Title: "Stakeholders and tropical reforestation: challenges, trade-offs, and strategies in dynamic environments"

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Abstract:

Reforestation involves potential trade-offs: hard choices between environmental and social benefits, individual and community benefits, and among stakeholders who bear different costs and benefits. In this manuscript, we aim to show that successful long-term reforestation requires stakeholder engagement beyond planning stages and a recognition of the dynamism of stakeholder outlooks as stakeholders' opportunities, relationships, interests, and roles change over time. We first summarize lessons from recent literature on stakeholder involvement within reforestation efforts. We then present findings from a multiple-stakeholder workshop organized in west-central Mexico, in which we illustrate their choices on how to navigate trade-offs among different reforestation intervention strategies (agroforestry/silvopastoral, natural regeneration, native species reforestation, commercial plantations). We confirm that individual stakeholders' circumstances, interests, and roles, as well as the contextual factors shaping them, are dynamic, continually changing the nature of the choices stakeholders face. Finally, we propose a four-phase pathway for addressing dynamic trade-offs and synergies in stakeholder participation in order to select, implement, and sustain successful reforestation activities. The pathway comprises four phases: 1) *collaborate* to devise a reforestation strategy through dialogue about dynamic trade-offs; 2) *pledge* robust stakeholder commitments to mutual arrangements for implementing reforestation; 3) *implement* reforestation interventions; and 4) *adjust* strategy through continuous evaluation of outcomes. We then elucidate how components of these four phases can be operationalized so that, on one side, scientists and practitioners might better understand the dynamic trade-offs reforestation poses for stakeholders, and on the other, stakeholders might balance their hard choices in ways that promote forest recovery.

Keywords: tropical reforestation, reforestation trade-offs, environmental and social benefits, stakeholder dynamics, Chamela-Cuitzmala reserve, Mexico

Abstract in Spanish:

La reforestación involucra negociaciones y compromisos: decisiones difíciles entre beneficios sociales y ambientales, entre beneficios individuales y comunitarios, y entre los diversos actores sociales, ya que beneficios y costos se reparten diferencialmente. En este manuscrito, nos proponemos mostrar cómo una reforestación exitosa a largo plazo requiere, por un lado de compromisos por parte de los actores más allá de las etapas de planeación; y por otro lado, del reconocimiento que las oportunidades, relaciones, intereses de los actores cambian dinámicamente. Para lograrlo, primero sintetizamos lecciones que se derivan de la literatura reciente sobre involucramiento de los actores en los esfuerzos de reforestación. Luego presentamos resultados de un taller con un grupo diverso de actores organizado en el occidente de México, ilustramos las elecciones que toman ante las disyuntivas que surgen de distintas estrategias de reforestación (agroforestería/silvopastoril, regeneración natural, reforestación con especies nativas, plantaciones comerciales). Confirmamos que las circunstancias, los intereses y los papeles jugados por los actores, al igual que los factores contextuales que influyen son dinámicos, cambiando continuamente la naturaleza de las selecciones que los actores acuerdan. Finalmente, proponemos un camino para enfrentar estos compromisos dinámicos y sinergias de la participación de los actores para seleccionar, implementar y sostener exitosamente actividades de reforestación. Aventuramos cómo los componentes de cada una de estas fases pueden operacionalizarse para que, por un lado, científicos y técnicos puedan sopesar mejor los

compromisos que la reforestación impone a los actores; y por otro lado, los actores mismos puedan balancear sus decisiones para lograr la restauración forestal.

Introduction

Tropical reforestation can provide multiple ecological, economic, and social benefits including increased biodiversity, landscape connectivity, ecosystem services, and social and cultural well-being (Chazdon 2008, Rey Benayas *et al.* 2009, Knoke *et al.* 2009, Scoones *et al.* 2015). It also can involve substantial inputs, leading to hard choices and a potentially uneven distribution of costs and benefits among stakeholders in a context of high vulnerability (Hirsch *et al.* 2010). The trajectory of reforestation and, thus, the costs and benefits accruing to different stakeholders, will depend on the reforestation strategy implemented, as well as biophysical (Nagendra & Southworth 2009), political (Scoones *et al.* 2015), and socioeconomic contexts (Januchowski-Hartley *et al.* 2012).

Any reforestation intervention, from more passive approaches like natural regeneration to more active management as in agroforestry or commercial tree plantations, involves potential trade-offs. Trade-offs are defined here as situations in which getting more of something you want requires giving up something else you value. Trade-offs pose hard choices, meaning that even the best or ''optimal" choices involve at least some loss that is likely to be significant for those affected (McShane *et al.* 2011). In particular, reforestation efforts can raise trade-offs between 1) environmental and social advantages, 2) individual and community benefits, and 3) burdens and gains borne by different stakeholders (Bullock *et al.* 2011, Hirsch *et al.* 2010, Gibson *et al.* 2000). For example, the individual social benefits to local people from carbon credits counted towards global environmental goals are not comparable to financial profits of global firms that use those credits to justify lucrative ventures. Tensions in choices about land management emerge between human and nonhuman, individual and collective, local and distant parties. Reforestation advocates hope to realize synergies in cases where stakeholders' interests are aligned, restoring forests while enhancing livelihoods and promoting equity. In practice, trade-offs are unavoidable and must be recognized and managed to deliver effective reforestation.

Promoting reforestation initiatives as a win-win solution for environmental and socioeconomic outcomes sidesteps the hard choices that most stakeholders face, the inherent trade-offs involved, and the challenging reality that trade-offs change over time. The inevitability of hard choices is increasingly recognized, but the ways trade-offs change over time have received little attention. Previous analyses have emphasized the importance of stakeholder engagement in initial phases of reforestation planning (Khater *et al.* 2012, Kukrety *et al.* 2013, IUCN & WRI 2014, Chambers 2005). Some have described mechanisms for maintaining stakeholder involvement beyond planning stages (Chambers 1997, Armitage *et al.* 2009, Kozak & Piazza 2015). However, approaching conservation and reforestation with a static view of trade-offs obscures the reality that stakeholders at various scales of governance experience reforestation activities differently (McShane *et al.* 2011, Hirsch & Brosius 2013). More importantly, stakeholders may be affected both positively and negatively, in diverse ways that *change* – sometimes dramatically – over time (Hirsch *et al.* 2010).

The truism that all people and all landscapes vary over time has crucial implications for reforestation efforts. When different human and biophysical elements change in tandem, potential trade-offs and synergies also change. Broad economic and political shifts influence the prices of commodities and demand for land, altering the effective cost of turning farmland into forest. As conservation paradigms shift, subsidies, grants, and land policy instruments evolve, reshaping opportunities. As local stakeholders' life circumstances transform over time, they may come to value agriculture less relative to lucrative off-farm opportunities. Later in life, they may

return to the land for security in old age. Where new forests become established, the changed landscape presents new options for people who live within it. This can lead to changes in stakeholders' perceptions and values surrounding different land uses and land covers. (Agrawal 2005). As a result, the set of trade-offs that present themselves today may not be the same that emerge a few years on.

In this manuscript we aim to show that successful long-term reforestation requires stakeholder engagement beyond planning stages and a recognition of the dynamism of stakeholder outlooks as stakeholders' opportunities, relationships, interests, and roles constantly transform. Some of the ways in which stakeholder trade-offs related to reforestation change over time is shown in Figure 1. The article comprises three main parts. First we summarize lessons from recent literature on stakeholder involvement within reforestation efforts. Then, we present findings from a multiple-stakeholder workshop organized in west-central Mexico, which explored reforestation decision making and, to illustrate key issues for identification of dynamic trade-offs within reforestation. Finally, we propose a four-phase pathway for addressing dynamic trade-offs and synergies in stakeholder participation in order to select, implement, and sustain successful reforestation activities that are robust to inherent stakeholder dynamism and variation across scales of governance, income strategies, and time trajectories. With this article, we aim to assist scientists and practitioners in better understanding the dynamic trade-offs reforestation poses for stakeholders and to help stakeholders address their hard choices in ways that promote forest recovery.

1. Diversity and Dynamism of Reforestation Stakeholders: Learning from Current Research

Community engagement in reforestation
Any effort at reforestation will encounter historically sedimented social and political relationships surrounding land use and development. In Latin America, major reforestation projects in the 1970s and 1980s emphasized tree production at massive scales (Jardel 1996, Lazos 2013, Chokkalingham *et al.* 2006) with only occasional consideration of biophysical suitability (Nagendra & Southworth 2009). Poor reforestation outcomes were linked to disregard for local and regional social and cultural dimensions (Hirsch & Brosius 2013, O´Neill *et al.* 2008). To address this shortfall, international environmental organizations subsequently began promoting community-based forest management (Ribot *et al.* 2006, Chambers 2005).

Where government reforestation plans disregard local needs and realities, unintended consequences can include impaired livelihoods, insecurity of employment and land tenure, and socio-economic inequality, as well as conflicts, violence, and illegal logging or poaching (Zinda *et al.* 2016, Galudra *et al.* 2014, Grulke & Tennigkneit 2012). Reforestation success is less likely when participants are offered token rewards or unclear incentives for participation, when trust among stakeholders has not been fostered, and/or when legal and policy barriers exist (Le *et al.* 2012, Leotaud & Eckelmann 2014). Early planning requires processes for understanding "whose claims matter" (Galudra *et al.* 2014).

Involvement of local communities on its own does not guarantee successful reforestation. Gender, generational, and power disparities within communities, as well as tensions between local and regional, private and communal interests, or among national political institutions, make engaging with communities more complex than idealized notions of community suggest (Agrawal & Gibson 1999, Paz 2005). While many initiatives fail at different points in time and

for different reasons (McShane *et al.* 2011, Chokkalingham *et al.* 2006, Hirsch & Brosius 2013, Pramova *et al.* 2012), some collaborative initiatives and governance arrangements have flourished when a common agrarian history has fostered strong social relationships and enabled resilient institutions (Ostrom 1987, Bray *et al.* 2003, Berkes 1989).

Stakeholder dynamism
Meaningfully involving community members and other stakeholders in reforestation endeavors means stepping into and understanding a complex and dynamic network of stakeholder relationships that includes, but is not limited to, landholders, entrepreneurs, national and regional government agencies, and organizations from the transnational to the local level (Pieck & Moog 2009, Nygren 1995, Maldidier 1999). Members of different stakeholder groups have differing and often contrasting options, opportunities, and preferences related to livelihood strategies. For example, stakeholder options tend to vary by cultural background, sense of and connection to place, access to resources and information, quality of infrastructure, economic security and diversity of income, and political power (Escobar 2001, McAfee & Shapiro 2010). Additionally, individuals may not fit neatly into typical stakeholder categories. For example, paid farm-hand workers may also have land where they produce their own crops, tend livestock, or harvest forest products (Ellis 1999, Van der Ploeg 2009, Lazos 2011). Individual stakeholders involved in reforestation projects often play multiple roles, and their different political and social positions can be synergistic or may represent a conflict.

Shifting activities and socio-economic circumstances can change the stakes and options an individual considers. Cattle ranchers, for instance, differ in terms of age, education, herd size, ranching area, and land distribution. A herder's interests can evolve as the herd or land holdings grow, perhaps in response to favorable national or international meat market conditions, or contract, as might happen in response to prolonged drought. A farmer may sell or lease part of his land, or his children may transition out of agriculture into formal professions or migrate and send remittances. As roles change, the costs and benefits of reforestation initiatives experienced by each stakeholder may shift. Rural residents may reassess forest value in response to gains or losses of ecosystem services or social benefits (Meyfroidt 2013). Smallholders may prize a subsistence livelihood, or access to capital and markets may incentivize them to take strategical risks to maximize immediate financial gain (VanWey *et al.* 2007).

Involvement in new activities and exposure to innovative markets can change people's perspectives toward forests. These changes can include off-farm income reducing investment in agriculture (Hecht 2014), commodity production heightening the commercial value of trees or agricultural products (Sturgeon 2010), or participation in forest conservation leading rural residents to value forests more (Agrawal 2005). Likewise, the reforestation goals of governments, intergovernmental organizations, and nongovernmental organizations (NGOs), and how they pursue these goals, change with shifts in policy emphases, political conditions, markets and increased information (Gadgil & Guha 1993, Léna 1999, Rudel *et al.* 2005, Biermann & Pattberg 2008).

Stakeholders' dynamic interests and roles are embedded in intertwining processes operating at different geographical and political scales. Economic globalization, population growth, and cultural transformations increase demand for commercial crops and off-farm labor, while economic volatility disrupts demands for both, as well as reforestation funding (Hecht 2014, Lambin & Meyfroidt 2010). Environmental degradation, in gradual shifts or sudden

disasters, as well as short-term policies, can change how stakeholders evaluate costs and benefits (Meyfroidt 2013, Blaikie & Muldavin 2004).

For long-term reforestation success, practitioners need to consider how multiple and unpredictable processes might change how stakeholders relate to landscapes and one another. Scholars and practitioners have increased our understanding of trade-offs and synergies (Kanowski *et al.* 2005, Chhatre & Agrawal 2009, Stickler *et al.* 2009, Brooks *et al.* 2012) and have developed tools to incorporate multifaceted considerations into reforestation efforts (IUCN & WRI 2014). Yet this body of work insufficiently addresses the dynamism of diverse stakeholders and the corresponding economic uncertainty, which necessitate involving all stakeholders in making decisions and building relationships that are resilient to evolving circumstances.

2. Dynamic Trade-offs and Synergies of Reforestation Types: Chamela-Cuitzmala Case Study

Just as different stakeholders experience unique trade-offs and synergies, alternative reforestation strategies will bring diverse sets of trade-offs over time. To understand the dynamism of trade-offs inherent in reforestation initiatives, we held a stakeholder workshop in the Chamela-Cuixmala Biosphere Reserve on the South Coast of Jalisco, Mexico (Figure 2), to explore plausible hypothetical scenarios for reforestation and to assess trade-offs, uncertainties, and potential strategies to increase the likelihood of reforestation success. This reserve was selected in light of long-term social-ecological research that has been carried out since 1980 (Maass *et al.* 2005). The reserve encapsulates many issues central to tropical reforestation and exhibits varied and pronounced stakeholder interests, necessitating a socially-oriented approach to future land management (Castillo *et al.* 2005, Ávila & Luna 2013, Lazos n.d.).

Site history
The Chamela-Cuixmala Biosphere Reserve, declared in 1993, covers 13,142 hectares and is dominated by 1) lowland tropical dry forest, 2) riparian semi-deciduous tropical forest, and 3) highland temperate forest. These landscapes have been transformed since pre-colonial times by indigenous populations (Regalado 2008, Lazos n.d.). During the early 20th century, vast haciendas dominated and large landowners exploited forests, exporting wood to buyers around the world. In the 1940s, agrarian leaders began to push for land redistribution, but made limited inroads against large landowners, who used intimidation and violence (Lazos n.d.). Over time, encouraged by federal policies, migrants streamed in from other parts of Jalisco and nearby states, struggled for land, and established *ejidos*—a collective land tenure system established under Mexico's agrarian land reforms (Castillo *et al.* 2005, Lazos n.d.). In the 1990s, privatization of *ejido* tenure fragmented smallholder communities, weakening *ejido* institutions and local governance.[1]

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[1] During colonial times, Spanish authorities recognized the land tenure in Mexico of private landowners and some indigenous communities. Originally, these communities had a communal system; but in many cases, communal lands were little by little divided into family plots. After the Revolution (1910), the government granted landless communities that had struggled for land a form of communal land tenure, known as the *ejido*. Until the beginning of 1990s, land was divided among ejidos, indigenous communities, and private property. After 1994, new land reform policies transformed the majority of the ejidos into private property.

Approximately 20% of the current formal land rights allocations in the Cuixmala watershed pertain to indigenous communities, 30% to *ejidatarios,* and 50% to large and medium landholders (Lazos n.d.). Organizing stakeholders around land use management is challenging because of the legacy of failed reform. Examples of how reforms have collapsed include the diversion of development funds away from smallholders, state and federal agencies aligning with agrarian elites to deliver only token land reform, and officials buying votes with benefits like agricultural production credits. Nevertheless, families have always cultivated small diversified cornfields and little by little they established pasturelands, resulting in extensive cattle raising. Agricultural policies since the 1970s have opened a flow of credits to convert maize plots into pasturelands and transformed the region into a cattle producer. At the same time, some ejidatarios and big landowners started commercial agricultural lines (i.e. sugarcane, watermelon, papaya, mango, palms). Meanwhile, as a site of rapidly growing beach tourism, Chamela-Cuixmala has seen fierce battles between conservationists and developers (Ávila & Luna 2013). This troubled history, combined with a mix of cultural backgrounds, inhibits cooperation, which must be cultivated for successful reforestation endeavors.

Reforestation depends also on biophysical feasibility. In Chamela-Cuixmala, high temporal (seasonal, interannual) and spatial (topographic gradients) heterogeneity in water availability are critical factors in forest regrowth (García-oliva *et al.* 2002). Although much of the region's abundant and largely endemic biodiversity, particularly plant, animal, and insect taxa (Noguera *et al.* 2002), has been able to persist within the current land cover mosaic (Martínez-Ramos *et al.* 2012), land management is changing relative species abundances (Rendón-Carmona *et al.* 2009) as well as ecosystem integrity. Local inhabitants observe that large trees have disappeared due to logging; rivers, streams, and wells are getting drier and dirtier; river fauna is going extinct; and soils are being degraded (Lazos n.d.). Any effort of reforestation must begin by acknowledging the challenges political conflict and environmental change present.

Workshop methodology

The workshop was held at the Chamela Biological Field Station, which is operated by the National University of Mexico (UNAM). The workshop convened stakeholders that reflected the heterogeneity of the region with respect to: 1) type of stakeholder (*ejidatarios*; members of indigenous communities; municipal, state, and federal government representatives; agricultural extensionists and consultants; NGO personnel), 2) geographic balance across the study region, 3) historical connection to the region (ranging from indigenous communities to settlers who arrived from the 1970s onwards), 4) age of stakeholders (from 25-70), and 5) education (ranging from illiterate informants to bilingual individuals holding master's degrees). The twelve participants adequately reflected the region's diversity, with some important exceptions. There was sub-optimal representation of people from the upper Chamela-Cuitzmala watershed and, of particular concern, women. The participation of men only was reflective of gender bias in land management decision-making in the region and does not critically limit the current analysis. Many of the participants simultaneously represented multiple stakeholder categories, as well as changing roles and categories over time. For example, some farmers also worked as consultants or technicians for governmental programs or had previously been employed by the government.

In order to inform our proposed pathway, it was important to work with this small, but heterogeneous group of participants to understand the reforestation opportunities, constraints,

and trade-offs and the potential socio-environmental futures of the region. We were inspired by Rapid Rural Appraisal (RRA) methods to derive the desired information. RRA involves collecting information by talking directly to people "on the ground," using participatory activities and games to enable discussion and stimulate interaction. Methodologically, it prioritizes the involvement of local stakeholders in collecting, interpreting, and presenting information. Accordingly, RRA practitioners use tools that are easily understood by a wide range of people, as well as methods for quickly reporting findings and suggesting appropriate action (Chambers 1985). The workshop data showed markedly varying perspectives and visions. While the size and nature of the sample did not support statistical analyses, our presentations reflect qualitative differences that correspond to the divergent experiences and relationships of the stakeholders.

The workshop had four principal phases. The first was a group brainstorming exercise in which participants were invited to talk about their roles, their histories, their affiliations, their land use strategies, and their hopes for the future. The questions posed by the organizers facilitated conversation among stakeholders that may not normally interact and encouraged less confident attendees to address the whole group. This exercise also allowed us to understand stakeholders' social contexts and the different ways their experiences instantiate dynamism.

The second phase was a group activity in which research team members invited attendees to condense the themes discussed in the brainstorming session into categories of the most relevant land use types based on their shared perceptions. These categories were transcribed as topic 'headings' and placed in the center of the workshop space. The intention was to use these headings as a conceptual framework to guide the rest of the sessions' activities, so that the data could be analyzed comparatively.

The third phase comprised a series of preference ranking exercises (Chambers 1985). These exercises were flexible but consistent in their method to facilitate analysis. We posed a series of questions that involved participants reflecting on their own preferences and experiences as well as perceived positions of other stakeholders, with reference to the focal land use types. Each participant was given 20 tokens (seeds, beans, thumbtacks, etc.), which were unique to each individual. Facilitators invited participants to distribute their tokens across the five reforestation strategies according to, in the first instance, their personal interests; second, perceived interests of the other five stakeholder categories; and, third, perceptions of two hypothetical funding scenarios (adapted from Chambers 2002). More tokens went to the headings that they agreed with most or preferred, and fewer tokens went to the options they preferred less. With each exercise, a member of the research team recorded counts of tokens by heading category and individual. These activities allowed us to identify patterns for the group as a whole and compare across stakeholder categories.

Additionally, we asked participants to make 'opinion' slips in order to compile preferences in a more informative way. Each participant was invited to write down, or dictate to workshop facilitators, up to three key reasons that explained the allocation of tokens. Participants assigned the slips to the reforestation alternative they believed each statement applied to. We repeated these activities for a series of questions. Results are not indicative of participants' likely decisions about engaging in reforestation activities. Rather, they illuminate hypothetical stakeholders' perspectives on what salient costs and benefits each of the five alternatives would be likely to have.

The fourth phase was a plenary session. At several occasions during the workshop, we invited participants to discuss what they had learned about other stakeholders' perspectives.

Workshop outcomes

Participants' dynamism. The personal histories shared in the brainstorming session allowed us to assess how relevant our picture of dynamism was in the Mexico-Chamela context and to identify particular ways trade-offs vary. Some participants spoke about their shifting views on land use over time, related to changes in their lives. Government representatives changed positions every 3 years, shifting from municipal to state level or from government to consultancy. Those working for NGOs had been recently hired or participated in NGO creation in the last 10 years. Older *ejidatarios* had established themselves in the region more than 40 years ago from other areas of the country at a time when governmental programs promoted colonization and rural development. Younger *ejidatarios* were born in the region, and had been constantly looking for opportunities in the cities or in the United States. *Ejidatarios* face year-to-year shifts in cattle market prices and water availability and have to adjust accordingly the amount of land devoted to cattle ranching as well as herd size.

Analyzing the transcripts of the workshop, we identified three prominent dynamic elements with relation to land use: income strategies, generational change, and governance scales. Over time, participants' land use and income strategies varied in response to both external factors, such as national markets and policy incentives, and internal factors, such as diverse financial needs across the household life-cycle. Three common foci of changing strategies were cattle, conservation, and land holdings.

New government incentives for community-based conservation, as well as a general increase in the number of branches of the environmental ministries, had effects at both community and individual levels, bringing new alternatives for people and landscapes. First, paid government and non-government programs provided temporary environmental jobs which brought a small income source and different roles within the communities as outreach workers or communications personnel for individuals. These jobs also build capacity within communities. Although state jobs and the individual benefits reached a few people, they also brought new ideas about the environment into the heart of socio-political life. Participants reported that in two communities, these changes in environmental thinking translated to an increase in forest cover and wetland area in community lands. As a result of pro-environment incentives, one community had become heavily engaged in eco-tourism and wildlife conservation based on turtles and crocodiles.

Different opportunities for individuals led to diverging experiences across generations. Workshop participants included two indigenous community members, a community leader and his son. The indigenous leader, although illiterate, told of a life of diverse land-based activities such as fishing, forestry and animal husbandry. His son, on the other hand, was educated to third level, had been to the United States to work, and spoke English. His ideas about how the community could move forward included intensifying land use through mechanization and 'scaling up'. Generational transitions like this and the diverging perceptions they bring are a challenging element of social reality for reforestation projects.

Participants also showed dynamic involvement at different levels of governance. Some participants who had worked in government roles had moved across administrative levels from local to state, due to political shifts and involvement in particular projects at given points in time. Others who had once worked in an office at the state or federal level had moved to regional or local-level government roles, bringing their knowledge and networks with them.

Framing reforestation. To frame a discussion of reforestation, participants addressed the question, "Do we need trees, and how could we increase the amount of trees in the region?" To refrain from imposing preset concepts, facilitators deliberately avoided the terms *reforestation* or *restoration*. None of the participants mentioned "restoration" in discussions about how to increase the coverage of trees on the landscape. However, the word "reforestation" was used by participants in reference to planting native species under specific federal programs. Participants focused on a set of plausible reforestation interventions and key stakeholders who might be involved.

Identification of reforestation interventions. While brainstorming reforestation alternatives that could be feasible within their current cultural heritage, socio-political, economic and biophysical conditions, participants demonstrated familiarity with numerous strategies for proliferating trees on the landscape. The group narrowed these down to five interventions.

1. *Reducing burning*: participants explained that woody vegetation grows quickly in active pastures when slashing and burning are not conducted regularly; in fact, current regulations restrict the use of burning around the reserve.
2. *Establishing agrosilvopastoral systems*: participants listed multiple combinations of pasture grasses, annual or perennial crops, and trees or palms (planted or naturally regenerating) that have been explored in the region.
3. *Facilitating natural regeneration:* participants stated that, in this region, native woody vegetation establishes and grows quickly in areas where pastures or agricultural lands are not weeded and maintained.
4. *Reforestation with native species:* participants mentioned that seedlings from native species are available at some greenhouses in the region or from governmental programs, or they can be directly grown from seeds land users collect on their own.
5. *Establishing commercial plantations*: participants knew of instances in which non-native trees with high commercial value for their wood, fruits, or oil content of their seeds have been cultivated.

Key Stakeholders. Next, participants identified what they considered the five most contrasting and representative regional stakeholder groups to consider in subsequent reforestation exercises.

1. *Cattle ranchers*, including *ejidatarios*, indigenous community members, private land-owners, and those who rent the land for raising cattle.
2. *Federal government officials from the Ministry of Environment*, Secretary for Environment and Natural Resources (SEMARNAT).
3. *Federal government officials from the Ministry of Agriculture*, Secretary for Agriculture, Ranching, Rural Development, Fishing, and Food (SAGARPA).
4. *Municipal government representatives*
5. *Entrepreneurs and local business owners*

Preference ranking outcomes. Personal preferences among reforestation alternatives were evenly distributed (Column 1, Fig. 2), with somewhat greater amounts for natural regeneration (25%), agro-silvopastoral systems (24%), and reforestation with native species (20%), while commercial plantation was least desired (14%). Agro-silvopastoral interventions were equally liked by participants who directly manage land (*ejidatarios* and indigenous communities) and those who

do not (government officials, NGOs and consultants), as cattle raising has played an important role in the regional development. However, land managers showed greater inclination for natural regeneration, while all others combined had higher preference for commercial plantations.

Preferences for reforestation alternatives shifted when participants were asked to "stand in the shoes" of other stakeholders (Figure 3). Agro-silvopastoral systems, involving continued livestock production, were ranked higher when participants envisioned themselves as cattle ranchers (65%) and Ministry of Agriculture officials (43%). As participants expressed, cattle raising, as an important driver of deforestation, can be converted into a positive driver of reforestation if it is labor-intensively managed in agro-silvopastoral systems. Nevertheless, this transformation needs political and financial support through adequate policies. These requirements induced serious doubts among *ejidatarios* that agro-pastoral systems would lead to sustainable management of pastures and forests. Commercial plantations, perceived to offer the highest potential economic benefits, were ranked higher when participants envisioned themselves as entrepreneurs and business owners (38%).

Participants repeated the token distribution exercise for two hypothetical funding scenarios. For partnerships between *ejidatarios* and private investors (a prospect suggested by workshop participants), interest in agrosilvopastoral systems increased from 24% (with no outside funding) to 34%. A scenario of international investment support under a Global Reforestation Initiative (briefly described by workshop organizers) raised interest in commercial plantations from 14% to 19%.

Perceived trade-offs. In the "opinion slip" exercise and plenary discussions, participants identified a range of trade-offs and synergies associated with each of the five reforestation interventions (Table 1), which were seen as competitors for space required for livelihood activities. In some instances, participants saw a tension between income prospects, mainly from cattle raising, which would lead to income over the short term but which would degrade the land over the long term. Natural regeneration was seen as well suited for the region's poor soils and dry climate, especially in comparison with tree planting, due to its low cost of establishment, despite low profit potential and a long delay in realization of benefits. Native species were seen as biophysically suitable, while commercial plantations with exotic trees were seen to have the highest potential for long-term financial gains. In other instances, participants saw long-term rewards pitted against short-term costs and risk due to long maturation periods. Potential economic returns made both planting native species and commercial tree plantations attractive, although high establishment costs, long delay in return on investments, and high risks were perceived as obstacles (see quotes in Table 2). Participants favored agrosilvopastoral systems and reduced burning as options that allow continued cattle ranching. However, long establishment time, high cost, and concerns about suitability given the region's arid climate were seen as trade-offs (Tables 1 and 2). They found balancing short-term risks, long-term gains, and biological suitability daunting.

These trade-offs pitted different values across diverse social units. In particular, participants tended to associate environmental considerations with community-level benefits and costs (52% and 51% of slips, respectively). Improved ecosystem services (e.g. reduced erosion or increased carbon stocks) were among the most cited communal environmental benefits, while undesirable plants and animals, as well as climatic or soil limitations to plant growth, were shared communal environmental costs. These collective concerns often came into tension with economic considerations experienced by households. When households were the focus, 75% of

slips relating to costs and 80 % of slips concerning benefits referred to economic issues, with change in net income most commonly mentioned (Table 1). For example, forest conservation may bring environmental benefits for the community by protecting land from hurricanes and improving water quality and quantity. Nevertheless, nowadays families need to convert their land into pasturelands to capture rising cattle prices. Also, a water source in a plot can be controlled individually, and this has environmental and social costs for the community. Another example is hunting. It has individual economic benefits, but may cause loss of biodiversity at the community level.

Limiting factors and enabling conditions. As limiting conditions for reforestation, participants most frequently indicated socio-political factors (55% of paper slips), followed by environmental (26%) and economic (18%) factors. Participants lamented weak consideration of stakeholders' knowledge, culture, and family economic needs by government officials. They asserted that officials may see local stakeholders as having cultural resistance to innovation. Other perceived obstacles to reforestation included the following: interannual variability in precipitation and seedling establishment; tendency of volatile market prices for cattle, wood, and other commercial trees to turn attractive reforestation investments into failures; technological knowledge and support gaps; poorly timed seedling delivery; varied, contradictory, and insufficient government incentives for conservation and reforestation; pervasive problems with burdensome and changeable bureaucratic processes, low transparency, corruption, and power imbalances; land grabbing; regional violence and personal safety risks related to land conflict; variable and often deficient informal institutional arrangements within communities.

Perceived information gaps included tree species-level information (growth rates, pests, longevity, seasonality for harvesting and maintenance), regional zonation maps (fertility, ecological characteristics), land tenure maps, technological information and training, and mechanisms to increase political and project-level transparency.

Participants frequently mentioned social enabling factors for reforestation (84% of paper slips). They emphasized transparent and corruption-free paper trails, reduced bureaucracy, and long-term training programs. Economic enabling factors included market orientation training, programs with clear economic support, and higher-value payments for ecosystem services.

Future actions. In considering future actions, participants most commonly mentioned social strategies (84% of slips) such as participating in training, establishing family commitments, increasing knowledge, and being responsible about environmental issues linked to reforestation. Strategies for strengthening economic resources (personal savings) for reforestation included committing a portion of their land to reforestation and investing in long-term maintenance (Table 2).

Participants indicated that actions by others should include both social (56% of slips) and economic items (48% of slips). Clear informal and formal governance arrangements, improved infrastructure (roads, information systems), technical education, access to credits, less bureaucratic processes, and good communication, as well as reduced corruption and conflict among sectoral policies, were suggested. Other factors mentioned included guaranteed markets and clients, financial inputs from large landholders, economic diversification, and alternative incomes during crisis periods (Tables 1 and 2).

Perceived needs for long-term regional reforestation success were largely economic (84% of slips), particularly income diversification (22% of slips) and stabilization as well as increased

awareness of environmental issues and establishing long-term commitments for maintenance of selected reforestation interventions. From this perspective, agrosilvopastoral systems could provide income diversification and economic as well as ecological stabilization over the long term.

Insights gained in the workshop and implications beyond the study area

The Chamela-Cuixmala workshop gave clear evidence of varied trade-offs facing different stakeholders and change over time in the trade-offs a given stakeholder or stakeholder group may face. Different stakeholders recognized a range of possible reforestation interventions and associated trade-offs and synergies rather than perceiving reforestation as a monolithic land use strategy. Four key aspects of these situations stand out.

Diversity. Farmers preferred agrosilvopastoral systems that might sustain cattle and crop production as well as tree cultivation for environmental values, reflecting a strong sense of place and a need to prioritize subsistence production to cover their families' needs. Entrepreneurs considered reforestation as a business activity and were more interested in commercial plantations, while ecological protection was crucial for participants working for federal environmental institutions. Federal agricultural ministry representatives prioritized crop and cattle production. Divergent stakeholder priorities may combine with different cultural, historic, and economic backgrounds to inhibit cooperation around reforestation. To build robust engagement, stakeholders' priorities should be discussed and addressed within short and long-term agreements.

Dynamism. Workshop participants repeatedly stressed how biophysical, political, and economic factors shift continuously. Decreases in total annual precipitation had jeopardized previous reforestation efforts. Vacillating governmental programs brought plantations of a particular species one year and a different one the next. Abrupt changes in market prices of commodities like beef and timber hindered people in making long-term commitments. As a result, participants preferred reforestation strategies that demand little change in current activities, such as establishment and maintenance of agrosilvopastoral systems. If ecological, social, and financial unpredictability increase in the future, stakeholder appetite for reforestation may be reduced, and a range of potential benefits may be foregone.

Multiple Dimensions of Trade-Offs. In Chamela-Cuixmala, like in many other places, trade-offs run across multiple domains. Workshop participants highlighted weighing short-term opportunity costs against long-term prospects, tensions between economic and environmental values, and conflicts between household benefits and the welfare of broader collectives. In any given locale, the nature and intensity of trade-offs reforestation raises will be specific to that place's confluence of historical, political, and environmental conditions. But the need to address multifarious tensions, far beyond the ambit of cost-benefit analyses, will arise in any context.

Conflicts and Governance Concerns. For many decades, farmers in Chamela-Cuixmala have been accustomed to clientelist relationships with government agencies. These relationships perpetuate corruption and hamper development of community institutions. As in many regions,

governance continues to be opaque, non-participatory, and unreliable. Workshop participants suggested alternative, participatory models in which government institutions respect the needs of *ejidatarios* and other landowners, laying the ground for all stakeholders to respect collaboratively established norms and rules. They envisioned a coordinated, multi-centered governance structure capable of bringing together diverse stakeholders from local, regional, state, and national levels to jointly develop solutions. In light of the diversity, dynamism, and trade-offs they discussed, arriving at durable arrangements requires inclusive *processes* towards reforestation. But instituting inclusive processes requires clearing up sclerotic governance (Berkes et al. 2003, Armitage et al. 2009).

Regeneration assessments rarely include this full range of considerations nor extend beyond forest establishment into forest growth and maturation. Greater focus is needed on mechanisms for robust deliberation among stakeholders, for local and regional governance, for cultivating trust and cultural respect, and for ensuring co-financing and information flow across the long lifespans of tropical reforestation initiatives (Hirsch *et al.* 2010).

3. A Pathway for Constructing a Long-Term Reforestation Initiative

How might people of different walks of life in Chamela-Cuixmala, or anywhere else, turn this tangle of hopes, worries, expectations, and doubts into a workable collaborative effort to restore forests and strengthen human ties? Conclusive answers have eluded generations of people deeply committed to working through hard choices. In each instance, the answer will depend on the extended, painstaking efforts of stakeholders. But the insights gained from the literature review in the first section and from the workshop in the second section yield a set of heuristic principles from which we can sketch a pathway that will be of value in undertaking reforestation efforts.

Principles that emerge from the literature review and the workshop

Any reforestation initiative hinges on a workable *strategy* for reforestation; however what makes for a workable strategy is not self-evident. A reforestation strategy will be built around one or several interventions such as those that workshop participants proposed. It will outline reforestation goals and the roles of different stakeholders in achieving them. Arriving at these will require inclusive and iterated discussions that identify and bring in stakeholders and engage them in bringing to light potential trade-offs and synergies and ways to balance the needs and aspirations of different stakeholders.

Realizing a reforestation strategy depends on securing *commitments* from stakeholders to implement the strategy. Our literature review highlighted the importance of community involvement, yet the dynamism of trade-offs and stakeholders revealed through the workshop calls for specific strategies to secure commitments that are robust to changing conditions over the long-term. Commodity and carbon offset prices, government policies, political tensions, and trends among international environmental NGOs change unpredictably, creating uncertainty for reforestation planning, which requires reforestation proponents to provide assurances and contingency plans, particularly for the most vulnerable stakeholders. Since conditions change, with the potential to enhance or lessen the rewards of participants, keeping people involved requires commitments. Securing commitments requires establishing reciprocity and trust (Armitage et al. 2009, Poteete *et al.* 2012), which in some cases may necessitate repairing the credibility of governance structures where these have been damaged by historical corruption. Of course, dialogue grounded in trust is vital at all phases and reciprocity is central to establishing

legitimate governance arrangements. Addressing uncertainty and conflict requires innovative strategies that foster collaboration, contribute to trust building, and consolidate social networks among diverse stakeholders, highlighted by the theoretical current known as adaptive co-management (Armitage et al. 2009).

People implement commitments within *governance arrangements*. Our literature review emphasized the need for understanding the complex and dynamic network of stakeholder relationships; workshop results underscored the importance of legacies in such relationships. Effective governance arrangements center on rules and procedures that sustain rights, responsibilities, and reciprocity. Reforestation initiatives rely on voluntary engagement and depend on flexible, dynamic platforms for stakeholder engagement that emphasize information-sharing, collaboration, and innovation. Land users need clarity and security of rights surrounding land tenure, terms of participation, and cultural and territorial belonging. Reciprocity entails good faith dialogue as well as material transactions. Inadequate financial incentives for small-scale land managers hampers many reforestation efforts (Lemenih & Kassa 2014, Mansourian *et al.* 2014). Substantial and reliable financial incentives can make it possible for smallholders to participate (Melo *et al.* 2013). Nonetheless, where money flows, diversion and corruption often germinate. The bedrock of effective operational arrangements is establishing rules and relationships that are firm enough to maintain commitments, sanction violators, and respond to differing and changing situations.

Reforestation participants can balance firmness and flexibility through *recursive monitoring* and evaluation. Governance arrangements must provide for regular assessment of progress towards goals and changing conditions. Such arrangements allow stakeholders to jointly take stock so as to adjust reforestation strategies and implementation arrangements as needed.

A suggested pathway

These principles inform a pathway that we propose below as a heuristic aid to participants in reforestation initiatives. The pathway suggested here is intended to assist stakeholders—land users, government staff, NGOs, funding entities— in adopting strategies that could lead to long-term forest regeneration projects (Figure 4).

In seeking more successful navigation of dynamic stakeholder reforestation trade-offs, the proposed pathway comprises four "phases": 1) *collaborate* to devise a reforestation strategy through dialogue about dynamic trade-offs; 2) *pledge* robust stakeholder commitments to mutual arrangements for implementing reforestation; 3) *implement* reforestation interventions; and 4) *adjust* strategy through adaptive evaluation of outcomes. We picture these phases as conceptually distinct components of an interconnected and recursive process. In practice they are likely to overlap as people backtrack or jump from one point to another as they deal with emergent concerns, making a linear sequence unlikely. For example, robust stakeholder commitments will be forthcoming only if the governance arrangements are made clear and explicit.

Phase 1. Collaborate to devise a reforestation strategy through dialogue about dynamic trade-offs. In this phase, the key outcome is determining a preferred reforestation strategy. Stakeholders with direct or indirect involvement in a reforestation initiative must be engaged as dynamic agents involved in interactions and interdependencies (Swallow 2009, Armitage et al. 2009, Grimble & Chan 1995). Facilitators must bring stakeholders together to identify and

explicitly discuss relevant social-ecological and biophysical constraints as well as common and divergent values relating to potential reforestation interventions (Cavender-Bares *et al.* 2015, Chan *et al.* 2012, King *et al.* 2015). Collaborative efforts to identify viable reforestation pathways should accommodate political and socio-economic conditions, agricultural history, and cultural heritage. In evaluating trade-offs, stakeholders will need to make clear the different objectives each brings to the table, the resources each can contribute, and how each potential reforestation intervention might draw on these (Guariguata *et al.* 2008, Holl & Aide 2011). These discussions must attend to not only how each stakeholder's changing land uses and management intensity may influence the durability of a reforestation intervention, but also the biophysical conditions that may affect its potential to succeed.

Reforestation options have different costs and benefits in terms of biological productivity, ecological restoration potential, and economic returns. Facilitating natural regrowth tends to have lower establishment costs and potentially higher biodiversity and ecosystem service potential, but provides less control over forest products than native or commercial tree plantings (Chazdon 2008, Lamb *et al.* 2005) and lower economic benefits to landowners. Low-cost assisted natural regeneration or on-farm tree planting may, therefore, be preferred by land managers themselves or by cash-strapped nonprofit organizations supporting reforestation (Murgueito *et al.* 2011, Griscom & Ashton 2011).Where financial support for reforestation is greater, more labor-intensive interventions (e.g. raising seedlings in nurseries, site preparation, tree planting, weeding) may be feasible based on potential socio-economic benefits they may generate for land managers, small land-owners, and laborers in the form of employment, income, and connection to the project. The decision to select one or a suite of reforestation interventions must flow out of inclusive dialogue.

Phase 2. *Pledge* robust stakeholder commitments within collectively devised governance arrangements. Once trade-offs have been examined, progress toward successful and equitable reforestation requires that all stakeholders make fair and credible commitments toward agreed objectives. Stakeholders must construct a shared understanding of what members of each stakeholder group need and what they are willing and able to contribute in terms of financing, labor, and resources, as well as coordination and monitoring. Achieving credible commitments requires an inclusive process that addresses the asymmetric stakes and power structure of different stakeholders. Drawing on small networks that engage individuals beyond local leadership can be effective for garnering multiple perspectives and assuring that outcomes secure broad confidence. We have discussed how unclear and unstable governance arrangements can disrupt forest regeneration efforts. Establishing stable, trusting, and open governance arrangements will not only lessen these threats but also, by stabilizing participants' expectations and making trust enforceable (Williamson 1993), mitigate some of the risks that stakeholder dynamism poses.

To advance the reforestation options emerging from Phase 1, stakeholders need clearly articulated objectives and agreement on a staged implementation strategy. Such a strategy should include the following:

1) plans for specific activities that delineate how costs will be met, who will receive revenues and other benefits, and how the welfare of disadvantaged stakeholders will be ensured if unexpected circumstances arise;

2) governance arrangements that maintain open communication and accommodate negotiation and compromise among stakeholders through, for example, advisory boards,

stakeholder committees, indigenous and peasant organizations, and government liaisons; and

3) provisions for implementing monitoring metrics (i.e. biophysical, financial, socio-cultural, and other types of data) and stakeholder commitments to operate or contribute to credible, accessible information systems.

In a context of dynamic trade-offs and stakeholder asymmetries, governance arrangements must allow stakeholders to air and negotiate divergent perceptions, values, interests, and power relations across and within different groups. This may require explicitly addressing how agenda-setting power and other privileges held by some stakeholders can limit the options considered and marginalize or alienate some stakeholders (Hirsch & Brosius 2013). Stakeholders can use tools like multi-criterion analysis, mediated modeling, and participatory decision-making approaches to help clarify trade-offs across multiple values and scales and so work toward inclusive deliberation. By establishing strong, transparent governance structures, reforestation stakeholders can develop norms of reciprocity and increase investment in collective efforts (Berkes 2007, Ostrom 1987, Poteete *et al.* 2012). In the workshop, participants stated the importance of generating dialogue, experimenting with new modes of communication, and building empathetic understanding by stepping back to stand in other stakeholders' shoes. This is a modest starting point, but an important one that can provoke new ways of working out collective environmental problems.

Phase 3. *Implement* reforestation interventions. In this phase, the key outcome is clarification and implementation of specific actions to be taken by designated stakeholders. This includes both on-site (e.g. changes in land management practice, tree planting) and off-site activities (e.g. provision of capital funds, information management). Stakeholders likely to be involved in this phase include land managers, technical advisors, and financing entities.

Key actions include:

1) initiation and ongoing implementation of reforestation activities and financial arrangements as specified within Phase 2 commitments;
2) operation of information systems that gather data (e.g. biophysical and socio-economic conditions, financial flows, commodity markets) to support implementation and document performance (i.e. monitoring, reporting and verification, MRV), and manage access and reporting; and
3) continuation of governance arrangements agreed upon in Phase 2, including appropriate compensation to individuals or entities delivering coordination and information services and sanctions for stakeholders who do not deliver on commitments.

In the medium and long term, implementation activities rely on reasonable sharing of costs and benefits and maintaining responsive governance mechanisms in light of the asymmetric risks different stakeholders face. Long-term planning and contingency strategies can help address disparities by, for example, specifying responsibility for unfavorable outcomes. Stakeholders that implement and maintain forest regeneration are often the least advantaged: smallholder farmers and ranchers asked to perform labor and change land uses that have previously provided their livelihoods. If reforestation fails, these stakeholders can face immense costs. Larger landholders and residents with off-farm income sources have proportionately less at stake. Government personnel must meet mandates and avoid conflict, but in many cases will not face catastrophic

personal loss if a local project fails. International organizations and funders manage large project portfolios and can redirect their efforts to other locales if one project proves unrewarding. Over recent decades, in our experience, there are many examples of NGOs and agencies disappearing at the end of a project cycle, leaving local residents to live with negative or unforeseen impacts on local livelihoods and landscapes. To ensure that the people tending trees can continue to perform their roles, other stakeholders need to provide credible assurances of goodwill and reciprocity.

Such assurances will depend in part on steady financing. In many cases, the magnitude and character of 'public good' financing in programs of payments for ecosystem services are inadequate to sustain reforestation (McAfee & Shapiro 2010, Zinda *et al.* 2016). Inadequate amounts of funding, delays, or inaccessibility to key implementers (including diversion or loss due to corruption) can inhibit effective financing of reforestation initiatives, resulting in slow progress toward implementation, benefit flow, and solidified or expanded participation (Le *et al.* 2012). Projects that commence with short-term financing (e.g. grants) should have realistic plans for income generation and re-investment (Le *et al.* 2014, 2012).

Phase 4. *Adjust* strategy through adaptive evaluation of outcomes . In this phase, the key outcomes are ensuring the sustainability and equity of reforestation interventions and ensuring continued stakeholder commitment. This phase is critical for achieving long-term success of a specific reforestation initiative; if information is made broadly accessible, it can also expand the base of knowledge on which to build future successful reforestation initiatives. Recent reports based on project-level MRV have been useful for understanding costs and benefits to stakeholders (Pinto *et al.* 2014, Lemenih & Kassa 2014, Mansourian *et al.* 2014). The following activities are central:

1) comparing reforestation performance against agreed reforestation targets using monitoring data;
2) determining costs and benefits accrued by different stakeholders;
3) assessing changes in social, ecological, and financial contexts that may influence future costs and benefits; and
4) course corrections such as adjustments in targets, stakeholders' commitments, and governance arrangements (van Oosten *et al.* 2014).

Although local stakeholders may have strong collective institutions through which to organize agreements and commitments, individuals and households decide whether to participate in regeneration programs based on consideration of potential rewards, foregone opportunities, availability of land and labor, perceived risks, family possibilities and cultural dynamics. Inherent diversity among households often requires flexible incentives and risk mitigation measures.

Conclusion

All reforestation interventions are entangled in social and political structures. Stakeholders differ in the trade-offs they face. A stakeholder's trade-offs will vary across different reforestation strategies and also over time as political, socioeconomic, cultural, and environmental conditions change. At the same time, rather than having intrinsic and stable identities, stakeholders change over time in their interests and roles, bringing corresponding changes to their preferences and

perceptions of trade-offs. Stakeholder engagement and reforestation governance structures need to account for the dynamic character of trade-offs and synergies.

Trade-offs are not just dynamic but heterogeneous across stakeholders. Stakeholders' diverse socio-economic and cultural positions generate divergent interests, preferences, and perceived risks, and these may change over time as stakeholders' individual situations evolve and as their roles (as leaders, as government public servants or as members of NGOs) change over the course of their lives. Stakeholders who are part of indigenous communities, *ejidos*, or localities where private landowners dominate may approach reforestation efforts differently. The effects of dynamism on trade-offs and synergies for these and various other stakeholders should be considered in planning phases and reevaluated throughout a reforestation effort.

Diverse stakeholders face dynamic and uncertain contexts as they evaluate the hard choices that reforestation presents: between economic and environmental values, between short- and long-term needs and outcomes, between household benefits and the welfare of broader collectivities. Securing long-term commitments from relevant stakeholders requires achieving legitimate compromises that result in mutually acceptable reforestation methods and distributions of costs and benefits. It also necessitates continuous financial flows as well as capacity-building processes. Financial unpredictability could undermine the intended benefits of reforestation efforts. To make decisions stick, participants must negotiate together how to monitor one another's conduct, evaluate progress, and anticipate and respond to unexpected changes. Such inclusive dialogue is vital to enabling stakeholders to pledge commitments within collectively devised governance arrangements, making robust reforestation efforts possible.

The workshop at Chamela-Cuixmala exemplifies what land users, officials, and organization personnel all over the world face when they are part of a forest regeneration initiative. While the specific issues at stake in trade-offs will be different in every case, the work presented here illuminates the multiple dimensions of trade-offs, including the tensions, conflicts, and governance concerns. Transparent and participatory governance arrangements, with regular evaluation of their effectiveness, are critical. Reforestation poses specific challenges in getting to credible and resilient commitments, and adequate frameworks constructed through direct consultation with stakeholders are often lacking. We believe that resources dedicated to engagement, governance, and evaluation will enhance the likelihood of success of reforestation efforts from socioeconomic and biophysical perspectives.

FIGURES AND TABLES
Figure 1. Examples of the ways in which stakeholder tradeoffs related to reforestation may change over time. We focus on individual and community tradeoffs because these groups

experience the greatest costs and benefits of reforestation. Dynamism in stakeholder's tradeoffs will also affect regions and the global community.

Figure 2: Map of the region

Figure 3: Changing preferences for reforestation alternatives by different stakeholders for tropical dry forests in western Mexico. In a first step, workshop participants were asked to assess their own preferences (first column); in the following steps they were asked to express the preferences of each of the other stakeholders identified during the workshop.

Figure 4: A pathway for reforestation

Table 1: Trade-offs and synergies associated to the five reforestation interventions

Table 2: Quotes from the Stakeholders at the Chamela-Cuixmala Workshop

Literature cited

AGRAWAL, A. 2005. Environmentality: Technologies of Government and the Making of Subjects. 325. Available at: http://www.researchgate.net/publication/42764659_Environmentality_Technologies_of_Government_and_the_Making_of_Subject.

AGRAWAL, A., and C. C. GIBSON. 1999. Enchantment and Disenchantment: The role of community in natural resource conservation. *In* Communities and the Environment: Ethnicity, Gender and the State in Community-Based Conservation. pp. 629–649.

ARMITAGE, D., R. PLUMMER, F. BERKES, R. ARTHUR, A. CHARLES, I. DAVIDSON-HUNT, A. DIDUCK, N. DOUBLEDAY, D. JOHNSON, M. MARSCHKE, P. MCCONNEY, E. PINKERTON, AND E. WOLLENBERG. 2009. Adaptive co-management for social-ecological complexity. Front Ecol Environ 7 (2): 95-102

ÁVILA, P., and E. LUNA. 2013. Del ecologismo de los ricos al ecologismo de los pobres. Rev. Mex. Sociol. 75: 63–89.

BERKES, F. 1989. Common property resources: ecology and community based sustainable development. Belhaven Press, London, UK.

Berkes, F., C. Folke, and J. Colding. 2003. Navigating social-ecological systems: building resilience for complexity and change. Cambridge, UK: Cambridge University Press.

BERKES, F. 2007. Community-based conservation in a globalized world. Proc. Natl. Acad. Sci. 104: 15188–15193. Available at: http://www.pnas.org/cgi/doi/10.1073/pnas.0702098104.

BIERMANN, F., and P. PATTBERG. 2008. Global Environmental Governance: Taking Stock, Moving Forward. Annu. Rev. Environ. Resour. 33: 277–294.

BLAIKIE, P. M., and J. S. S. MULDAVIN. 2004. Upstream, Downstream, China, India: The politics of environment in the Himalayan Region. Ann. Assoc. Am. Geogr. 94: 520–548.

BRAY, D. B., L. MERINO-PÉREZ, P. NEGREROS-CASTILLO, G. SEGURA-WARNHOLTZ, J. M. TORRES-ROJO, and H. F. M. VESTER. 2003. Mexico's Community-Managed Forests as a Global Model for Sustainable Landscapes. Conserv. Biol. 17: 672–677.

BROOKS, S. J., K. A. WAYLEN, and B. MULDER. 2012. How national context, project design, and local community characteristics influence success in community-based conservation projects. Proc. Natl. Acad. Sci. 109: 21265–21270.

BULLOCK, J. M., J. ARONSON, A. C. NEWTON, R. F. PYWELL, and J. M. REY-BENAYAS. 2011. Restoration of ecosystem services and biodiversity: Conflicts and opportunities. Trends Ecol. Evol. 26: 541–549.

CASTILLO, A., A. MAGAÑA, A. PUJADAS, L. MARTÍNEZ, and C. GODÍNEZ. 2005. Understanding the interaction of rural people with ecosystems: A case study in a tropical dry forest of Mexico. Ecosystems 8: 630–643.

CAVENDER-BARES, J., S. POLASKY, E. KING, and P. BALVANERA. 2015. A sustainability framework for assessing trade-offs in ecosystem services. Ecol. Soc. 20.

CHAMBERS, R. 1985. Shortcut Methods of Gathering Social Information for Rural Development Projects. *In* M. Cernea (Ed.) Putting People First. Sociological Variables in Rural Development. pp. 399–415, Oxford University Press/The World Bank, Washington, US.

CHAMBERS, R. 1997. Whose reality counts? Putting the first last. Practical Action Publishing, UK.

CHAMBERS, R. 2002. Participatory workshops: a sourcebook of 21 sets of ideas and activities. Earthscan, London, UK.

CHAMBERS, R. 2005. Ideas for Development. Earthscan, London, UK.

CHAN, K. M. A., A. D. GUERRY, P. BALVANERA, S. KLAIN, T. SATTERFIELD, X. BASURTO, A. BOSTROM, R. CHUENPAGDEE, R. GOULD, B. S. HALPERN, and N. HANNAHS. 2012. Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement. Bioscience 62: 744–756. Available at: http://bioscience.oxfordjournals.org/cgi/doi/10.1525/bio.2012.62.8.7.

CHAZDON, R. L. 2008. Beyond Deforestation : Restoring Degraded Lands. Science (80-.). 1458: 1458–1460. Available at: http://www.ncbi.nlm.nih.gov/pubmed/18556551.

CHHATRE, A., and A. AGRAWAL. 2009. Trade-offs and synergies between carbon storage and livelihood benefits from forest commons. Proc. Natl. Acad. Sci. 106: 17667–17670. Available at: http://www.pnas.org/content/106/42/17667\nhttp://www.ncbi.nlm.nih.gov/pubmed/1981552 2\nhttp://www.pnas.org/content/106/42/17667.full.pdf\nhttp://www.pnas.org/content/106/4 2/17667.short.

CHOKKALINGHAM, U., U. ZAIZHI, W. CHUNFEENG, and T. TOMA. 2006. Learning lessons from China's forest rehabilitation efforts. CIFOR, Chinese Academy of Forestry Research Institute of Tropical Forestry, State Forestry Administration Afforestation Department, Jakarta

ELLIS, F. 1999. Rural Livelihood Diversity in Developing Countries : Evidence and Policy Implications. ODI Nat. Resour. Perspect. 40: 1–10. Available at: http://www.mendeley.com/research/rural-livelihood-diversity-developing-countries-evidence-policy-implications-10/.

ESCOBAR, A. 2001. Culture sits in places: Reflections on globalism and subaltern strategies of localization. Polit. Geogr. 20: 139–174.

GADGIL, M., and R. GUHA. 1993. This fissured land: an ecological history of India. University of California, Berkeley.

GALUDRA, G., S. DE ROYER, P. AGUND, and U. PRADHAN. 2014. Planning for social justice. *In* J. Chavez-Tafur and J. Z. Roderick (Eds.) Towards Productive Landscapes. pp. 212–219,

Tropenbos International, Wageningen, the Netherlands.

GARCÍA-OLIVA, F., A. CAMOU, and J. M. MAASS. 2002. El clima de la región central de la costa del pacífico mexicano. *In* F. A. Noguera, J. H. Vega, A. García-Aldrete, and M. Quesada (Eds.) Historia Natural de Chamela. pp. 3–10, Instituto de Biología, UNAM, México, D. F.

GIBSON, C. C., E. OSTROM, and M. A. McKEAN. 2000. Forests, People, and Governance: Some Initial Theoretical Lessons. *In* C. C. Gibson, M. A. McKean, and E. Ostrom (Eds.) People and Forests: Communities, Institutions, and Governance. Politics, science, and the environment. pp. 227–242, MIT Press, Cambridge, Mass, Cambridge.

GRIMBLE, R., and M. K. CHAN. 1995. Stakeholder analysis for natural resource management in developing countries. Nat. Resour. Forum 19: 113–124.

GRISCOM, H. P., and M. S. ASHTON. 2011. Restoration of dry tropical forests in Central America: a review of pattern and process. For. Ecol. Manage. 261: 1564–1579.

GRULKE, M., and T. TENNIGKNEIT. 2012. Private equity investments in forestry: overcoming barriers. *In* A. Asen, H. Savenije, and F. Schmidt (Eds.) Good Business: Making Private Investments Work for Tropical Forests. pp. 27–34, Tropenbos International, Wageningen, the Netherlands.

GUARIGUATA, M. R., J. P. CORNELLIUS, B. LOCATELLI, C. FORNER, and A. SÁNCHEZ-AZOFEIFA. 2008. Mitigation needs adaptation: Tropical forestry and climate change. Mitig. Adapt. Strateg. Glob. Chang. 13: 793–808.

HECHT, S. B. 2014. Forests lost and found in tropical Latin America: the woodland "green revolution." J. Peasant Stud. 41: 877–909. Available at: http://www.tandfonline.com/doi/abs/10.1080/03066150.2014.917371.

HIRSCH, P. D., W. M. ADAMS, J. P. BROSIUS, A. ZIA, N. BARIOLA, and J. L. DAMMERT. 2010. Acknowledging Conservation Trade-Offs and Embracing Complexity. Conserv. Biol. 25: no–no. Available at: http://doi.wiley.com/10.1111/j.1523-1739.2010.01608.x.

HIRSCH, P. D., and J. P. BROSIUS. 2013. Navigating Complex Trade-offs in Conservation and Development: An integrative Framework, Issues in Interdisciplinary Studies. 31: 99–122.

HOLL, K. D., and T. M. AIDE. 2011. When and where to actively restore ecosystems? For. Ecol. Manage. 261: 1558–1563.

IUCN, and WRI. 2014. A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level. (Road-test Ed. 125pp.

JANUCHOWSKI-HARTLEY, S. R., K. MOON, N. STOECKL, and S. GRAY. 2012. Social factors and private benefits influence landholders' riverine restoration priorities in tropical Australia. J. Environ. Manage. 110: 20–26. Available at: http://dx.doi.org/10.1016/j.jenvman.2012.05.011.

JARDEL, E. 1996. Árbol que nace torcido… plantaciones y política forestal en México. Cuad. Agrar. 14: 63–77.

KANOWSKI, J., C. P. CATTERALL, and G. W. WARDELL-JOHNSON. 2005. Consequences of broadscale timber plantations for biodiversity in cleared rainforest landscapes of tropical and subtropical Australia. For. Ecol. Manage. 208: 359–372.

KHATER, C., V. RAEVEL, J. SALLANTIN, J. D. THOMPSON, M. HAMZE, and A. MARTIN. 2012. Restoring ecosystems around the Mediterranean basin: Beyond the frontiers of ecological science. Restor. Ecol. 20: 1–6.

KING, E., J. CAVENDER-BARES, P. BALVANERA, T. H. MWAMPAMBA, and S. POLASKY. 2015. Trade-offs in ecosystem services and varying stakeholder preferences: evaluating conflicts,

obstacles, and opportunities. Ecol. Soc. 20: art25. Available at: http://www.ecologyandsociety.org/vol20/iss3/art25/.

KNOKE, T., B. CALVAS, N. AGUIRRE, R. M. ROMAN-CUESTA, S. GÜNTER, B. STIMM, M. WEBER, and R. MOSANDL. 2009. Can tropical farmers reconcile subsistence needs with forest conservation? Front. Ecol. Environ. 7: 548–554.

KOZAK, J. P., and B. P. PIAZZA. 2015. A proposed process for applying a structured decision-making framework to restoration planning in the Atchafalaya River Basin, Louisiana, U.S.A. Restor. Ecol. 23: 46–52. Available at: http://doi.wiley.com/10.1111/rec.12125.

KUKRETY, S., S. JOSE, and J. R. R. ALAVALAPATI. 2013. Exploring Stakeholders' Perceptions with Analytic Hierarchy Process-A Case Study of Red Sanders (Pterocarpus santalinus L.) Restoration in India. Restor. Ecol. 21: 777–784. Available at: http://doi.wiley.com/10.1111/j.1526-100X.2012.00938.x.

LAMB, D., P. ERSKINE, and J. PARROTTA. 2005. Restoration of degraded tropical forest landscapes. Science (80-.). 310: 1628–1632.

LAMBIN, E. F., and P. MEYFROIDT. 2010. Land use transitions: Socio-ecological feedback versus socio-economic change. Land use policy 27: 108–118.

LAZOS, E. 2011. Tiempos del maíz: Tiempos del ayer y del mañana. *In* Saberes ambientales campesinos: Cultura y naturaleza en comunidades indígenas y mestizas en México. pp. 61–95, Agencia Española de Cooperación Internacional y Desarrollo/Univ. Autónoma de Madrid/Univ. Ciencias y Artes de Chiapas, Chiapas.

LAZOS, E. 2013. Interculturalidad: Naturalezas dominadas, Naturalezas vividas. *In* S. Hernández, I. Ramírez, Y. Manjarrez, and A. Flores (Eds.) Educación Intercultural a nivel Superior: Reflexiones desde diversas realidades latinoamericanas. pp. 299–34, Univ. Intercultural del Estado de Puebla/Univ. Campesina Indígena en Red/Univ. Pedagógica Experimental Libertador.

LAZOS, E. (Coord.) *Memorias agrarias, vivencias ambientales: Pueblos en movimiento en Villa Purificación, Jalisco.* Ed. IIS-UNAM, México (in press)

LE, H. D., C. SMITH, and J. HERBOHN. 2014. What drives the success of reforestation projects in tropical developing countries? The case of the Philippines. Glob. Environ. Chang. 24: 334–348.

LE, H. D., C. SMITH, J. HERBOHN, and S. HARRISON. 2012. More than just trees: Assessing reforestation success in tropical developing countries. J. Rural Stud. 28: 5–19. Available at: http://dx.doi.org/10.1016/j.jrurstud.2011.07.006.

LEMENIH, M., and H. KASSA. 2014. Re-greening Ethiopia: History, challenges and lessons. Forests 5: 1896–1909.

LÉNA, P. 1999. La forêt amazonienne : un enjeu politique et social contemporain. Autrepart 97–120. Available at: http://www.documentation.ird.fr/hor/fdi:010017991.

LEOTAUD, N., and C. ECKELMANN. 2014. Participatory forest management in the Caribbean. *In* J. Chavez-Tafur and J. Z. Roderick (Eds.) Towards Productive Landscapes. pp. 116–123, Tropenbos International, Wageningen, the Netherlands.

MAASS, J. M., P. BALVANERA, A. CASTILLO, G. C. DAILY, H. A MOONEY, P. EHRLICH, M. QUESADA, A. MIRANDA, V. J. JARAMILLO, F. GARCÍA-OLIVA, A. MARTÍNEZ-YRIZAR, H. COTLER, J. LÓPEZ-BLANCO, A. PÉREZ-JIMÉNEZ, A. BÚRQUEZ, C. TINOCO, G. CEBALLOS, L. BARRAZA, and R. AYALA. 2005. Ecosystem Services of Tropical Dry Forests : Insights from Long- term Ecological and Social Research on the Pacific Coast of Mexico. Ecol. Soc. 10: 17. Available at: http://www.ecologyandsociety.org/vol10/iss1/art17/.

MALDIDIER, C. 1999. Le local, le national et l'international dans la gestion des forêts tropicales: une aire protégée au Nicaragua. *In* F. Verdeaux (Ed.) La forêt-monde en question. pp. 83–96, Autrepart, France.

MANSOURIAN, S., L. AQUINO, T. K. ERDMANN, and F. PEREIRA. 2014. A comparison of governance challenges in forest restoration in Paraguay's privately-owned forests and Madagascar's co-managed state forests. Forests 5: 763–783.

MARTÍNEZ-RAMOS, M. ET AL. 2012. Manejo de bosques tropicales: bases científicas para la conservación, restauración y aprovechamiento de ecosistemas en paisajes rurales. Investig. Ambient. 4: 111–129.

MCAFEE, K., and E. N. SHAPIRO. 2010. Payments for Ecosystem Services in Mexico: Nature, Neoliberalism, Social Movements, and the State. Ann. Assoc. Am. Geogr. 100: 579–599.

MCSHANE, T. O., P. D. HIRSCH, T. C. TRUNG, A. N. SONGORWA, A. KINZIG, B. MONTEFERRI, D. MUTEKANGA, H. VAN THANG, J. L. DAMMERT, M. PULGAR-VIDAL, M. WELCH-DEVINE, J. PETER BROSIUS, P. COPPOLILLO, and S. O'CONNOR. 2011. Hard choices: Making trade-offs between biodiversity conservation and human well-being. Biol. Conserv. 144: 966–972. Available at: http://dx.doi.org/10.1016/j.biocon.2010.04.038.

MELO, F. P. L., S. R. R. PINTO, P. H. S. BRANCALION, P. S. CASTRO, R. R. RODRIGUES, J. ARONSON, and M. TABARELLI. 2013. Priority setting for scaling-up tropical forest restoration projects: Early lessons from the Atlantic forest restoration pact. Environ. Sci. Policy 33: 395–404. Available at: http://dx.doi.org/10.1016/j.envsci.2013.07.013.

MEYFROIDT, P. 2013. Environmental Cognitions, Land Change and Social-Ecological Feedbacks: Local Case Studies of Forest Transition in Vietnam. Hum. Ecol. 41: 367–392.

MURGUEITO, E., Z. CALLE, F. URIBE, A. CALLE, and B. SOLORIO. 2011. Native trees and shrubs for the productive rehabilitation of tropical cattle ranching lands. For. Ecol. Manag. 261: 1654–1663.

NAGENDRA, H., and J. SOUTHWORTH eds. 2009. Reforesting landscapes: linking pattern and process Vol.10 ed. Springer Science & Business Media.

NOGUERA, F., J. H. VEGA, A. GARCÍA-ALDRETE, and M. QUESADA. 2002. Historia Natural de Chamela. Instituto de Biología, UNAM, México, D. F.

NYGREN, A. 1995. Forest, Power and Development. Costa Rican peasants in the changing environment, The Finnish Anthropological Society. Helsinki.

O´NEILL, J., A. HOLLAND, and A. LIGHT. 2008. Environmental Values. Taylor & Francis, New York, US.

VAN OOSTEN, C., P. GUNARSO, I. KOESOETJAHJO, and F. WIERSUM. 2014. Governing forest landscape restoration: Cases from Indonesia. Forests 5: 1143–1162.

OSTROM, E. 1987. Institutional Arrangements for Resolving the Commons Dilemma:Some Contending Approaches. *In* B. J. McCay and J. M. Acheson (Eds.) The Question of the Commons: The Culture and Ecology of Communal Resources. pp. 250–265, University of Arizona Press, Tucson.

PAZ, F. 2005. La participación en el manejo de áreas naturales protegidas. Actores e intereses en conflicto en el Corredor Biológico Chichinautzin. CRIM-UNAM, Cuernavaca, Morelos.

PIECK, S. K., and S. A. MOOG. 2009. Competing entanglements in the struggle to save the Amazon: The shifting terrain of transnational civil society. Polit. Geogr. 28: 416–425. Available at: http://dx.doi.org/10.1016/j.polgeo.2009.09.009.

PINTO, S. R., F. MELO, M. TABARELLI, A. PADOVESI, C. A. MESQUITA, C. A. DE MATTOS SCARAMUZZA, P. CASTRO, H. CARRASCOSA, M. CALMON, R. RODRIGUES, R. G. C??SAR, and

P. H. S. BRANCALION. 2014. Governing and delivering a biome-wide restoration initiative: The case of Atlantic Forest Restoration Pact in Brazil. Forests 5: 2212–2229.

VAN DER PLOEG, J. D. EASANTRIES. STRUGGLES FOR AUTONOMY AND SUSTAINABILITY IN AN ERA OF EMPIRE AND. 2009. The new globalization. 1–7.

POTEETE, A., M. JANSSEN, and E. OSTROM. 2012. Trabajar juntos. Acción colectiva, bienes communes y multiples métodos en la práctica. Ed. UNAM y FCE, México, D. F.

PRAMOVA, E., B. LOCATELLI, M. BROCKHAUS, and S. FOHLMEISTER. 2012. Ecosystem services in the national adaptation programmes of action. Clim. Policy 12: 393–409.

REGALADO, A. 2008. La fundación de la Villa de la Purificación. 225.

RENDÓN-CARMONA, H., A. MARTÍNEZ-YRÍZAR, P. BALVANERA, and D. PÉREZ-SALICRUP. 2009. Selective cutting of woody species in a Mexican tropical dry forest: Incompatibility between use and conservation. For. Ecol. Manage. 257: 567–579.

REY BENAYAS, J. M., A. C. NEWTON, A. DIAZ, and J. M. BULLOCK. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: a meta-analysis. Science (80) 325: 1121–4. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19644076.

RIBOT, J. C., A. AGRAWAL, and A. M. LARSON. 2006. Recentralizing While Decentralizing: How National Governments Reappropriate Forest Resources. World Dev. 34: 1864–1886.

RUDEL, T. K., O. T. COOMES, E. MORAN, F. ACHARD, A. ANGELSEN, J. XU, and E. LAMBIN. 2005. Forest transitions: Towards a global understanding of land use change. Glob. Environ. Chang. 15: 23–31.

SCOONES, I., P. NEWELL, and M. LEACH. 2015. The politics of green transformations. In: The Politics of Green Transformations, Earthscan, Routledge, U.K., 1–24.

STICKLER, C. M., D. C. NEPSTAD, M. T. COE, D. G. MCGRATH, H. O. RODRIGUES, W. S. WALKER, B. S. SOARES-FILHO, and E. A. DAVIDSON. 2009. The potential ecological costs and cobenefits of REDD: A critical review and case study from the Amazon region. Glob. Chang. Biol. 15: 2803–2824.

STURGEON, J. C. 2010. Governing minorities and development in Xishuangbanna, China: Akha and Dai rubber farmers as entrepreneurs. Geoforum 41: 318–328. Available at: http://dx.doi.org/10.1016/j.geoforum.2009.10.010.

SWALLOW, B. ET AL. 2009. 2009. Compensation and Rewards for Environmental Services in the Developing World. Ecol.ogy Soc. Working Pa: 26. Available at: http://www.worldagroforestrycentre.org/downloads/publications/PDFs/wp14963.pdf.

VANWEY, L. K., Á. O. D'ANTONA, and E. S. BRONDÍZIO. 2007. Household demographic change and land use/land cover change in the Brazilian Amazon. Popul. Environ. 28: 163–185.

WILLIAMSON, O. E. 1993. Calculativeness, Trust, and Economic Organization. J. Law Econ. 36: 453–486.

ZINDA, J. A., C. J. TRAC, D. ZHAI, and S. HARRELL. 2016. Dual-function forests in the returning farmland to forest program and the flexibility of environmental policy in China. Geoforum. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0016718516301178.