Minimalist trends in Mexican tropical forest management: motives and experiences

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Photo 1. Riparian zone, example of forest conditions that justifies a specific treatment regime, as the other examples (photos 2).

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**RÉSUMÉ**

**Tendances minimalistes dans la gestion des forêts tropicales au Mexique : motivations et expériences**

Les zones forestières tropicales de par le monde sont confrontées aux mêmes problèmes, tels que la dégradation et une régénération insuffisante suite à l’exploitation. La culture itinérante sur brûlis, mode de gestion traditionnel des Mayas, est aujourd’hui reconnue comme un moyen efficace de régénération des peuplements multi-espèces en zone forestière tropicale. La pratique des cultures sur brûlis au Mexique a donné lieu à une réglementation par zonage, si bien que la valeur du foncier est devenue un moyen commode pour évaluer différents plans d’exploitation forestière. En utilisant la valeur attendue du foncier comme indicateur de performance, le gestionnaire porte davantage son attention sur les arbitrages financiers entre la liquidation ou la rétention de la biomasse en pied que sur la gestion d’un peuplement mixte. Le stock résiduel sur l’ensemble de la forêt étant très important, la valeur du foncier prime sur les revenus des ventes de bois.

Plusieurs méthodes de gestion forestière allant dans ce sens sont apparues dans les régions tropicales du Mexique depuis une trentaine d’années, et représentent un mode de gestion patrimonial (GP). Le présent article décrit l’innovation générée peu à peu par ces modes de gestion, ainsi que des exemples de pratique en mode GP. Aujourd’hui, ces méthodes sont appliquées à la gestion de 155 814 ha au total dans différentes régions du Mexique. Leurs performances seront visibles à terme ; en attendant, l’adoption du mode GP par les propriétaires privés et les instances de réglementation est perçue comme un avis positif et indépendant sur la conception du mode GP. L’expérience mexicaine suggère des voies pour la gestion raisonnée de tous les types de forêts. Les éléments qui méritent réplication comprennent, par exemple, la prise en compte des forêts boisées, forêts denses, sommets de colline, marges, zones ripicoles, clairières et lisières.

**Mots-clés :** réglementation par zonage, valeur attendue du foncier, forêts mixtes, propriété forestière privée, culture sur brûlis, remplacement des peuplements, Mexique.

**ABSTRACT**

**Minimalist trends in Mexican tropical forest management: motives and experiences**

Tropical timber regions across the world share common problems such as degradation and poor regeneration after timber harvesting. Traditional Mayan land management through slash and burn is now recognized as an effective way of renewing forest stands in multispecies tropical forests. The practice of slash and burn for forest management in Mexico has led to area regulation, which has made land value a convenient means of assessing alternative forest plans. The use of expected land value as a performance indicator shifts the manager’s attention from managing a species mix to balancing financial tradeoffs between liquidation or retention of the standing biomass. Since the forest-wide residual stock is so large, land value overrides the importance of revenue from timber sales. Several forest management methods along these lines have appeared in tropical regions of Mexico over a thirty-year time span and represent a Patrimonial System of forest management (PS). The gradual innovation generated by PS is described here, as well as examples of PS practices. PS methods today provide stewardship for a total of 155,814 ha in different parts of Mexico. PS performance will become evident in the long run; in the meantime, the embrace of PS by private landowners and regulatory institutions is equated with a positive, independent opinion about PS design. The Mexican experience suggests pathways for rational management of all types of forests. PS features that are worth replicating are, for instance, the inclusion of disturbance patterns as factors in decision making, as well as the use of specific silvicultural regimes for roads, woodlands, closed forests, hilltops, swamps, riparian zones, clearings and forest edges.

**Keywords:** area regulation, land value expectation, mixed forests, private timber forests, slash and burn, stand replacement, Mexico.

**RESUMEN**

**Tendencias minimalistas en la gestión de los bosques tropicales mexicanos: motivaciones y experiencias**

Las regiones tropicales madereras de todo el mundo comparten problemas comunes, como la degradación y la escasa regeneración tras el aprovechamiento maderero. La gestión tradicional de la tierra mediante roza, tumba y quema (RTQ) se reconoce ahora como una forma eficaz de renovar las masas forestales en los bosques tropicales multiespecíficos. La práctica de RTQ para la gestión forestal en México ha obligado a la regulación de la tierra por superficie, lo que ha hecho que el valor de la tierra sea una herramienta conveniente para evaluar planes forestales alternativos. El uso del valor actual de la tierra como indicador de rendimiento desplaza la atención del gestor de la gestión de una mezcla de especies hacia balancear las conveniencias financieras entre la liquidación o la retención de la biomasa en pie. Dado que las existencias residuales del bosque son tan grandes, el valor de la tierra prevalece sobre los ingresos procedentes de la venta de madera. En las regiones tropicales de México han aparecido varios métodos de explotación forestal en este sentido. Ellos constituyen el sistema de ordenación forestal patrimonial (SP). Aquí se describe la innovación gradual generada por el SP, así como ejemplos de prácticas de SP. Hoy en día se aplican los métodos del SP para administrar un total de 155 814 hectáreas en diferentes zonas de México. El rendimiento de los SP serán evidente a largo plazo; mientras tanto, la actual aceptación del SP por parte de los propietarios privados y las instituciones regulatorias se puede considerar que es una opinión independiente sobre el diseño del SP. Esta experiencia mexicana sugiere vías para la gestión racional para todo tipo de bosques. Las características del SP que merecen ser reproducidas son, por ejemplo: la inclusión de los patrones de perturbación como factores en la toma de decisiones, así como el uso de regímenes silvícolas específicos para caminos, arboledas, bosques cerrados, cumbres, humedales, riberas, claros y bosques de orilla.

**Palabras clave:** regulación por superficie, valor actual de la tierra, bosques mixtos, bosques madereros privados, roza, tumba y quema (RTQ), reemplazo del rodal, México.
**Introduction**

Systematic, planned forest harvesting in Mexican tropical timberlands started in 1954 (Diario Oficial de la Federación, 1954). The guiding vision was that large trees are senile and declining in vigor. Selective harvest of the larger trees proceeded at a slow pace with the expectation that younger, residual trees would eventually accrue new biomass exceeding the amount removed. These ideas about partial cutting and minimum cutting diameter have become unfeasible worldwide (Clément, 1997; Blaser et al., 2006; Sist et al., 2015).

The Patrimonial System of forest management (PS) offers an alternative to Mexican and international selective management by shifting to land stewardship goals on privately-owned tropical forests (Mendoza et al., 2021; Mendoza et al., in press). This new system comprises all the usual features of a temperate forest plan: silviculture, protection, harvest regulation, forest inventory, roads, and logging. Fundamental ideas in PS were gradually assembled, starting with Plan Costa (Mendoza et al., 2015) in 1980. Manejo de Paisajes (Landscape Management Method) started in 2002, and now it is near completion of the second cutting cycle (Mendoza et al. 2005). Método Silvícola Peninsular (Negreros-Castillo et al., 2018) is the newest component, the initial forest plans under MSP were in place by 2020. Today (2020) over 155,000 hectares are managed under the stewardship of PS concepts (table I). PS name is more than a common tag for several forest management methods that support the value of land as an indicator of performance and success. The Patrimonial System elicits the idea of patrimony as something of value that deserves responsible stewardship with, among other things, the intention to inherit. For most practical purposes, patrimony in this paper is akin to capitalization and equity.

The central argument in the classical Martin Faustmann’s valuation formula means that the merits of a forest plan are better defined by the effects that such a policy has on land expectation value (Faustmann, 1849). The aim in this paper is to showcase PS as a new vision of timber management that revisits the old idea that timber management rests upon real estate management concepts. A rational decision-maker will consider assessing these effects in the context of other important decision criteria. This paper shows one possible way to design forest management upon the idea of harvest scheduling through area regulation of slash and burn silviculture. Complex tropical forests can be responsibly managed with simple rules for silviculture and harvest regulation.

**Table I.**

Ownerships that use patrimonial system management methods in 2020.

<table>
<thead>
<tr>
<th>Tenure</th>
<th>Name</th>
<th>Location</th>
<th>Method</th>
<th>Status</th>
<th>Area Ha</th>
</tr>
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<tr>
<td>Ejido</td>
<td>Kancabchen</td>
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<td>Silvícola peninsular</td>
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<tr>
<td>Ejido</td>
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<td>Quintana Roo</td>
<td>Silvícola peninsular</td>
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<tr>
<td>Ejido</td>
<td>Lázaro Cárdenas</td>
<td>Quintana Roo</td>
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<td>Approved</td>
<td>6,472</td>
</tr>
<tr>
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<td>Silvícola peninsular</td>
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<tr>
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<td>Silvícola peninsular</td>
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<tr>
<td>Ejido</td>
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<tr>
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<td>Silvícola peninsular</td>
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<tr>
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<td>Silvícola peninsular</td>
<td>Submitted</td>
<td>6,540</td>
</tr>
<tr>
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<tr>
<td>Ejido</td>
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</tr>
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<td>Ejido</td>
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<td>Ejido</td>
<td>Plan de San Luis</td>
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</tr>
<tr>
<td>Ejido</td>
<td>Nuevo Becal</td>
<td>Campeche</td>
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<tr>
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<td>Campeche</td>
<td>Silvícola peninsular</td>
<td>Submitted</td>
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<tr>
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<td>Llanito y 4 más</td>
<td>Jalisco</td>
<td>Manejo del paisaje</td>
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<td>3,305</td>
</tr>
<tr>
<td>Private</td>
<td>Santa Bárbara y 10 más</td>
<td>Jalisco</td>
<td>Manejo del paisaje</td>
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<td>5,650</td>
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<tr>
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<td>Manejo del paisaje</td>
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<td>656</td>
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<td>Jalisco</td>
<td>Manejo del paisaje</td>
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<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>155,814</strong></td>
</tr>
</tbody>
</table>
Methods

This paper is a chronicle of a local innovation experience told from the perspective of the developers. As such, it is an exercise on self-reflection seeking to enclose all the essentials and those issues and concerns of international interest.

Sources of information consulted include publications on PS concepts (Navarro-Martínez et al., 2020). This book describes in detail concepts, methods, and parameters for all methods currently complying with PS. It also provides links to publications and materials related to PS. International issues and concerns addressed in PS are discussed in Negreros-Castillo et al. (2018).

PS is a recent creation, publications about its features are expected to reach the public in the near future. Even so, this paper’s references already comprise the essential and most important elements of PS, and its position against all other forest management approaches.

Forest plans provided by practicing foresters, where consulted to provided evidence of PS practice. The value of land transactions was provided by Ruben Uu Chi (SESISA forestry consulting firm).

Results

This section starts with background factors that opened a window of opportunity for innovation in tropical forest management. The silvicultural features of slash and burn are then discussed as a response to historic trends. The next topic deals with how slash and burn fits into the simple harvest allocation schemes typical of area regulation. Only a small step is then needed to arrive at performance assessed through increased land expectation value. The paper closes with comments on the level of acceptance and practice of innovations proposed, and possible international relevance.

Local historic context

PS is a theoretical development. As such, it is expected to serve as a framework for forest plans anywhere; even so, PS has been specially tuned to the current Mexican scenario. The main features of Mexican forestry are shaped by the historic fact that all forest land is regulated by agrarian laws (Cámara de Diputados, 2018b). Public timberlands in Mexico are negligible, with some 3.9% of the country being...
public (Morett-Sánchez and Cosío-Ruiz, 2017). The mandate in the Mexican constitution (Cámara de Diputados, 2020b) can be interpreted as a need for timberlands to support landowners and other rural households. Also, wildlife law (Cámara de Diputados, 2018a) states that all wild creatures are public property. Similar laws claim public ownership of other natural resources, such as water (Cámara de Diputados, 2020a). These laws shape the legal framework for the practice of silviculture as a private business with a specific set of environmental responsibilities.

The international scenario shows some ten million hectares of tropical forests under planned forest management (Blaser et al., 2006). This is a significant amount of land whose management may benefit from the Mexican experience.

**Silviculture**

Although PS ecological success rests upon the multiple evidences of slash and burn efficacy (Ribeiro Filho et al., 2013), its design can also be thought of as an application of disturbance ecology as explained by Oliver and Larson (1996). The fundamental treatment in PS is the stand replacement. Stand replacement (Franklin et al., 2002) means near complete overstory removals over 0.5 to 6 hectares, with some degree of partial retention to secure ample ground with direct sunlight. At the same time, all microsites must be shaded part of the day. Legacy of structures retained from the previous stand (snags, litter, downed wood, small groups of live trees) provides a good seedbed to help in the prompt and healthy establishment of regeneration. Slash and burn is a common practice in the tropical forest of the world, and this practice can be considered a silvicultural treatment since the end result is a forest stand with an enriched species composition (Negreiros-Castillo et al., 2003; Ebel, 2018).

Any area in the commercial forest is eligible for final cut and stand replacement, as long as the treatment adds to the total target for replacement. The treatment is more than a clearcut, since it requires certain minimal partial shade and legacies (Franklin et al., 2002). Market opportunities and convenience in logging engineering and logistics are the main drivers defining where and when to harvest. It is important to keep in mind that harvest allocation rules require that final cut areas must be surrounded by forested vegetation at all times. No adjacent cuts will be planned until the new stand has reached the overstory height. Exceptions to this policy include special environments, such as hilltops, roads, riparian vegetation, understocked stands, natural permanent openings, and their border vegetation (photos 1 & 2). These special scenarios each deserve their own silvicultural regime. A description of each of these regimes can be found at Negreiros-Castillo et al. (2018) and Navarro-Martínez et al. (2020).

The silvicultural system in PS strives for a slow pace in stand conversion, meaning that annual operations impact a minimal amount of terrain. However, stands not harvested in an annual cutting block are eligible for partial cutting to release goal trees, trees of desirable species and form.

Annual cutting blocks form a cutting cycle of arbitrary duration; current plans use a 20-year cycle for land tracks between 3,000 and 30,000 hectares of productive timberland. This cycle is a continuation of previous forest plans; there is no particular reason to retain or to change it.

The recorded pattern of disturbances is expected to continue with similar probabilities of periodicity, severity, and extension. Instead of preventing damages, combating incidents, or restoring affected sites, parameters for disturbed places are updated in the forest data set so that their new condition plays a part in the treatment allocation procedures (Negreiros-Castillo et al., 2018). Preventive treatments can be considered for places with high exposure to disturbances if their expected efficacy compensates for their costs and uncertainty. Hurricanes can be erratic, beyond any planning, but disturbances caused by wildfire can be prevented by keeping tabs on fuel loads and their geographic distribution. Firebreaks and prescribed burning are good examples of cost-effective measures that prevent losses and damages from wildfires.

This simple silviculture allows effective control of the stand and the forest, despite the very large number of species and the considerable site variability typical of tropical timberlands. Other silvicultural systems that use the knowledge available about individual species and sites are unlikely to arrive at a feasible management solution for the whole mix; by contrast, PS has shown that a tropical forest can be handled as mixtures of bundled species and sites. This approach to a collective identity of a mixture collates the individual species’ behavior in a way that treatments for the total stand provide the needed habitat for each component, as long as individual species are fit for that environment. In large spaces, and in the long run, there will be plenty of suitable spots for each and every species in the mix.

The overall management policy comes down to a treatment protocol similar to traditional Maya slash and burn shifting agriculture (Diemont et al., 2006; Negreiros-Castillo et al., 2014), which is known to provide rapid restocking of clearings with a mixture representative of the natural forest with an increased density of the most valuable species.

Figure 1 shows a summary of the planning process for PS methods. This road map of decisions marks the places where silvicultural decisions are used. The intended use of silviculture data sets quality requirements for its acquisition. The decision-making process starts with the forest owner providing the legal documentation about his property. The land classification depends on terrain and cover. Land classification and historic precedents give support to a choice of silvicultural system for each type of land. A stand is a piece of land with a given forest structure where a field technician may suggest a number of alternative treatments. Mathematical models describing theory and results from experimental plots forecast economic effects of alternative silvicultural treatments and dynamics after plausible disturbances. These forecasts provide entry data to a harvest regulation routine. Harvest allocation follows financial indicators to suggest a set of alternative plans for the forest owner to choose and present to government regulatory agencies.
Forest management as a conversion process

PS strives for responsible management of forest-owner assets. Because land is the overwhelming component, forest plans drift towards the question of holding and improving current stocking or converting it to new, likely better stands. The longer the original timber is retained, the more the benefits of a redesigned forest are pushed into the future.

If current stocking conditions were in such a shape as to provide an outlook of significant future output flow of products and economic benefits, then the incentive would be for postponing any final harvest that initiates new stands, and vice versa. Should the new forest outpace the current forest performance, a faster conversion is in order.

A recollection of historic experiences in Mexico (Mendoza et al., 2015) shows that after a few entries, the forest usually attains the main design features drafted in forest plans, but the reality in the market and expectations among the general public glosses over that outcome and dismisses the effort and talent of foresters of the past. There is no reason to expect that today’s foresters have a sounder image of the target future forest than their predecessors. The choice in PS then is to slowly build a diversified forest structure, and gradually move the stand structure and distribution towards what is known about the timberlands of the early 20th Century. This is a no-regrets strategy that might not maximize revenue or land value, but it surely will be closer to the long-term risk avoidance preferences of forest owners.

Valuation and planning strategy

Mexican agrarian law, among other policies, provides protection to landowners against the odds that the owner might lose his land in bad deals with investors or creditors. These protections end up imposing regulatory takings that function as disincentives for real estate trading in rural areas. Even though it is infrequent, the sale of land and the sale of partial property rights happens regularly. The value of these transactions is stable enough to serve as a benchmark for PS valuation. Currently, a typical piece of good timberland bears a price tag equivalent to 94 US dollars per hectare, as reported by SESISA. PS practice is expected to sustain and even improve this land value better than the previous management policy, and upend real growth in retirement funds (annual average of 7.2%, after taxes, for the last 10 years).

The inexorable risky environment for timber production prompted PS silvicultural treatments to be low cost, high efficacy, and small scale by design. In forest plans now underway the conversion process is expected to last over 200 years so that the annual entries for stand replacement will be around 0.5% of the available productive land.

PS departs from current Mexican forest practices because of its emphasis on forest land as a fixed asset, usually the most valuable item on the timber growing balance sheet. PS dropped the usual Mexican reliance on timber sales as a performance indicator because the net sales revenue approach makes sense only for infinite or very long-time horizons.

The valuation approach in PS can be thought of as if a rational investor would raise capital, or borrow it, to acquire timberland with intention of establishing a permanent logging business that would use net revenues to pay off investors and creditors. The residual income after paying costs and capital would be considered the economic benefit of timber production. PS algorithms draft a path to provide a steady positive flow of those benefits.

This logic stands regardless of the means of land acquisition. Agrarian reform land grants, which resulted in the landowners receiving the land for free, might give a false impression that land has no value, but that way of thinking leads to inferior timber management decisions. For instance, large trees and overstocked stands common at the time of the earlier entries are perceived as profitable and renewable resources, without realizing the extreme amount of time that it took for that stocking to reach big timber dimensions. If a sensible alternative investment were taken as the fulcrum in the assessment of silviculture alternatives, then big timber and old growth become windfall profits that are perfectly feasible but unprofitable to repeat.

Retirement funds can be a sensible alternative investment for benchmarking purposes. Using retirement funds as an alternative investment to forest management provides a visualization that forest land might be considered a form of long-term investment whose main benefit could be to build up equity faster than the retirement fund. Measuring timber production performance against retirement fund rates helps the forest owner better understand his holding or cutting decisions, but it does not replace the traditional use of an alternative rate of investment like the social rate of return in the planning phase and sensitivity analysis.

Cash received from timber sales, after paying direct costs could be deposited in
financial investments as a way to park money until needed for silviculture practices, or to cover other forest management expenditures (González-Guillén et al., 1990). Such an arrangement creates the need to demonstrate that forest activities must offer benefits larger than the retirement fund, or else, the parked money would be better permanently committed to the retirement fund, growing faster and safer.

Capitalization of the retirement fund then could be converted to a periodic rent to support future needs, such as retirement and insurance coverage (medical, life, home, etc.) The level of future rents will depend on the initial size and value of forest land. For purposes of this paper, patrimony will be the value of forest land if sold at a given future time, plus the net value of any parked money, plus the current balance in the retirement fund. This vision widens the current expectation that the forest logging purpose is limited to providing wages and dividends.

Discussion

Management methods are seldom tested for performance. After their public release, they are put into practice. For the most part, long-term results are the outcome of the interplay between location, environment, technology, political and market dynamics. Accepting these limitations, an insight on the soundness of PS methods might be possible looking at landowners’ adoption of these innovations. As of today (2020), PS comprises three management methods: Plan Costa (Apodaca-Martínez, 2014), Método Silvícola Peninsular (Negreños-Castillo et al., 2018), and Manejo de Paisajes Ecológicos (Mendoza et al., 2005). Other methods currently in practice have been modified to comply with PS criteria, for instance, minimum cutting diameter was adapted for secondary forest management in Calakmul, Campeche. PS management is practiced in Jalisco, Quintana Roo and Campeche (table I). Dissemination of PS ideas is underway to attract forest owners in other regions of Mexico. The total area reported in table I includes the complete ownerships because of PS oversight and goals encompassing every type of land beyond the actual area under timber production.

Public opinion about PS practice leans toward a concern that environmental impacts of stand replacement practices will lead to deforestation. This fear may simply express mistrust because PS is a major departure from selective cutting and volume regulation. These perceptions might improve later on, as soon as the prompt regeneration of harvested stands is observed.

Leadership at government institutions has expressed enthusiastic support for PS (Mendoza et al., 2019). Regulatory agencies have offered their support for several reasons. For one, tropical forest logging has been declining for a long time, so it is good that PS has been well taken by previously reluctant forest owners. Second, complex and unreliable volume regulation has been replaced with area regulation. This simplification increases accountability and norm compliance. Another reason is the prospect that PS may foster more of the current forests in the tropics to remain forested. Last, but not least, the economic needs of forest dwellers might be better secured by real alternate investments like retirement funds instead of reliance on labor wages, dividends from timber sales, or subsidies like payments for environmental services.

Conclusion

Landowners and regulatory institutions in Mexico have received with enthusiasm the Patrimonial System of forest management (PS) to guide forest plans for tropical timberlands. Current plans provide responsible stewardship to over 156,000 hectares in several tropical regions of Mexico. PS involves several forest management methods. Harvest regulation is area-based, and land expectation value is the merit criterion for alternative forest plans. A finite number of silvicultural treatments is available to manage mixed-species forests with a simple policy of retention or conversion of the current forest structure. In all methods, the final cut is a stand replacement procedure that follows traditional Mayan slash and burn. Experience shows slash and burn provide immediate restocking of natural regeneration at minimal expense. PS innovation means that only a few treatments are considered in a given harvest schedule, and simple rules for choosing cutting areas suffice to produce forest plans accepted by owners and government regulators. These tools have been successful in Mexico and they should be easily translated to forests in other countries.

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References


