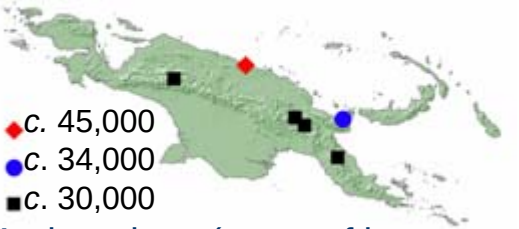
The Human Footprints



Archaeology (years of human records)

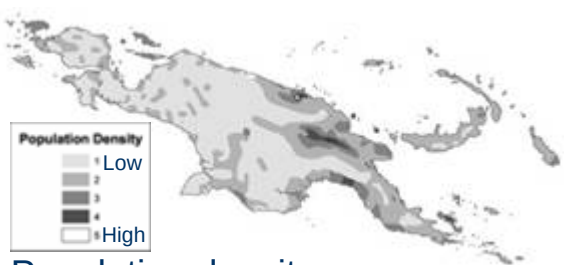
Data source: Prof. Geoff Hope, ANU (pers. comm.)

Inhabited places

Data source: ESRI

Fires

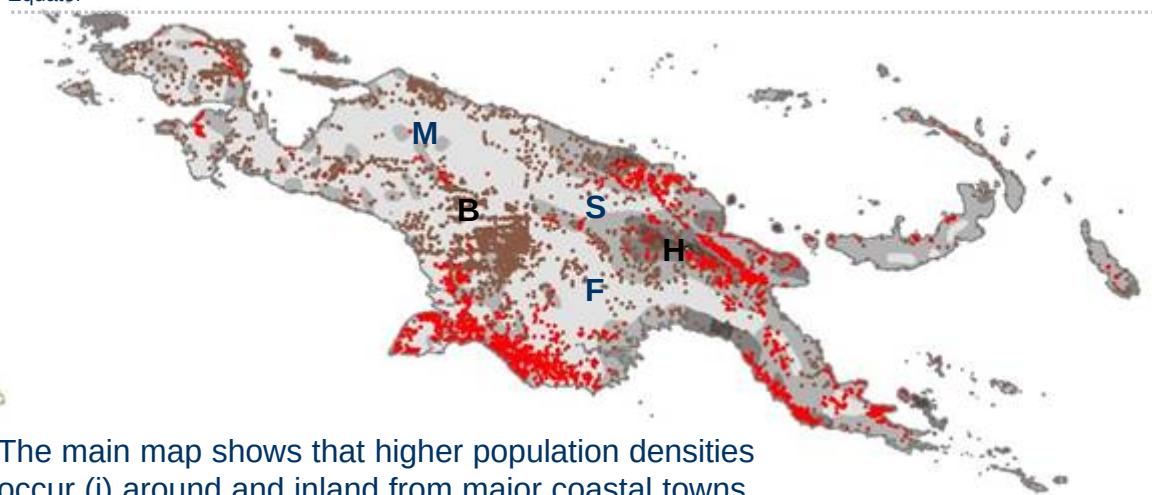
Data source: NASA & UM, 2001-2002



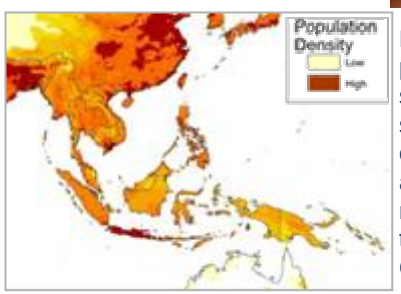
Population density

Data source: ESRI

The basic footprint of human society in the New Guinea Region may be represented by the combination of *inhabited places* (each shown with 5km radius buffer), *annual fire occurrences* and *population density*.



The main map shows that higher population densities occur (i) around and inland from major coastal towns, (ii) in the elevated PNG Highlands (H) and the Baliem Valley (B) of Papua, and (iii) along most of the coasts of the mainland and major islands. The distributions of *inhabited places* and of *annual fires* reveal that people and their effects are widely dispersed across much of the landscape. However, vast landscapes in the upper catchments of the Mamberamo River (M) in Papua and in parts of the upper Fly River (F) and Sepik River (S) in PNG remain sparsely inhabited.



Even a cursory assessment of population densities across south-east Asia will quickly suggest the near-unique opportunities for conservation achievements within the large rainforest blocks in sections of the sparsely populated New Guinea region.

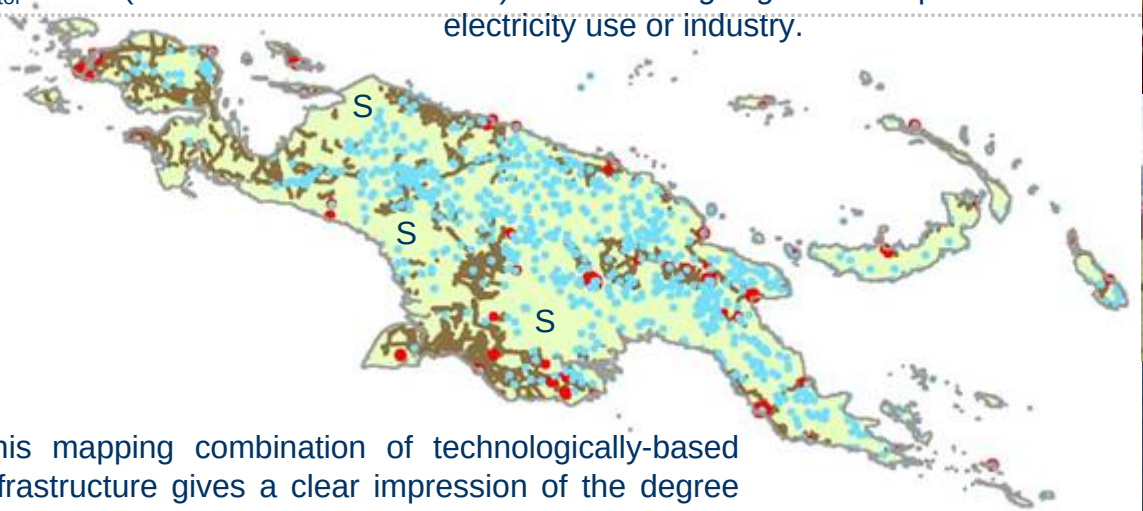
Community Infrastructure Footprints

Roads

Data source: ESRI

Community infrastructure has been represented by the combination of major *roads* (shown with 5km radius buffer), major and minor *airfields* (with a 10 km radius buffer) and *stable nightlights* that represent urban electricity use or industry.

Equator



Airfields

Data source: Royal Australian Air Force 2002

This mapping combination of technologically-based infrastructure gives a clear impression of the degree to which some aspects of modern society and western culture (including religion) have penetrated into much of the region. Only the vast coastal and sub-coastal swamplands (S) remain relatively inaccessible. Over a time span of only a few decades, opportunities for travel, migration (in and out), trade and resource development have been greatly enhanced. With this radical change in access, rural communities now hold high expectations for attaining modern lifestyles.

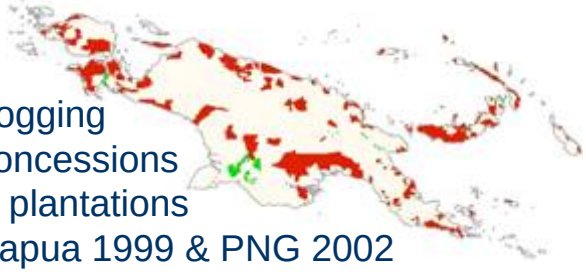
Stable nightlights

Data sourcee: NOAA NGDC & US AFWA

Agriculture and Development Footprints

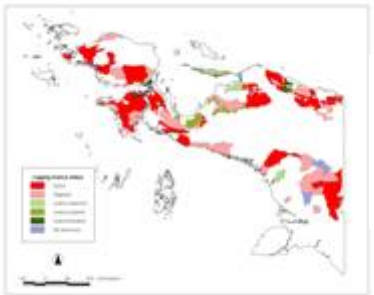
Agriculture

Data sources: PNGRIS/MASP DEC PNG; LP DAAC USGS/NASA



Logging concessions & plantations Papua 1999 & PNG 2002

Data sources: PNG DEC & GFW



Logging concessions in PNG have changed little in the last two years due to the moratorium on new leases.

Papua logging concessions 2002

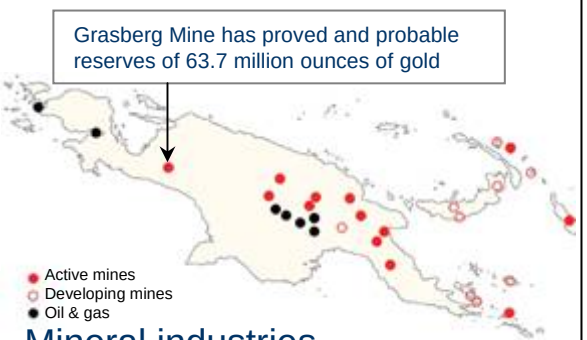
Data source: Mertens 2002a, CIFOR funded by CI

Lowland cash crops

Data sources: PNGRIS/MASP DEC PNG & GFW

Main Ports

Data source: CIA Fact Book and Jakarta Post



Mineral industries

In PNG, lowland forest biodiversity may be seriously threatened by a proposal to substitute oil palm income for declining mining revenues. Export income and royalties from mining and oil production in PNG may decline in the next decade due to falling reserves and resource access problems with serious implications for government revenue. The European Union has sponsored a study on the use of palm oil, PNG's most valuable agricultural export, as a mining revenue substitute but this will require large areas of agricultural land.

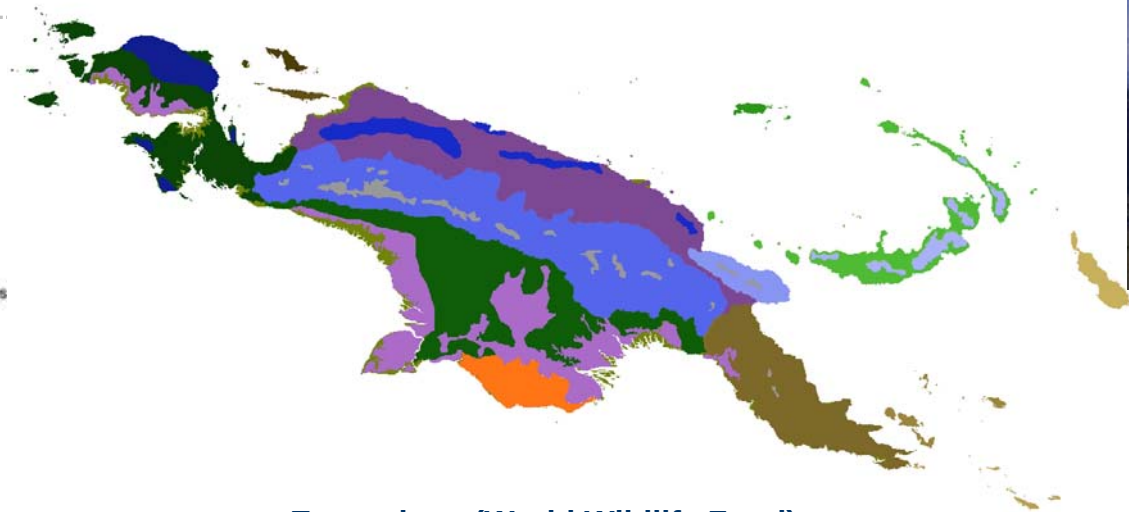
- This dark green square represents the 4,500 square kilometers (**1%** of the PNG land area) of *new* oil palm plantations needed to earn 900 million Euro (US$1000 million) at 6 tons of palm oil per hectare per year and 326 Euro per ton.
- This light green square represents the 9,000 square kilometers of *new* oil palm plantations needed if price or productivity drops by 50%.
- Scaled footprint (red rectangle) of mining operations, estimated as 150 to 200 square kilometers (ignoring downstream impacts), for the same financial returns as above.

Regional Ecological Communities

Ecoregions of New Guinea

Ecoregions in Papuan conservation areas (Mertens, 2002 a, CIFOR & CI).

An ecoregional approach allows for rapid comparisons of conservation progress under differing national administrations. It assists in answering the four critical questions: "What will it take to save all the pieces", "How much is enough?", "How do we maintain functionality across landscapes?" and "Where do we need to act first?"

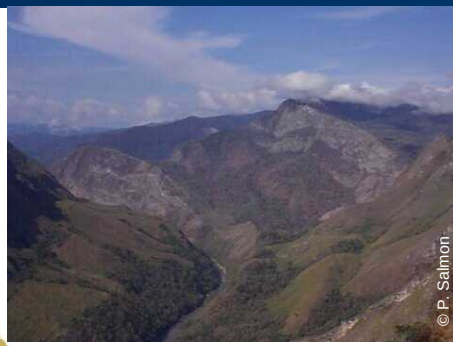


Ecoregions (World Wildlife Fund)

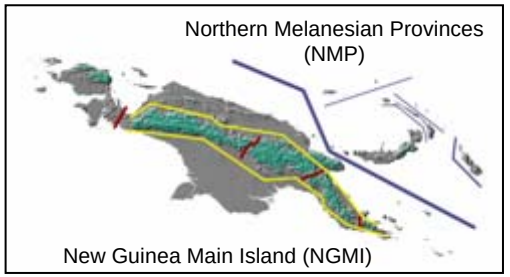
Over the past decade, the World Wildlife Fund has developed a broad-scale regional classification of the Earth's terrestrial biodiversity. In this approach, the basic unit is termed an *ecoregion.* This is defined as "a relatively large unit of land or water that contains a distinct assemblage of natural communities". The boundaries of ecoregions approximate the original extent of natural communities prior to major land-use change.

Within ecoregions, finer scales of variability in the occurrences of species and communities will usually be found, with variations determined by local topography, soils and climates as well as by ecological and evolutionary history. (See boxes and picture to right.)

However, the approach allows conservation research and planning to focus on key areas of the globe where actions may bring the greatest reward. For example, recent research (Olson and others, 2001, in Bioscience) has shown that **the Central Range montane rain forest ecoregion of the New Guinea region is truly exceptional at the global level as it has one of the highest concentrations of ecoregion-endemic mammal species in the world (i.e. mammals that occur only in that ecoregion) –** a feature shared only with two relatively small areas in Central Africa and Sulawesi (Indonesia).



In the PNG section of the Central Cordillera, the Strickland River Gorge is around 1000 meters deep. It separates the Star Mountains to the west and the Central Highlands to the east. In terms of bird distributions, this is one of two major biogeographic barriers that cut the Central Range montane rain forests eco-region. (see bird biogeography map below)



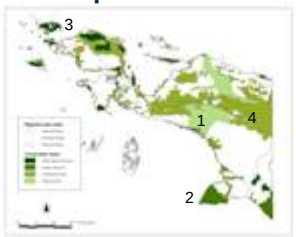
Key to biogeographic barriers for birds (Schodde)

Blue thick: water barrier between NGMI and NMP
Blue mid: major water barrier within NMP;
Blue thin: minor water barrier within NMP.
Yellow: mountain barriers for lowland populations
Red: internal montane community barriers

Conservation and Protection Areas of Various Types and Tenures

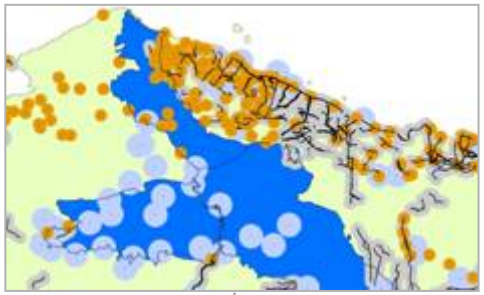
Existing conservation areas
Airfields with 10 km radius buffer
Inhabited places with 5 km radius buffer
Roads with 5 km radius buffer

Papuan conservation areas updated to 2002

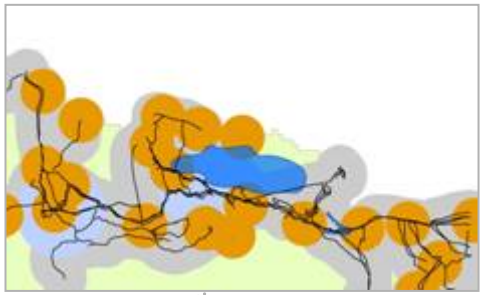


National Park, light green (1)
Nature Reserve, midgreen (2)
Strict Nature, dark green (3)
Protection forest, olive green (4)
(Mertens 2002a)

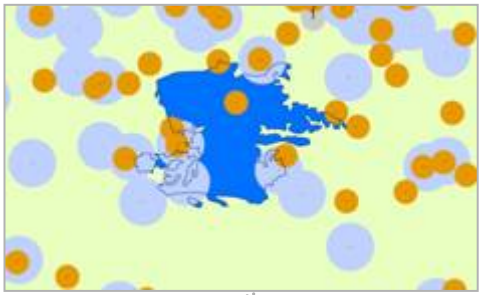
There are strong contrasts in regional conservation achievements. Protected Areas (PAs) constitute only 2.9% of PNG but 15% of Papua. Most PAs have grave management problems, e.g. the Lorentz World Heritage Area with resident Papuans and uncontrolled exploitation, Wasur NP with resident Papuans and large transmigrant populations nearby, roads in Tonda Wildlife Management Area (WMA), Kikori Integrated Conservation & Development (ICAD) area with no legal status, while mining threatens the Crater Mt. WMA.



Mamberamo Wildlife Sanctuary

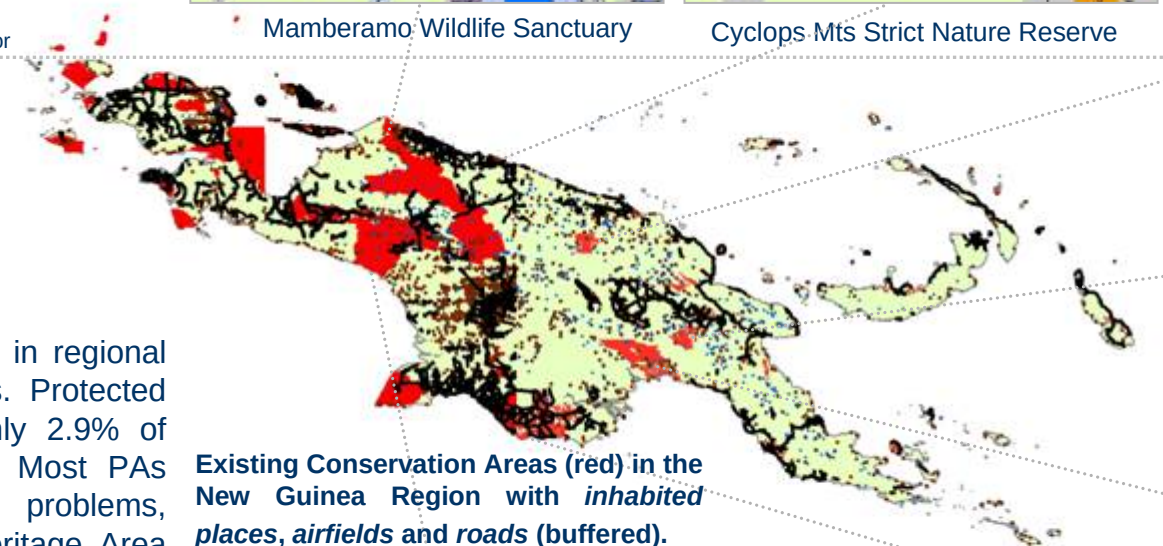


Cyclops Mts Strict Nature Reserve

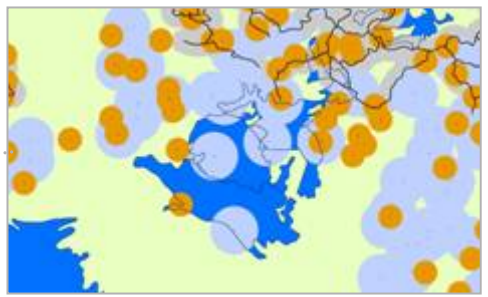


Hunstein Ra. Wildlife Management Area

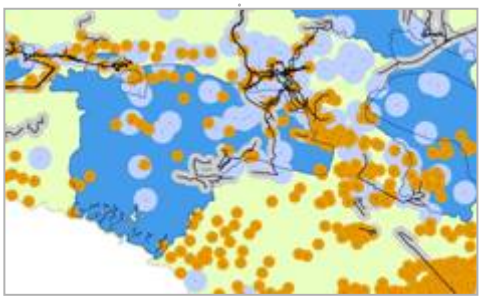
Equator



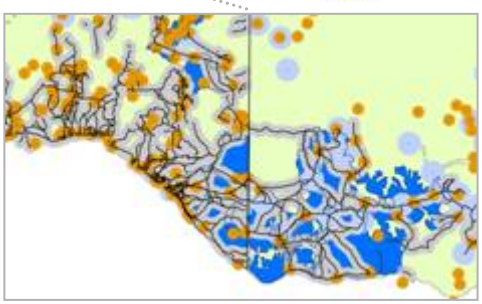
Existing Conservation Areas (red) in the New Guinea Region with *inhabited places*, *airfields* and *roads* (buffered).



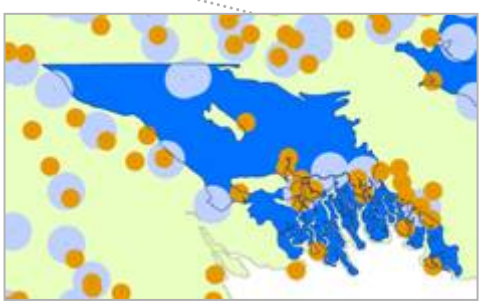
Crater Mt. Wildlife Management Area



Lorentz World Heritage Area



Wasur National Park and Tonda WMA

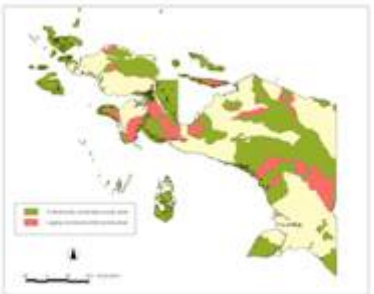


Kikori ICAD

Priority Conservation Areas

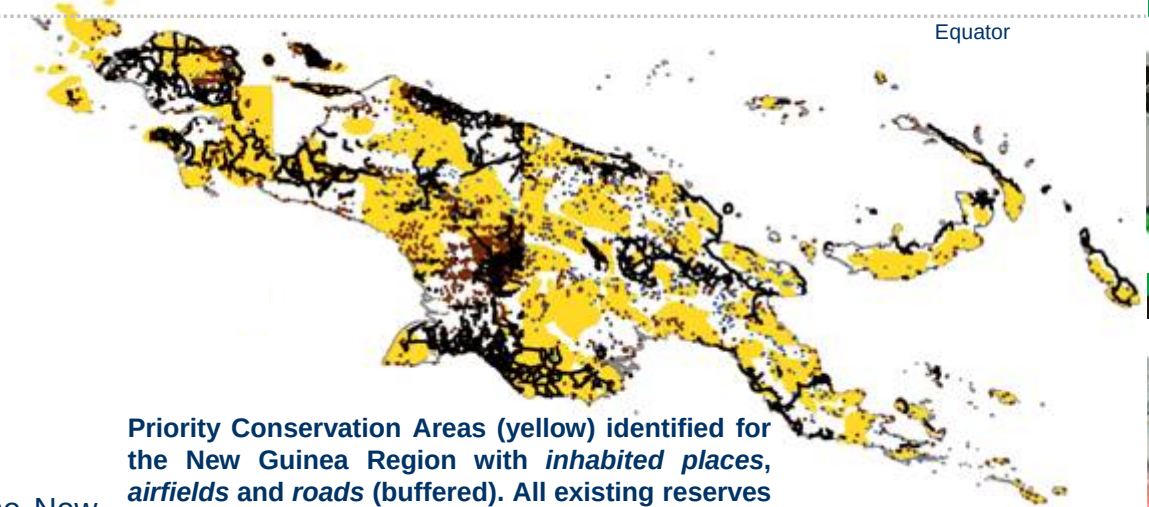
Priority Conservation Areas for the New Guinea Region were defined in two major scientific studies, the **PNG Conservation Needs Assessment** (CAN) workshop in 1992 and **The Irian Jaya Biodiversity Conservation Priority-Setting Workshop** in 1997. National and international experts defined areas of land that were considered of high priority for conservation action based on the best available information on community distributions and species occurrences. In PNG, a later study (**BioRap**) made a rapid planning assessment for biodiversity areas using very detailed knowledge of the climate, topography, soils and competing land uses.

Papuan priority conservation areas leased for logging

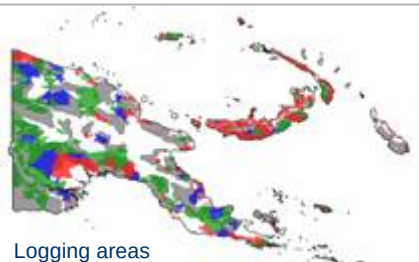


Logging concessions (red) within bio-diversity priority conservation areas (green) in Papua (Mertens 2002a)

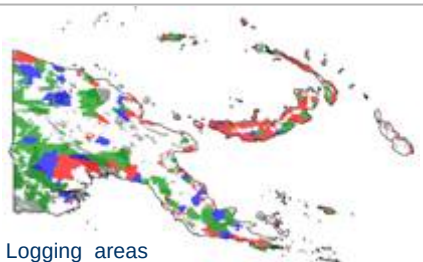
The future of biodiversity in the New Guinea region may depend more on political developments than on international financial support, particularly in regard to the extraction and management regimes in the timber production forests as well as in the planning processes for regional development and industrialization. There appears to be little current interest or activity in post-logging intervention projects.



Priority Conservation Areas (yellow) identified for the New Guinea Region with *inhabited places*, *airfields* and *roads* (buffered). All existing reserves in Papua were defined as priority areas.



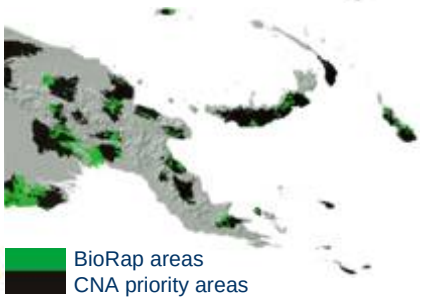
Logging areas
(red logged, blue moratorium, green proposed) overlaid on CNA areas in grey



Logging areas
(red logged, blue moratorium, green proposed) overlaid on BioRap areas shown in grey

Logging may have already closed options for some BioRap and CNA areas

BioRap Biodiversity priority areas



BioRap areas
CNA priority areas

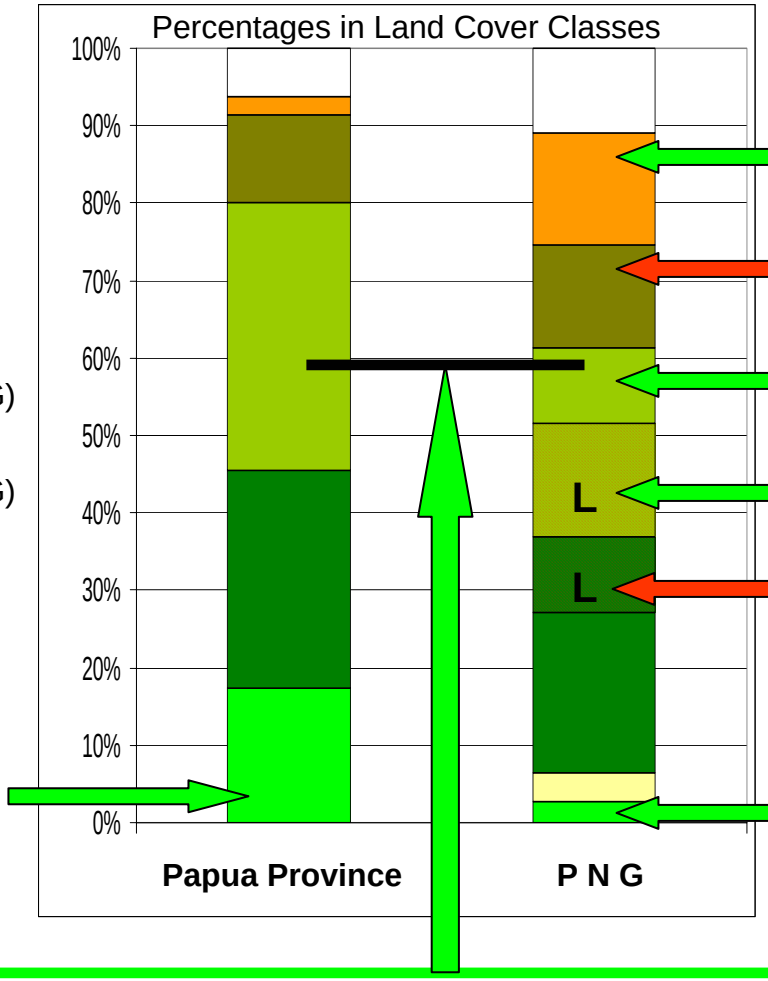
BioRap "must have" areas for % targets
areas for 10% target
other proposed priority areas
areas for 15% target

BioRap High volume timber substitution
brown areas deleted
unchanged
substituted in

Actions for a Conservation Landscape

Key to land use classes

- Settlements, damaged soil, or not identified
- Farmland including wetland, dryland & aquaculture)
- Forest conversion and agroforestry areas
- Production forest (hatched, 'L' = logged in PNG)
- Protection forest (hatched, 'L' = logged in PNG)
- Other PNG vegetation types (grasslands and mangroves)
- Conservation areas (national parks, PNG WMAs *etc.)*,



Support sustainable farming to avoid more forest clearance

Monitor impacts of forest conversion

Support sustainable logging through community development

Define conservation values of logged forests

Stop logging and rescind leases in environmentally unsuitable areas

Increase area of conservation management lands in PNG

Build management capacity in Papuan conservation areas

Set Regional Target: retain 60% native vegetation cover (including logged & unlogged forest)

Capacity Building

Conservation Capacity Constraints

•There is a lack of awareness of as well as limited support for conservation throughout the region.

•There is no coherent approach to conservation with which local people are comfortable.

•Resource exploitation attracts investment opportunists rather than responsible corporate investors.

Conservation Science Capacity

•In conservation planning, there is a critical need for accurate scientific data, but current information is sparse from a landscape that is biogeographically complex.

•Within national institutions, the herbaria and museums are poorly supported, and access to off-shore collections is difficult.

•Educational institutions will be best served by scientists educated locally, and working locally to become, and to train, the best leaders for long-term conservation.

Conservation Management Capacity

•Even the most successful conservation agencies are plagued with staffing, leadership, financial management and operational problems.

•Donor and international NGO funding often is not aimed at building capacity, community engagement and trust. Many current strategies provide no ongoing commitment for when, or if, international NGOs walk away.

Conservation Challenges

Cultural Challenges

•To maintain the natural resource base, including biodiversity, as the foundation for community organization, thereby supporting the social and cultural institutions and beliefs that hold traditional society together.

•To ensure acknowledgement that New Guinea Islanders' relationships to their territory are part of their values, and are an expression of their identity.

•To assist them to benefit from, and to participate in, the activities of modern society, and to know that future generations will benefit as well.

Community Challenges

•To blend traditional resource management practice and knowledge with modern conservation techniques so as to develop engagement and involvement of people within communities as meaningful leaders, participants and contributors in conservation activities.

•To develop viable and rewarding industries based on traditional livelihoods for the sustainable use of biodiversity and protection of habitats by the resource owners.

Economic Challenges

•To construct and popularise persuasive economic and other arguments demonstrating the benefits of conservation to landowners, stake-holders and crucial decision-makers.

•To ensure conservation efforts include economic development initiatives and contribute to poverty alleviation, to enhance inclusion, to increase social capital and ownership, and to eliminate (or at least reduce or mitigate) any adverse social impacts.

New Guinea Region Statistics

Table 1. Key geographic and social data for the New Guinea region showing both contrasts and similarities between Indonesian Papua Province and the nation of Papua New Guinea.

	Papua Province (formerly Irian Jaya)	Papua New Guinea
National status	26th province of Indonesia	Independent Nation 1975
Faunal emblem	Burung Bird of Paradise (*Aseleucidus melanoleuca*)	Raggiana Bird of Paradise (*Paradisea raggiana*)
Land area estimates (square kilometers)	421,981 to 410,790	474,000 to 452,860
Comparative size	slightly smaller than California	slightly larger than California
Landmass distribution	mainland & 40 islands	Mainland (85%) & 600 islands
Highest point (meters)	Jaya Pk (Mt Carstensz) 5030 m	Mount Wilhelm 4,509 m
Population		
2002	Not available	5.1 million
1998/9 PP; 1999/2000 PNG	2.1 million	4.6 million
1990	1.6 million	3.6 million
1971	0.9 million	
Average population density (persons per square kilometre)	5 (1998)	11 (2002)
Urban pop	25.8%	28% estimate
Growth rate	2.8% (1995-98)	2.39%
Structure 0 – 14 years old	39 % (1998)	38.6%
15 – 64 years old	60 % (1998)	57.7%
>64 years old	0.85% (1998)	3.7%
Birth rate	37.81 per 1000 (1995)	31.61 per 1000 (2002)
Death rate	18.8 per 1000 (1991)	7.75 per 1000 (2002 est.)
Ethnic composition	79% Melanesian, 21% born outside the province (1997)	95% Melanesian, 5% Poly/Micronesian, Chinese
Indigenous Languages	200 to 700 estimated	715
Official and main languages	Bahasa Indonesia;	English; Pidgin (Tok Pisisn), Motu
Literacy rate estimates (age 15 and over who read & write)	71.5% (locally lower)	64.5% - <50% (locally lower)
Religions	Islam, 21.4% (mainly coastal) Roman Catholic 22.7% Protestant 55.5% Hindu 0.3% Buddhist 0.2%	Indigenous beliefs 34% Roman Catholic 22% Lutheran 16% Other & Protestant 28%

Table 2. Key economic and development statistics for the New Guinea region showing both contrasts and similarities between Indonesian Papua Province and the nation of Papua New Guinea.

	Papua Province	Papua New Guinea
Currency	Indonesian Rupiah	Kina
US$ exchange rate 1 March 2003	1 IDR = 0.000112297 USD 1 US$ = 8,904.99 IDR	1.00 PGK = 0.278396 USD 1 US$ = 3.59200 PGK
Currency devaluation	Indonesian rupiahs to US$	PNG kina to US$
2002 January	10,377.3	3.706
2001	10,260.9	3.374
2000	8,421.8	2.765
1999	7,855.2	2.539
1998	10,013.6	2.058
1997	2,909.4	1.434
GNP per capita (national average, rural majority lower)	Rp. 9,239,409.11 (1998) or *c.* US$1050 at 2003 exch. rate	US$ 890 (1999/2000)
Growth 1990-98	3,62% (1998) -- 4,55% (1997)	5.7 % per annum (1990-98)
Landuse (1998 estimates)	forested land 81.5% temporary fallow land 6.6% dry field/garden 5.8% house compound 0.5% grassland 4.9% wetland, dykes & ponds <1% plantation estates 0.4%, but 1.59% by 2002	mostly forest 98.52% arable land 0.13% permanent crops 1.35% One of world's largest swamps is located along the southwest coast.
Telephone subscribers	44.190 (lines 1998)	61,152 (lines 1999) 3,053 (cells 1996)
Natural resources	Petroleum, nickel, copper, silver, gold, marble, coal, etc.	gold, copper, silver, natural gas, timber, oil, fisheries
Exports	US$ 1.5 billion (value, 1998)	US$1.8 billion (f.o.b., 2001 est.); 67% of all exports minerals in 1991.
Export commodities	Minerals, petroleum products palm oil, nutmeg, cocoa, coffee, timber	Minerals, petroleum products copra, coffee, palm oil, cocoa, timber
Roads (total kilometers)		
1998	15,845.83	-
1997	12.418,28	-
1996	-	19,600

Data Sources, References and Acknowledgements

Unless otherwise specified, all maps of the New Guinea Region are based on the digital outline and digital elevation model (DEM) provided by the Papua New Guinea Department of Environment and Conservation. Photographs with the two-part alpha-numeric codes are reproduced from the CSIRO/ANU collection currently held at the Australian National University. The assistance of Prof. Geoff Hope at ANU in making his Papua Province slide collection (GH-series) available is gratefully acknowledged.

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3. AN AMAZING ISLAND

Header photocredit Yellow Valley of the Meeren Glacier, January 1972. GH18 © Geoff Hope, ANU.
Photocredits (left to right) Highlands mound agriculture. G2b_95F © CSIRO/ANU; Cuscus (no details). GH44 © Geoff Hope, ANU; Captured cuscus slung from stick. GH46 © Geoff Hope, ANU; Outrigger canoe on Opi River. G3_98C © CSIRO/ANU; Southern Cassowary. © D. Westcott, CSIRO; Twelve foot termite mound in low grassland, surrounded by rim of dense low *Melaleuca*; mixed savannah in background. Fa_77M © CSIRO/ANU; Interior of *Musa-Heliconia* tall herbaceous regrowth; Buka Island. E1g_67F © CSIRO/ANU; Mid-height grassland near Marienberg. E1d_60K © CSIRO/ANU; *Avicennia* swamp and beach ridges near Lesiwalai. A6a_23E © CSIRO/ANU.
Inset map ESRI from the PC World Data Base (see ESRI credits below), April 1990, as modified and enhanced at GRID-Geneva.
Cross section from DEM supplied by PNG DEC.

4. 100 MILLION YEARS OF EARTH HISTORY

Header photocredit Mt Trikora, Papua Province (Irian Jaya). GH36 © Geoff Hope, ANU.
Main diagram after Scotese, C. R., 2001. Earth System History Geographic Information System v. 02b, PALEOMAP Project, Arlington, Texas.
Assembly diagram After Hill, K.C., Kendrick, R.D., Crowhurst, P.V. and Gow, P.A. (2002) Copper-gold mineralisation in New Guinea: tectonics, lineaments, thermochronology and structure. *Australian Journal of Earth Sciences* 49, 737-752.
Photocredits Birds of Paradise from near Pongani Falls, PNG. Fc_79J © CSIRO/ANU; Long-beaked Echidna (*Zaglossus bruijnii*) from Neon Basin 3050 m Wharton Range PNG. After GH06 © Geoff Hope, ANU; Tenkile Tree-kangaroo (*Dendrolagus scottae*). © Tenkile Conservation Alliance.

5. MIXING OF THE FLORAS

Header photocredit Large waterlilly from Ramu oxbow lake, PNG. E2a_69H © CSIRO/ANU.
Photocredits (left to right) *Rhododendron.* © Australian National Botanic Gardens; *Rhododendron* specimen H&S6659 from Zenag Hill, Lae-Bulolo road, PNG, 3500 ft. E2a_68E © CSIRO/ANU; *Nothofagus*. © Australian National Botanic Gardens; *Nothofagus* forest. © Geoff Hope, ANU; *Archidendron*. © Australian National Botanic Gardens; *Hibbertia banksii*. © Australian National Botanic Gardens.
Main diagrams after Balgooy, M.M.J. van (1976) *Phytogeography* pp 1-22 in K. Paijmans (ed) New Guinea Vegetation. CSIRO and ANU Press Canberra. 213 pp, using the world map derived from gnv019.zip (description: World Boundary Databank - map of world; source: UNEP/GRID, www.grid.unep.ch/data/grid/gnv19.html).

6. MEETING OF THE FAUNAS

Header photocredit Cuscus (no details). GH44 © Geoff Hope, ANU.
Photocredits (left to right) **Row 1** Black-tailed Giant-rat *Uromys anak*. GH01 © Geoff Hope, ANU; Long-Beaked Echidna (*Zaglossus bruijnii*) Mt Suckling, 10000ft. Fd_80J © CSIRO/ANU; Large moth. Fa_77K © CSIRO/ANU. **Row 2** Stuffed birds of paradise in Sibia village. Fc_79H © CSIRO/ANU; Small native possum, at Poio, near the Tale River. Fd_80F © CSIRO/ANU; Herd of exotic deer in coastal region. Fd_80H © CSIRO/ANU; Flying fox “Blek bokis” Fd_80A © CSIRO/ANU.
Biogeography diagram after Balgooy, M.M.J. van (1976) *Phytogeography* pp 1-22 in K. Paijmans (ed) New Guinea Vegetation. CSIRO and ANU Press Canberra. 213 pp. World map section as on previous page.
Sea level diagrams after Fig. 5 of Nix, H.A. and Kalma, J.D. (1972) *Climate as a dominant control in the biogeography of northern Australia and New Guinea* pp 61-91 in Bridge and Barrier: The Natural and Cultural History of Torres Strait. D. Walker (ed). Research School of Pacific Studies Publication BG/3 (1972). Australian National University, Canberra.
Text after Balgooy, M.M.J. van (1976) cited above & http://www.biodiversityhotspots.org/xp/Hotspots/wallacea/).

Data Sources, References and Acknowledgements (continued)

7. BIOPHYSICAL ENVIRONMENTS

Header photocredit Mountains. GH38 © Geoff Hope, ANU.
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Lithology/soil diagram and Precipitation diagram Portions of this document include intellectual property of ESRI and are used herein by permission. Copyright © 2003 Environmental Systems Research Institute, Inc. All Rights Reserved.
Temperature diagram From model by Gerard Natera, PNG DEC: Natera, G (2000)(in press). Application of field survey and spatial modeling methods for mapping and selection of a suitable site for pine planting in the Slate-creek grassland catchment, Upper Watut, Papua New Guinea. M. Phil. Thesis submitted to the University of Technology, Lae, PNG, 200+pp.
Climate patterns ITCZ map from http://www.planearthsci.com/products/Hurricanes/tutorial%20pieces/Stages_of_Hurri%20cane_Dev/ITCZ/ITCZ.html; Satellite image of Cyclone Rona February 1999. Satellite image processed by the Bureau of Meteorology, originally obtained from the Geostationary Meteorological Satellite (GMS-5) of the Japanese Meteorological Agency, http://www.bom.gov.au/weather/satellite/samples.
PNG Environmental domains with permission from Nix, H.A., Faith, D.P., Hutchinson, M.F., Margules, C.R., West, J., Allison, A., Kesteven, J.L., Natera, G., Slater, W., Stein, J.L. and Walker, P. (2000) The Biorap Toolbox: a national study of biodiversity assessment and planning for Papua New Guinea. Consultancy report to the World Bank. Centre for Resource and Environmental Studies, Australian National University, Canberra.
Cross section from DEM supplied by PNG DEC.

8. ECOLOGICAL COMMUNITIES

Header photocredit Alpine grassland on Mt.Giluwe at ca. 11,500 ft. E1a_54F © CSIRO/ANU.
Photocredits top row (left to right) View from discovery valley to North Wall, Mt Carstensz, Irian Jaya; treefern savannah; Peak Djaya, CGE February 1972. © Geoff Hope, ANU; *Campnosperma* swamp forest, flood plain of Alice River east of Atkamba. E1e_63S © CSIRO/ANU; Mangrove environment with *Nypa* palm along creeks and coconut palms on patches of slightly higher ground. E1f_65N © CSIRO/ANU; Waterlillies on open water in grass swamp near Sanai. E1e_62J © CSIRO/ANU; Tall well drained river forest on levee bank of the Ramu river. E1b_56C © CSIRO/ANU. *Rhizophora* mangroves, about 15 ft high, along Lea-lea Creek. E1f_64K © CSIRO/ANU.
Left column *Cyathea* treefern grassland, swamp-grassland, surrounded by *Podocarpus* forest, Limbo grasslands. E1a_54H © CSIRO/ANU; Semi-deciduous forest. E1c_58C © CSIRO/ANU; *Eucalyptus papuana* savannah. E1c_58M © CSIRO/ANU; "Waria-Waria trees" (*Asteromyrtus symphyocarpa*). © CSIRO Images Online.
Right column Klinkii pine (*Araucaria hunsteinii)* and the dipterocarp tree *Anisoptera*, Managalase area. E1b_55L © CSIRO/ANU; Interior of *Nothofagus* forest at 8000 ft, near Tale River. E1b_55C © CSIRO/ANU; Mossy forest at 10,000 ft, Finisterre Range. E1a_54S © CSIRO/ANU.
Text based on Flannery (1995) who based his simplified descriptions on a typology adapted from Paijmans (1976), and on Collins *et al.* (1991). Flannery, T.F. (1995) *Mammals of New Guinea* (2nd edition), Reed Books, Australia. K. Paijmans (ed) New Guinea Vegetation. CSIRO and ANU Press Canberra. 213 pp. Collins, N.M., Sayer, J.A. & Whitmore, T.C. (Eds) (1991) The Conservation Atlas of Tropical Forests. Asia and the Pacific. Macmillan Press Ltd, London and Basingstoke. 256 pp.

9. BIODIVERSITY AND ENDEMISM

Photocredits (left column) Tenkile Tree-kangaroo (*Dendrolagus scottae*). © Tenkile Conservation Alliance; Huon Tree-kangaroo (*Dendrolagus matschiei*) © W. Betz, Roger Williams Park Zoo; Cuscus in *Cyathea* tree fern on Sugarloaf Plateau. Fd_80D © CSIRO/ANU; **(right column)** *Rhododendron* Fa_77J. © CSIRO/ANU; *Rhododendron*. After E2a_series © CSIRO/ANU; *Rhododendron.* E2a_series © CSIRO/ANU; Rhododendron. E2a_series © CSIRO/ANU.
References Filer, C. with Sekhran, N. (1998) Loggers, donors and resource owners. Policy that works for forests and people series no. 2: Papua New Guinea. National Research Institute, Port Moresby, and International Institute for Environment and Development, London.; http://www.orchidspng.com/orfam.html; Conservation International 1999. The Irian Jaya Biodiversity Conservation Priority-Setting Workshop. Biak, 7-12 January 1997. Final Report. Conservation International, Washington, DC.; Mack, A.L. and Alonso, L.E. (eds) (2000) A Biological assessment of the Wapoga River Area of Northwestern Irian Jaya, Indonesia. RAP Bulletin of Biological Assessment 14, Conservation International, Washington, DC.; G. D. Weiblen (1998) Composition and structure of a one hectare forest plot in the Crater Mountain Wildlife Management area, Papua New Guinea Science in New Guinea 24, 23-32.

10. CULTURE AND POLITICS

Header photocredit People of Nondugl, Wahgi Valley, one with bird of paradise plumes. G1b_83E © CSIRO/ANU.
Photocredits (top row) Port Moresby 2002. © A. Graham, CSIRO; A canoe for a child being made on the beach near Mingam. G1c_85P © CSIRO/ANU; Namudi in the early morning. A large spacious village on a grass plain. G1a_81J © CSIRO/ANU; Grarmut (tomtom) on Ali Island. G1c_86T © CSIRO/ANU; **(bottom row)** Old chap from Kaip Valley with shell (Kena) decorations. G1b_83B © CSIRO/ANU; Girls dressed in tapa cloth and feathers for sing-sing, Popondetta. G1b_83V © CSIRO/ANU; Haus tamboran, showing roof line. G1b_87A © CSIRO/ANU; Fertility symbol in the spirit house in Uba. G1c_86O © CSIRO/ANU; Haus tambaran decoration at Mato. G1c_86N © CSIRO/ANU; Tambaran from Maprik area. G1c_86A © CSIRO/ANU.
Provincial and boundaries PNG: from province.shp from PNG DEC; Papua Province: digitized from http://www.accommodationsbali.com/maps/html/ijayamap1.htm.
Language map PNG: with permission from SIL International (formerly the Summer Institute of Linguistics) digitised from Languages of New Guinea http://www.ethnologue.com/show_map.asp?name=Papua+New+Guinea. Papua Province: language polygon shapefile from Conservation International (1999) The Irian Jaya Biodiversity Conservation Priority-Setting Workshop. Biak, 7-12 January 1997. Final Report. (CD version) Conservation International, Washington, DC.
Historical details from Lipscomb, A., Mckinnon, R. and Murray, J. (1998) Papua New Guinea. Lonely Planet Publications, Footscray, Victoria.

Data Sources, References and Acknowledgements (continued)

11. THE HUMAN FOOTPRINTS

Header photocredit Grass fire near Laloki River. E1d_61A © CSIRO/ANU.
Photocredits (left to right and down) Village site Elevala River. G1a_82P © CSIRO/ANU; Firewood for cash sale, mostly *Casuarina*. G1d_90J © CSIRO/ANU; Kukukuku gardens and houses near Eriangga. G1d_90V © CSIRO/ANU; Tupeselei near Port Moresby. Protected from heavy swell by barrier reef. G1a_81A © CSIRO/ANU; Cassowary prepared for cooking © John McGregor; Foothills of Schrader Range with Tugum Resthouse. A2a_3F © CSIRO/ANU; Port Moresby 2002. © A. Graham, CSIRO.
Archaeology diagram Data kindly provided by Prof. Geoff Hope, Research School of Pacific and Asian Studies, Australian National University, Canberra.
Inhabited Places diagram ESRI (1993). Digital Chart of the World for use with ARC/INFO data dictionary. Environmental Systems Research Institute, Inc. (ESRI), New York Street, Redlands, California 92373-8100, USA. Data were validated against the most recently available Australian Defence Forces 1:500,000 Tactical Pilotage Charts for the region; digital data appear an underestimate.
Fires 2001-2002 diagram http://rapidfire.sci.gsfc.nasa.gov/ and Missy Crisologo, Faculty Research Assistant, University of Maryland, Department of Geography, 1104 LeFrak Hall, College Park MD 20742 USA.
Population Density diagrams, New Guinea Region and South East Asia, Environmental Systems Research Institute, Inc. (ESRI), New York Street, Redlands, California 92373-8100, USA. Date unspecified.

12. COMMUNITY INFRASTRUCTURE FOOTPRINTS

Header photocredit Large cane suspension bridge across Erave River. G3_97N © CSIRO/ANU.
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Road diagram ESRI. 1993. Digital Chart of the World for use with ARC/INFO: data dictionary. Environmental Systems Research Institute, Inc. (ESRI), New York Street, Redlands, California 92373-8100, USA. Data were the most recent available in the public domain.
Airfield diagram Location data extracted from Royal Australian Air Force Aeronautical Information Service publications: *En Route Supplement Regional (ERSR)* and *Tactical Airfield Guide Regional (TAGR)* as downloaded in 2002 from http://www.raafais.gov.au/.
Stable nightlights diagram Image and data processing by NOAA's National Geophysical Data Center. DMSP data collected by US Air Force Weather Agency. These 'cities and flares combined' data are derived from a global map of four primary types of lights (human settlements, fires, gas flares and fishing boats) present at the earth's surface during a 6-month period in 1994-1995 by the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS).

13. AGRICULTURE AND DEVELOPMENT FOOTPRINTS

Header photocredit Irian Jaya mound agriculture. O_West_Irian_25 © CSIRO/ANU.
Photocredits (left to right) **Top row** Kunai cropped by cattle in foreground and other pasture trials at rear at Korofegu, Eastern Highlands. G2b_95A © CSIRO/ANU; Sugar cane tied into bundles to raise sugar content. G1d_90E © CSIRO/ANU; Garden built along typical "government track". G3_97X © CSIRO/ANU; Garden on very steep slopes near Pompameri; central patch with skeletal soils is avoided at left land slide in *Miscanthus* area. G1d_90A © CSIRO/ANU; **Bottom row** *Areca* palms (betel nut). G1d_89B © CSIRO/ANU; Plantation GH21 © Geoff Hope, ANU; Coconut plantation. G2b_94C © CSIRO/ANU; *Pandanus* fruit preparation. GH08 © Geoff Hope, ANU; *Metroxylon salamonense* (Buka sago palm). E2c_76V.tif © CSIRO/ANU; Good taro crop on volcanic soil. G1d_88W © CSIRO/ANU.
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Logging concessions and plantations Papua 1999 and PNG 2002 diagram
Logging
PNG : allpng_conc from PNG DEC.
Irian Jaya: id_fcon shapefile (logging concessions, Indonesia) from Global Forest Watch. Source: Directorate General of Forest Inventory and Land Use Planning, Ministry of Forestry, Government of Indonesia, and Food and Agriculture Organization of the United Nations (GOI-FAO). 1996. National Forest Inventory of Indonesia (NFI): Final Forest Resources Statistics Report. Field Document No. 55 and associated digital files. Jakarta, Indonesia: GOI/FAO. Metadata summary for id_fcon: *Abstract:* Logging Concession (Past, Present, and Future); *Purpose:* Display and Analysis; *Time Period of Content:* - ; *Time Period Information:* -; R*ange of Dates / Times:* -; *Beginning Date:* 1990; *Ending Date:* 1995; *Currentness Reference:* early 1990s.
Plantations
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Irian Jaya: id_iplant shapefile (industrial plantations, Indonesia) and id_plcon.zip (industrial plantations in former logging concessions, Indonesia), both from Global Forest Watch. Source: Directorate General of Forest Inventory and Land Use Planning, Ministry of Forestry, Government of Indonesia, and Food and Agriculture Organization of the United Nations (GOI-FAO). 1996. National Forest Inventory of Indonesia (NFI): Final Forest Resources Statistics Report. Field Document No. 55 and associated digital files. Jakarta, Indonesia: GOI/FAO.
Papua logging concessions 2002 diagram used with permission from Figure 14 of Mertens, B. (2002) Spatial analyses for the Rapid Assessment of Conservation and Economy (RACE) in Papua. Centre for International Forestry Research, Conservation International - Grant Agreement RED07, Report n°I. This study was carried out by B. Mertens, Centre for International Forestry Research (CIFOR) and financed by Conservation International (CI).

Data Sources, References and Acknowledgements (continued)

13. AGRICULTURE AND DEVELOPMENT FOOTPRINTS (continued)

Cash crops diagram
PNG: allagsys_region.shp in PNGRIS/MASP/ (oilpalm and cocoa themes).
Irian Jaya: id_eccon shapefile (estate crops in former logging concessions, Indonesia) and id_eccrop shapefile (estate crops), both from Global Forest Watch; Source: Directorate General of Forest Inventory and Land Use Planning, Ministry of Forestry, Government of Indonesia, and Food and Agriculture Organization of the United Nations (GOI-FAO). 1996. National Forest Inventory of Indonesia (NFI): Final Forest Resources Statistics Report. Field Document No. 55 and associated digital files. Jakarta, Indonesia: GOI/FAO.
Agricultural suitability diagram with permission from Nix, H.A., Faith, D.P., Hutchinson, M.F., Margules, C.R., West, J., Allison, A., Kesteven, J.L., Natera, G., Slater, W., Stein, J.L. and Walker, P. (2000) The Biorap Toolbox: a national study of biodiversity assessment and planning for Papua New Guinea. Consultancy report to the World Bank. Centre for Resource and Environmental Studies, Australian National University, Canberra.
Ports diagram CIA Fact Book (on line).
Mining diagram General geological data, mining reports & etc.
Palm oil project data SYSMIN Program Feasibility Study – Draft Final Report. SYSMIN Eligibility and Programme Identification Study in Papua New Guinea. European Commission Project 8.ACP.PNG.003864.00 (post-2001).

14. REGIONAL ECOLOGICAL COMMUNITIES

Header photocredit Sago swamp forest along Biaru River. E1e_63B © CSIRO/ANU.
Photocredit Strickland Gorge. © Peter Salmon (http://exkiap.net).
Ecoregions diagram WWF data provided by DEC PNG.
Ecoregions in Papuan conservation areas Figure 12 used with permission from Mertens, B. (2002a) Spatial analyses for the Rapid Assessment of Conservation and Economy (RACE) in Papua. Centre for International Forestry Research, Conservation International - Grant Agreement RED07, Report n°I. This study was carried out by B. Mertens, Centre for International Forestry Research (CIFOR) and financed by Conservation International (CI).
Biogeographic barriers for birds diagram after Schodde, R. (1972) *Birds* pp 67-89 in Ryan, P. (ed.) The Encyclopedia of New Guinea. Vol. 1.

15. CONSERVATION AND PROTECTION AREAS OF VARIOUS TYPES AND TENURES

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16. PRIORITY CONSERVATION AREAS

Header photocredit *Podocarpus* forest on the edge of the Limbo grasslands. E1b_55B © CSIRO/ANU.
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17. ACTIONS FOR A CONSERVATION LANDSCAPE

Header photocredit – *Drosera* sp. specimen PCH 1331. Savannah north-east of Mt.Lawes. E2b_74F © CSIRO/ANU.
Data for Papua Province landuse were derived directly from the land cover data from Table 2 of Mertens (2002) using the following aggregations:
•conservation areas (national park, strict nature reserve, nature reserve),
•protection forest and other vegetation (protected forest),
•production forest (production forest, limited production forest),
•agroforestry and conversion (agroforestry, plantation, conversion production forest),
•farming (farming, wetland crop, fisheries), and
•settlements & *etc.* (transmigration, settlement, damaged soil, not identified).

Data for landuse and vegetation cover in Papua New Guinea were derived and calculated from publications based on the Papua New Guinea Resource Information System (PNGRIS) with the 1975 baseline data (Saunders 1993) updated to 1996 (McAlpine & Freyne 2001), forest use and logging lease data from McAlpine & Quigley (1998) and the Forest Inventory Mapping System, plantation data (FAO 1987 in Collins et a.l 1991) updated by forest conversion areas noted in McAlpine & Freyne (2001), and the 1997 extent of conservation areas (Leedom 1997).

Data Sources, References and Acknowledgements (continued)

17. ACTIONS FOR A CONSERVATION LANDSCAPE (continued)

The following aggregations were used:

•conservation area (representing national parks and wildlife management areas, the area being arbitrarily allocated as 3000 sq km of grassland and 10,000 sq km of forest unsuited to logging, and these areas being subtracted from the corresponding land cover totals)
•grasslands and mangroves (PNGRIS mapping units LU7grassland, LU9 subalpine grassland, LU10 alpine grassland and LU11 savanna woodland) and the mangrove area from Collins et al. 1991.
•forests unsuited to logging, predominantly for environmental reasons, and not leased for logging (FIMS data)
•forests unsuited to logging, predominantly for environmental reasons, and leased for logging (FIMS data)
•forests environmentally suited to logging and leased for logging (FIMS data)
•forests environmentally suited to logging and as yet unleased for logging (FIMS data)
•agroforestry, conversion and sago palm forest (plantations, oil palms and other tree crops, extensive sago palm forests of PNGRIS LU8, and low to moderate intensity land use classes PNGRIS LU5 and LU6), including an allocation of 2000 sq km of recent forest clearance to estate based on McAlpine & Freyne (2001), and
•high intensity land use areas (PNGRIS mapping units LU0 to LU4), urban area and other unallocated land use (by subtraction of all specified land covers from the national total).

The 1975 to 1996 increase in the area in high intensity land use was allocated between land uses as indicated by McAlpine and Freyene (2001), and the area of production forest correspondingly reduced. In the absence of descriptive data, the area of conservation lands was arbitrarily subtracted from the total land area deemed unsuited to logging, with 3000 sq km deducted from grasslands and 10,000 sq km from the area of forest unsuited to logging. It should be noted that updated data from the North Solomon Islands was not available for the PNGRIS revision of 1996 by McAlpine and Freyene (2001).

Collins, N.M., Sayer, J.A. & Whitmore, T.C. (Eds) (1991) The Conservation Atlas of Tropical Forests. Asia and the Pacific. Macmillan Press Ltd, London and Basingstoke. 256 pp.
Leedom, J.M. (1997) Nature conservation in Irian Jaya: a counterpoint to Papua New Guinea? Ch. 20, pp.450489 in *The Political Economy of Forest Management in Papua New Guinea* (C. Filer ed.) The National Research Institute Monograph 32. National Research Institute and The International Institute for Environment and Development.
McAlpine, J.R. and Freyne D.F. (2001) Land use change and intensification in Papua New Guinea 1975-1996. Asia Pacific Viewpoint 42, 2/3, 209-218.
McAlpine, J. & Quigley, J. (1998) Forest Resources of Papua New Guinea. Summary statistics from the forest inventory mapping (FIM) system. Coffey MPW Pty Ltd for the Australian Agency for International Development and the Papua New Guinea National Forest Service.
Mertens, B. (2002) Spatial analyses for the Rapid Assessment of Conservation and Economy (RACE) in Papua. Centre for International Forestry Research, Conservation International - Grant Agreement RED07, Report n°I.
Saunders J.C. (1993) Agricultural Land Use of Papua New Guinea: explanatory notes and map. PNGRIS Publication No. 1, Canberra: Commonwealth Scientific and Industrial Research Organization for Australian International Development Assistance Bureau.

18. CAPACITY BUILDING

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19. CONSERVATION CHALLENGES

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Bottom of page NY_YAMS_11 © CSIRO/ANU; NC_CEREMONIES_65 © CSIRO/ANU; NY_YAMS_20 © CSIRO/ANU.

20. STATISTICS

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Statistical data compiled from a range of on-line data sources including the CIA Fact Book, http://www.postcourier.com.pg, http://www.niugini.com/~pngcom/profile1.htm#12, http://www.thejakartapost.com/special/os_8_facts.asp, and http://www.xe.com/ucc/convert.cgi.

21. DATA SOURCES, REFERENCES AND ACKNOWLEDGEMENTS

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