SPC
Secretariat of the Pacific Community

Applied Geoscience and Technology Division (SOPAC)

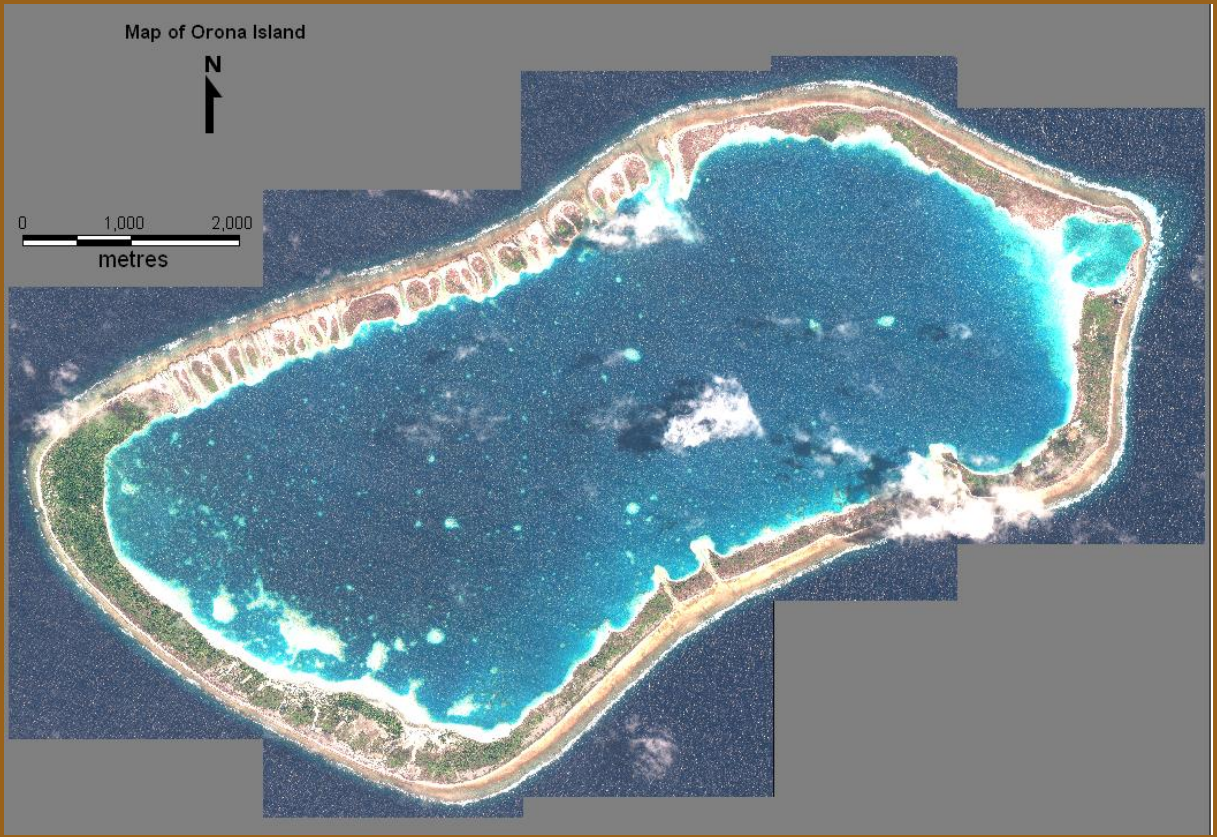
Technical Note – Land cover type mapping utilising Geo Eye image data, Orona Island, Kiribati

May 2011

SOPAC TECHNICAL NOTE (PR63)

Wolf Forstreuter[1], Kataebati Bataua[2]

[1]GIS & Remote Sensing Section, Technical Support Services, [2]Republic of Kiribati



This report may also be referred to as SPC SOPAC Division Published Report 63

Applied Geoscience and Technology Division (SOPAC)
Private Mail Bag
GPO Suva
Fiji Islands
Telephone: (679) 338 1377
Fax: (679) 337 0040
E-mail: director@sopac.org
Web site: http://www.sopac.org

Table of Contents

1 Introduction

The vegetation mapping for low lying islands started at SPC/SOPAC as a initiative related to the FAO programme **M**onitoring **A**ssessing and **R**eporting (MAR) in Tuvalu. In 2009 a monitoring system was established in the Agriculture Department in Kiribati and initial training was provided through SPC/SOPAC. The Agriculture Department worked together with the Department of Environment and the Lands Department on the vegetation mapping task. Kiribati - like Tuvalu at a later stage - expressed additional reasons to map the vegetation of their outer islands. They explained the importance of mapping the coconut resource because accurate figures are required to attract bio fuel related projects. Spatial and statistical information of the coconut resource is also required to be able to start regeneration activities as most coconut palm stands are getting senile. Another important reason to map the vegetation is the food security of low lying islands where the Agriculture Department needs to know the available amount and condition of pandanas, coconut and bread fruit to support management of this natural resource. Finally, the vegetation cover is supposed to be documented to be able to record any changes through a re-mapping at a later stage. It is presumed that the impact of climate change will be visible through vegetation changes which refer especially to mangrove vegetation.

SPC Forest and Trees is financing one position at SPC-SOPAC's GIS&RS section where Kataebati Bataua from Kiribati fills this position and continues the vegetation mapping to supports the mapping in Kiribati's Environment, Lands Department and Agriculture Department.

All mapping is based on visual interpretation at 1:5,000 working scale. The mapping is based on geo-coded very high resolution image data (pan-sharpened GeoEye). The geo-location accuracy is not at 1:5,000 scale level, however, the this new generation of VHR satellite data should be in 1:10,000 accuracy; there can be a linear shift, which can be corrected as soon as reference image points are established. If a geo-location correction will be applied, the area calculation will not be effected.

The coconut cover is stratified into three density classes. These classes might be revised after establishing sample plots within the image data to count the number of palms per hectare.

Currently there is no area subdivision of Orona Islands this will be done if the official boundaries are delivered by the Lands Department in Kiribati.

2 The Satellite Image Data

The interpretation is based on pan-sharpened GeoEye image data providing 50 cm spatial resolution and colour. The colour contrast enhancement is limited due to the limited number of spectral bands and the merge process between colour and panchromatic image channels. The image data was recorded on 3rd April 2011. VHR image data is recorded in tiles whenever the satellite passes the target area and has free onboard storage capacity. This image was recorded as one tile only, however, it had to be split into tiles to be handled by the GIS software.

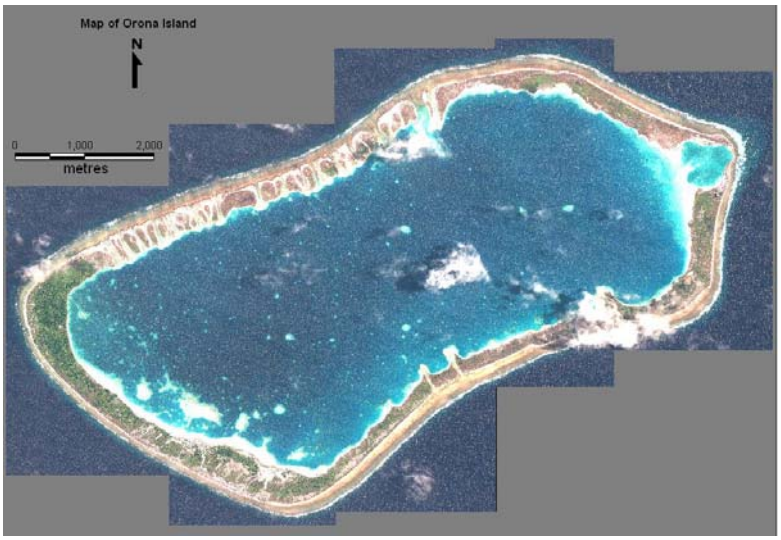


Figure 01: *GeoEye image Data of Orona Islands*

The image data set was purchased as geo-coded in UTM WGS84 zone 59.

3 Area Analysis and Coconut Resource

The area analysis was carried out in Access as area database. The actual area calculation for every polygon was performed in GIS environment and afterwards the MapInfo table was copied to Access.

551 hectare or 76 % of Orona Island are covered by vegetation where 22 % is coconut cover and out of this 21 % or about 114 hectare are dense or semi dense ("plantation") stands, which are the areas economically to harvest.

24 % or 173 hectares of Orona Islands have non vegetation cover where 70 hectares or 41 % are water bodies.

Vegetation Cover	Area [hectare]	% Sum
Settlement	6	1.1
Shrub	396	71.9
Scattered Coconut	6	1.1
Coconut Plantation	8	1.5
Dense Coconut	106	19.2
Mangrove	29	5.3
Sum Vegetation	**551**	**100**
Water Body	70	40.5
Bare Land	88	50.9
Not clear	15	8.7
Sum None Vegetation	**173**	**100**
Total:	**724**	

Table 01: *Land cover summary of Orona Islands*

If the harvestable coconut (coconut plantation and dense stands) are calculated with 100 (coconut plantation) and 200 (dense) palms per hectare Christmas Islands has a coconut resource of about 22,000 coconut palms[1]. This does not mean that all these areas are harvestable as the distance to the next transport line (track) has to be estimated through buffer zone analysis. Normally 300 to 350 metres is the maximum distance coconuts will be carried by hand.

The coconut production also depends on age of the palms, the soil and the amount of hybrids in the coconut stands, which only can be determined by field sample plots.

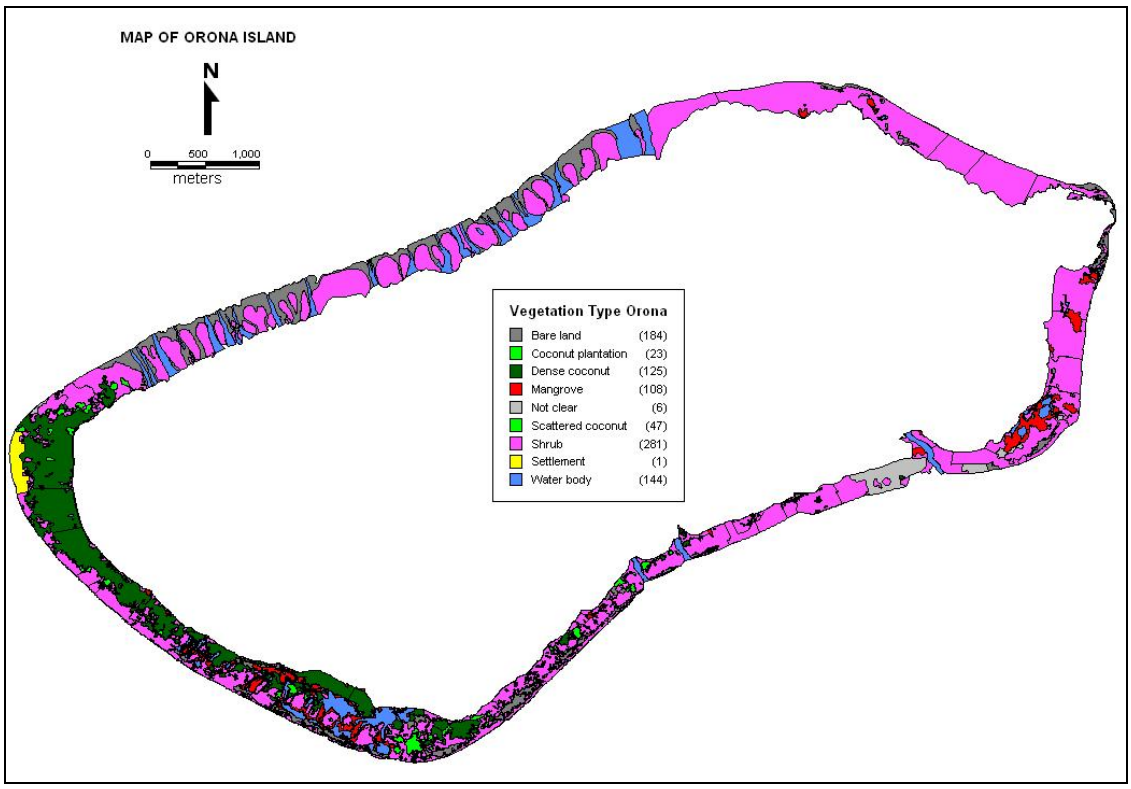


Figure 03: *Land cover type map Orona Island. The number in brackets behind the class name indicates the number of polygons not the size in hectare.*

[1] The number of palms per hectare will be calculated with sample plots within the image data. The stratification into the three densities will be revised afterwards. For dense coconut stands the number of palms per hectare has to be adjusted through field sample plots at a later stage.

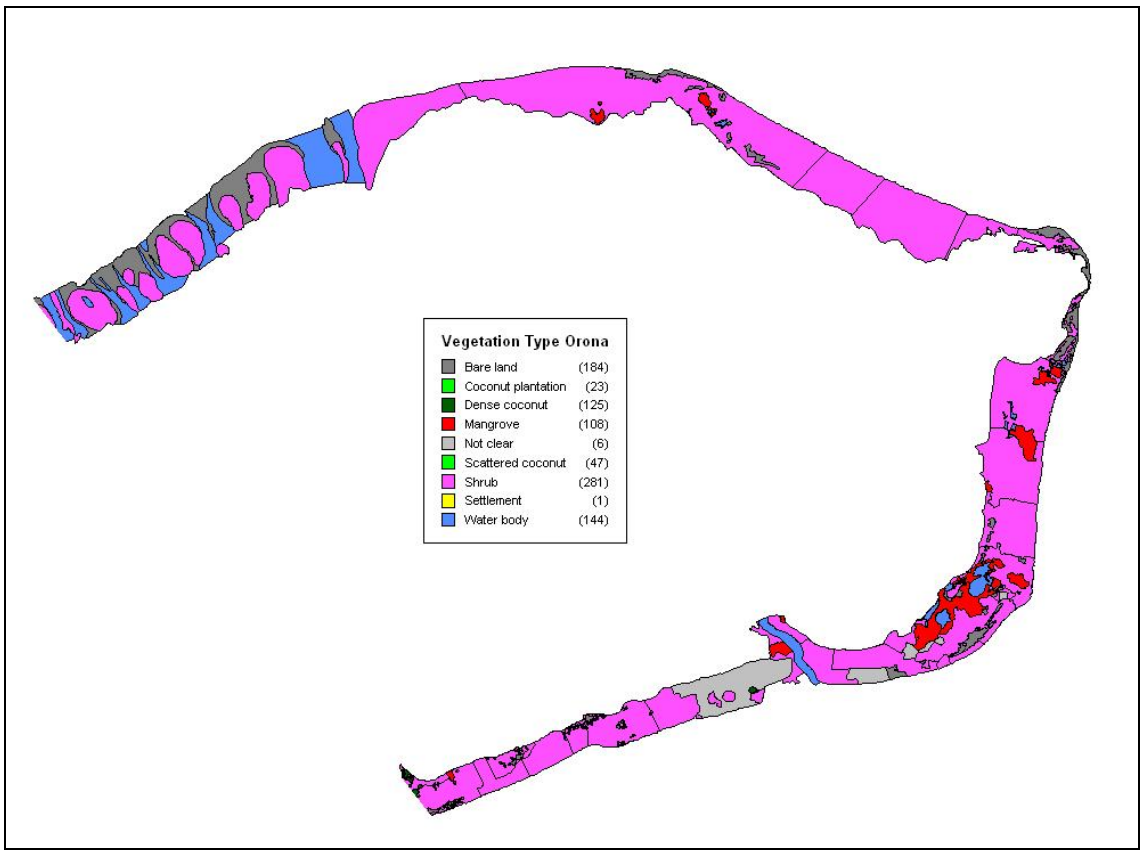


Figure 04: *Land cover type map Orona1 Island. The number in brackets behind the class name indicates the number of polygons not the size in hectare.*

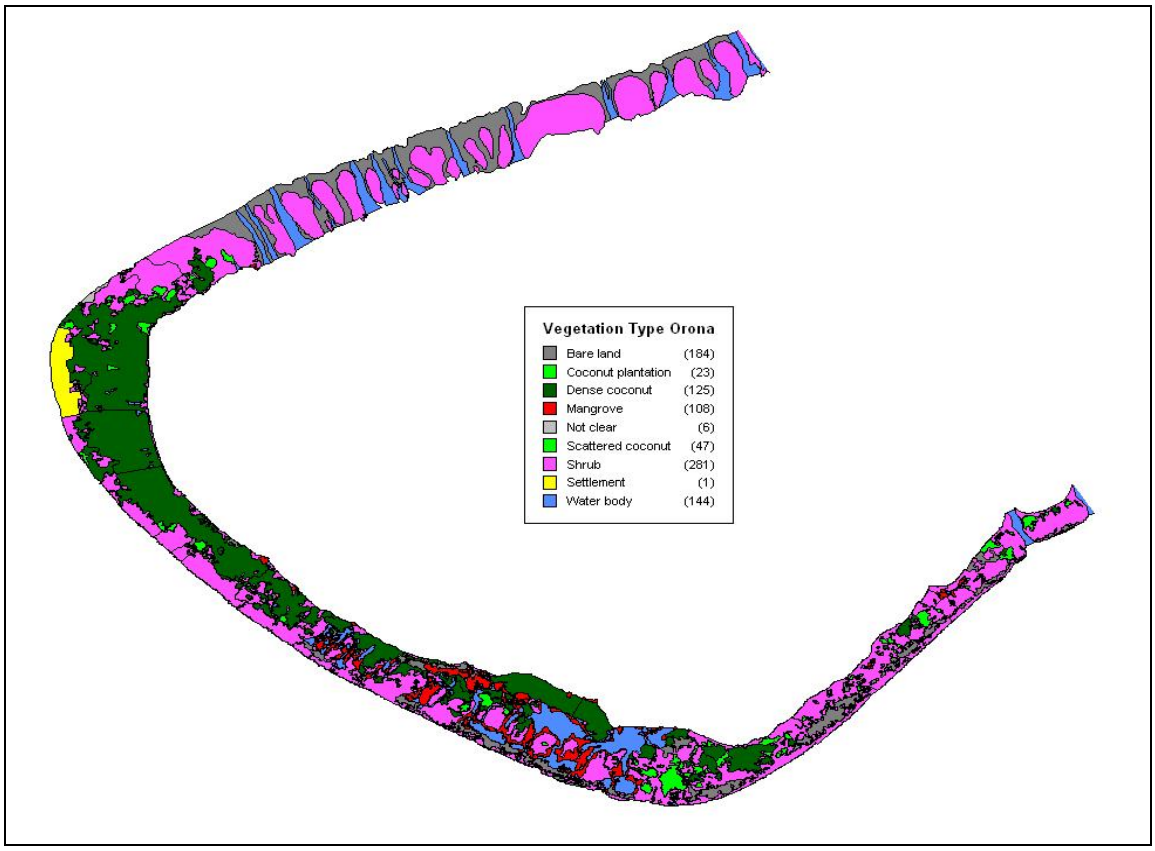


Figure 05: *Land cover type map Orona2 Island. The number in brackets behind the class name indicates the number of polygons not the size in hectare.*

4 Interpretation of Land Cover Classes

The stratification and delineation of the land cover classes is based on on-screen visual interpretation.

4.1 The Visual Interpretation

The Digitising was performed with a zoom factor of 500 m where 1 cm screen distance represented 10 m in the filed. The Zoom factor of 500 m was the optimal display to separate coconut palm from over vegetation types.

At 1:10,000 scale, 1 cm on the map represents 100 m in the field. A quarter of hectare (50 x 50 m) is shown 5 x 5 mm. This was agreed as a smallest mappable unit for vegetation outside the village area..

Even with the limited geometric accuracy (described in the chapter "Image Data", will not affect the area accuracy as even if the image data has to be shifted the shift is normally linear and the polygons will not be distorted.

4.2 The Land Cover Classes

This chapter describes the land cover and the interpretation key.

4.2.1 Scattered Palm

Coconut palms have a typical star like shape and this texture allows a separation from other vegetation even if the colour is similar. Figure 07 shows scattered coconut palms within shrub vegetation. Coconut harvest is normally uneconomic in scattered coconut stands. Scattered palm stands have less than 50 coconut palms per hector. The number of palms per hectare can be counted on VHR image data with sub-metre resolution such as this pan-sharpened GeoEye images.

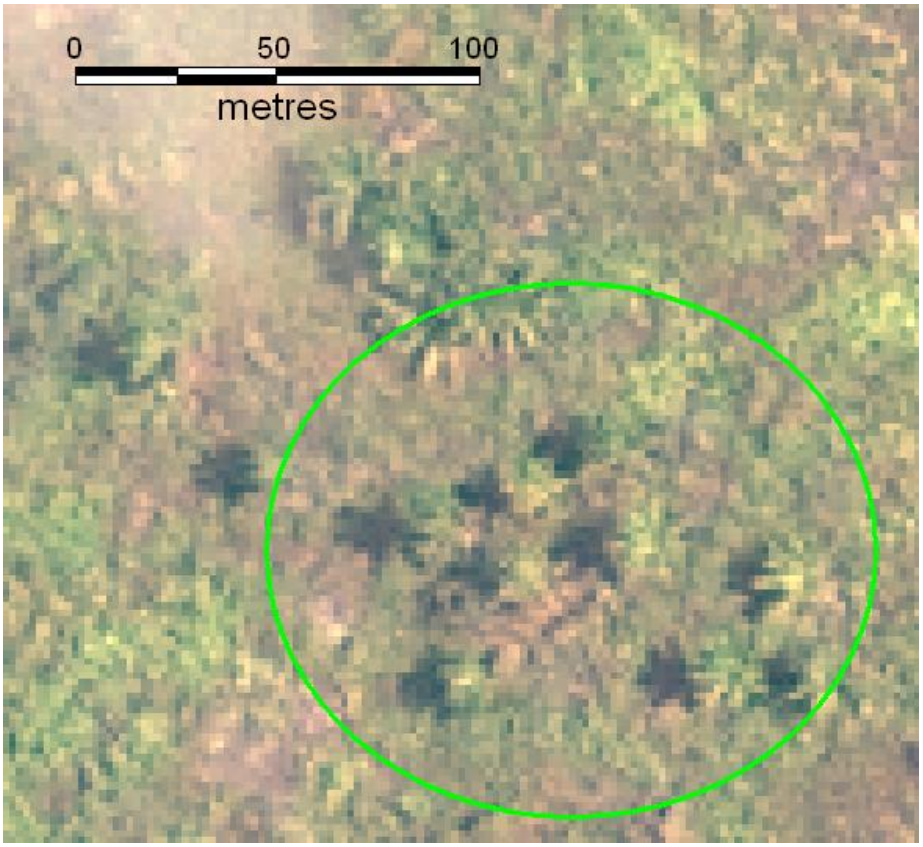


Figure 07: *Scattered coconut GeoEye image data Orona Islands*

4.2.2 Palm Plantation

The class “Palm Plantation” reflects a density typical in coconut plantations of 50 to 150 palms per hectare. The class name does not indicate that there are actual plantations on the ground. It is possible that the plantations are not maintained anymore or that by coincidence such a palm density is mapped. Again the texture allows a separation of palms from other vegetation. In addition, planting rows are clearly visible and make the separation from other vegetation easy even if the is an understory of shrub vegetation. Sample plots within the image data allow an estimation of palms per hectare with 100 % accuracy in sub metre resolution image data.

Semi dense coconut stands are ideal for coconut harvest as the collector has sufficient cocnuts per hectare to collect (in opposite to scattered coconuts) and he can easy move in the area (in opposite to some dense coconut stands). Important is the distance to the next road from where the harvested coconut can be transported by truck to the next processing facility as transport by hand has a limit by a distance of 300 to 350 metres where the transport is uneconomic.

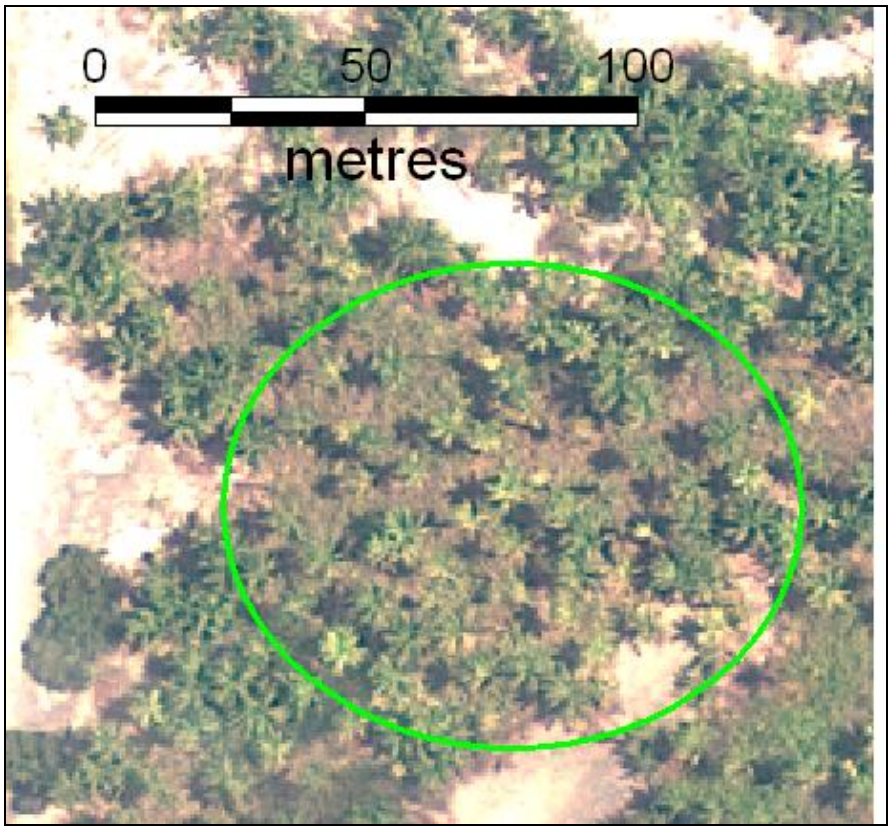


Figure 08: *Palm plantations or semi dense coconut stands on GeoEye image data in Orona Islands*

4.2.3 Dense Palms

Dense coconut stands have a palm density of 150 to 300 palms per hectare. The number of palms per hectare cannot be counted on the images as this typically leads to an underestimation because the palms in the understory are not visible. Field sample plots have to be analysed to create a correlation between visible and actual number of palms per hectare. In opposite to forest vegetation the smaller and invisible palms are important as they are more productive than the tall and old palms. In cases the vegetation is too dense coconut harvest is sometime difficult.

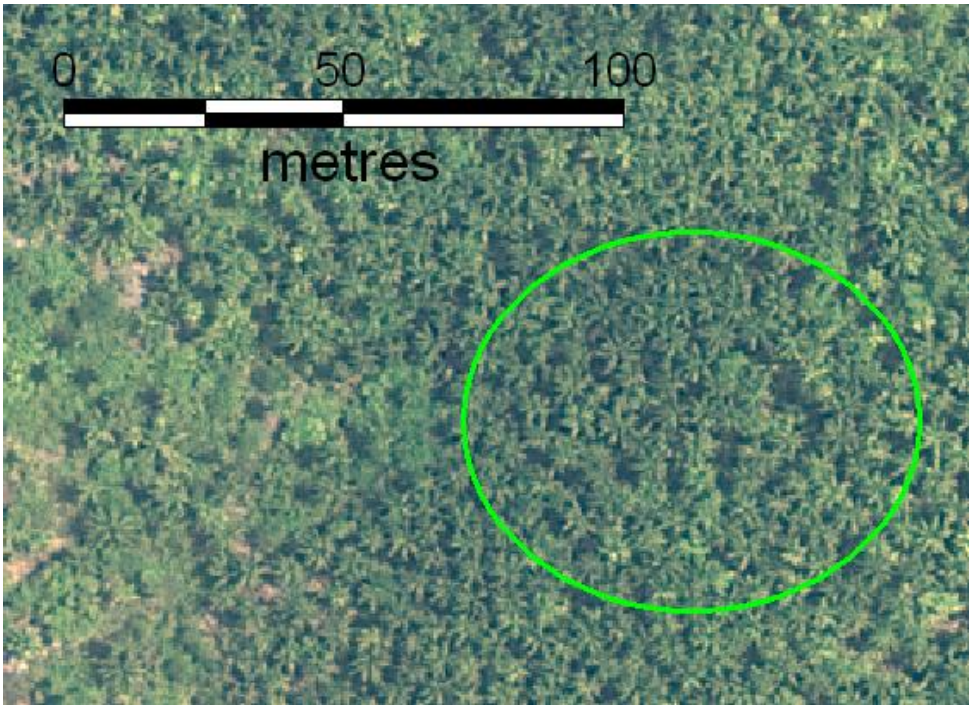


Figure 09: *Dense coconut stands on GeoEye image data in Orona Islands*

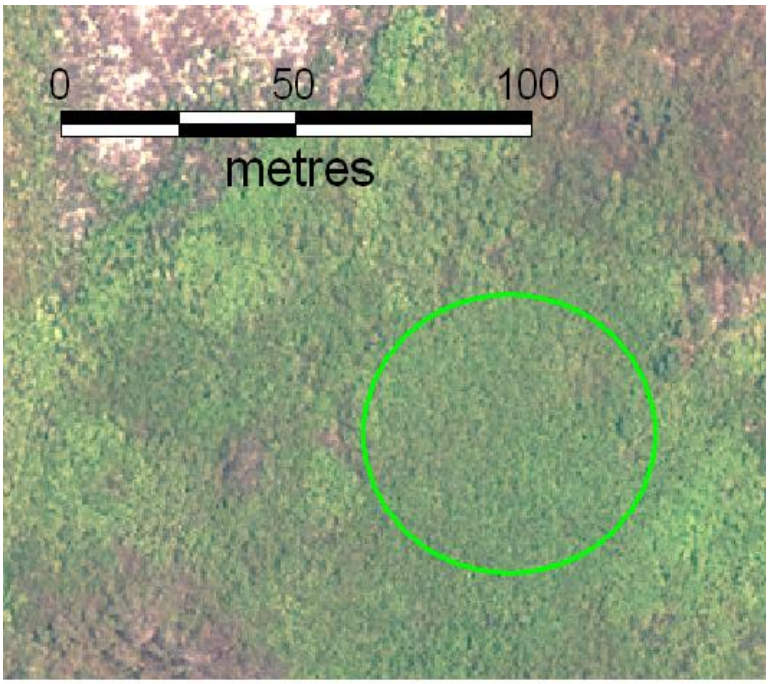


Figure 10: *Shrub vegetation on GeoEye images Data, Orona Islands*

4.2.4 Shrub

Shrub is vegetation under 5 meters in height. The vegetation type “shrub” looks green but does not shows the coconut palm texture or the texture of planting rows. The surface appears smoother than coconut stands.

4.2.5 Bare Land

Bare land is considered as areas without or marginal vegetation. This land cover type is visible as brown to yellow and white in the pan sharpened GeoEye image with homogeneous flat texture.

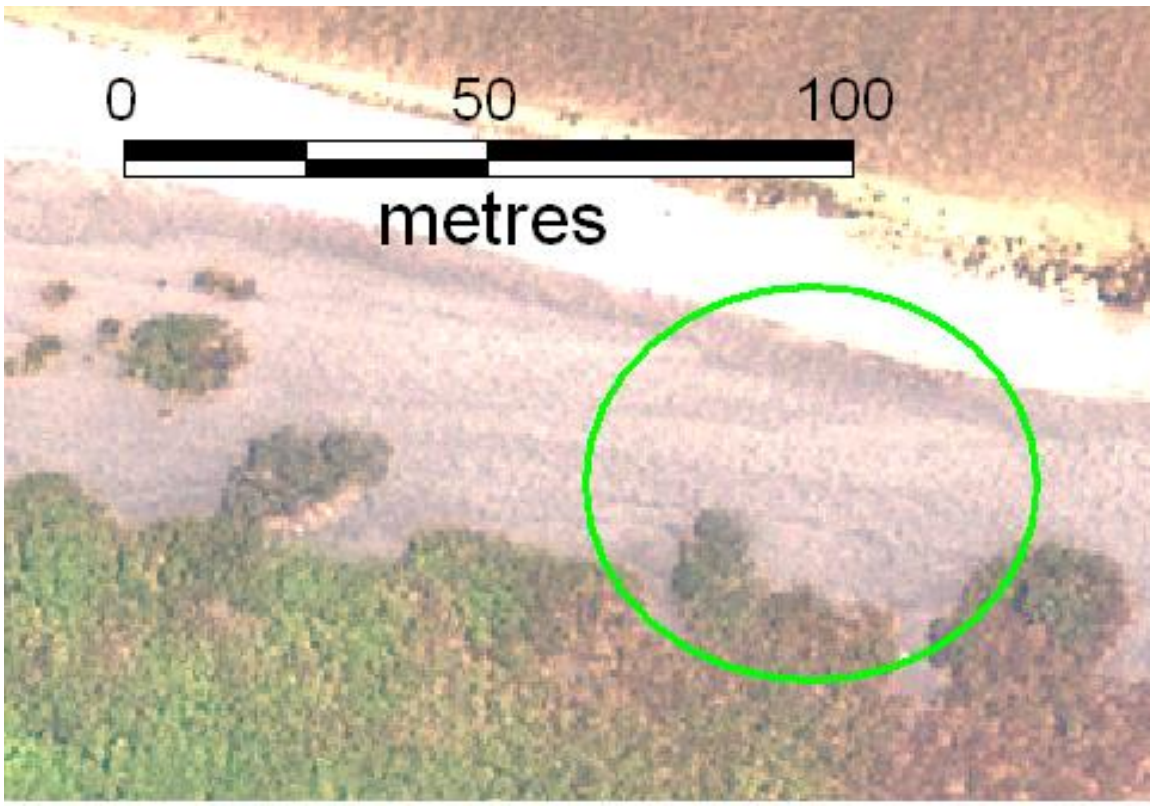


Figure 11: *Bare land GeoEye image data Orona Islands*

4.2.6 Settlements

Figure 12: *Settlement GeoEye image data Orona Islands*

The visibility of house or huts on the pan images indicates settlements. Within a distance of about 75 metres to settlements human influence changes the natural species composition. Therefore the area is delineated as a 75m buffer to both sides of the road and houses. If the high water mark is closer than 75m to the road the high water mark is the boundary.

At a later stage vegetation patches within settlement areas will be mapped in more detail where 25 x 25 metres or 1/16 hectare will be the smallest mappable unit. These vegetation patches will be stratified into palm and other vegetation where "other vegetation" will be statistical stratified into breadfruit and pandanas through field visits as a separation is currently difficult with the available image data.

4.2.7 Water Bodies

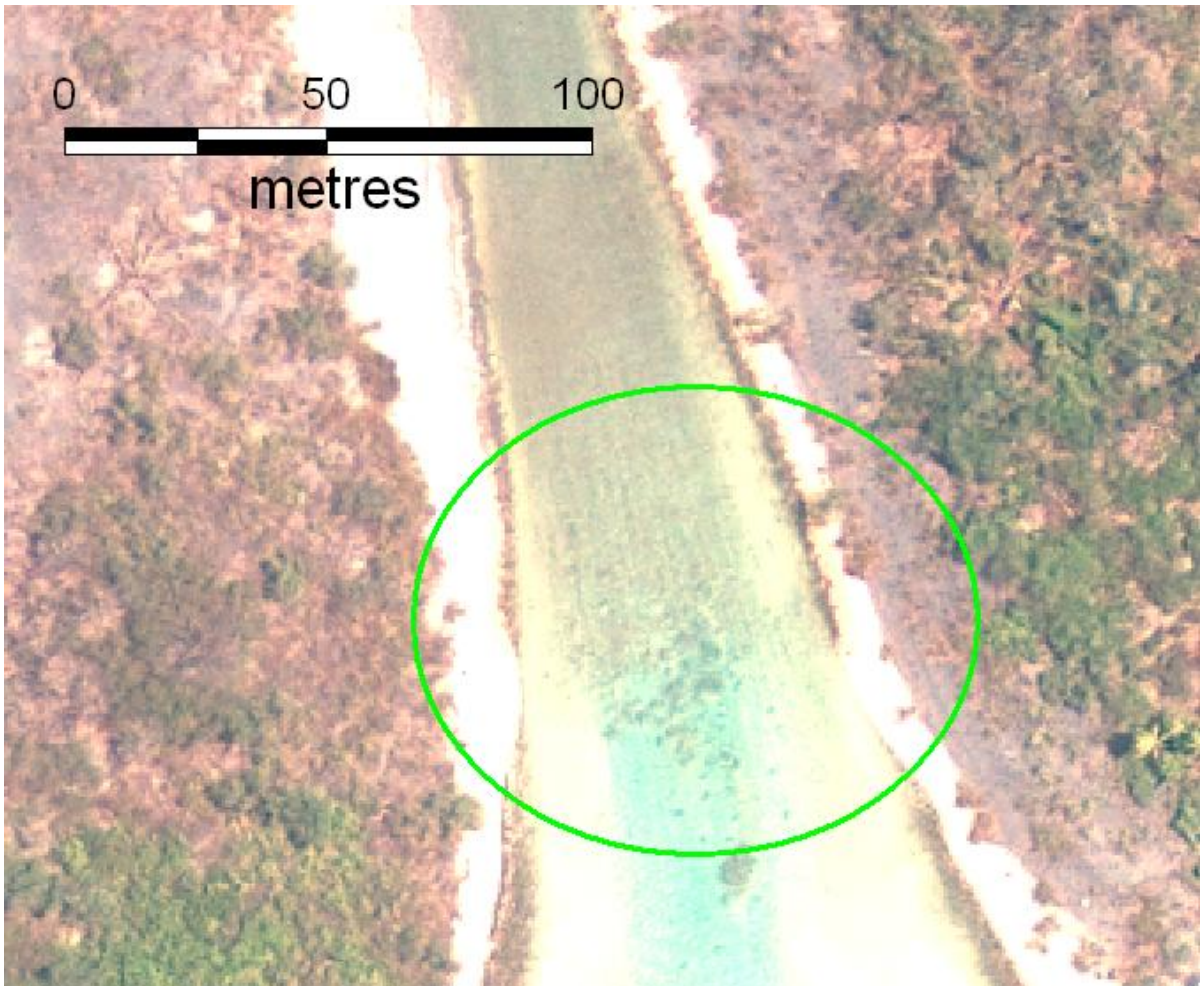


Figure 13: *Water body on image data Orona Islands*

Any form of inland water is classified as "water body". The plain dark surface without any texture identifies it. These can be ponds, lakes and swamps.

4.2.8 Mangrove

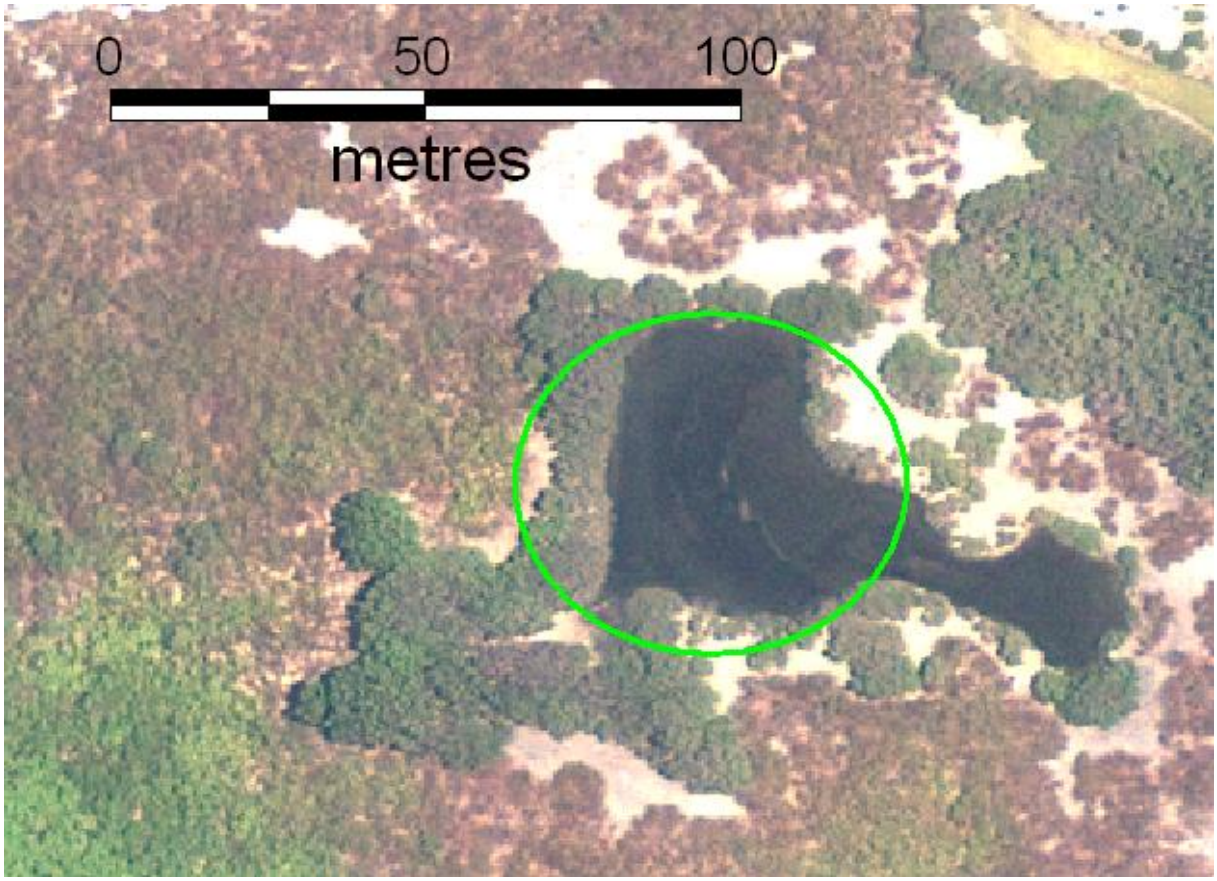


Figure 14: *Mangroves on GeoEye image data Orona Islands*

Mangroves live at the edge of the land and grow at sea level. They can be identified by their texture like a woollen carpet. The colour appears darker green than closed by vegetation. Sometimes mangroves have two types of colour darker in water is and lighter inland (see figure 14) not directly in the water. Mangroves grow normally at the beach but also inland in low lying parts of islands where salt water infiltration appears.

5 Appendix 1 Abbreviations

Table of class names

Land Cover Classes	Abbreviation of Land cover Classes
ST	Settlement
Shrub	Shrub
SCO	Scattered Coconut
CP	Coconut Plantation
DCO	Dense Coconut
WB	Water Body
BL	Bare Land
Notclear	Not clear
MG	Mangrove

6 Appendix 2 Data Storage