terraereginae	Flacourtiaceae	9	
Jaco	Aitasi	Avicenia sp	Verbenaceae	8	
Jaco	Ailalar	Wrigthia javanica	Apocynaceae	8	
Jaco	Valuvalur	Elaeocarpus arnhemicus	Elaocarpaceae	7	T
Jaco	Kauloko	Diospyros sp	Ebenaceae	6	
Jaco	Ikaana	Emmenosperma cunninghamii	Rhamnaceae	6	
Jaco	Aina	Pterocarpus indicus	Fabaceae	5	R
Jaco	Sukaer	Tamarindus indicus	Arecaceae	5	
Jaco	Etelakuvaro	Elattostachys sp	Sapindaceae	4	
Jaco	Aisisimutin	Celtis sp	Ulmaceae	3	
Jaco	Aitali	Corypa elata	Arecaceae	3	
Jaco	Kaitemuru	Suriana maritima	Rubiaceae	2	
Jaco	Aikalanmatanbubu	Bridelia tomentosa	Euphorbiaceae	1	
Jaco	Jave	Cordia subcordata	Boraginaceae	1	
Jaco	Aitarakmutin	Flacourtia sp	Flacourtiaceae	1	
Jaco	Ainitas	Sterculia foetida	Sterculiceae	1	
Jaco	Aitahatoluk	Vitex sp	Verbenaceae	1	

Site	Local Name	Scientific Name	Family	Freq.	IUCN
Paitchao	Aibeco	Syzygium minutiliflorum	Myrtaceae	36	
Paitchao	Aibesi	Intsia bijuga	Fabaceae	128	R
Paitchao	Aidak	Schleichera oleosa	Sapindaceae	212	
Paitchao	Aidikinmean	Mallotus philippensis	Euphorbiaceae	3	
Paitchao	Aifau	Hibiscus tiliaceus	Malvaceae	2	
Paitchao	Aifaulor	Pterospermum acerifolium	Sterculiceae	249	
Paitchao	Aifeu	Garuga floribunda	Burseraceae	99	
Paitchao	Aifolis	Vitex pubescens	Verbenaceae	22	
Paitchao	Aifukira	Nauclea orientalis	Rubiaceae	2	
Paitchao	Aihanek	Alstonia microphylla	Apocynaceae	19	
Paitchao	Aikadus	Cassia fitssula	Caesalpinaceae	3	
Paitchao	Aikakumakaas	Aidia cochinchinensis	Rubiaceae	14	
Paitchao	Aikami	Aleuritas molucana	Euphorbiaceae	9	
Paitchao	Aikatimu	Timonius timon	Rubiaceae	6	
Paitchao	Aikuuntan	Ficus racemosa	Moraceae	6	
Paitchao	Aikuuntan	Ficus racemosa	Moraceae	4	
Paitchao	Ailalar	Wrigthia javanica	Apocynaceae	5	
Paitchao	Ailele	Gossampinus hetaphylla	Bombacaceae	1	
Paitchao	Ailenok	Grewia breviflora	Malvaceae	41	
Paitchao	Ailokfuik	Cryptocaria sp	Lauraceae	43	
Paitchao	Aimanuhirus	Anthiaris toxicaria	Moraceae	43	R
Paitchao	Aimaras	Pometia pionata	Sapindaceae	39	
Paitchao	Aimutin	Melochia sp	Sterculiceae	71	
Paitchao	Aina	Pterocarpus indicus	Fabaceae	465	R
Paitchao	Ainitas	Sterculia foetida	Sterculiceae	21	
Paitchao	Aisabao	Pygeum latifolium	Rosaceae	5	
Paitchao	Aisiba	Syzygium nervosum	Myrtaceae	3	
Paitchao	Aisisi	Celtis sp	Ulmaceae	20	
Paitchao	Aitahafuk	Pittosporum muluccanum	Pittosporaceae	1	
Paitchao	Aitahatoluk	Vitex sp	Verbenaceae	23	
Paitchao	Aitali	Corypa elata	Arecaceae	39	
Paitchao	Aitanu	Mimusops elengi	Sapotaceae	71	
Paitchao	Aitarakmutin	Flacourtia sp	Flacourtiaceae	3	
Paitchao	Aitoo	Calophyllum inophyllum	Clusiaceae	1	
Paitchao	Aiuhus	Pelthoporum pterocarpum	Fabaceae	111	
Paitchao	Akadiru	Borassus flabellifer	Arecaceae	20	
Paitchao	Amivaia	Cerbera mangas	Apocynaceae	4	
Paitchao	Aquilesu	Terminalia catappa	Combretaceae	29	
Paitchao	Au	Bambusa vulgaris	Poaceae	6	
Paitchao	Halimean	Ficus benjamina	Moraceae	39	
Paitchao	Halimutin	Ficus sp	Moraceae	62	
Paitchao	Hasfuik	Mangifera indica	Anacardiaceae	150	
Paitchao	Hedan	Pandanus spirals	Pandanaceae	3	
Paitchao	Helo	Dalbergia timorense	Fabaceae	5	
Paitchao	Ikaana	Emmenosperma cunninghamii	Rhamnaceae	2	
Paitchao	Iparupulu	Terminalia ceriocarpa	Combretaceae	2	
Paitchao	Kaitemuru	Guetarda speciosa	Malvaceae	1	
Paitchao	Kakeu	Casuarina equisetifolia	Casuarinaceae	8	
Paitchao	Kauloko	Diospyros sp	Ebenaceae	6	

Site	Local Name	Scientic Name	Family	Freq.	IUCN
Lore	Aimaras	Pometia pinnata	Sapindaceae	368	
Lore	Aifaulor	Pterospermum acerifolium	Sterculiceae	253	
Lore	Vatafuano	Haplolopus floribundus	Burseraceae	139	
Lore	Aibesi	Intsia bijuga	Fabaceae	105	R
Lore	Aikiar	Canarium sp	Burseraceae	94	
Lore	Ailokfuik	Cryptocaria sp	Lauraceae	66	
Lore	Aibeco	Syzygium minutiliflorum	Myrtaceae	57	
Lore	Hasfuik	Mangirafera indica	Anacardiaceae	54	
Lore	Aidak	Schleichera oleosa	Sapindaceae	51	
Lore	Paaraku	Flueggea sp	Euphorbiaceae	44	
Lore	Aiteka	Tectona grandis	Verbenaceae	40	
Lore	Ulumeru	Pleyiogium timorensis	Anacardiaceae	36	
Lore	Aisiba	Syzygium nervosum	Myrtaceae	36	
Lore	Upuku	Mammea sp	Sapotaceae	29	
Lore	Aina	Pterocarpus indicus	Fabaceae	29	R
Lore	Sukaer	Tamarindus indicus	Caesalpinaceae	18	
Lore	Rota	Calamus sp	Arecaceae	16	
Lore	Hali	Ficus sp	Moraceae	15	
Lore	Aisabao	Pygeum latifolium	Rosaceae	15	
Lore	Luaro	Caryota mitis	Arecaceae	13	
Lore	Aiuhus	Pelthoporum pterocarpum	Fabaceae	13	
Lore	Au	Bambusa vulgaris	Poaceae	12	
Lore	Aifukira	Nauclea orientalis	Rubiaceae	12	
Lore	Aisisimutin	Celtis sp	Ulmaceae	11	
Lore	Aitanu	Mimusops elengi	Sapotaceae	10	
Lore	Aimanuhirus	Anthiaris toxicaria	Moraceae	9	T
Lore	Kauloko	Diospyros sp	Ebenaceae	9	
Lore	Aitali	Corypha elata	Arecaceae	8	
Lore	Aifeu	Garuga floribunda	Fabaceae	8	
Lore	Savatu	Kleinhovia hospita	Sterculiceae	8	
Lore	Tuana	Arenga pinnata	Arecaceae	7	
Lore	Luapaiahu	Buchanania nitida	Anacardiaceae	7	
Lore	Ailele	Gossampinus hetaphylla	Bombacaceae	6	
Lore	Laihere	Adenanthera pavonina	Mimosaceae	5	
Lore	Aihanek	Alstonia macrophylla	Apocynaceae	5	
Lore	Aikatimu	Timonius timon	Rubiaceae	5	
Lore	Aitahatoluk	Vitex pubescens	Verbenaceae	5	
Lore	Aikamanasa	Baringtonia asiatica	Lecythidaceae	3	
Lore	Ailenok	Grewia breviflora	Malvaceae	3	
Lore	Hedan	Pandanus spirals	Pandanaceae	3	
Lore	Amivaia	Cerbera manghas	Apocynaceae	2	
Lore	Varirasa	Planchonella sp	Sapotaceae	2	
Lore	Iparupulu	Terminalia ceriocarpa	Combretaceae	2	
Lore	Samtuku	Albizzia chinensis	Mimosaceae	1	
Lore	Aifrota	Boehmeria sp	Urticaceae	1	
Lore	Aikadus	Cassia fitsula	Caesalpinaceae	1	
Lore	Peiko	Cycas calciola	Euphorbiaceae	1	
Lore	Aitarakmutin	Flacourtia sp	Flacourtiaceae	1	
Lore	Malalakuvaro	Pometia sp	Sapindaceae	1	
Lore	Komila	Sterculia quadrifida	Sterculiceae	1	
Lore	Aikatapa	Terminalia catapa	Combretaceae	1	

Appendix 9   GPS Points on Ratu Boundary Identification, Beaches.

Ident	Lat	Long	Place Name
1	-8.53263544	127.17596018	Vecasuver
2	-8.52683139	127.18684500	Puhututu
3	-8.51303671	127.20437944	Waiharatutu
4	-8.49888713	127.21614470	Maca
5	-8.48925389	127.22655594	Wakahulu
6	-8.45575277	127.26837561	Hakulopor
7	-8.44690768	127.27210865	Malikileun
8	-8.44053785	127.28022929	Jono
9	-8.40810115	127.29988477	Valu
10	-8.38404642	127.26213318	Lumucu
11	-8.38215714	127.25020062	Etehuruha
12	-8.37066170	127.22567157	Manomerehaiho
13	-8.43199083	127.34373654	Masici
14	-8.41707649	127.30866054	Inikkaile

Appendix 10   GPS Points on Culture Sites

Ident	Lat	Long	Site Name	Culture Values
1	-8.39390765	127.2895833	Ilikere-kere	Lukisan pada dinding Benteng Pertahanan Sarang Lebah Fosil Kotoran Kerbau Altar
2	-8.41585910	127.2910854	Leneara	3 makam kuno Lukisan dinding Altar Gua
3	-8.39155217	127.2570593	Tutuhala	Lukisan pada dinding Tiang Tutuhala Sarang Lebah
4	-8.38214968	127.2400557	Jasa Kovaca	Tempat tinggal Lukisan dinding Makam kuno Gua, sarang walet
5	-8.38525442	127.2553995	Pantai Jon	Papakasa Tauraka Iparu Aca Tal/api lopu

Appendix 11 GPS Points on Farming Spots

Place_Name	Area	Lat	Long	Elev
Lote	0.75	8 24 05	127 16 47	315
Lote	0.75	8 24 05	127 16 47	315
Lote	0.75	8 24 07	127 16 49	315
Lote	0.75	8 24 07	127 16 49	315
Lote	0.75	8 24 07	127 16 49	315
Lote	0.75	8 24 07	127 16 49	315
Lote	0.75	8 24 07	127 16 49	315
Totonu	0.25	8 24 11	127 16 31	368
Totonu	0.8	8 24 14	127 16 30	368
Jerihoru	1	8 24 25	127 16 36	315
Jerihoru	1	8 24 25	127 16 36	315
Muacau	2	8 24 26	127 16 41	299
Muacau	0.5	8 24 28	127 16 39	297
Muacau	0.5	8 24 28	127 16 39	297
Muacau	0.7	8 24 28	127 16 39	297
Muacau	0.5	8 24 28	127 16 39	297
Muacau	0.5	8 24 28	127 16 39	297
Muacau	0.5	8 24 29	127 16 39	291
Muacau	0.5	8 24 29	127 16 38	284
Muacau	0.5	8 24 35	127 16 35	278
Muacau	0.5	8 24 32	127 16 36	284
Sawata	0.5	8 24 35	127 16 31	292
Sawata	0.5	8 24 35	127 16 31	292
Sawata	0.5	8 24 35	127 16 31	292
Sawata		8 24 35	127 16 31	292
Sawata		8 24 35	127 16 31	292
Sawata		8 24 37	127 16 24	292
Muacau		8 24 37	127 16 24	315
Muacau		8 24 42	127 16 24	315
Hamalata		8 24 34	127 16 19	306
Hamalata		8 24 36	127 16 18	304
Hamalata		8 24 36	127 16 15	346
Hamalata		8 24 36	127 16 15	346
Hamalata		8 24 38	127 16 15	346
Omkakareti		8 24 43	127 16 16	337
Omkakareti		8 24 42	127 16 06	3328
Omkakareti		8 24 92	127 16 03	341
Omkakareti		8 24 44	127 16 03	341
Omkakareti		8 24 44	127 16 00	337

Appendix 12   Traditional Ratu existed within national park area

Page 1 of 2

Ratu Name	Place Name
Celeri Ratu	Sapuru
Opor Ratu	Ocolavai
Paiuru Ratu	Ocolavai
Home Ratu	Kermoko
Paiuru Ratu	Kermoko
Home Ratu	Kerlavai
Hulapa Ratu	Kerlavai
Home Ratu	Jesoru
Maulevenu Ratu	Heru
Maleki Ratu	Savirara
Martei Ratu	Pulur
Acaloho Ratu	Acaloho Tei-tei
Kapitano Ratu	Sete-Sete
Kapitano Ratu	Kinlai
Robolapa Ratu	Taitoli
Masipanu Ratu	Mehara
Masipanu Ratu	Mehara
Pularu Ratu	Mehara
Laitupa Ratu	Mehara
Paiuru Ratu	Paimatar
Upularu Ratu	Mehara
Hulapa Ratu	Mehara
Kapitano Ratu	Mehara
Maho Ratu	Mehara
Vetuwai	Porlamano
Nari Ratu	Poros, Levenu, Kakaru
Letimece Ratu	Poros, Punuposi
Roukati Rati	Poros, Levenu, Kakaru
Chailoro Ratu	Saraira, Serelau, Futucuru, Pualuki, Herili
Tutuala Ratu	Pocoili
Sepe Ratu	Sepeloho
Sepe Ratu	Seracate
Sepe Ratu	Neluili
Jenilai Ratu	Rusili
Paitchao Ratu	Paitchao Ili
Chailoro Ratu	Pantai Jone
Kovaca Ratu	Rasanu-Cami
Putunina Ratu	Seulu
Putunina Ratu	Makaluli, Iralemes, Jainu, Jeta
Tutuala Ratu	Jeta-Hilapuna-Valu
Tutuala Ratu	Lisina, Ilikaimana, Lenemacala

Ratu Name	Place Name
Jenilai Ratu	Hilapuna-Lekemasa-Iuro Antigo
Marapaki Ratu, Reni Ratu, Paiuru Ratu	Asirulavai-Vero-Kocovaliku
Vacumura	Himakaluli Monte
Marapaki Ratu, Reni Ratu, Paiuru Ratu	Asiru-Loakuvalu-Seremoco
Acacau Ratu, Paichao Ratu	Vero Ver-Vaiara/Vecasu Ver
Acacau Ratu, Paichao Ratu	Vero Ver-Pocoili Monte-Paichao
Jeluna Ratu, Hupulasu Ratu, Lenaparou Ratu	Hio-Hakupoto-Muacau
Vacumura	Cutcha
Chailoro Ratu	Asirumoko, Cenlu, Jonu-norte, Luturu
Paichao Ratu	Vecasu Ver-Arapmaco Ver
Paichao Ratu	Arapmaco Ver-Bobiara
Poirili Ratu	Arapmaco Ver-Urunami Ver
Poirili Ratu	Arapmaco Ver-Aldeia Antigo Muapitine-Tamu Ver
Fara Ratu	Urunami Ver-Lapalapa Ver
Fara Ratu	Pupuru-Lukaloho
Naza Ratu	Lapalapa Ver-Sokoloho Ver
Chaohava Ratu	Periko-Ho
Latuloho Ratu	Bobiara-Acamoko-Vailoro
Latuloho Ratu	Bobiara-Futu-Pehefitu
Naza Ratu	Pupuru-Iraara
Naza Ratu	Lukaloho-Iraara
Kaicilapa Ratu	Lapalapa Ver-Tchino Ver
Kutunina Ratu	Irakava-Tchino Ver
Pair Ratu, Latuloho Ratu	Irakava-Iratei-Tchino Ver
Kaicilapa Ratu	Souco-Molavai
Kaicilapa Ratu and Pitileti Ratu	Molavai
Pitileti Ratu and Kutunina Ratu	Moamimireke
Kaicilapa Ratu	Souco-Raka-Postu Antigu
Kutunina Ratu and Naza	Sokoloho
Chailoro Ratu	Ahiru-Souco-Tchino Ver
Pitileti Ratu	Souco-Chainamo-Tchino Ver
Pitileti Ratu	Iralafai-Namalutu Ver-Tchino
Naza Ratu, Perevata Ratu	Chainamo-Iralavai-Tchino
Pair and Letimece	Likasu-hapiru
Pair and Latuloho	Helfatil-paharmotara
Latuloho Ratu	Laikara
Latuloho Ratu and Chailoro Ratu	Iralavai, Cede Suco
Pair Ratu	Acavari (West)
Pair Ratu	Celetau-Moatau, Lakinu Penunu, Foelohai, Totonu ho Acinu (North)
Pair Ratu	Iramalaru, Louomana-Taraumana, Puipui Kacuwai, Lokoho Pelino (North)
Pair Ratu	Iirhokaihi, Sifoe Safoe, Punuposi Carinora, Likasu Hapiru (East)
Pair Ratu	Oalahu, Oalahu Vacualahu, Seracati Vacafain, Titikoho Roumali (East)
Pair Ratu	Veihorana Icahorana, Pair latamatu, ipartaal paitaal, Ciripa'a Motara, Iramoko Vacutei, Levenara Serelau (South)