Direct payments for Conservation. Can we pay the way out of habitat loss?

María A. Máñez Costa & Swen C. Renner

Abstract

The name "Guatemala" is derived from the Nahuatl *guauhtemallan*, which means "land of trees". Guatemala is home to a unique mix of plants and animals. The country's biological diversity is among the highest in Central America and it ranks among the 25 most plant-rich countries in the world. Increasing conservation efforts in this region are crucial to preserving Guatemala's wealth of ecosystems.

As a case study the region of the "Macizo de Cobán" has been chosen. The area contains one of the biodiversity's hotspots, consisting of large areas of cloud forest. Degradation and loss of forest cover is caused mainly by slash-and-burn increased agricultural expansion to grow subsistence crops (e.g., corn and beans), forest clearing for cash crops (e.g., cardamom and coffee), extraction of firewood (the only domestic fuel of rural inhabitants), local demand for construction, illegal logging rising demand for commercial forest products (particularly of the reserve's primary and old-growth forest) and finally, the clearing of forest for the grazing of cattle. Slash-and-burn is becoming a pushing method that destroys the most intricate part of the tropical nutrient cycle and continues to degrade and destroy this biologically rich region.

Due to the socio-economic conditions and the pressure on resource in the Macizo de Cobán, it is almost impossible to conserve forest as a pristine area. Therefore, environmental measures must be implemented to mitigate the loss of biological diverse forests. Revisions from Ferraro and Kiss (2002), Nasi et al. (2002), Vosti et al. (2002), Chomnitz (1998), Espinoza and Smyle (1999), about incentives for conservations clarify that direct payment to land owners could pay the way out of forest decline.

To elucidate the problem at the local level interdisciplinary data from bird populations and environmental measures in the Macizo de Cobán will be used. Based on them policy recommendations for habitat conservation will be made.

Key-words: *interdisciplinary approach, environmental measures, ecological services, species extinction, conservation*

Introduction

Environmental degradation and unfavourable environmental conditions disproportionately affect poor people: their health, livelihood and security (World Bank 2000). In the study region degradation of soil and vegetative resources already threatens agricultural productivity, biodiversity and water quality and availability[1]. Therefore, to create incentives and to compensate the poor for conserving or managing resource of value to others and themselves is the main objective of this chapter.

Based on Vosti and Reardon (1997) and Terborgh (1999) in the long-term, the goals of poverty alleviation, agricultural growth and environmental protection should be complementary, as human development depends on the ability of the environment to provide a variety of goods and services and to sustain these into the future.

The first step to address this critical triangle means is to put rural households and communities first (Zeller et al. 2000) and to have an in-depth understanding of the forces that drives farmers to deforest.

Marginal hillsides suffer in Guatemala from oblivion. Local policies that link the outcomes of the critical triangle of development have been until now seldom implemented. Some international development agencies have developed agendas for a broader development under sustainable conditions but their measures have been limited so far to the establishment of protected areas reflecting different conditions and degrees of protection (WWF and IUCN). Moreover, the various poverty-reduction strategies have only focused on improving the economic conditions of the rural population without explicitly considering its impact on the environment. Thus, single policy instruments pursue environmental, economic and social policy objectives and projects instead of integrated ones.

Therefore the design of policies that focus on development as an overall description of environmental sustainability and poverty alleviation are needed for the area and also for other river basins in Guatemala in order to reach a level of sustainability that allow the poor to develop in a long term. Direct payments for conservation to smallholders could potentially contribute to achieving of all three objectives of the critical triangle of rural development: poverty reduction, economic development, and environmental protection (Vosti and Reardon 1997).

Background of the problem statement

El Macizo de Cobán lies in the north on the eastern tropical and temperate highland of Guatemala. The area belongs to the humid corridor formed by the Sierras de Lacandón to the West and the Sierra de Chamá and Santa Cruz to the East (Méndez et al. 1995). The area is categorised through annual precipitations of between 1600 mm and 2500 mm, while the chosen study area has rainfalls of about

[1] Compare Scherr and Yadav (1995), cited by Scherr and White (2002)

4000 mm yearly. The majority of the vegetation pertains to the biome mountainous tropical and cloud forest. Montane cloud forests are a highly endangered ecosystem or habitat type. They hold higher numbers and significantly higher abundances of sensitive and indicator species. This area is also notoriously important for migrant species (Kapelle & Brown 2001, Doumenge et al. 1995).

Data from Renner (2003) about endemic bird species diversity of the area are reflected in Table 1. Endemics – or restricted range species – mostly are dependent on restricted habitat use in special areas. Centres of such areas with higher degree of endemism are named Endemic Bird Areas (EBA after Stattersfield et al. 1998). Within Central America there are 30 EBAs. EBA # 018 "North Central American highlands" is 15,000,000 ha large, 500 – 3500 m in elevation, key habitats are montane forest, pine-oak forest, and deciduous forest which are threatened by moderate habitat loss. EBA 018 is classified as "Priority – Urgent". Two of the 20 restricted range species of EBA 018 are threatened (*Oreophasis derbianus, Tangara cabanisi*), both were not present at Macizo de Cobán or already extinct there. Nevertheless, 13 of the 20 restricted range species were recorded. Out of the 13 at least three were exclusively montane evergreen and pine-oak species (*Strix fulvescens, Lampornis viridipallens, Troglodytes rufociliatus*. See Table 1).

Possingham et al. (2002) stated that Red Lists are not designed (i) to set priorities for resource allocation for species recovery, (ii) to inform reserve system design, (iii) to constrain development and exploration and (iv) to report the state of the environment. On the other site Lamoreux et al. (2003) stated that the misuse is indeed given and agree with Possingham (2002) '(i)t is naïve and counterproductive from all point of views to use threatened species lists alone to allocate resources for recovery, …'. Therefore, here several more aspects were integrated to evaluate the research area. On the one hand biological data about habitat comparison, measure of influences, body mass, etc and on the other hand socio-economic data to fulfil the gap of information.

The Region has one of the highest proportions of Mayan inhabitants (89.0%) in Guatemala. The distribution of rural and urban population in Alta Verapaz is also disproportionate: 15.8% urban population and 84.2% of rural population[2]. The Q´eqchí, the local Mayan population of Macizo de Cobán, are victims of high incidences of poverty, limited infra-structural development, low market integration and restrained off-farm income opportunities. The subsistence economy of the Q´eqchi, based on traditional slash and burn farming, has led not only to well-documented loss of biodiversity but also to economic loss due to soil degradation (INAB-MAGA-PAFG-MARN-CONAP 2002). The Macizo de Cobán belongs to one of the poorest areas in Mesoamerica with a GDP of € 264 per capita[3]. It has

[2] United Nations Development Program. Guatemala: los contrastes del desarrollo humano (Guatemala: UNDP 1998), p. 217.

[3] 1852,20 Quetzales/Data Source Segeplan 2003 (Secretaría de Planificación y Programación de la Presidencia); 1 € = 1.19 US $

also one of the lowest Human Development Index (HDI)[4] scores (0.355) in Guatemala. Its HDI rank is 32 places below its real GDP per capita rank, indicating comparatively poor performance on human development in relationship to the material resources at its disposal[5]. We have once more an example of an area where the poorest people inhabit one of the biologically richest area.

Table 1. Endemic and specialized birds of the Sierra Yalijux and the Chelemhá Plot. Listed are all species classified in the Endemic Bird Area # 018 "North Central American highlands" (Stattersfield et al. 1998).

Species	Global status[1]	Altitude (m)	Present in study area	Habitat[2]
Podilymbus gigas	extinct (1987)	1500	-	water
Oreophasis derbianus	vulnerable	2000-3000	extinct (~ 1990)	NF
Cyrtonyx ocellatus	near threatened	1000-3000	*	PO
Otus barbatus	near threatened	1800-2500	not recorded	NF, PO
Strix fulvescens	least concern	1200-3000	*	NF, PO
Campylopterus rufus	least concern	900-2000	not recorded	NF, PO, SF, e, a
Lampornis viridipallens	least concern	1400-2200	*	NF, PO, e
Lampornis sybillae	least concern	1400-2200	not recorded	NF, PO, e
Doricha enicura	least concern	1000-2200	*	NF, PO, SF
Atthis ellioti	least concern	1500-3500	*	NF, PO, SF
Asphata gularis	least concern	1500-3000	*	NF, PO, SF
Xenotriccus callizonus	near threatened	1200-2000	not recorded	deciduous forest
Notiochelidon pileata	least concern	1000-3000	*	NF, PO, SF
Troglodytes rufociliatus	least concern	1700-3500	*	NF, PO, e
Melanotis hypoleucus	least concern	1000-3000	*	NF, PO, SF
Turdus rufitorques	least concern	1500-3350	*	NF, PO, e
Tangara cabanisi	least concern	1000-1700	not recorded	NF, PO
Ergaticus versicolor	near threatened	1800-3500	*	NF, PO, SF
Icterus maculialatus	least concern	500-1800	not recorded	PO, SF
Carduelis atriceps	near threatened	2000-3500	*	PO, e, SF
Cyanocorax melanocyaneus	least concern	600-2450	*	e, PO, SF

[1] adapted from Stattersfield et al. (1998) [2] NF: montane evergreen forest, PO: pine-oak forest, SF: secondary growth, e: forest edge, clearings; a: agricultural areas, * observed in Chelemhá.

Between 1987 and 1995 the annual deforestation rate for Guatemala was 1.1 per cent of the total forested area, equivalent to 80,000 ha per year (Jolom-Morales 1997), while worldwide deforestation data from the FAO (2001) suggest

[4] The HDI measures a country's achievements in terms of life expectancy, educational attainment and adjusted real income. UNO. "Human Development Index Report." United Nations, 02 February 2000 (Consult in internet).

[5] United Nations Development Program. Human Development Report 1999 (New York: UNDP and Oxford University Press, 1999), pp. 134-137.

that in the tropics, the annual rate of deforestation is about 0.8 percent. Table 2 reflects the actual causes for deforestation[6].

Table 2. Actual causes for deforestation.

Caused for deforestation	%
Shifting Agriculture	79 %
Livestock	10 %
Illegal logging	5 %
Uncontrolled burning	3 %
Plagues and plant diseases	2 %
Export agriculture	1 %
Source: Gálvez (2000)	

Predicting the future of the region

Spatial diversity (species-area relationship) patterns have important implications for conservation of biodiversity, and understanding these patterns contributes to our knowledge of community structure.

Species and area are related with $S = cA^z$, where S number of species, A area, z and c constants (e.g., MacArthur & Wilson 1967, Rosenzweig 1995, Krebs 1999, Waltert et al. 2003).

The inverse species-area relationship (Preston 1962) might assess the number of extinct forest dependent bird species threatened from deforestation. This procedure has been proven to be valid since it produced results that were concordant with assessments of mammal and bird threat status made by conservationists. The observations were consistent both in Neotropical and south-east Asian tropical rainforest (Brooks & Balmford 1996, Brooks et al. 1999a, 1999b, 1999c, Waltert et al. 2003). Rearranging the relationship $S = cA^z$, one can calculate the number of species most likely to go extinct in a fragment (or nested subset) of a given size by dividing $S_{surviving} = cA_{surviving}{}^z$ by $S_{original} = cA_{original}{}^z$. This results in $S_{surviving} / S_{original} = (A_{surviving} / A_{original})^z$ and one can estimate the extinct species $S_{extinct} = S_{original} - (S_{original} \bullet (A_{surviving} / A_{original})^z)$, because $S_{extinct} = S_{original} - S_{surviving}$.

Assuming the regional meta-population of the Macizo de Cobán has no or limited individuals' or genetic exchange (the next natural montane cloud forest is located in the Sierra de las Minas, 20 km southwards, separated by the valley of the Río Polochic), one can set $A_{surviving}$ to 55,000 ha as the remaining natural montane cloud forest with $A_{original}$ = 165,000 ha for the Macizo de Cobán (Mühlenberg et al. 1989). The original area of EBA # 018 Central American highlands is $A_{original}$ = 15,000,000 ha.

Focusing on the 21 natural montane cloud forests specialists endemic to the Central American highlands (Table 1; Stattersfield et al. 1998), ten should be pre-

[6] For more data about deforestation in the Macizo de Cobán see Máñez et al. (2004).

sent in natural forest and oak-pine forests. Six out of the 21 were observed in the study plot (Table 1). Figure 1 illustrates the relationship between the 21 mentioned endemics and area.

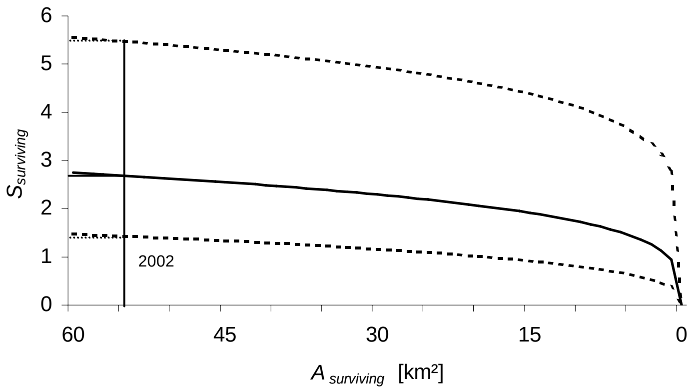

Figure 1. Relationship between 21 highland bird species of EBA # 018 remaining ($S_{surviving}$) and remaining closed forest cover within areas of the Macizo de Cobán. Dotted curves represent calculations using extreme z = 0.17 and z = 0.34, respectively.

According the 21 endemics from EBA # 018 "Central American highlands" (Stattersfield et al. 1998) there will be 2.68 endemics remain ($S_{surviving}$) for the 55,000 ha surviving natural forest in the Macizo de Cobán. For extreme z-values, 1.4 and 5.47 endemics will remain, respectively. Contrastingly, 13 endemics were observed.

Therefore a lot of more species are still present than might be carried by natural forest and species-area equilibrium. Even when area is not decreasing and deforestation rate will immediately be pushed to zero, four to five out of the observed ten natural forest highland endemics will not survive because the area-species equilibrium is not reached.

Results from the socio-economic study in the same area show us that development under the actual conditions will drive to further conversion of forest and forested land into agricultural land. The current crises on the world coffee markets and the corresponding decline of coffee prices have seriously worsened the wage-earning potential of the area seasonal labourers. About 68 percent of the sample households were found to engage in wage-labour activities linked to coffee farming. Thus, the coffee crisis led to a considerable decline in income in many households in the Macizo de Cobán. Hence, as a response to this crisis, the farmers were increasingly forced to use the remaining forestland for food crop cultivation. In this context, it is well-known facts that in such ecologically fragile areas, if the soils lose their vegetation cover then they are greatly exposed to the leaching and eroding effects of rain. Indeed in Macizo de Cobán it was observed that farmers started to cut and burn new surfaces for staple crops production. Moreover, they sold timber to traders in order to compensate for the loss of off-farm cash income. About 76% of the sample farmers were found to view timber as precautionary savings. Further on forest and vegetation conservation also makes “sense from the viewpoint of minimising high environmental risk under considerable uncertainty” (Nasi et al. 2002). This will coincide with the safety-first criterion of Low (1974) insuring minimum conditions to meet farmers’ necessities by conserving environmental measures within farming systems. In the opposite, when trees are harvested and vegetation eradicated farmers are in a kind “destroying” their own minimum and stay empty handed.

Figure 2 gives an overview of the development of land use for the next years if the actual socio-economic situation continues.

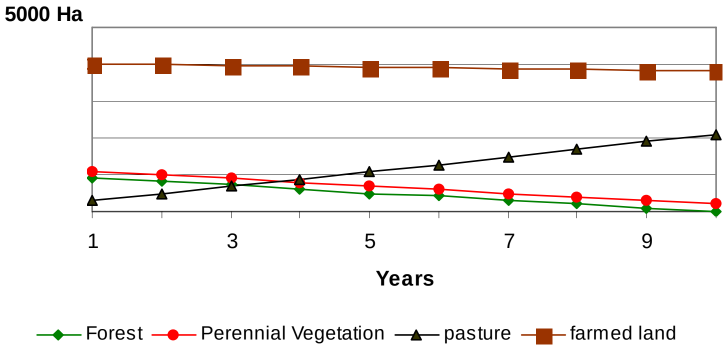

Figure 2. Prediction of land use in the Macizo de Cobán (source: Máñez Costa, 2004).

Comparing the trend of both Figures (1 and 2) we can conclude that land use patterns will drive to the loss of forest and the intrinsic loss of species in Macizo de Cobán. As indicated in Figure 2 further natural forests will vanished and therefore as indicated in Figure 1 the tendency of endemic species extinction will be aggravated. The services of the ecosystem “cloud and montane forest” will be not only affected by the loss of biological diversity but also by the depletion of soils productivity[7] and consequently to the endangerment of the basic conditions for development for the inhabitants of the Macizo de Cobán.

The needs of environmental conservation

Since now in Guatemala different effort to reach conservation in a broader sense have been established[8]. Even with all these measures, reforested areas and other revegetation initiatives have recovered about 50,000 ha per year. Nevertheless, deforestation continues to the rate of about 80,000 ha per year (Jolom-Morales

[7] Compare Markussen (forthcoming)
[8] Compare Birner et al. (see chapter xy)

1997). Consequently despite all efforts, forest policies have not been successful so far.

Cervigni (2001) exposed that recent theories of extinctions and the basic postulate of economic theory are consistent to each other. Both are based on the fact that "resources are allocated among competing uses". The economic theory reveals further on that farmers allocate resources among competing uses in such a manner that monetary returns from them could be maximise (Cervigni 2001:39). Therefore, it could be assumed that land uses with less monetary return would disappear in favour of others with more monetary returns.

It is therefore a fact that forests and habitat conservation needs from new economic and policy instruments to be implemented. Thinking in the sustainable triangle of development, as reflected in Figure 3, there is a field on it where goods and payments for these goods still do not have found a market or policy instrument that regulate them. On the one hand, we have farmers producing different goods and in the other hand we have the society consuming such goods but not paying for them. Such goods, still without markets, are landscape conservation, habitat and environmental protection and at least biodiversity conservation. The only market relation between the society and farmers is established through agricultural market products. For this reason environmental policy instruments for these "goods without monetary returns" should be developed to compensate farmers and to incentive them.

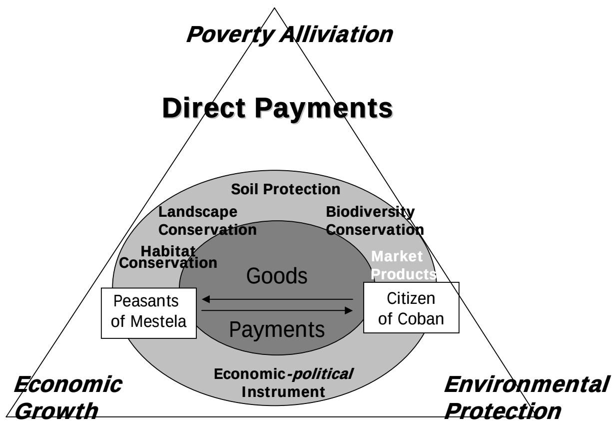

Figure 3. Conceptual framework for direct payments (Source: Máñez Costa 2003, adapted from Vosti and Reardon (1997)

Direct payments have been so far implemented in Mesoamerica, mostly in Costa Rica. Ferraro and Kiss (2002) cited a project where Costa Rica pays rural residents about € 29.17 annually per hectare forest protected, and access demand for conservation contracts suggests that these payments are higher than necessary

(Ortiz 2002, cit. Ferraro and Kiss 2002). Espinoza and Smyle (1999) presented different direct payments to forest owners for biodiversity protection in Costa Rica in the range of € 4.12 till € 9.3. Due to these payments but also to the forest conservation policy of Costa Rica, Malavasi and Kellenberg (2003) reported a deceleration of deforestation.

Table 3. Summary of Studies of Environmental Services in Guatemala (source: Aylward 2002).

Study (those referred to in this paper are shaded)	Location or Ecosystem of Study	Environmental Service			Type of Analysis		Comment
		Hydro Services	Carbon	Tourism	Bio-physical	Economic	
Brown et al. (1996)	Sierra de Las Minas Biosphere Reserve	Yes			Yes	Yes	valuation in the case of cloud forests
Velásquez, et al. (no date)	Xayá-Pixcayá watersheds	Yes				Yes	cost estimates rather than values per se
Pape and Ixcot (1998)	Lale Amatitlán.					Yes	valuation of water and water quality in the lake not of hydrological services
Velasquez and Montalvo (1998)	Chixoy River					Yes	valuation of water – unclear if of hydrological services
Márquez (no date)	various		Yes		Yes		Summary of other studies
OCIC Consulting Group (2000)	Mayan Biosphere Reserve, Peten		Yes		Yes		Cost estimates rather than values per se
Márquez (1997)	Agroforestry systems.		Yes		Yes		primary data
Winrock International (1998)	coffee, Sololá.		Yes		Yes		primary data
Medina et al. (2000)			Yes		Yes		primary data
Solano Alvarez (2000)	coffee plantation		Yes		Yes		primary data
Fundación Solar/ Gremial de Huleros (1999)	rubber plantation		Yes		Yes		primary data
Fundación Solar (1999)	rubber plantations.		Yes		Yes		primary data
Morales Ralda (2000)	rubber plantation - S Guatemala.		Yes		Yes		primary data
Fundación Solar (1999)	hardwood forests - Lake Atitlán.		Yes		Yes		primary data
Castellanos (2000)	evergreen and cloud forest in Chiquimula		Yes		Yes		primary data
López (1998)	countrywide		Yes		Yes		secondary data
López (1998)	Volcán San Pedro			Yes		Yes	contingent valuation and also valuation of forestry and agriculture alternatives
Ortiz (2000)	Guatemalan Protected Areas	Yes	Yes	Yes	Yes	Yes	secondary data
Martínez (2000)	forests-Sololá, Baja Verapaz.	Yes	Yes		Yes		primary data
Castanier (1999)	Punta de Manabique						varios services using technical coefficients

Despite from the data for Costa Rica there have been no calculation for direct payments for Guatemala neither there are any data available about the success of forest policy are obtainable. In contrast as already cited, Jolom-Morales (1997) reported for Guatemala a decrease of forested areas (not necessarily "untouched" forests, Nasi et al. 2002).

In Table 3, Aylward (2002) summarized studies about economic evaluation of environmental services in Guatemala. Although there is a wide range of data obtained through these studies there is since yet no implementation of the results. Certainly, Aylward (ibid) argues that the "results – such as they are – for caution before extolling the value of environmental services". Thus, he suggests of examining smaller scale environmental services supply issues in rural settings in relation particularly to healthy ecosystems concerns.

Máñez Costa calculated for Guatemala in the period until 2003 payments for farmers in the Macizo de Cobán. She evaluated the environmental services that farmers are already offering and that contribute somehow to preserve the contemporary environmental conditions of the study area. Her calculations shows that direct payments will/could affect positively the environment[9]. As reflected in Figure 4 direct payments could reach the maintenance of at least secondary forests for the following 10 years.

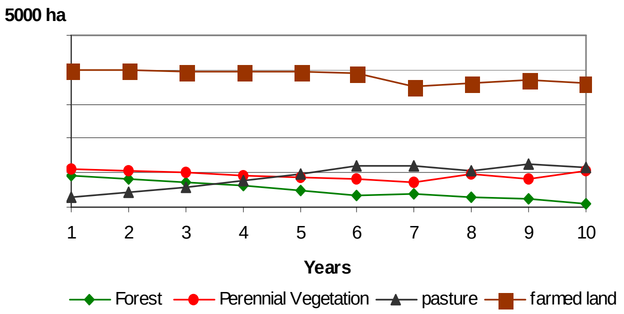

Figure 4. Modelling land use change for the Macizo de Cobán with direct payments (source: Máñez Costa, 2004).

Figure 4 reflects that farmers react positive to direct incentives. Under these calculations, farmers include direct payments for forest conservation in their production function as a remunerated activity. Based on this assumption we can derive that also direct payments for natural forest conservation will serve their purpose.

Summarising and including the interdisciplinary data already presented about birds populations and forest conservation under direct payments, we can conclude that at least ten endemic bird species might be preserved from extinction, when direct payments to preserve secondary forests and perennial vegetation occur.

[9] Compare Máñez Costa and Zeller, chapter xy.

Policy Implications

Even if deforestation is coming to an immediate still stand, 10 bird endemics of EBA Central American highlands will vanish from the study plot. Direct payments might be a suitable tool to prevent further deforestation or implement new natural-like reforestation areas and landscape structures promoting biological diversity in areas like e.g. old secondary forest.

In Guatemala, policy instruments for environmental protection should definitively include the three goals of the critical triangle of development. Without direct payments forests remnants will disappear completely and with it the habitat for the still remaining bird species (as shown in Figures 1 and 2). If forest owners of the Macizo de Cobán do not see in forest and perennial vegetation a valuable commodity and in forest preservation an alternative land use, the equilibrium of the critical triangle will be displaced. Consequently, neither conservation nor development aims will/could be reached.

References

Aylward, B. (2002). Mecanismos de mercado y Servicios Ambientales. Planteamiento Conceptual y Revisión de Experiencias Internacionales. Guatemala, Proyecto Mirna: 114.

Brooks, T.M., and Balmford, A. (1996). Atlantic forest extinctions. Nature 380: 115.

Brooks, T.M., Pimm, S.L., and Oyugi, J.O. (1999a). Time lag between deforestation and bird extinction in tropical forest fragments. Conservation Biology 13: 1140-1150.

Brooks, T.M., Pimm, S.L., Kapos, V., and Ravilious, C. (1999b). Threat from deforestation to montane and lowland forest birds and mammals in insular south-east Asia. Journal of Animal Ecology 68: 1061-1078.

Brooks, T.M., Tobias, J., and Balmford, A. (1999c). Deforestation and bird extinctions in the Atlantic forest. Animal Conservation 2: 211-222.

Cervigni, R. (2001). Biodiversity in the balance: land use, national development, and global welfare. Cheltelham, UK, Edward Elgar.

Chomnitz, K. M., and Kumari, K. (1998). "The domestic benefits of tropical forest: A critical review." The World Bank Research Observer 13: 13-35.

Doumenge, C., Gilmour, D., Ruíz Pérez, M., and Blockhus, J. (1995). Tropical montane cloud forests: conservation status and management issues. Pp. 24-37 in: L. Hamilton, J. Juvik, and F. Scatena. Tropical montane cloud forests. Springer Verlag, Berlin.

Espinoza, N. G., and Smyle, J. (1999). El pago de servicios ambientales y el desarrollo sostenible en el medio rural. Turrialba, RUTA.

FAO (2001). State of the worlds forests. FAO, Roma.

Ferraro, P., and Kiss, A. (2002). "Direct Payments to Conserve Biodiversity." Science 298: 1718-1719.

Gálvez, J. J. a., and Rodas., O.A. (2000). Potencial de producción forestal de Guatemala. Guatemala: 28.

INAB-MAGA-PAFG-MARN-CONAP (2002). Programa de Forestería Social. Guatemala, MAGA: 49.

Jolom-Morales, INITIALS? (1997). Caracterización de la actividad de cacería en la reserva de la biosfera sierra de las minas y diseño de un plan de monitoreo. Guatemala.

Kappelle, M., and Brown, A.D. (2001). Bosques nublados del neotrópico. Instituto Nacional de Biodiversidad, San José.

Krebs, C.J. (1999). Ecological methodology. Addison-Welsey Educational Publisher, Menlo Park.

Lamoreux, J., Akcakaya, H.R., Bennun, L., Collar, N.J., Boitani, L., Brackett, D., Bräutigam, A., Brooks, T., da Fonseca, G.A.B., Mittermeier, R.A., Rylands, A.B., Gärdenfors, U., Hilton-Taylor, G., Mace, G., Stein, B.A., and Stuart, S. (2003). Value of the IUCN Red List. Trends in Ecology and Evolution 18: 214-215.

Low, A. R. C. (1974). "Decision taking under uncertainty: a linear programming model of peasant farm behaviour." Journal of Agricultural Economics 62: 311-320.

MacArthur, R.H., and Wilson, E.O. (1967). The theory of island biogeography. Princeton University Press, Princeton, New Jersey.

Malavasi, E. O., and Kellenberg, J. (2002). Program of Payments for Ecological Services in Costa Rica. International Expert Meeting on Forest Landscape Restoration, Heredia, Costa Rica, CATIE.

Máñez Costa, M. A. (2003). "Strategien und Optionen für den Natur und Umweltschutz in agrarischen Produktionssystema - Ein Fallbeispiel aus Guatemala." Treffpunkt Biologische Vielfalt III: 213-219.

Mendez, C.A., Sisk, T.D., and Haddad, N.M. (1995). Beyond birds: multitaxonomic monitoring programs provide a broad measure of tropical diversity. Pages 451-456 in J.A. Bissonette and P.R. Krausman, eds. Integrating people and wildlife for a sustainable future. Proceedings of the First International Wildlife Management Congress. The Wildlife Society, Bethesda, MD.

Mühlenberg, M., Hovestadt, T., and Unger, D. (1989). Schutz des Nebelwaldes in Guatemala. Ökologische Station der Universität Würzburg, Würzburg.

Nasi, R., Wunder, S., and Campos, J.J. (2002). Forest Ecosystem Services: Can they pay our way out of deforestation? Forestry Roundtable, Costa Rica, GEF.

Possingham, H.P., Andelman, S.J., Burgman, M.A., Medellín, R.A., Master, L.L., and Keith, D.A. (2002). Limits to the use of threatened species lists. Trends in Ecology and Evolution 17: 503-507.

Preston, F.W. (1962). The canonical distribution of commonness and rarity. Ecology 43: 185-215.

Renner, S.C. (2003). Structure and diversity of cloud forest bird communities in Alta Verapaz, Guatemala, and implications for conservation. Niedersächsische Staats-und Universitätsbibliothek, Göttingen.

Rosenzweig, M.L. (1995). Species diversity in space and time. Cambridge University Press, Cambridge.

Scherr, S. J., and White, A. (2002). A new agenda for forest conservation and poverty reduction. Washington, Forest Ternds: 99.

Stattersfield, A.J., Crosby, M.J., Long, A.J., and Wege, D.C. (1998). Endemic bird areas of the world. Priorities for biodiversity and conservation. BirdLife International, London.

Terborgh, J. (1999). Requiem for nature. Island Press, Washington DC.

UNO (2000). Human Development Index Report. New York, United Nations.

Vosti, S. a. Reardon., T. (1997). Agricultural Sustainability, Growth, and Poverty Alleviation: A Policy and Agroecological Perspective. Baltimore, Johns Hopkins University Press.

Vosti, S., Witcover, J., and Carpentier, C.L. (2002). Agricultural Intensification by Smallholders in the Western Brazilian Amazon: From Deforestation to Sustainable Land Use. Washington, IFPRI: 30.

Waltert, M., Langkau, M., Maertens, M., Härtel, M., Erasmi, S., and Mühlenberg, M. (2003). Predicting losses of bird species from deforestation in Central Sulawesi. submitted.

Winker, K., Rappole, J.H., and Ramos, M.A. (1995). The use of movement data as an assay of habitat quality. Oecologia 101: 211-216.

World Bank (2001). World development indicators 2001. World Bank, Washington, DC.

Zeller, M., and Meyer, R.L. (eds.) (2002). The Triangle of Microfinance. Financial Sustainability, Outreach and Impact. IFPRI, Washington DC.