

Oil Palm and Deforestation in Papua New Guinea

Paul N. Nelson^{1,2,3}, Jennifer Gabriel⁴, Colin Filer⁵, Murom Banabas⁶, Jeffrey A. Sayer^{1,3}, George N. Curry⁷, Gina Koczberski⁷, & Oscar Venter^{1,8}

¹ Centre for Tropical Environmental and Sustainability Science, James Cook University, Cairns, Australia

² UR34, CIRAD, Montpellier, France

³ School of Earth and Environmental Sciences, James Cook University, Cairns, Australia

⁴ The Cairns Institute, James Cook University, Cairns, Australia

⁵ The Australian National University, Canberra, Australia

⁶ PNG Oil Palm Research Association, Popondetta, Papua New Guinea

⁷ Curtin University, Perth, Australia

⁸ School of Marine and Tropical Biology, James Cook University, Cairns, Australia

Keywords

Forest clearing; logging; oil palm; palm oil; Papua New Guinea; rural development; Special Agricultural and Business Lease.

Correspondence

Paul Nelson, School of Earth and Environmental Sciences, James Cook University, PO Box 6811 Cairns Qld 4870, Australia.

Tel: +61 7 4232 1375; fax: +61 7 4232 1284.

E-mail: paul.nelson@jcu.edu.au

Received

22 April 2013

Accepted

25 July 2013

Editor

Amy Ando

doi: 10.1111/conl.12058

Abstract

An unprecedented increase in oil palm developments may be underway in Papua New Guinea (PNG) through controversial “special agricultural and business leases” (SABLS) covering over two million hectares. Oil palm development can create societal benefits, but doubt has been raised about whether the SABL developers intend establishing plantations. Here, we examine the development objectives of these proposals through an assessment of their land suitability, developer experience and capacity, and sociolegal constraints. Our review reveals 36 oil palm proposals with plantings planned for 948,000 ha, a sevenfold increase over the existing planted area in PNG. Based on our criteria, however, we estimate that only five plantations covering 181,700 ha might eventuate within the foreseeable future. We conclude that most of the developers are clearing forest with no intention of cultivating oil palm, and that a large-scale land grab is therefore occurring in PNG under the guise of oil palm development.

Introduction

The link between deforestation and expansion of the palm oil industry is complex and varied. In the two countries with the highest tropical deforestation rates, Brazil and Indonesia, the proportion of cleared forest planted to oil palm is currently low but expanding rapidly in Brazil (UNEP 2011; Miccolis & Andrade 2012) and has been estimated at 57% over the 1990–2010 period in Kalimantan, Indonesia (Carlson *et al.* 2012). Of the oil palm expansion in Indonesia in the period 1990–2005, at least 56% was at the expense of forests (Koh & Ghazoul 2008). The potential loss of forest to oil palm in the future is greatest in countries with the largest areas of forest suitable for oil palm: Brazil, Congo-Kinshasa, and Indonesia (Stickler *et al.* 2007).

This article examines oil palm in relation to deforestation in Papua New Guinea (PNG). The island of New Guinea is one of the three largest remaining tropical forest areas, with huge and unique biological and cultural diversity. The palm oil industry is economically important for PNG, being the country’s most valuable agricultural export and the largest nongovernment employer (Allen *et al.* 2009; Cramb & Curry 2012). Until recently, the industry has been only a minor contributor to forest loss; the main cause of deforestation in PNG has been subsistence agriculture and the main cause of forest degradation has been logging (Shearman *et al.* 2009a; Filer 2010). But further expansion is controversial. There are many proposed oil palm developments, mostly associated with special agricultural and business leases (SABLS) in which land tenure has been converted from customary

ownership (the predominant form of land tenure in PNG) to long-term corporate leases (Filer 2012a,b). SABLs are based on a lease-lease-back arrangement, whereby customary landowners form an Incorporated Land Group (ILG), register their land for development and lease it to the government. The government then leases the land back to the ILG, which subleases it to a company to develop and manage (Filer 2012a). From 2003 to 2011, the area of land in SABLs rose exponentially, to a total of 5.5–5.6 million ha, about 12% of PNG's land area (Filer 2012b). In 2011, the Government imposed a moratorium on the issuing of SABLs and established a Commission of Inquiry (hereafter referred to as the "Commission") to examine their legality.

While the PNG government is keen to expand commercial agricultural activities through the granting of SABLs, it has been suggested they are being used as a pretext for unsustainable logging rather than the establishment of viable agricultural developments (Nelson *et al.* 2010; Filer 2012a, b; Winn 2012; Cramb & Curry 2012). Here, we examine evidence to determine whether or not current oil palm proposals in SABLs are likely to eventuate as oil palm plantations within the foreseeable future, and reveal the apparent use of SABLs as a pretext for logging.

Methods

We examined the current palm oil industry in PNG and all the SABLs involving "agroforestry" proposals that proposed planting oil palm following forest clearance. Information on the oil palm developments associated with SABLs was obtained from Environmental Inception Reports and Environmental Impact Statements submitted to the PNG Department of Environment and Conservation. Additional information on the SABLs and sociolegal disputes associated with them was obtained from transcripts of the Commission available from the websites of Canopy Watch (2012) and Act Now (www.actnowpng.org), and from a report prepared for Greenpeace (Winn 2012). The final report from the Commission was not available at the time of writing. Information about companies involved in these proposed "agroforestry" developments was obtained from company annual reports, industry and media reports, academic articles, and analyst reviews. Company reports provided information on the scale and investment portfolios of public companies in oil palm development and processing, while analyst reviews provided broader information on market trends and industry responses. Additional information on landowner and company disputes was obtained from the PNG newspapers "*The National*" and "*The Post-Courier*."

Based on the information available, we assessed the likelihood of successful development in the foreseeable future in terms of land suitability and capacity of the developer to implement the development, modified by constraints due to sociolegal disputes between landowners, developers, and the government. The presence of sufficient suitable land was scored as 0 (insufficient), 1 (marginal or unknown), or 2 (sufficient). These scores were based on a previous land suitability assessment (Figure 1), comments recorded in the Commission, and our own knowledge of the areas. Using a national-scale suitability map, it was not always possible to determine accurately if there was sufficient suitable land in the area of each proposed development to support a mill (around 5,000–10,000 ha is required). In cases where it was not clear a score of 1 was assigned. Capacity of the developer was scored as 0 (no known investor backing or corporate experience in plantation development) or 1 (known financial and technical capacity). Many of the companies examined had experience and capacity in logging but not in plantation and mill development; these companies were given a score of 0. The land suitability and developer capacity scores were multiplied together to produce an overall capacity score, ranging from 0 to 2. We chose to multiply these two metrics to obtain a zero if one score was zero, because we thought that a score of zero on either metric would preclude subsequent plantation development; there must be sufficient suitable land and a capable developer. Sociolegal constraints on oil palm development were given a score of 0 (no known constraints), 1 (minor issues), or 2 (major issues). "No known constraints" does not mean that there were no current or potential problems, but rather that they were not severe or controversial enough to have surfaced in the media or through the Commission's enquiries. Constraints were classified as "minor issues" where they involved disputes between landowners, which might be resolved relatively easily and are a normal part of the process of determining how responsibilities and benefits are distributed. Constraints were classified as "major issues" where there was clear evidence of illegality, incorrect boundaries, or other problems that would prevent development.

The area of oil palm plantings proposed was obtained from documents described above or, where not available, was estimated. The estimation was done by assuming that the proportion of the lease planned to be planted to oil palm was equal to the average for those leases that stipulated their planned planted area. Of the 36 proposals examined, 21 stipulated planned areas of oil palm plantings, which, on average, covered 42% of the total lease areas.

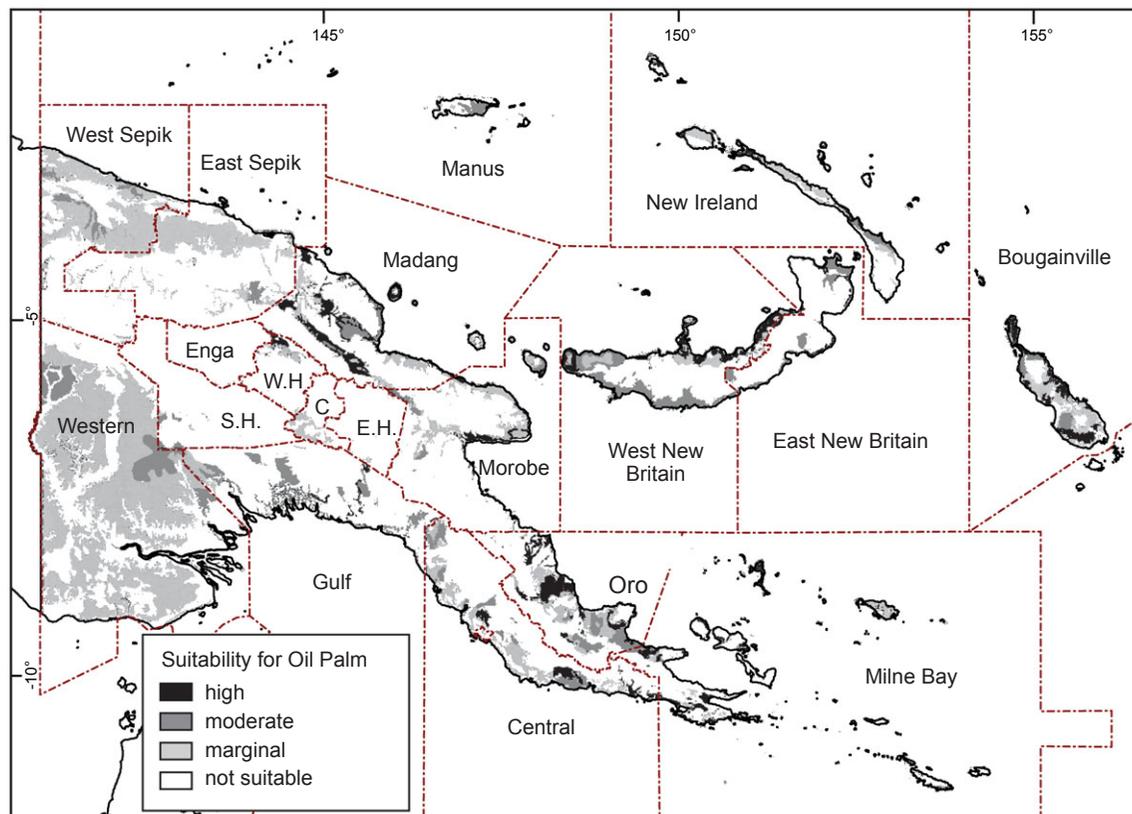


Figure 1 Map of PNG showing provinces and suitability for oil palm cultivation (source Trangmar *et al.* 1995). Province acronyms are: C, Chimbu; E.H., Eastern Highlands; S.H., Southern Highlands; W.H., Western Highlands.

Results

In 2012, there were 144,183 ha of commercial oil palm in PNG, operated by two companies and 19,777 smallholders (60% and 40% of the area, respectively) expanding at approximately 3,000 ha/year over the last decade (PNG-POC 2013). Most of that oil palm is on land with moderate or high suitability (Figures 1 and 2), of which there are 4,899,000 ha in the country (Trangmar *et al.* 1995).

We found 36 “agroforestry” project proposals outlining plans to develop new oil palm plantations, with all but one involving companies not currently producing palm oil in PNG (details in Table S1). The total area of the SABLs involved, most having terms of 99 years, is 2,212,246 ha and the total area planned for oil palm within them comes to 947,814 ha (including estimates for the leases without stipulated areas). Of the 36 proposals, 12 have sufficient land suitable for oil palm, six appear to have insufficient land and in the remaining cases we could not be certain. At the time of writing, only 25 of the 36 proposals were formally registered with the Department of Environment and Conservation, including 16

already approved. Permits to clear forest for the development (Forest Clearing Authorities) had been issued by the PNG Forest Authority for 15 of the proposals. In virtually all these cases the area of the Forest Clearing Authority was greater than that proposed for oil palm, and in most cases covered the entire lease. This discrepancy suggests that the clearing is intended not for oil palm, but rather for extraction of timber. Incidentally, in some cases, the Forest Clearing Authority is greater than the entire lease area, which must be related to inaccurate recording of areas.

Of the 36 oil palm proposals, 15 (comprising 815,601 ha of lease-hold land with approximately 404,547 ha of oil palm proposed) are controlled by developers that have or claim to have experience in oil palm plantations and palm oil production (six companies). In the other 21 proposals, the companies holding subleases or development agreements over the SABLs (14 companies) have no prior experience with agricultural development. Although oil palm nurseries have been established and considerable areas have been planted in some developments (e.g., Aitape East Integrated Development,

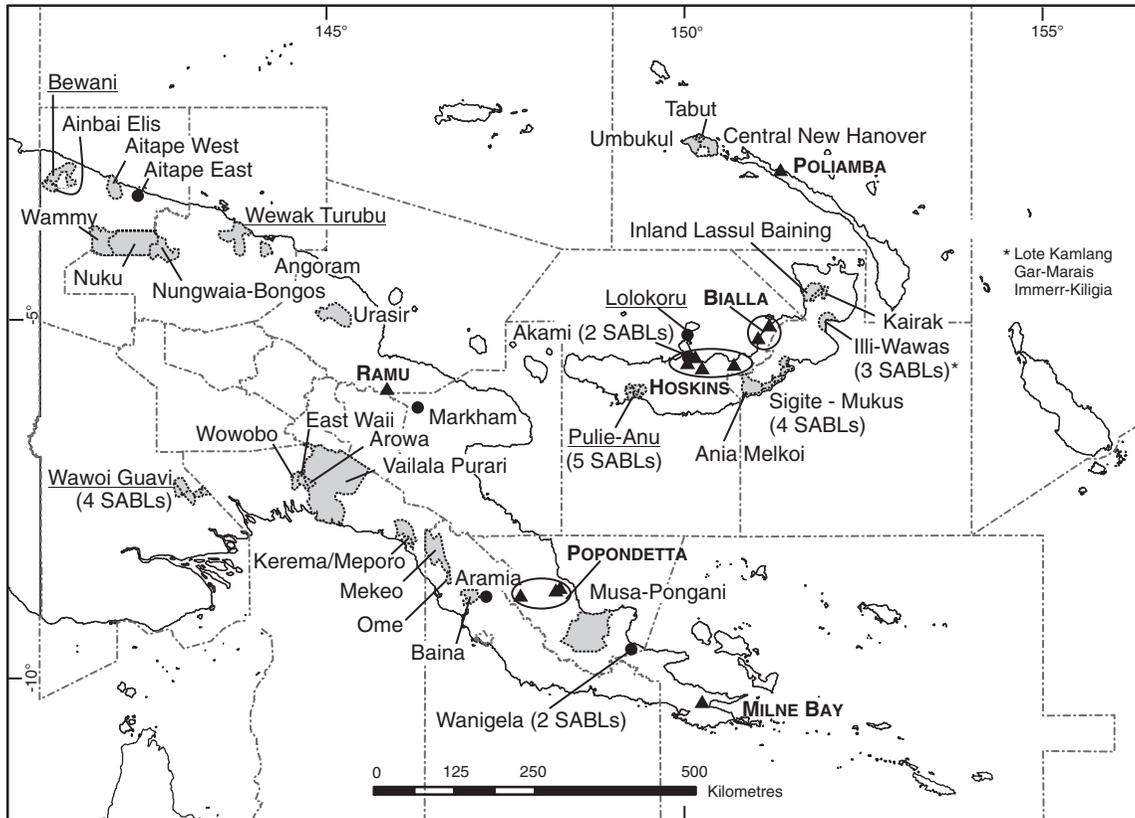


Figure 2 Location of operating palm oil mills (triangles) and SABLs with stated intentions of growing oil palm (grey shading, except where maps were not available, in which case the approximate location is shown as a black point). The five SABLs in which commercial oil palm plantations are most likely to eventuate are underlined. For full names, areas and other details of the SABLs, see Table S1. The areas of commercial oil palm plantations in 2012, associated with the palm oil mills shown and including smallholder blocks, totaled 65,728 ha in Hoskins, 25,020 ha in Bialla, 21,795 ha in Popondetta (Higaturu), 12,168 ha in Milne Bay, 11,295 ha in Ramu, and 8,177 ha in Poljamba (PNGPOC 2013).

Baina Agroforestry Project, Lolokoru Estates), none had commenced construction of a palm oil mill. Viable developments normally ensure that a mill, which is the most expensive component of an oil palm development, is operating within several years of planting, as harvesting commences about 2 years after planting and the harvested fruit must be processed to generate income and return on the investment. Lolokoru Estates and Akami Oil Palm Estate are the only projects with access to existing mills. The task of identifying the nominated developer in SABL sublease agreements was difficult due to a lack of transparency that obscured the identity of interests involved in the project agreements. Moreover, the state was often not aware of the transactions that transpired after the state lease had been granted.

Nineteen of the 36 oil palm proposals have major legal problems (Table 1) and a litany of failures at national, provincial, and local levels was revealed by the Commission for most of the SABLs. Thus, the legal status of the

Table 1 Number of proposals and planned area under oil palm, according to capacity and constraint scores

Overall capacity score	Sociolegal constraints score		Total
	0 or 1 (low)	2 (high)	
0 (low)	12 (203,850 ha)	10 (339,416 ha)	22 (543,266 ha)
1 (moderate)	3 (142,318 ha)	4 (156,000 ha)	7 (298,318 ha)
2 (high)	2 (39,350 ha)	5 (66,879 ha)	7 (106,229 ha)
Total	17 (385,518 ha)	19 (562,296 ha)	36 (947,814 ha)

SABLs is hotly contested. Most of the disputes revolve around the absence of free, prior, and informed consent of the landowners. Developer and landowner companies holding SABLs have frequently changed in structure and ownership. In many cases, there are competing landowner companies and groups. Even the boundaries of the leases are often unclear, overlapping, or disputed. For Forest Clearing Authorities to be granted, the SABLs

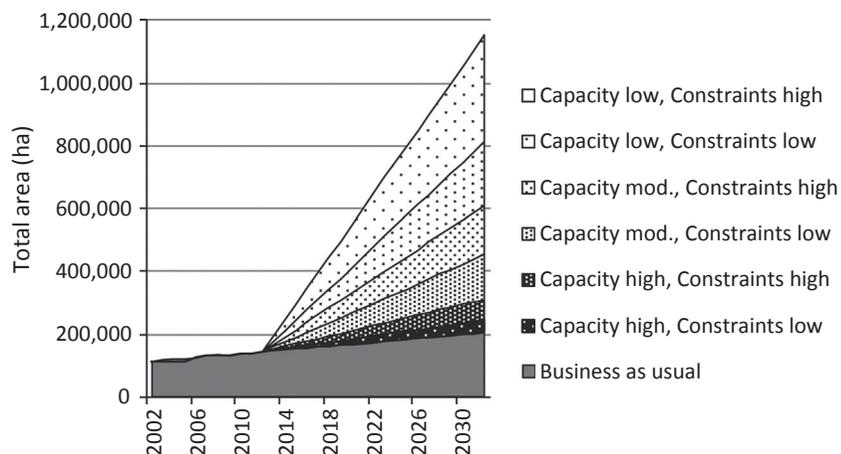


Figure 3 Actual area (2002–2012) and estimated future area under oil palm plantations in PNG according to capacity and constraint scores of current proposals, assuming that they are realized within 20 years.

must be accompanied by a registered survey, Land Investigation Report, Environmental Impact Statement, and Environmental Inception Report. Of the Environmental Impact Statements and Environmental Inception Reports we have examined, some were technically reasonable whereas others provided little or no information about likely impacts. Many of the leases, including all of those of more than 100,000 ha, have been granted to companies and not ILGs. Such leases give reason to suspect that customary rights have been ignored or manipulated because it is unlikely that 100s to 1,000s of adults owning such areas would give free, prior, and informed consent to grant control of their land for 99 years to a corporate body whose decision-making powers are vested in fewer than 10 adults (Filer 2012b).

Combining capacity and constraints scores, we found that of the 36 oil palm development proposals, only a small proportion are likely to result in commercial oil palm plantations within the foreseeable future (Table 1, Figure 3). Five of the proposals (totaling 181,668 ha of proposed oil palm) had or possibly had suitable overall capacity (score 1 or 2) and no major sociolegal constraints (score 0 or 1). Ten of the proposals (339,416 ha of the proposed oil palm) had insufficient capacity and major constraints, and the remainder had either insufficient capacity or major constraints.

Discussion

Our investigation indicates that PNG's oil palm industry is likely to continue to expand slowly, contrary to the impression in the public domain that millions of hectares have been set aside for oil palm plantations in PNG (e.g., Colchester *et al.* 2011). Of the 36 oil palm proposals we found, 24 do not have sufficient suitable land to allow oil palm development and 21 are controlled by compa-

nies with no experience in the oil palm industry. Both of these factors represent major constraints to oil palm development. Moreover, from reviewing legal documents and media reporting, we discover that 19 of the 36 proposals are currently facing major sociolegal constraints, mostly due to a lack of "free, prior, and informed consent" from local landowners. Overall, we estimate that only five proposals are likely to eventuate in the foreseeable future, totaling 181,668 ha of new commercial oil palm plantations. Our projection of likely oil palm industry expansion in the foreseeable future corresponds with the "low growth scenario" of Filer (2010) and is much less than those predicted for Indonesia and Malaysia (Wicke *et al.* 2011; Carlson *et al.* 2012).

The majority of actual or intended forest clearing in SABLs appears to be for logging under the pretext of oil palm development. The 2009 National Forestry Development Guidelines prohibit export of raw logs (the major forest product exported from PNG) from areas covered by new Timber Permits, but not from areas with Forest Clearing Authorities. Thus, once a Forest Clearing Authority has been granted, SABLs represent a unique opportunity for logging firms to circumvent restrictions imposed on log exports. The PNG Forest Authority, which is responsible for regulation of the Forest Clearing Authorities, has inadequate resources to monitor on-ground progress (Barker 2011), so companies are able to extract wood without the need for further investment into agricultural development. It is worth noting that during the 2005–2011 period, log exports increased from 2.3 to 3.5 million m³ per year, with the proportion coming from areas with Forest Clearing Authorities increasing from 0% to 19% over the same period (Winn 2012).

Owing to its biologically productive environment and rural population, PNG has the opportunity to pursue development through agriculture and forestry,

hand-in-hand with conservation of biodiversity. Sensible development will require better understanding of indigenous society-environment relationships and the factors driving deforestation, logging and expansion of agriculture (Filer 2011; Keppel *et al.* 2012; Sayer & Collins 2012). In PNG, the primary factors appear to be local demand for income, food, infrastructure and services, global demand for primary products, and the interplay between landowners and developers. Adult annual income in the areas discussed is typically in the range of USD 25–250, so any potential sources of income are attractive, especially logging, which provides quick income. To be successful, conservation efforts must pay heed to this, considering alternatives that balance conservation with income-generating activities (Novotny 2010; Sayer *et al.* 2012). Optimum solutions will inevitably involve trade-offs rather than win-win situations (Faith and Walker 2002; Sandker *et al.* 2007; Sandker *et al.* 2010), and transparent negotiations between the main actors are essential (Rist *et al.* 2010; Sayer & Collins 2012; Cramb 2013). There has been relatively little conflict during the slow expansion by existing producers in PNG, so it is worth examining them.

PNG's corporate mills and plantations were initially established on "alienated" land held in 99-year leases. This land was purchased from customary landowners by the state during the time of Australian administration. Alienated land suitable for oil palm is now fully taken up, so most of the plantation expansion since the late 1990s has been on customary-owned land, implemented using SABLs. The SABLs in which oil palm has been developed successfully involve companies with a long history in PNG, ILGs that are accepted by the customary landowners, and lease durations generally <45 years, giving landowners the ability to opt out of oil palm after one or two crop cycles if they wish (the time between planting and replanting being about 25 years). Of the smallholdings, 27% are "land settlement scheme" blocks (typically 6 ha) with 99-year leases, 67% are "village oil palm" with customary tenure (typically 2 ha blocks), and 5% are blocks in which the right to grow oil palm has been negotiated with customary landowners. Recent expansion has been mostly in the latter two categories (Koczberski *et al.* 2009; Koczberski *et al.* 2012; PNGPOC 2013). All PNG producers are accredited by the Roundtable on Sustainable Palm Oil (RSPO).

Accreditation by the RSPO appears to be the most effective instrument currently available for ensuring fair agreements between landowners and developers and restricting detrimental environmental impacts. Its principles and criteria stipulate a commitment to transparency, a participatory approach to establish land use agreements with landowners, and no clearing of primary forest or for-

est with high conservation value (RSPO 2013). The RSPO brings public scrutiny to bear on the industry and allows environmental lobby organizations to influence developments (Venter *et al.* 2008). The approach of potential new producers to the RSPO is mixed. Some are actively pursuing RSPO accreditation, whereas others have campaigned against the RSPO principles, citing inordinate control by green groups over economic development and food production.

In other countries, the state might be expected to play a key role in managing development to optimize benefits. Unfortunately, in PNG, the various levels of government generally lack coordination, have a poor record of establishing and maintaining services and infrastructure, and do not have the capacity to implement policies and enforce laws (Allen 2009; Lattas 2011). Some suggest that nongovernment organizations could take over normal roles of government, but they cannot be expected to sustainably deliver benefits to communities (Venter *et al.* 2008; Allen 2009; Keppel *et al.* 2012). Similarly, while reducing emissions from deforestation and forest degradation (REDD+) could potentially provide both income and conservation benefits (Venter *et al.* 2009; Venter *et al.* 2013), there are risks of perverse outcomes in the Asia-Pacific context (Ghazoul *et al.* 2010; Barr & Sayer 2012; Filer 2012a).

In conclusion, the rate of expansion of the oil palm industry in PNG is likely to remain low. While on paper a massive expansion of the industry appears imminent, most of the current oil palm proposals are unlikely to result in commercial plantations within the foreseeable future, but appear to be a means of circumventing restrictions on logging, which continues apace. To optimize the benefits of future agricultural developments such as oil palm while limiting deforestation, transparent consultation and agreements between developer companies and representative landowner groups, and strategic regional and local planning are required. Land use planning is traditionally the realm of government, but governance is weak in PNG so the onus to do it well will fall to the palm oil companies and the landowners, with public scrutiny playing an essential role.

Acknowledgments

We are grateful for the assistance provided by Ian Orrell, who provided much information and insight, Robin Hide, who helped track down data, and Adella Edwards, who developed the maps. Involvement of Nelson, Curry and Koczberski in the PNG oil palm industry has been funded by the Australian Centre for International Agricultural Research.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Table S1. "Agroforestry" development projects under Special Agricultural Business Leases (SABLs) with plans to grow oil palm in PNG, showing scores for land suitability, the capacity of the developer to produce palm oil, and sociolegal constraints preventing development in the foreseeable future.

References

- Allen, B. (2009) Agricultural development, policies and governance. Pages 425–488 in R.M. Bourke, T. Harwood, editors. *Food and agriculture in Papua New Guinea*. The Australian National University, Canberra.
- Allen, M., Bourke, R.M. & McGregor, A. (2009) Cash Income from agriculture. Pages 283–424 in R.M. Bourke, T. Harwood, editors. *Food and agriculture in Papua New Guinea*. The Australian National University, Canberra.
- Barker, P. (2011) Special Agricultural Business Leases (SABLs): A Preview. Institute of National Affairs, February 2011. Available at: http://www.inapng.com/pdf_files/SABL%20brief%20-%20for%20March%20Girls%20OP%20workshop%20Feb%202011.pdf. Accessed 13 September 2012.
- Barr, C.M. & Sayer, J.A. (2012) The political economy of reforestation and forest restoration in Asia-Pacific: critical issues for REDD+. *Biol. Conserv.*, **154**, 9–19.
- Canopy Watch. (2012) Commission of Inquiry transcripts. Available from <http://www.canopywatch.org/p/coi-transcripts.html>. Accessed November 2012.
- Carlson, K.M., Curran, L.M., Asner, G.P., Pittman, A.M., Trigg, S.N. & Adeney, J.M. (2012) Carbon emissions from forest conversion by Kalimantan oil palm plantations. *Nature Climate Change*, **3**, 283–287.
- Colchester, M., Chao, S., Dallinger, J., Sokhannaro, H.E.P., Dan, V.T. & Villanueva, J. (2011) *Oil palm expansion in South East Asia: trends and implications for local communities and indigenous peoples*. Forest Peoples Programme and Perkumpulan Sawit Watch, Moreton-in-Marsh and Bogor.
- Cramb, R.A. (2013) Palmed off: incentive problems with joint venture schemes for oil palm development on customary land. *World Dev.*, **43**, 84–99.
- Cramb, R.A. & Curry, G.N. (2012) Oil palm and rural livelihoods in the Asia-Pacific region: an overview. *Asia Pac. Viewpoint*, **53**, 223–239.
- Faith, D.P. & Walker, P.A. (2002) The role of trade-offs in biodiversity conservation planning: linking local management, regional planning and global conservation efforts. *J. Biosci.*, **27**(Suppl. 2), 393–407.
- Filer, C. (2010) The impacts of rural industry on the native forests of Papua New Guinea. *Pac. Econ. Bull.*, **25**, 135–153.
- Filer, C. (2011) Interdisciplinary perspectives on historical ecology and environmental policy in Papua New Guinea. *Environ. Conserv.*, **38**, 256–269.
- Filer, C. (2012a) Why green grabs don't work in Papua New Guinea. *J. Peasant Stud.*, **39**, 599–617.
- Filer, C. (2012b) The commission of inquiry into special agricultural and business leases in Papua New Guinea: fresh details for the portrait of a process of expropriation. Second International Academic Workshop on 'Global Land Grabbing', Cornell University, 17–19 October 2012.
- Ghazoul, J., Butler, R.A., Mateo-Vega, J. & Kok, L.P. (2010) REDD: a reckoning of environment and development implications. *Trends Ecol. Evol.*, **25**, 396–402.
- Keppel, G., Morrison, C., Watling, D., Tuiwawa, M.V. & Rounds, I.A. (2012) Conservation in tropical Pacific island countries: why most current approaches are failing. *Conserv. Lett.*, **5**, 256–265.
- Koczberski G., Curry, G.N. & Imbun, B. (2009) Property rights for social inclusion: migrant strategies for securing land and livelihoods in Papua New Guinea. *Asia Pac. Viewpoint*, **50**, 29–42.
- Koczberski, G., Curry, G.N. & Anjen, J. (2012) Changing land tenure and informal land markets in the oil palm frontier regions of Papua New Guinea: the challenge for land reform. *Aust. Geogr.*, **43**, 181–196.
- Koh, L.P. & Ghazoul, J. (2008) Biofuels, biodiversity, and people: understanding the conflicts and finding opportunities. *Biol. Conserv.*, **141**, 2450–2460.
- Lattas, A. (2011) Logging, violence and pleasure: neoliberalism, civil society and corporate governance in West New Britain. *Oceania*, **81**, 88–107.
- Miccolis, A. & Andrade, R.M.T. (2012) The expansion of oil palm in the Brazilian Amazon: paths forward for sustainability. Latin American Studies Association (LASA) 2012 Conference.
- Nelson, P.N., Webb, M.J., Orrell, I. *et al.* (2010) *Environmental sustainability of oil palm cultivation in Papua New Guinea*. ACIAR Technical Report No. 75. The Australian Centre for International Agricultural Research, Canberra.
- Novotny, V. (2010) Rainforest conservation in a tribal world: why forest dwellers prefer loggers to conservationists. *Biotropica*, **42**, 546–549.
- PNGPOC (Papua New Guinea Palm Oil Council). (2013) *Palm oil industry statistics - 2012*. Papua New Guinea Palm Oil Council, Port Moresby.
- Rist, L., Feintrenie, L. & Levang, P. (2010) The livelihood impacts of oil palm: smallholders in Indonesia. *Biodivers. Conserv.*, **19**, 1009–1024.
- RSPO (Roundtable on Sustainable Palm Oil). (2013) RSPO principles and criteria for sustainable palm oil production. including indicators and guidance. *Roundtable on Sustainable Palm Oil*, www.rspo.org.
- Sandker, M., Campbell, B.M., Ruiz-Pérez, M. *et al.* (2010) The role of participatory modelling in landscape approaches to

- reconcile conservation and development. *Ecol. Soc.*, **15**(2), 13 (online).
- Sandker, M., Suwarno, A. & Campbell, B.M. (2007) Will forests remain in the face of oil palm expansion? Simulating change in Malinau, Indonesia. *Ecol. Soc.*, **12**(2), 37 (online).
- Sayer, J.A. & Collins, M. (2012) Forest governance in a changing world: reconciling local and global values. *Round Table*, **101**, 137-146.
- Sayer, J., Ghazoul, J., Nelson, P.N. & Boedhihartono, A.K. (2012) Oil palm expansion transforms tropical landscapes and livelihoods. *Global Food Secur.*, **1**, 114-119.
- Shearman, P.L., Ash, J., Mackey, B., Bryan, J.E. & Lokes, B. (2009) Forest conversion and degradation in Papua New Guinea 1972-2002. *Biotropica*, **41**, 379-390.
- Stickler, C., Coe, M., Nepstad, D., Fiske, G. & Lefebvre, P. (2007) *Ready for REDD? A preliminary assessment of global forested land suitability for agriculture*. Woods Hole Research Center, Massachusetts.
- Trangmar, B.B., Giltrap, D.J., Burgham, S.J. & Savage, T.J. (1995) *Land suitability assessments for selected crops in Papua New Guinea*, PNGRIS Publication No. 8. Australian International Development Assistance Bureau (Landcare Research New Zealand Ltd on contract to CSIRO), Canberra.
- UNEP (United Nations Environment Programme). (2011) UNEP Oil palm plantations: threats and opportunities for tropical ecosystems. *UNEP Global Environmental Alert Service*, December 2011.
- Venter, O., Laurance, W.F., Iwamura, T., Wilson, K.A., Fuller, R.A. & Possingham, H.P. (2009) Harnessing carbon payments to protect biodiversity. *Science*, **326**, 1368.
- Venter, O., Meijaard, E. & Wilson, K. (2008) Strategies and alliances needed to protect forest from palm-oil industry. *Nature*, **451**, 16.
- Venter, O., Possingham, H.P., Hovani, L. *et al.* (2013) Using systematic conservation planning to minimize REDD+ conflict with agriculture and logging in the tropics. *Conserv. Lett.*, **6**(2), 116-124.
- Wicke, B., Sikkema, R., Dornburg, V. & Faaij, A. (2011) Exploring land use changes and the role of palm oil production in Indonesia and Malaysia. *Land Use Policy*, **28**, 193-206.
- Winn, P. (2012) *Up for grabs. Millions of hectares of customary land in PNG stolen for logging*. Greenpeace Australia Pacific, Ultimo.