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Metadata and Description of TransFly Conservation Scenario Process

Developed for the TransFly Vision Workshop
May 16 – 18, 2006

Report by

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TransFly Ecoregion

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1. INTRODUCTION

On 16 - 18 May 2006, WWF facilitated the TransFly Ecoregion vision workshop which was held at the Alexishafen Conference Centre, Madang, Papua New Guinea. The vision workshop brought together a large number of experts and stakeholders from Indonesia and PNG and elsewhere to determine a conservation landscape for the TransFly ecoregion that incorporated biodiversity and cultural values as well as development plans. The vision that was developed over these three days more than fulfils each country's commitments to the Convention of Biological Diversity (CBD).

This report is a record of the method and process that were used to develop the range of conservation scenarios that were presented at the workshop. The report contains the datasets and procedures used, the trials and errors we underwent, and the parameters of the final scenarios as discussed by the stakeholders. The report is in three main parts. The first part of this report concerns the base layers of the analysis and the biodiversity elements identified as conservation targets. The second part illustrates the process we used to develop the conservation scenarios, including the cost matrix. The final part of the report includes the various trials that were developed to refine the Marxan analysis and the resulting scenarios developed for the workshop. All out put data is stored as ArcView shapefiles and in the following format:

Projection: Albers (Equal- Area Conic)
Spheroid: Sphere
Central Meridian: 141.354557
Reference Latitude: -7.0813105
Standard Parallel 1: -8.4294595
Standard Parallel 2: -5.7331615
False Easting: 0
False Northing: 0

This report would not have been possible without the assistance of Stu Sheppard of TNC.

2. BASE LAYERS

2.1 PROJECT AREA

The TransFly ecoregion project area was created by dissolving the merged Land Systems coverage for the ecoregion (see section 3.1). A 3-kilometer buffer was then created around the project area to accommodate for the coastal mudflats, mangroves and the overhangs of the planning units.

2.2 PROTECTED AREAS

Layers used:

PNG Protected Areas (DEC/WWF SPPO)
Indonesia Protected Areas (Papua Data Base from Forest Watch)
In process Protected Areas (WWF SPPO)

Existing Protected areas for Indonesia and Papua New Guinea were clipped to the extent of the TransFly ecoregion and merged for an ecoregion wide coverage. Proposed conservation areas coverage is based on protected areas that are in process and already submitted to the PNG government.

2.3 TRADITIONAL SITES

Layers used:

Traditional sites (WWF Indonesia)

The traditional sites datasets originate from Indonesia. These are areas that the communities would like to see conserved. The dataset was created by manually digitizing community identified areas on paper maps and the collection of GPS points of important sites. The GPS points were buffered to 2km to form a polygon and merged with other sacred site polygons. The data includes: Ancestor routes, Sacred sites, Ancestor transit sites, Sago areas, Water areas and Traditional Conservation areas

2.4 NATIONAL BOUNDARIES

Layers used:

National Boundaries (Digital World Chart)

The international border of Indonesia and Papua New Guinea (PNG) was derived from the National Boundaries dataset of the Digital World Chart. This dataset was decided upon after several trials with several boundary datasets of Indonesia, PNG and ESRI. These trials were due to the fact that the PNG government recognizes the terrestrial international border of PNG and Indonesia as commencing at approximately east longitude 140 Degrees and south latitude 2 Degrees 36 Minutes in the north and ending at east longitude 141 Degrees and south latitude 9 Degrees 7 Minutes, while all Indonesian datasets ran from 140 Degrees in the north to 141 Degrees in the south with the exception of where the International boundary follows the bends of the Fly River . This dataset was the best fit, in that it aligned well with the central Fly River section of the border.

2.5 RIVERS

Layers used:

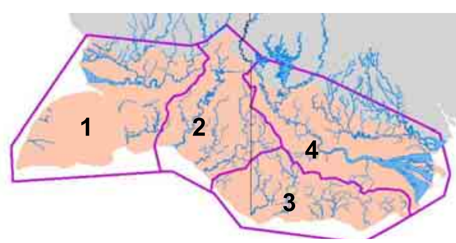
Rivers (TNC & WWF SPP)

The rivers dataset for the TransFly ecoregion was derived from the Rivers dataset of the Digital World Chart (DCW), and the WWF Global Wetlands dataset. This layer was aligned to the Reppprot rivers representation for consistency and to present a more comprehensive rivers layer for the TransFly Ecoregion.

2.6 SUB-ECOREGIONS

The ecoregion was divided into four sub-ecoregions. The sub-ecoregions layer is derived from digitizing four major groupings of river catchments in the TransFly. The region was then divided according to grouped catchments in the TransFly. The sub-ecoregions were named and coded as follows:

- Subecoregion 1: Kimaam and Digul Rivers (1000)
- Subecoregion 2: Bian Kumbe and Maro Rivers (2000)
- Subecoregion 3: Small TransFly Rivers and Streams (3000)
- Subecoregion 4: Fly and Aramia Rivers (4000)



3. DEVELOPING THE CONSERVATION TARGETS

3.1 LAYERS TO FORMULATE THE CONSERVATION TARGETS

Conservation targets include general habitat representation targets (based on landsystems), important vegetation communities from a focal species perspective as well as special elements in the TransFly landscape such as ecological processes, critical landscape features etc.

3.1.1. Land Systems used as a proxy due to the lack of vegetation or ecosystem coverage for the whole Ecoregion

3.1.2. Monsoon forest

3.1.3. Special elements:
   a. Mudflats

b. Areas of dry seasonal inundation
c. Critical land systems
d. Mangroves

3.1.1 Land Systems

Background - Mc Alpine, J. (2005)

In the absence of an ecoregion wide vegetation or ecosystem classification, Land Systems were used as a proxy. Land Systems are areas with recurring patterns of landform/soils/vegetation (i.e. similar to catenary sequence). The basic components of a land system are land units, also called land facets. An example would be the four units of a valley system, (i) the stream, (ii) the stream terraces, (iii) the valley slopes and (iv) the ridge crests. A valley system with wide terraces, short side slopes and broad crests would be a separate land system from one with narrow or no terraces, steep slopes and narrow ridge crests. The basic units are the same but the percentage area that each covers varies and differentiates the two land systems.

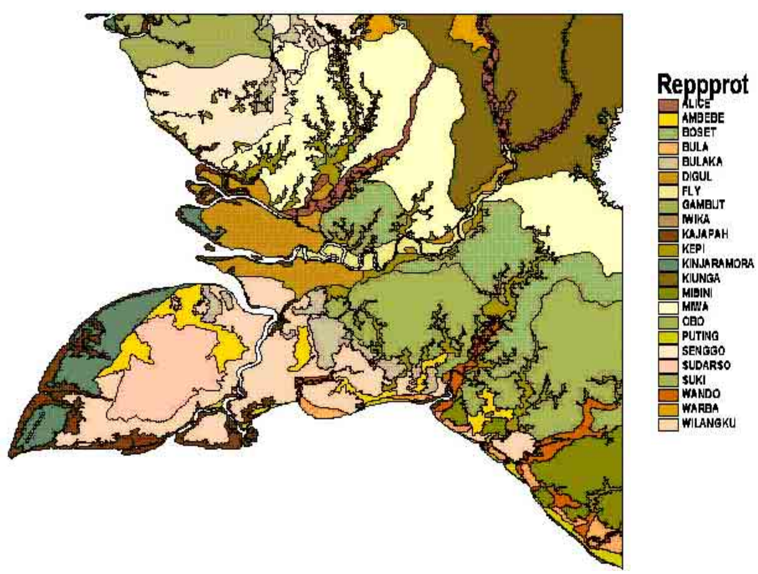
In practice what this means is that the description and arrangement (catenary sequence) of land units, usually at a scale of about 1:50,000, is the key element of the land system methodology and description. The arrangement of units into land systems allows the mapping of the land unit arrangements over large areas at much broader scales. The differences in landscape are sufficiently marked to minimise subjectivity in the delineation and arrangement of land systems except in areas of relict alluvial plains as in the Trans-Fly.

Layers used:

a REPPPROT (137°40”48" to international border)
b Land Resources of the Morehead-Kiunga Area, Territory of Papua and New Guinea: Land c. research Series No.29 CSIRO, 1971(international border to 141°45’)
c Interpretation of Papua New Guinea Resource Information Systems (PNGRIS) Resource Mapping Units (RMU) by John McAlpine (141º 45 eastwards to Fly and Aramia River delta)

a. REPPROT

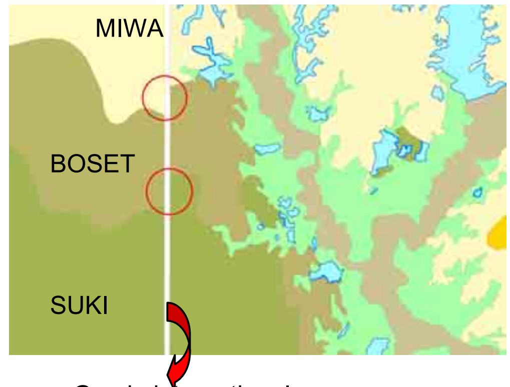
Reppprot Code	Reppprot Name
293	Putting
167	Kajapah
125	Gambut
257	Obo
320	Suki
311	Suddarso
362	Wilangku
50	Bula
100	Digul
52	Bulaka
2	Ambebe
153	Iwika
315	Senggo
185	Kinjaramora
182	Kepi
11	Alice
404	Warba
243	Miwa
74	Boset
296	Wando
116	Fly
174	Kiunga
222	Mibini



b. Land Resources of the Morehead-Kiunga Area

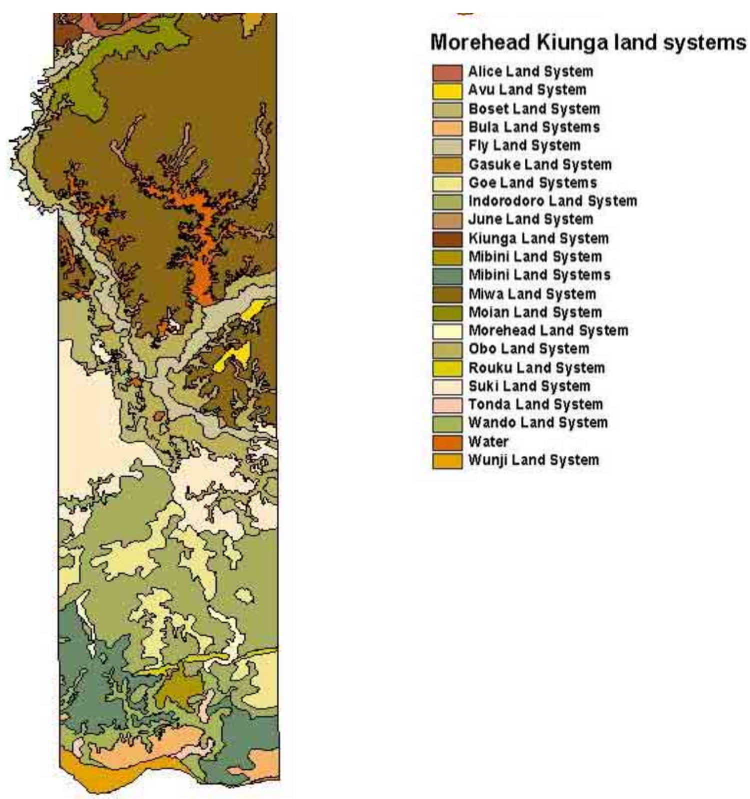
Morehead – Kiunga Land System (MKLS) was derived from manually digitizing on screen a scanned image of the CSIRO Morehead – Kiunga Land System atlas. Two problems arose when the Morehead – Kiunga was joined to the REPPPROT:

- The joining of the MKLS to the Reppprot in the southern portion of the boundary where the borders did not align by about 1km. To rectify this we aligned the MKLS to Reppprot by adjusting the vertices.
- Areas where there was slight mismatch of landsystems across border the MKLS and Repprot were overlaid onto Landsat image 54-05 and the boundaries for these affected land systems redefined using the difference in topography as seen on the image. These areas of interpretation were generally less than 5 hectares.



Gap in international border

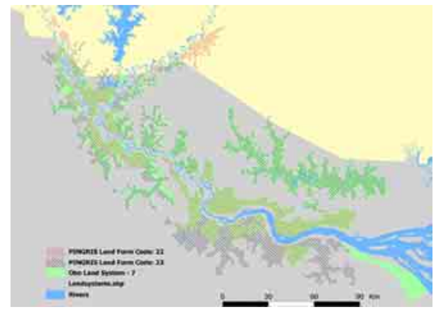
MKLS Code	Land System Name
0	Water
1	Wunji Land System
2	Bula Land System
3	Wando Land System
4	Tonda Land System
5	Fly Land System
6	Alice Land System
7	Alice Land System
8	Obo Land System
9	June Land System
10	Morehead Land System
11	Rouku Land System
12	Mibini Land System
13	Goe Land System
14	Indorodoro Land System
15	Suki Land System
16	Boset Land System
17	Avu Land System
18	Moian Land System
19	Miwa Land System
20	Kiunga Land System
21	Gasuke Land System



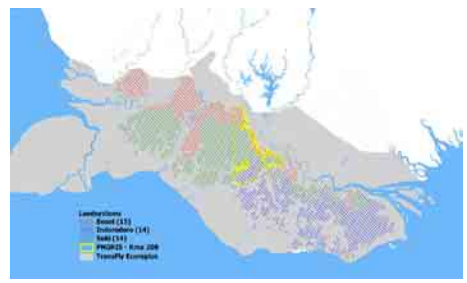
c. Extrapolation of Morehead - Kiunga Land Systems to the East (Fly River) – Mc Alpine, J. (2005)

The procedure adopted was to overlay the boundaries of the Morehead - Kiunga land systems (MKLS) on those of PNGRIS then using the relationships established between the two mappings extrapolate the land systems to the east using PNGRIS boundaries. The major problem was RMU 277 which combined Land System 13 - Indorodoro with Land System 11 - Mibini. In hindsight these should probably have been separated out as different RMUs. The problem is that to map out LS 11 in the east requires an identification of a difference in relief class, not possible on the contour intervals of the 1: 100,000 topographic map series (minimum contour interval 40 m.) As a consequence the PNGRIS mapping has been slightly modified by reference back to Bleeker and Loffier.

Areas where there is joint coverage of PNGRIS and LS mapping to North of Fly River



- For Land System 7 – Obo, PNGRIS mapping distinguishes between those areas that are back swamps where flooding is mainly from the Fly River (PNGRIS landform code 22) from areas that are blocked or drowned valley swamps or lakes with their associated floodplains where the flooding is also due to drainage from adjacent higher land (PNGRIS landform code 23). In this conversion the two codes 22 and 23 have been lumped back into Land System 7 Obo.
- Conversely PNGRIS lumps Land System 13 (Indorodoro), 14 (Suki) and 15 (Boset) together.



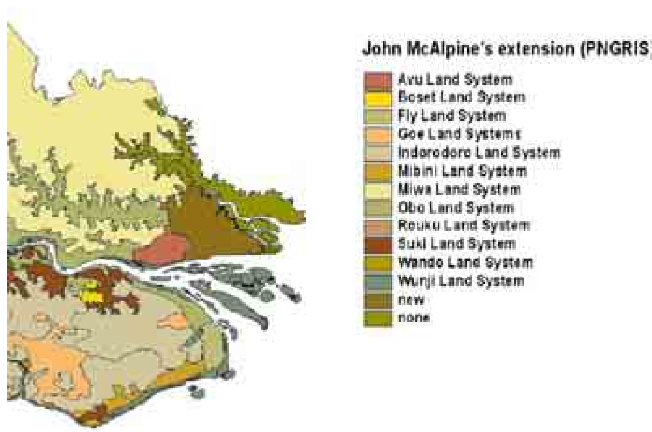
Extrapolation

There is one new land system. Land System 99, is a recent, not relict, alluvial landform, (PNGRIS landform code 18 - composite levee plain) comprising two land units, levee banks[1] and back plains[2].

The resulting extrapolation should be taken as indicative only.

Also note that PNGRIS mapping is more detailed for the littoral landforms than in the Morehead-Kiunga report Land Systems report for example mangroves are separated out in PNGRIS.

MKLS_Code	Land System Name
1	Wunji
3	Wando
7	Obo
10	Rouku
11	Mibini
12	Goe
13	Indorodoro
14	Suki
15	Boset
16	Avu
18	Miwa
35	Fly
99	***New***



d. The Merged TransFly Land Systems coverage

[1] Composite Levee Plains – Rock type: Alluvial Deposits, Mean annual Rainfall (mm): 1000 – 7000, Landform elements: Levee Banks, Slope (°): <2, Inundation: Long term inundation, Major Soil Classes: Fluvaquents, Tropofluvents
[2] Back Plains: Rock type: Alluvial deposits, Mean Annual Rainfall (mm): 1000 – 5000, Land form element: Lower plains, <2, Inundation: Seasonal to permeant inundation, Major soil classes: Hydraquents, Tropffibrists

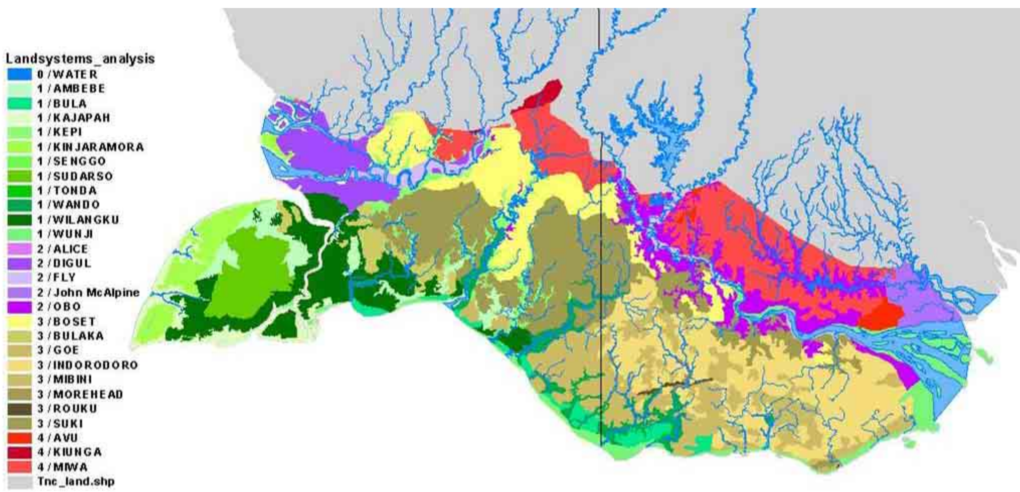
The TransFly Land System is the continuous Land System coverage for the whole of the TransFly Ecoregion. Commencing at the Kimaam and Digul Rivers and ending at the Fly and Aramia Rivers, this coverage is a combination of the REPPPROT (137°40”48" to international border), the Morehead - Kiunga Land System (international border to 141°45’) and the extrapolation of the Morehead - Kiunga Land System to the East (141° 45’ eastwards to Fly river delta).

To provide consistency across the merged land systems coverage, those land systems with similar characteristics but different names were renamed and merged, such as Puting Land System (REPPPROT - 293) was changed to Wunji Land System (MKLS - 1) then merged with the Wunji land system. Also Kepi Land System polygon number 6409 (REPPPROT – 182) was changed to Wando (MKLS - 3) creating seamless Wando coverage across the border. Note: other Kepi landsystem polygons were not changed.

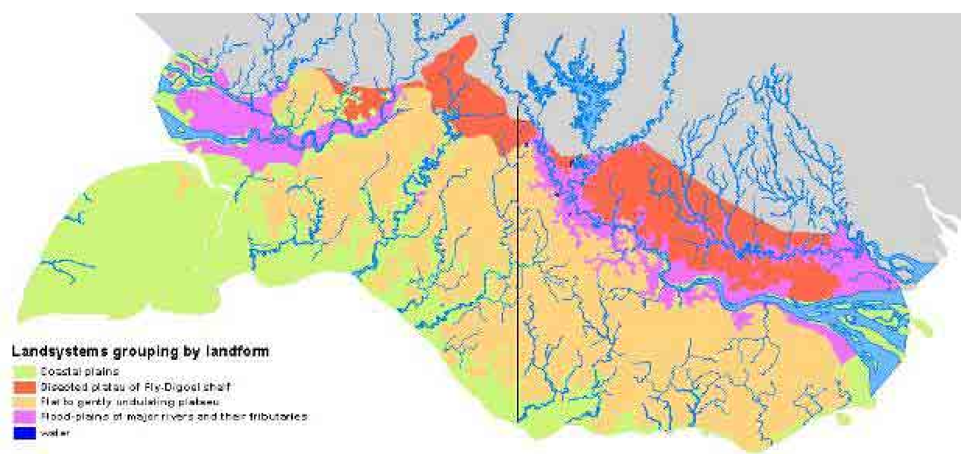
Table showing Land Systems descriptions of the Wunji, Putting, Kepi and Wando Land Systems.

Land System	Description
Wunji	Coastal Beach Ridges and Swales
Puting	Coastal Beach Ridges and Swales
Kepi	Seasonally inundated swampy valleys and low terraces
Wando	Seasonally inundated flood plains of large rivers

The merged Land Systems of the TransFly Ecoregion had a total of 28 Land System types.



The coverage was then grouped according to landform groupings, derived from CSIRO Land Systems (CSIRO, 1971



3.1.2 Monsoon Forest

Layers used:

The digital elevation model 90m resolution from SRTM was used as the base and then combined with field information from Reppprot and PNGRIS as follows:

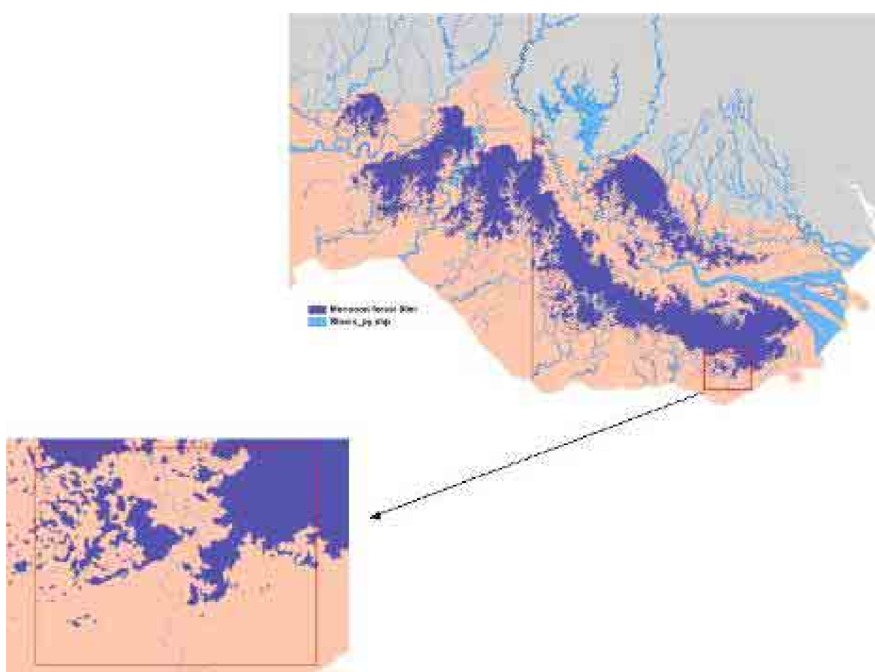
Indonesia side:
Northern boundary:
Select REPPPROT Riv_innunda = Slight (up to 1 week)
Select from set REPPPROT Wetmnt = 3-7

Southern boundary:
Select from above elevation greater than 31 meters. (Elevation from SRTM)

PNG side:
Northern boundary:
Select PNGRIS seasonal less than 3 (note 3 = "Moderate range heavy to intermediate" and class = 100 – 200mm > 200m). In PNGRIS Rainfall seasonality is defined as "the seasonal variability of mean monthly rainfall for each RMU is classified according to the estimated amounts, range and dominant levels of monthly rainfall through the year" (Bellamy, J.A. and McAlpine, J.R:1995)

Southern boundary:
Select from above elevation greater than 31 meters. (Elevation from SRTM)

From this we derived the Monsoon Forest 90m resolution predictive map. We selected a Minimum Mapping Unit (MMU) greater than 500 ha. Reasons for selecting the MMU of 500 ha were that there was a total feature record of 4,652 monsoon forest polygons. Running the scenarios with this many features would have taken a significant time. Another reason for the MMU was that a very large number of polygons contained a monsoon forest feature (albeit tiny) which would have influenced the computer to select a huge proportion of these. To ensure that no significant area of monsoon forest was overlooked, the MMU predictive map was cross-checked with a ground truthed satellite image. This dataset was then unioned with the land systems. The following map shows the pre-MMU selection monsoon forest map which results in much scatter and fragmentation of the results.



3.1.3 Special elements

a. Mudflats

In the TransFly mud flats provide ideal roosting/feeding areas for migratory birds that stop over in the TransFly.

Layers used:

LandSat Mr Sid S – 54 - 05 was digitized by Wetlands International to identify predicted areas of important mudflats. We selected a Minimum Mapping Unit (MMU) greater than 6 ha, again to reduce processing time.

b. Dry season Inundated areas

Layers used: Dry seasonal inundated areas (GecOZ)

Due to the seasonally dry climate of the TransFly ecoregion, permanently inundated areas are extremely important watering areas for wildlife and humans in peak dry seasons. This layer shows which areas remain wet all year around in the driest dry season.

The method used by consulting firm - GecOZ: 2004

Images for this project were obtained in the months towards the end of the dry season. A further refinement of satellite images chosen for the project is based on years with lowest rainfall depending on availability of the satellite images. Note: depending on lowest dry season for particular months between the mid 1980s and 2002.

Seasonal inundated mapping done using Earth Resource Satellite (ERS) Synthetic Aperture Radar (SAR), the particular images used in this project was supplied by the Australian Centre for Remote Sensing.
The SAR sensor was the best selection for data acquisition, due to its compatibilities of data acquisition at all times, weather conditions and its abilities to penetrate cloud, smoke and haze. To determine areas of inundation each image had a density slice applied and darker areas were classified as water or water vegetation. The coverage was then checked and cleaned in GIS.

When creating the conservation targets layer, the GIS coverage was filtered with the minimum mapping unit set at 5 ha. Before selecting a MMU of 5 ha there was a total count of 2,401 polygon features in this coverage. This large number of polygon features would have caused the analysis to run for too long a period for each scenario. The selection of planning units would also have been too scattered for a meaningful result.

c. Mangroves

Data layer used: New Guinea mangroves

The mangroves dataset was considered critical by the experts and stakeholders during the vision workshop. Mangroves are important in that they provide a nursery ground for fish and invertebrates which are an important source of food for both people and wildlife. Mangroves also prevent beach erosion and saltwater intrusion into freshwater systems.

d. 100% landsystem targets

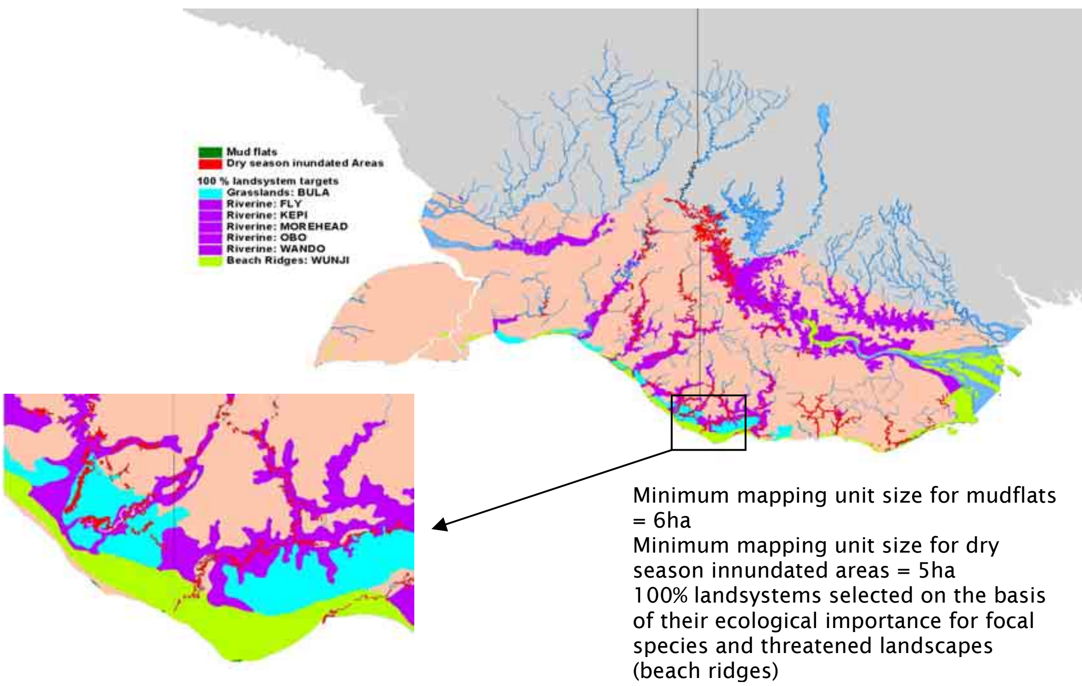
Derived from the Land System, these 100% Conservation targets are regular Land Systems but have a higher priority for a number of reasons:

1. Beach ridges and Grassland landsystems
Beach ridges are the most threatened landscape in the TransFly Ecoregion and contain critical freshwater aquifers used by coastal communities. Grasslands are the most unique environmental feature of the TransFly and are major hunting grounds for local communities.

2. Riverine Landsystems
Rivers provide freshwater, as well as major food sources for local people - they form critical rearing grounds for fish (including barramundi and saratoga). Connectivity is critical and rivers also provide sediment traps/erosion control.

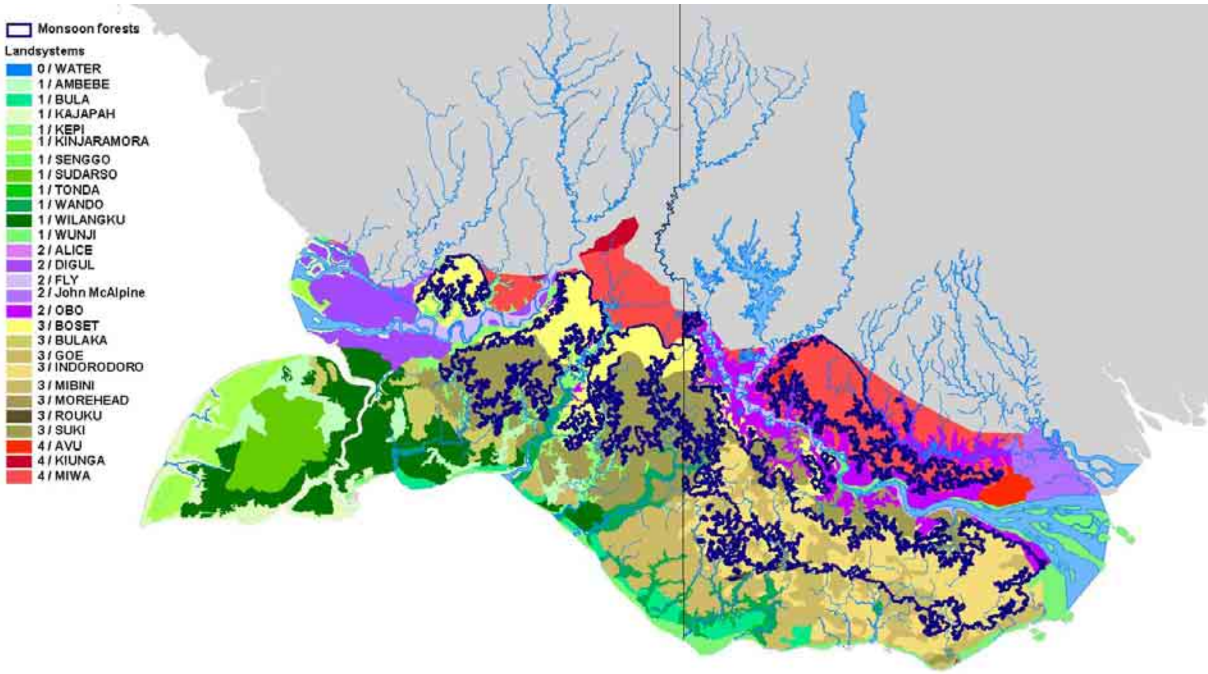
Code	LS Name	LS Description	Target type
130	KEPI	Seasonal inundated swampy valleys and low terraces	Riverine
280	WUNJI	Coastal beach ridges and swales	Beach ridge
50	BULA	Recent grassy coastal plains	Grassland
250	WANDO	Seasonally inundated floodplains of large rivers	Riverine
80	FLY	Scroll complexes of alluvial plains	Riverine
190	OBO	Blocked valley back swamps with numerous lakes	Riverine
180	MOREHEAD	Broad shallow valleys with narrow floodplains	Riverine

Map showing distribution of Special Elements



3.2 CONSERVATION TARGETS OF THE TRANSFLY

The final table of all conservation targets was derived by firstly identifying the 28 land system coverage then when unioned to the monsoon forest the table increased to show those land systems that contained monsoon forest with land system and land system alone, then overlaid with the special elements brought the total of the conservation targets to 49. The following tables and map illustrate the growth of the conservation targets.



CODE	CONSERVATION TARGET NAME	TOTAL HA
10	ALICE	7943.3
11	ALICE / Monsoon Forest	2.6
20	AMBEBE	228098.5
30	AVU	59695.8
31	AVU / Monsoon Forest	11373.8
40	BOSET	270267.3
41	BOSET / Monsoon Forest	503462.8
50	BULA	154186.7
60	BULAKA	165045.4
61	BULAKA / Monsoon Forest	5.7
70	DIGUL	376021.2
71	DIGUL / Monsoon Forest	4.1
80	FLY	192162.5
81	FLY / Monsoon Forest	226.9
90	GOE	257378.7
91	GOE / Monsoon Forest	193991.6
100	INDORODORO	485733.3
101	INDORODORO / Monsoon Forest	734016.2
110	John McAlpine	172729.7
120	KAJAPAH	323643.3
130	KEPI	240428.9
131	KEPI / Monsoon Forest	596.5
140	KINJARAMORA	253358.6
150	KIUNGA	43651.5
160	MIBINI	553370.4
161	MIBINI / Monsoon Forest	1268.7
170	MIWA	631378.2
171	MIWA / Monsoon Forest	374898.5
180	MOREHEAD	18818.1
181	MOREHEAD / Monsoon Forest	1340.1
190	OBO	593061
191	OBO / Monsoon Forest	51387.6
200	ROUKU	8507.1
201	ROUKU / Monsoon Forest	5186.8
210	SENGGO	1737.1
220	SUDARSO	315151.6
230	SUKI	849388.7
231	SUKI / Monsoon Forest	602099.8
240	TONDA	14211.9
250	WANDO	288264.9
251	WANDO / Monsoon Forest	720.9
260	WATER	19870.4
261	WATER / Monsoon Forest	510
270	WILANGKU	735932.3
280	WUNJI	374066.8
281	WUNJI / Monsoon Forest	438.8

28 basic land systems classification plus the monsoon forest overlays and the special elements resulted in a final 48 conservation targets. These 48 targets were then represented in each sub-ecoregion if they occurred.

Conservation targets areas according to sub - ecoregion

marx_code	feature	total_ha
1010	1010_ALICE	8078.8
1011	1011_ALICE Monsoon Forest	2.6
1020	1020_AMBEBE	176183.0
1040	1040_BOSET	97122.4
1041	1041_BOSET Monsoon Forest	155870.4
1050	1050_BULA	19178.7
1060	1060_BULAKA	124732.7
1070	1070_DIGUL	382752.1
1071	1071_DIGUL Monsoon Forest	4.1
1080	1080_FLY	95333.3
1081	1081_FLY Monsoon Forest	10.9
1120	1120_KAJAPAH	313899.9
1130	1130_KEPI	99876.8
1131	1131_KEPI Monsoon Forest	140.4
1140	1140_KINJARAMORA	258798.9
1150	1150_KIUNGA	3072.2
1170	1170_MIWA	75095.0
1171	1171_MIWA Monsoon Forest	187.1
1190	1190_OBO	3789.2
1191	1191_OBO Monsoon Forest	11.8
1210	1210_SENGGO	1770.4
1220	1220_SUDARSO	321488.3
1230	1230_SUKI	118192.0
1231	1231_SUKI Monsoon Forest	106274.6
1250	1250_WANDO	11079.5
1260	1260_WATER	55.2
1270	1270_WILANGKU	679469.4
1280	1280_WUNJI	14497.1
1300	1300_Mudflats	419.8
1500	1500_Seasonally inundated	723.1
	Mangrove	324.15

marx_code	feature	total_ha
3050	3050_BULA	106648.77
3090	3090_GOE	251350.39
3091	3091_GOE Monsoon Forest	155958.72
3100	3100_INDORODORO	389927.87
3101	3101_INDORODORO Monsoon Forest	400228.58
3120	3120_KAJAPAH	5550.55
3160	3160_MIBINI	449225.97
3161	3161_MIBINI Monsoon Forest	1276.72
3180	3180_MOREHEAD	18992.53
3181	3181_MOREHEAD Monsoon Forest	1351.78
3200	3200_ROUKU	8582.30
3201	3201_ROUKU Monsoon Forest	5231.24
3230	3230_SUKI	11302.66
3231	3231_SUKI Monsoon Forest	2535.35
3240	3240_TONDA	14343.79
3250	3250_WANDO	155065.67
3260	3260_WATER	1188.22
3280	3280_WUNJI	135131.72
3300	3300_Mudflats	835.79
3500	3500_Seasonally inundated	30857.83
	Mangrove	54412.03

marx_code	feature	total_ha
2020	2020_AMBEBE	56024.6
2040	2040_BOSET	99727.3
2041	2041_BOSET Monsoon Forest	306159.5
2050	2050_BULA	30161.2
2060	2060_BULAKA	43074.3
2061	2061_BULAKA Monsoon Forest	5.8
2090	2090_GOE	7809.3
2091	2091_GOE Monsoon Forest	8782.0
2100	2100_INDORODORO	18082.0
2101	2101_INDORODORO Monsoon Forest	68670.5
2120	2120_KAJAPAH	10710.9
2130	2130_KEPI	143998.3
2131	2131_KEPI Monsoon Forest	464.3
2150	2150_KIUNGA	41128.3
2160	2160_MIBINI	109653.5
2170	2170_MIWA	240356.9
2171	2171_MIWA Monsoon Forest	480.6
2190	2190_OBO	9134.3
2191	2191_OBO Monsoon Forest	46.6
2230	2230_SUKI	497686.0
2231	2231_SUKI Monsoon Forest	435040.5
2250	2250_WANDO	125427.5
2251	2251_WANDO Monsoon Forest	728.4
2260	2260_WATER	2173.4
2270	2270_WILANGKU	69858.5
2280	2280_WUNJI	21400.3
2300	2300_Mudflats	1189.4
2500	2500_Seasonally inundated	14424.3
	Mangrove	15585.1

marx_code	feature	total_ha
4030	4030_AVU	59912.87
4031	4031_AVU Monsoon Forest	11470.73
4040	4040_BOSET	76849.46
4041	4041_BOSET Monsoon Forest	47959.60
4080	4080_FLY	99138.95
4081	4081_FLY Monsoon Forest	217.91
4090	4090_GOE	190.72
4091	4091_GOE Monsoon Forest	30657.07
4100	4100_INDORODORO	81176.35
4101	4101_INDORODORO Monsoon Forest	269829.20
4110	4110_John McAlpine	173176.81
4170	4170_MIWA	321983.81
4171	4171_MIWA Monsoon Forest	376882.41
4190	4190_OBO	584286.26
4191	4191_OBO Monsoon Forest	51629.97
4230	4230_SUKI	231872.56
4231	4231_SUKI Monsoon Forest	65746.50
4260	4260_WATER	16662.72
4261	4261_WATER Monsoon Forest	515.44
4280	4280_WUNJI	212676.11
4281	4281_WUNJI Monsoon Forest	441.46
4300	4300_Mudflats	1836.65
4500	4500_Seasonally inundated	29397.81
	Mangroves	176204.05

4. DEVELOPING THE CONSERVATION SCENARIOS

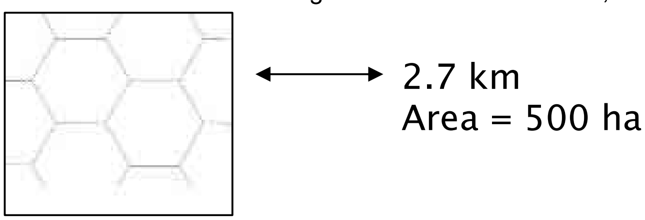
4.1 MARXAN – A RESERVE SYSTEM SELECTION TOOL

"MARXAN is software that delivers decision support for reserve system design. MARXAN finds reasonably efficient solutions to the problem of selecting a system of spatially cohesive sites that meet a suite of biodiversity targets." Ball & Possingham, (2005)

The run options used by Marxan are called Simulated Annealing, which evaluates a complete alternative portfolio at each step, and compares a very large number of alternative portfolios to identify a good solution. The procedure begins with a random set, and then at each iteration swaps planning units in and out of that set and measures the change in cost. If the change tends to improve the set, the new set is carried forward to the next iteration until the maximum number of iterations is reached. Shepphard (2005)

4.2 PLANNING UNITS

The planning units are computer generated polygons that can be used to spatially reference inputs. In this project we used Hexagons. Each hexagon is 500 hectares with an inner distance of 2.7 km from corner to corner. For the entire ecoregion there are a total of 23,894 analysis units



4.3 COSTS

Marxan assesses a plan based on several "costs". One, being a cost layer representing threat or opportunity. These cost values are referenced to the planning units. The higher the cost the less we would want our areas of biodiversity significance to occur on. This gives the user the opportunity to steer the SSM away from areas obviously not viable for conservation. (Sheppard, 2005).

Mappable threats for the ecoregion are mainly in the form of logging concessions, population (settlements), roads and cleared areas (areas cleared for agricultural purposes). These cost layers are then unioned creating a single cost layer. This cost layer is then overlaid onto the planning units and if a cost feature has its centre within a planning unit it is selected.

4.3.1 Layers that went into the cost grid

a. Logging Concessions

Layers used:

- PNG Logging Concessions (PNG Forest Authority)
- Indonesian Logging Concessions (Papua Data Base from Forest Watch)

Logging concessions from Papua New Guinea and Indonesia were merged and categorized as proposed, active and inactive

b. Populations

Layers used:

- Airstrips – PNG Gazetteer
- Community Units – PNG Census 2000
- Population – ESRI Gazetteer
- World Population – DCW

The TransFly population dataset contained two main categories:

- larger settlements including district stations, villages with airstrips and large villages digitized from satellite imagery
- small community units

The selection and classification of these datasets were mainly from expert knowledge of the area.

c. Roads and Cleared Areas

Layers Used:

- agriculture and cleared areas (University of Maryland)
- PNG roads (WWF SPP)

Cleared areas including roads, settlements, agricultural and logged areas within 2 Landsat ETM images (Path 100 Row 065 and Path 100 Row 066 - October 28, 2002) were delineated by on-screen digtizing.

Roads and settlements not covered by the above two scenes were manually digitized from LandSat Satellite Image, Zone 54-05 as line features. These features were then buffered to convert to a polygon feature. The results were then merged with the Cleared Areas layer (above) to create a full ecoregion coverage of roads and cleared areas. The new roads and cleared areas coverage was then categorized into degree of threat (see cost grid rules below).

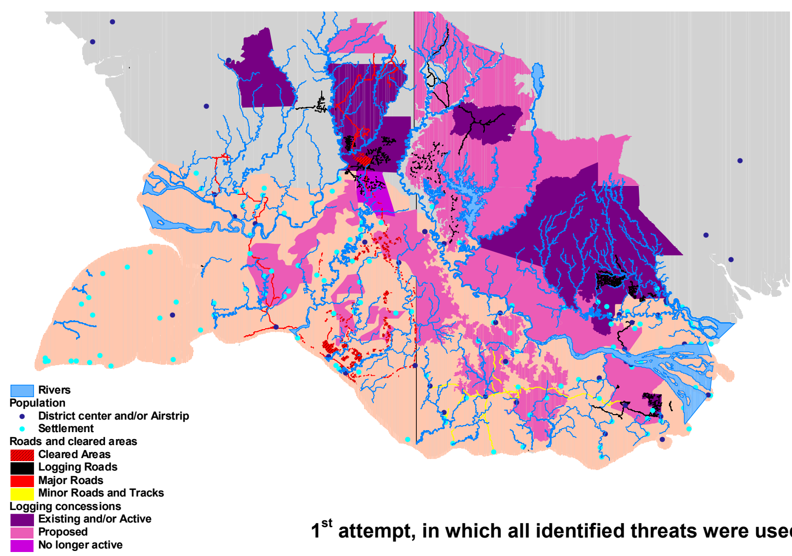
4.3.2 Building the Cost Grid

The cost grid was defined by overlaying the threat layers onto the planning units, then selecting all planning units that "intersected" a cost layer. For each selected threat (cost) an assigned weight was entered simultaneously.

A value of 1 was assigned to all hexagons that did not have a corresponding cost value. The final costs were scaled to reduce the number of digits, hence reducing any errors that may occur.

Scale Rule:
Cost Value/100

We attempted two cost grids before a satisfactory cost grid was chosen.



1st attempt, in which all identified threats were used.

COST GRID – RULE 1

GROUP 1		GROUP 2		GROUP 3		GROUP 4		
Cleared Areas	Active Concession	no longer active concession	proposed concession	District Centers and/or Airstrip	Settlements	Major Road	Logging Road	Road (track)
10,000								
	8,500							
		1,500	1,200	500	200	6,000	1,000	200

- Select all cells containing CLEARED AREAS
Cost = 10,000
- Select all cells containg ACTIVE CONCESSION not containing CLEARED AREAS
Cost - 8,500

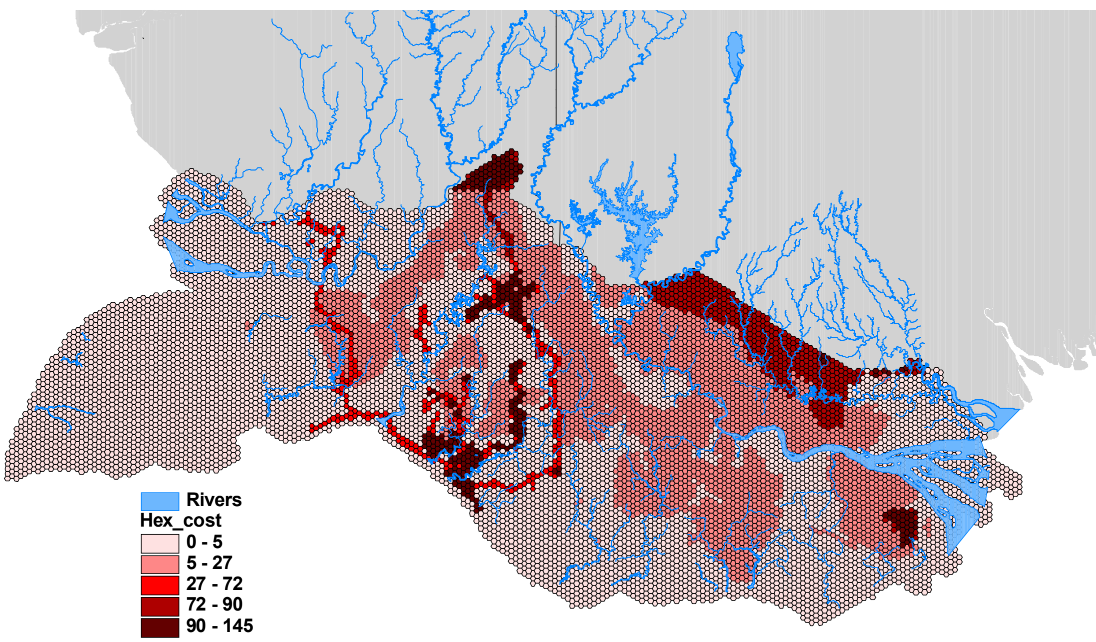
Select all not in group 1
- Select cells containing NO LONGER ACTIVE CONCESSION
Cost = 1,500
- Select cells containing PROPSED CONCESSION not containing NO LONGER ACTIVE CONCESSION
Cost - 1,200

- Select cells containing DISTRICT CENTERS AND/OR AIRSTRIP (500 meters from point)
Cost = group 2 plus 500
- Select cells containing SETTLEMENTS not containing DISTRICT CENTERS AND/OR AIRSTRIP
Cost = group 2 plus 200

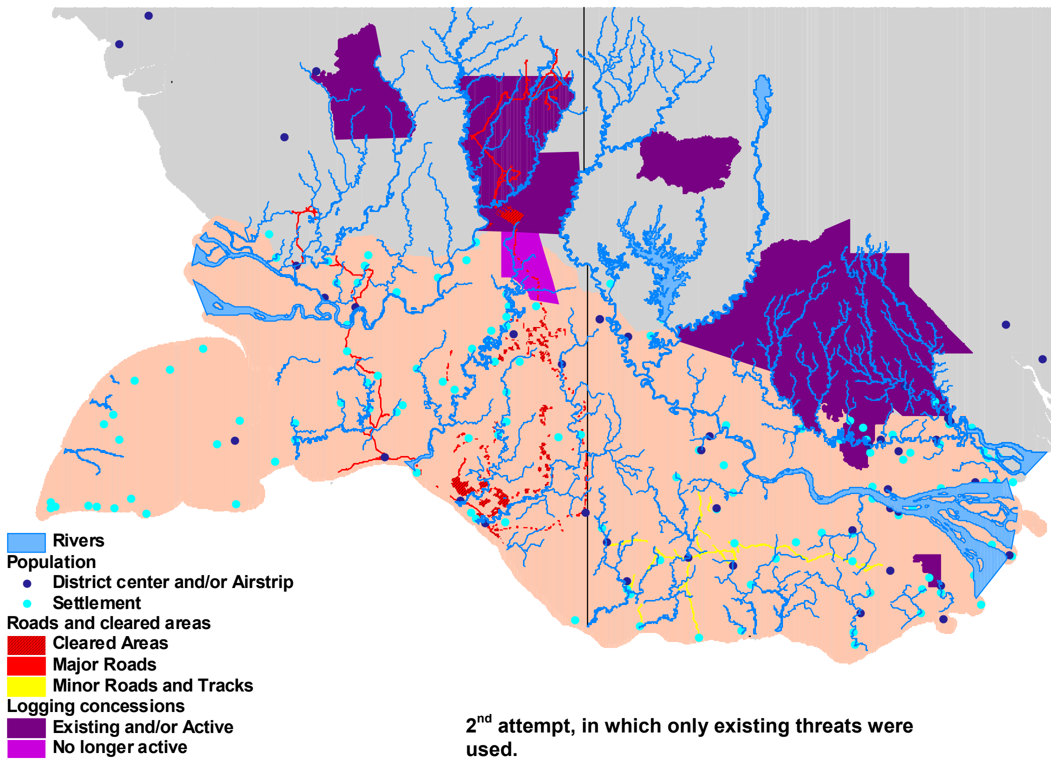
- Select cells containing MAJOR ROAD
Cost = group 2 plus group 3 plus 6,000
- Select cells containing LOGGING ROAD not containing MAJOR ROAD
Cost = group 2 plus group 3 plus 1,000
- Select cells containing MINOR ROADS AND TRACKS not containing MAJOR ROAD or LOGGING ROADS
Cost = group 2 plus group 3 plus 200

FINAL COST = group 1 if cells have this value , if not then group2 plus group3 plus group 4.

The first attempt to create a cost grid included all identified threats, that is; logging concessions (active, no longer active and proposed), population and roads and cleared areas.



The placement of selected planning units in the initial cost grid was a combination of both the existing and the proposed threats. This cost grid did not reflect the on ground situation in that it contained some potential threats but not all. We decided to use a cost grid that reflected existing on ground threats only. In addition a review of the weightings applied to the threats showed that logging roads would only exist in existing Logging Concessions and No Longer active Concessions, meaning that by assigning a cost value to the logging road as well as to the logging concession, we would be double costing a threat. The revised cost layer did not include the proposed forest concessions or logging roads in logging concessions.



2nd attempt, in which only existing threats were used.

COST GRID - RULE 2

GROUP 1		GROUP 2	GROUP 3		GROUP 4		
Cleared Areas	Active Concession	no longer active concession	District Centers and/or Airstrip	Settlements	Major Road	Road (track)	
10,000							10,000
	8,500						8,500
		2,500	500	200	6,000	200	Group 2 + Max group 3 + Max group 4

- Select all cells containing CLEARED AREAS
Cost = 10,000
- Select all cells containg ACTIVE CONCESSION not containing CLEARED AREAS
Cost - 8,500

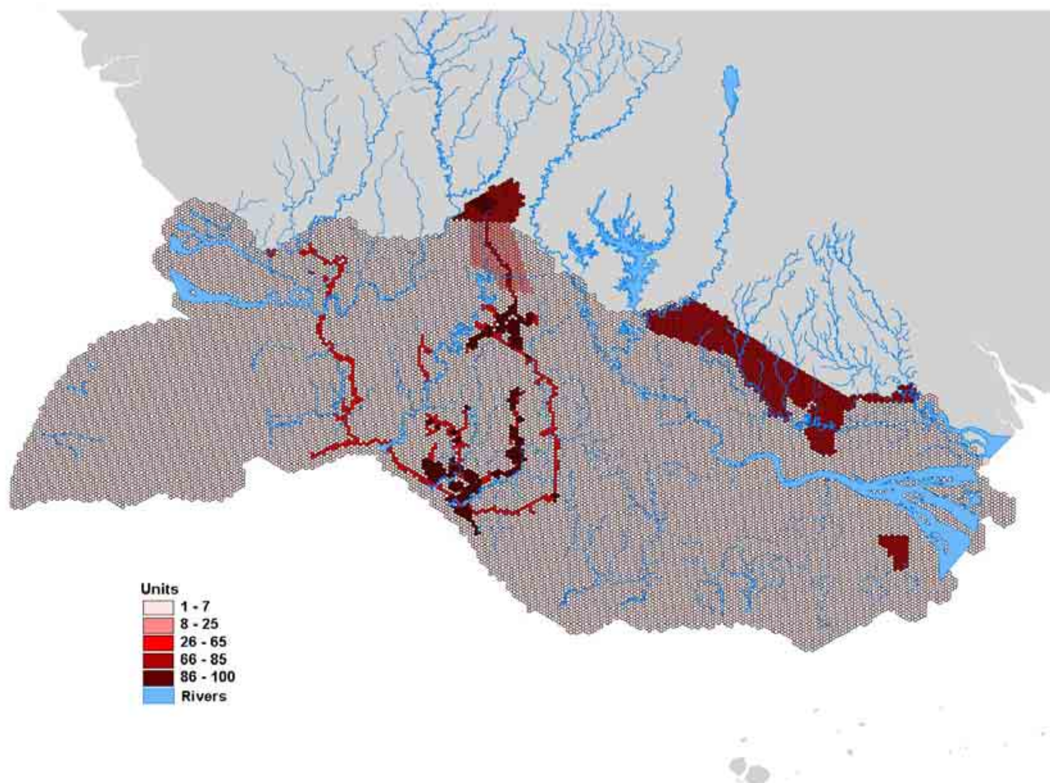
Select all not in group 1
- Select cells containing NO LONGER ACTIVE CONCESSION
Cost = 2,500

- Select cells containing DISTRICT CENTERS AND/OR AIRSTRIP (500 meters from point)
Cost = group 2 plus 500
- Select cells containing SETTLEMENTS not containing DISTRICT CENTERS AND/OR AIRSTRIP
Cost = group 2 plus 200

- Select cells containing MAJOR ROAD
Cost = group 2 plus group 3 plus 6,000
- Select cells containing MINOR ROADS AND TRACKS not containing MAJOR ROAD
Cost = group 2 plus group 3 plus 200

FINAL COST = group 1 if cells have this value , if not then group2 plus group3 plus group 4.

COST GRID 2



4.4 DEVLOPING THE SCENARIOS

4.4.1 Trials to develop the BLM and the number of runs and iterations

a. Test run 1

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and have their centre in traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.6
No. of iterations = 10,000,000
No. of runs = 5
Iterative improvements = ON

b. Test run 2

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and have their centre in traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.6
No. of iterations = 10,000,000
No. of runs = 5
Iterative improvements = OFF

c. Test run 3

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and have their centre in traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.5
No. of iterations = 10,000,000
No. of runs = 5
Iterative improvements = OFF

d. Test run 4

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and intersect traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.6
No. of iterations = 10,000,000
No. of runs = 5
Iterative improvements = OFF

e. Test run 5

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and intersect traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.5
No. of iterations = 10,000,000
No. of runs = 5
Iterative improvements = OFF

f. Test run 6

Select by theme: *Hexagon*
Locked in: Zero
Everything Locked out
Assessing against 10% goal (*flat*)
BLM = 0.6
No. of iterations = 10,000
No. of runs = 5
Iterative improvements = OFF

g. Test run 7

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and intersect traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.3
No. of iterations = 10,000,000
No. of runs = 5
Iterative of improvements = OFF

h. Test run 8

Select by theme: *Hexagon*
Locked in: *Hexagons that have their centre in Existing Conservation Areas and intersect traditional sites*
All else Locked out
Assessing against 10% goal (*flat*)
BLM = 0.1
No. of iterations = 10,000,000
No. of runs = 5
Iterative improvements = OFF

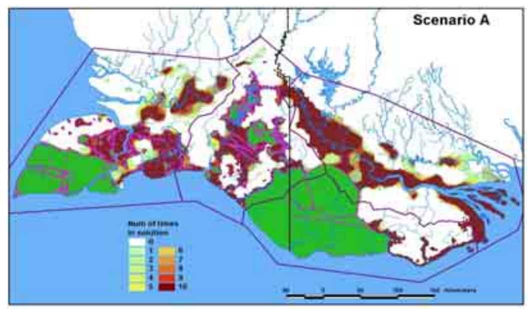
Test run 8 was the arrangement/settings chosen to run all subsequent scenarios

4.4.2 Resulting Scenarios

The following six scenarios were generated for discussion at the workshop using the parameters developed in test run 8:

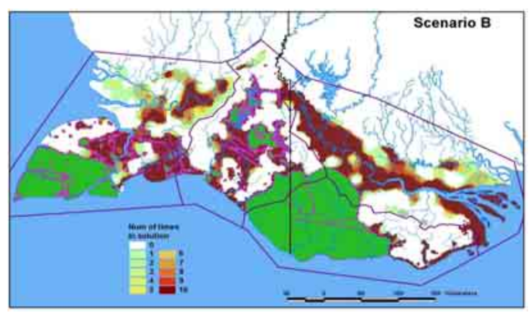
a. Scenario a

Select by theme: hexagon
Locked in: Hexagons that have their centre in existing and in process conservation areas, and intersect traditional sites
All else “Open”
Assessing against 20% goal (plus 75% riverine and 100% special targets)
BLM: 0.1
No. of iterations: 10,000,000
No. of runs: 10
Iterative Improvements: OFF



b. Scenario b

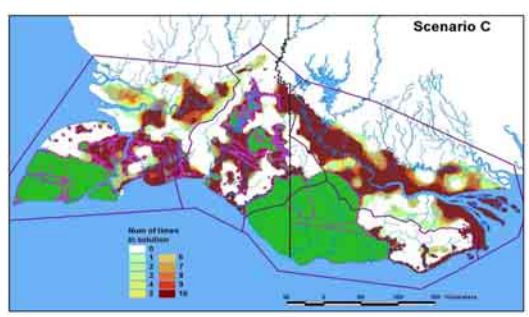
Select by theme: hexagon
Locked in: Hexagons that have their centre in existing and in process conservation areas, and intersect traditional sites
All else “open”
Assessing against 30% goal (plus 75% riverine and 100% special)
BLM: 0.1
No. of iterations: 10,000,000
No. of runs: 10
Iterative Improvements: OFF



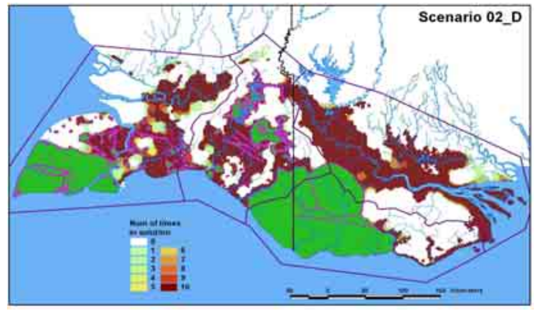
c. Scenario c

Select by theme: hexagon

Locked in: Hexagons that have their centre in existing and in process conservation areas, and intersect traditional sites
All else “open”
Assessing against 40% goal (plus 75% riverine and 100% special)
BLM: 0.1
No. of iterations: 10,000,000
No. of runs: 10
Iterative Improvements: OFF

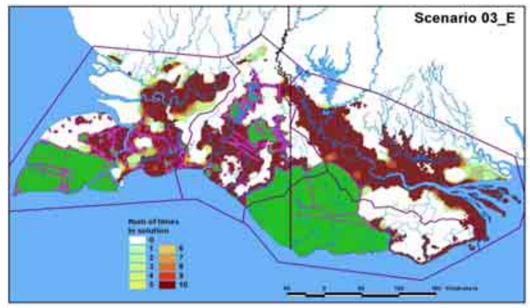


d. Scenario d



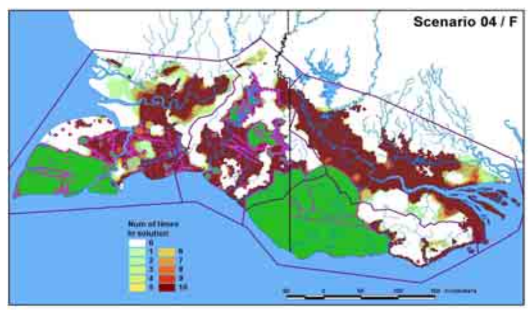
Select by theme: hexagon
Locked in: Hexagons that have their centre in existing and in process conservation areas, and intersect traditional sites
All else “open”
Assessing against 20% goal (plus 100% riverine and 100% special)
BLM: 0.1
No. of iterations: 10,000,000
No. of runs: 10
Iterative Improvements: OFF

e. Scenario e



Select by theme: hexagon
Locked in: Hexagons that have their centre in existing and in process conservation areas, and intersect traditional sites
All else “open”
Assessing against 30% goal (plus 100% riverine and 100% special)
BLM: 0.1
No. of iterations: 10,000,000
No. of runs: 10
Iterative Improvements: OFF

f. Scenario f



Select by theme: hexagon
Locked in: Hexagons that have their centre in existing and in process conservation areas, and intersect traditional sites
All else “open”
Assessing against 40% goal (plus 100% riverine and 100% special)
BLM: 0.1
No. of iterations: 10,000,000
No. of runs: 10
Iterative Improvements: OFF

DEFINITIONS

BLM		Boundary Length Modifier
CSIRO		Commonwealth Scientific and Industrial Research Organization
ERS		Earth Resource Satellite
ETM		Enhanced Thematic Mapper
FMA		Forest Management Area
GIS		Geographic Information Systems
HPH		Hak Perusahan Hutan
HTI		Hutan Tanaman Industri
LS		Land System
MKLS		Morehead - Kiunga Land System
MMU		Minimum Mapping Unit
MSS		Multi Spectral Scanner
PNGRIS		Papua New Guinea Resource Information Systems
REPPROT		
RMU		Resource Mapping Unit
SAR		Synthetic Aperture Radio
SPOT		Spatial Portfolio Optimization Tool
SRTM		Shuttle Radar Topography Mission
SSM		Site Selection Module
TM		Thematic Mapper
TNC		The Nature Conservancy
WWF		The Global Conservation Organization
PNG		Papua New Guinea
ESRI		Environmental Systems Research Institute
SITES		
CBD		Convention of Biological Diversity

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