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Newton, A. C., R. F. del Castillo, C. Echeverría, D. Geneletti, M. González-Espinosa, L. R. Malizia, A. C. Premoli, J. M. Rey Benayas, C. Smith-Ramírez, and G. Williams-Linera. 2012. Forest landscape restoration in the drylands of Latin America. *Ecology and Society* 17(1): 21.
http://dx.doi.org/10.5751/ES-04572-170121

Synthesis

Forest Landscape Restoration in the Drylands of Latin America

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ABSTRACT. Forest Landscape Restoration (FLR) involves the ecological restoration of degraded forest landscapes, with the aim of benefiting both biodiversity and human well-being. We first identify four fundamental principles of FLR, based on previous definitions. We then critically evaluate the application of these principles in practice, based on the experience gained during an international, collaborative research project conducted in six dry forest landscapes of Latin America. Research highlighted the potential for FLR; tree species of high socioeconomic value were identified in all study areas, and strong dependence of local communities on forest resources was widely encountered, particularly for fuelwood. We demonstrated that FLR can be achieved through both passive and active restoration approaches, and can be cost-effective if the increased provision of ecosystem services is taken into account. These results therefore highlight the potential for FLR, and the positive contribution that it could make to sustainable development. However, we also encountered a number of challenges to FLR implementation, including the difficulty of achieving strong engagement in FLR activities among local stakeholders, lack of capacity for community-led initiatives, and the lack of an appropriate institutional and regulatory environment to support restoration activities. Successful implementation of FLR will require new collaborative alliances among stakeholders, empowerment and capacity building of local communities to enable them to fully engage with restoration activities, and an enabling public policy context to enable local people to be active participants in the decision making process.

Key Words: *biodiversity; conservation; dryland; ecological restoration; forest landscape; Latin America; reforestation; rehabilitation*

INTRODUCTION

In recent years, restoration ecology has advanced significantly both as a scientific discipline and as a practical approach to environmental management (Young et al. 2005, Brudvig 2011, Bullock et al. 2011). It is now widely recognized that ecological restoration can make a positive contribution to sustainable development, by strengthening the provision of natural resources on which human livelihoods depend (Nellemann and Corcoran 2010). This is illustrated by the incorporation of ecological restoration among the objectives of global environmental policy. For example, the Convention on Biological Diversity (CBD) recently developed 2020 Headline Targets (http://www.cbd.int/decision/cop/?id=12268), which aim for the restoration of at least 15% of degraded ecosystems. Similarly the European Union aims to restore biodiversity and ecosystem services by 2020 (http://www.eu-un.europa.eu/articles/en/article_9571_en.htm).

Chazdon (2008) provides a recent overview of the ecological restoration of forests, highlighting the progress being made in many countries toward reversing recent forest loss and degradation. However, as noted by Chazdon (2008), the implications of large-scale forest restoration for the structure and composition of future landscapes and their associated species remain poorly understood. Information is also lacking on the effects of different restoration approaches on the recovery of ecosystem services, and their links with biodiversity (Chazdon et al. 2009, Palmer and Filoso 2009). As evidence suggests that restoration initiatives may often be unsuccessful, there is a need to understand the reasons for such failures, and the conditions required for successful restoration to be achieved (Palmer and Filoso 2009).

In this study we examine one particular restoration approach, namely Forest Landscape Restoration (FLR). The concept of FLR was first developed by World Wildlife Fund (WWF) and the International Union for the Conservation of Nature (IUCN) at a workshop in 2000, in response to the widespread failure of more traditional approaches to forest restoration (Dudley et al. 2005). Traditional approaches have often been site-based, and have typically focused on one or a few forest products, relied heavily on tree planting of a limited number of non-native species, and failed to address the root causes of forest loss and degradation (Dudley et al. 2005). FLR represents a significant departure from such approaches (Appendix 1). The development and application of FLR has become a major

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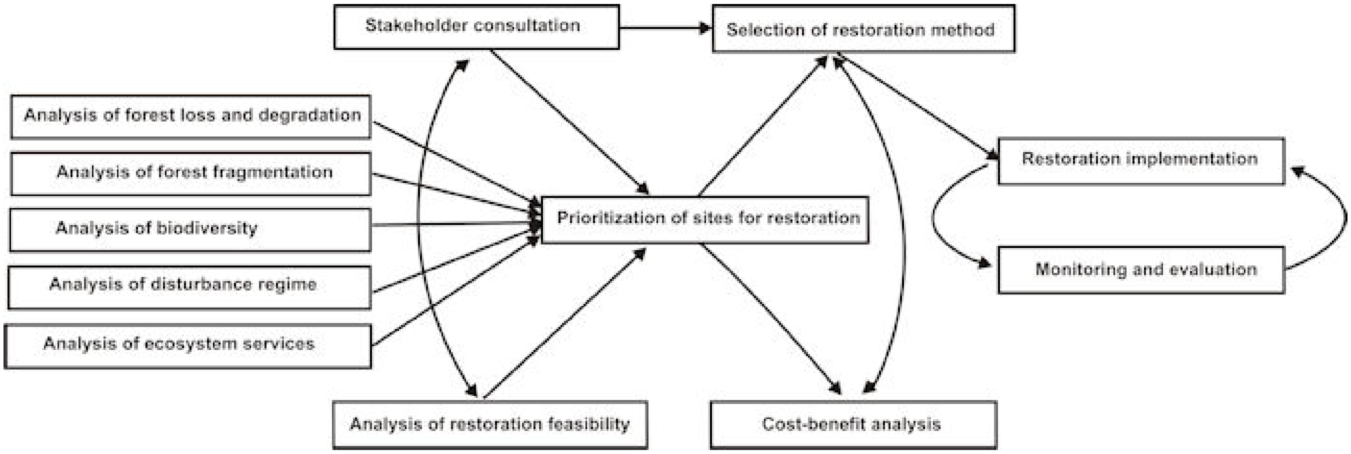
Fig. 1. The process of FLR, and its key elements.



As noted in the text, FLR is a flexible process that will need to be adapted to each individual ecological, socioeconomic, cultural, and political context. The elements illustrated here were those examined in the ReForLan project, and reflect the proposed core principles of FLR (see main text). Stakeholder consultation should occur throughout the FLR process, particularly when identifying where and how restoration actions should be implemented. Such site-level decisions should be made within a landscape context. Cost-benefit analysis can be performed by assessing both the costs and benefits of FLR to people, for example through the spatial analysis and valuation of ecosystem services. Such cost-benefit analysis should inform the selection of the restoration actions undertaken on particular sites. The need for adaptive management is illustrated by the iterative relationship between restoration implementation and monitoring and evaluation.

activity of the WWF and IUCN Forest Programmes, and was further supported by development of the Global Partnership on Forest Landscape Restoration (http://www.ideastransformlandscapes.org/), which now involves more than 25 organizations. Further details of the FLR approach are provided by Lamb and Gilmour (2003), Mansourian et al. (2005) and Rietbergen-McCracken et al. (2007).

If FLR is to be adopted widely, then its effectiveness first needs to be demonstrated. The principal aim of the research described here was to identify the principles underpinning FLR and to examine how these may be applied in practice. Specifically, the research explored application of FLR to dryland forests in Latin America, a forest type that is recognized as a global priority for biodiversity conservation and as being of high importance for supporting human livelihoods (Miles et al. 2006). Dryland areas have also been subjected to widespread degradation (Zika and Erb 2009), arising from human activities such as grazing, burning, and cutting of vegetation. Relatively little research has been undertaken on the impacts of human activities and the potential for ecological restoration of dryland forests. Here we provide a synthesis of the research results obtained by a major international research project (ReForLan, “Restoration of Forest Landscapes for Biodiversity Conservation and Rural Development in the Drylands of Latin America”; Newton 2008), to identify some of the key lessons learned. Further details of the research conducted in six different study areas are presented in a recent book (Newton and Tejedor 2011), to which the reader is referred for additional information. We here identify the general implications of the results obtained by this research, in relation to four fundamental principles of FLR (Appendix 1). The process of FLR implemented in this project is illustrated in Figure 1, and further details of the project are given in Appendices 2-4.

APPLYING THE PRINCIPLES OF FOREST LANDSCAPE RESTORATION (FLR)

Principle 1: FLR is a flexible, participatory process that is based on adaptive management and requires an adequate monitoring program.

As noted by Maginnis and Jackson (2007), active involvement of local stakeholders in planning and management decisions is considered to be an essential component of FLR. This is to ensure that local needs are adequately addressed, and that the distribution of benefits is equitable. Although stakeholder involvement is now widely recognized as essential for effective conservation management (Hockings et al. 1998), its application in FLR has received relatively little attention to date. In this context, stakeholder involvement is particularly important for identifying potential sites and approaches for restoration actions (Figure 1). Kusumanto (2007) identifies four steps to achieve stakeholder involvement in the context of FLR: (1) understand the context of stakeholder processes, (2) identify key stakeholders, (3) understand stakeholder interests and interactions, and (4) manage multi-stakeholder processes.

To understand the context and examine the potential for restoration, we conducted socioeconomic research in the different study areas through the use of participatory rural appraisal techniques, questionnaire surveys, focus group discussions and semi-structured interviews. This enabled current forest uses to be identified, and attitudes to restoration to be explored. Results indicated that awareness of the importance of native plant species of dryland forests varies considerably among regions, and even among different communities within the same region. In Paso de Ovejas in Central Veracruz, Mexico, for example, results from socioeconomic research documented 76 tree species with one or more categories of use, whereas in the Upper Mixtec Region in Oaxaca, Mexico, all 112 native local plant species were recognized as useful by at least some of the interviewees (del Castillo et al. 2011). However, in Central Chile very few of the sclerophyll forest species traditionally used as sources of medicine, food, and fiber were cited in the interviews conducted with local people. These results suggest that current knowledge of tree species in this region is limited, and has apparently been lost (del Castillo et al. 2011).

Forest-related activities compete with cattle ranching and agricultural cropping in virtually all of the areas studied. Native forest is typically now limited to low-quality sites such as steep sites or areas with poor soils. However, there is scope for forest restoration in such marginal areas, which could potentially benefit human well-being. Fuelwood and charcoal derived from dry forests were consistently found to be an important energy source for heating and cooking. For example, research in an indigenous Kolla community in northern Argentina indicated that the community of 260 inhabitants annually uses approximately 315 trees of different sizes for firewood. Overexploitation of native forest was encountered in all of the study areas, but current restoration efforts were either very limited or nonexistent. Despite this, individual tree species with relatively high socioeconomic value were identified through stakeholder consultation in all areas, highlighting the potential for restoration (del Castillo et al. 2011, Suárez et al. 2011).

The most detailed analysis of stakeholder interests and interactions was undertaken in the Yungas region of northern Argentina (Ianni and Geneletti 2010, Ianni et al. 2010). This highlighted the potential barriers facing introduction of FLR approaches. Land use in these communities is mainly devoted to husbandry of transhumant cattle, and improvement of forest resources was found to contribute little to community aspirations. Our results highlighted the difficulty of changing this situation, and accorded closely with those of Reed (2008), who found that the potential benefits of stakeholder participation are often difficult to realize in practice. We found that many local communities in this region participate in workshops, interviews, and surveys relating to environmental management initiatives, either carried out by the State, NGOs or research institutions. However, the level of engagement is often low, and these initiatives are producing few positive outcomes. Consequently we identified the need for new relationships to be developed between the communities and external actors, supporting the recommendations of Chazdon et al. (2009). Previous initiatives appear not to have strengthened the capacity of the communities to undertake social and economic development activities. This highlights the fact that natural resource management initiatives often originate outside local communities and create new levels of decision making and socio-political arrangements in the locations that the projects are targeted to benefit (McDaniel 2003). Our results therefore accord closely with those of Reed (2008), who argued that to be successful, stakeholder participation needs to be underpinned by a philosophy that emphasizes empowerment, equity, trust, and learning.

Gilmour (2007) indicates that FLR should adopt an adaptive management approach, based on incremental, experiential learning and decision making, supported by ongoing monitoring of the outcomes of decisions. Adaptive management, in which the results of monitoring are used to inform and adjust management actions, has long been viewed as an essential approach to managing complex ecosystems (Walters 1986). However, successful application of the concept to forest management has been limited to date (Bormann et al. 2007). We focused our attention on the development of indicators that would be appropriate for monitoring in a participatory management framework (Newton 2011), but we discovered a surprising lack of consensus in the identification of such indicators (Orsi et al. 2010). Monitoring of the extent and condition of dry forest has been very limited in these study areas to date, and while our research made some progress in this respect (Schulz et al. 2010, Rey Benayas et al. 2011, Schulz et al. 2011), such approaches will need to be widely adopted by the stakeholders of restoration initiatives if FLR is to be successful.

Principle 2: FLR seeks to restore ecological processes at the landscape scale that will ensure maintenance of biodiversity and ecosystem functions, and confer resilience to environmental change.

Lindenmayer et al. (2010) identify guiding principles for biodiversity conservation that are broadly applicable to any forested area, including the maintenance of forest connectivity, the maintenance of landscape heterogeneity, and the maintenance of stand structural complexity. As noted by these authors, forest connectivity influences key processes influencing biodiversity, including population persistence and recovery after disturbance, the movement of individuals and genes in a population, and the colonization of different locations within the landscape. Similarly, the diversity, size, and spatial arrangement of habitat patches are important determinants of habitat suitability for many taxa, and are influenced by the extent of landscape heterogeneity (Lindenmayer et al. 2010).

Our research examined the dynamics of forest loss and fragmentation in each of the study areas. Satellite remote sensing images from different dates were analyzed using FRAGSTATS (version 3) (McGarigal et al. 2002) to generate a range of landscape metrics, in order to compare the spatial patterns of forest cover at each time interval. All study areas registered a decline in forest cover over the past three decades (Table 1). Over this time period, results indicated that dryland forests have exhibited progressive fragmentation and degradation in most, but not all, of the study areas examined.

Table 1. Percentage forest cover detected in the 1970s (1990 for Chiapas) and mid-2000s, and annual deforestation rates recorded in each study area. Data were derived from analysis of Landsat MSS, TM and ETM+ imagery, and SPOT imagery (in the case of Veracruz and Oaxaca in 2000s). For precise dates of images, see Table 3. Source: Newton and Tejedor (2011).

Study area	% Forest cover in early or mid 1970s†	% Forest cover in 2000s	% Annual rate of change
Central Chile	43.3	33.9	-1.7
Southern Argentina	17.3	16.4	-0.17
Northern Argentina	94.0	73.0	-1.3
Veracruz, Mexico	11.3	6.56	-1.22
Oaxaca, Mexico	59.3	56.6	-0.18
Chiapas, Mexico	32.1	31.5	-0.12

†1990 for Chiapas

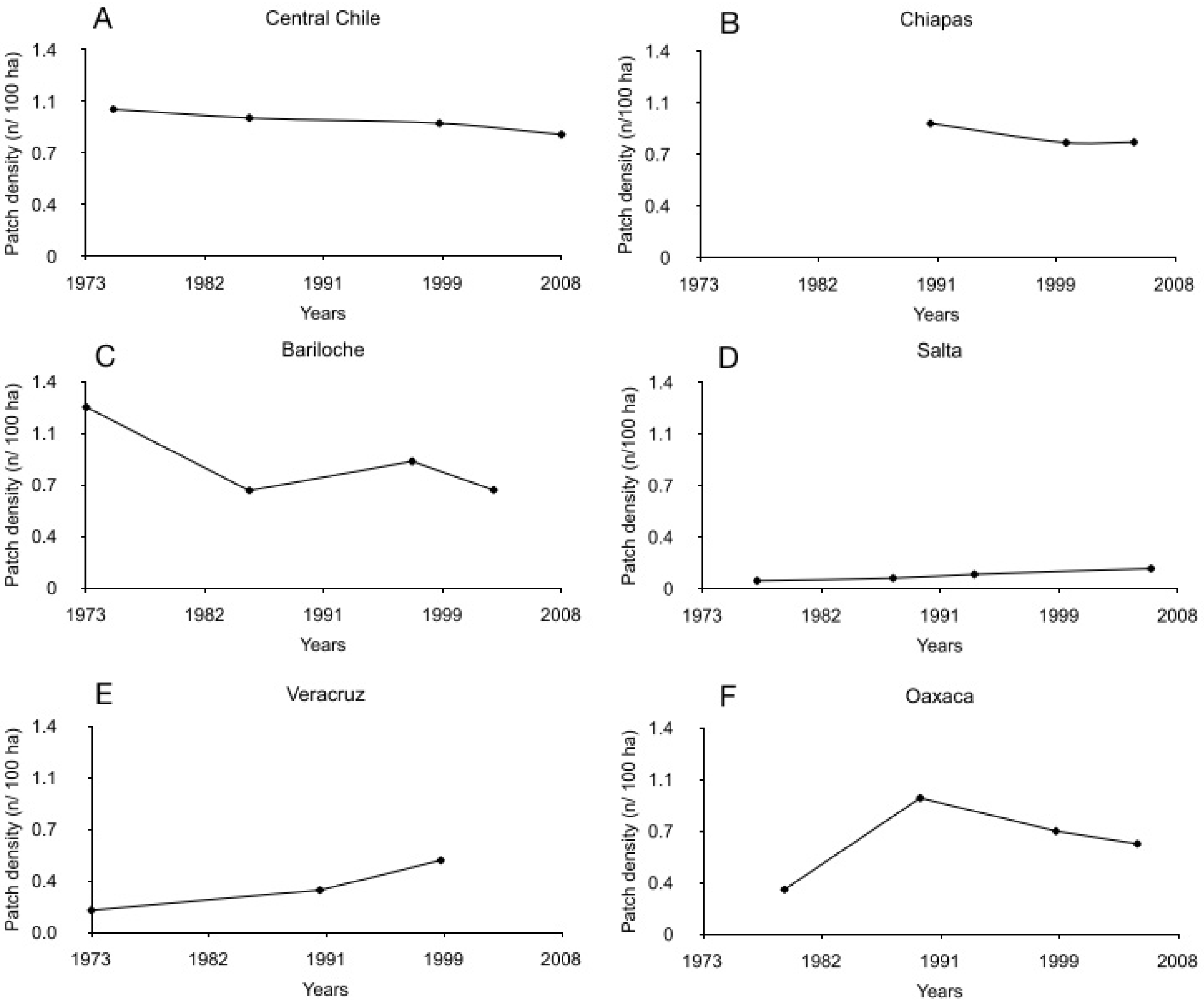
Mean size and total core area of forest patches declined in four of the study areas, but values either remained stable or increased slightly over time in two others (Chiapas and southern Argentina) (Table 2). Total edge length of forest patches tended to increase over the study interval in those areas recording a decline in mean patch size, but values demonstrated greater variability between years and between study areas than the other metrics. Patch density similarly displayed contrasting results between study areas, with continuous increases recorded in two areas (northern Argentina and Veracruz) and declines recorded in two others (Chiapas and Central Chile) (Figure 2). Overall, these results are consistent with other research that has suggested that spatial patterns of forest in human-modified landscapes can be highly individualistic (Lindenmayer and Fischer 2006).

Table 2. Changes in landscape metrics recorded over time for six study areas. Analyses were derived from satellite remote sensing imagery, using FRAGSTATS (see text). Adapted from Newton and Tejedor (2011).

Study area	Year	Mean patch size (ha)	Total edge length (m)	Total core area (ha)
Veracruz, Mexico				
	1973	140	3091320	44161
	1990	74	6334110	41404
	1999	28	6345420	21772
Oaxaca, Mexico				
	1979	100	64070	514323
	1989	23	105901	224689
	1999	41	106689	386259
	2005	47	89516	428650
Chiapas, Mexico				
	1990	13	113509	277821
	2000	14	110960	275821
	2005	14	111197	274287
Central Chile				
	1975	9	44400	76901
	1985	6	49838	29923
	1999	6	50769	23500
	2008	6	41898	26149
Salta, Argentina				
	1977	1075	8540	682693
	1987	758	15826	614457
	1993	529	15455	581090
	2006	330	14873	506464
Nahuel Huapi, Argentina				
	1973	9	79360	115080
	1985	14	52587	135654
	1997	12	62150	145918
	2003	14	52021	132901

We also examined the processes influencing forest biodiversity within each of the study areas, with a particular focus on tree species richness. For example in Veracruz, Mexico, Williams-Linera and Lorea (2009) examined tree species richness in relation to 14 environmental and anthropogenic variables in ten tropical dry forest fragments in which 98 canopy, 77 understory, and 60 seedling species were recorded. Ordination identified altitude, aspect, slope, water proximity, and presence of cattle and trails as significant explanatory variables of species richness patterns. These results indicated that human disturbance has reduced species richness in this study area; sites at lower elevations were more disturbed and less diverse. While elevation was found consistently to influence species richness and composition in a number of study areas (Rocha-Loredo et al. 2010, Zacarías-Eslava and del Castillo 2010), forest fragment area was related to species richness of adult trees in only one study area (Oaxaca), and to tree seedling abundance in only one other (Chile) (Table 3). Fragmentation impacts on genetic diversity were also examined. For example, the genetic structure of monospecific dryland forests of southern Argentina was assessed, focusing on the monotypic conifer *Austrocedrus chilensis*. While in the north marginal populations were

Fig. 2. Temporal variation in forest patch density in the six study areas: (A) Central Chile, (B) Chiapas, Mexico, (C) Bariloche, southern Argentina, (D) Salta, northern Argentina, (E) Veracruz, Mexico, (F) Oaxaca, Mexico. Source: Newton and Tejedor (2011).



relatively small and inbred yet genetically diverse, toward the south larger and relatively continuous populations had reduced diversity and showed signals of genetic admixture, highlighting the need for active restoration efforts (Souto et al. 2011). This illustrates the risk of assuming that relatively small, isolated populations are genetically impoverished, and large continuous populations are highly genetically variable (Souto et al. 2011).

We also explored the role of ecological processes in landscape-scale forest restoration, through the use of spatial modeling of vegetation dynamics at the landscape scale. We employed LANDIS II, a modeling tool that has been widely used to explore spatial forest dynamics (Scheller et al. 2007), although rarely in dry forest. LANDIS II incorporates a number of ecological processes, including dispersal, colonization, competition, and succession. Simulation of two dry forest landscapes in Mexico under different anthropogenic disturbance regimes indicated that tropical dry forests are more resilient to such disturbance than anticipated, with forest area increasing even under scenarios of small, infrequent fires and large, frequent fires (Cantarello et al. 2011). Such resilience is attributable to the high frequency of vegetative reproduction of tree species following disturbance, at least in part. However, forest structure and composition differed markedly between these scenarios. Modeling also revealed a number of

Table 3. Pearson correlation coefficients (r) between elevation and patch area and tree species richness (S), density (D) and seedling densities (d). Correlations with p < 0.05 are indicated with *, p < 0.01 indicated with **, ns = non-significant. Analyses were not conducted in southern Argentina because of the very low species richness values encountered. Source: Newton and Tejedor (2011).

Variables	Study area			
	Veracruz	Oaxaca	Chiapas	Central Chile
Elevation and S	0.83*	-0.10 ns	-0.12 ns	0.26 ns
Area and S	-0.2 ns	0.77*	-0.16 ns	0.16 ns
Elevation and D	0.85*	0.62*	-	0.14 ns
Area and D	0.30 ns	-0.38 ns	-	0.04 ns
Elevation and d	-0.22 ns	0.67*	-	0.20 ns
Area and d	-0.44 ns	0.44 ns	-	0.36*

interactions between different forms of disturbance. For example, grazing and fire were found to act synergistically, leading to a reduction in forest area (Cantarello et al. 2011).

Interactions between different forms of disturbance were also identified through modeling of a dry forest landscape in the Mediterranean region of Chile (Newton et al. 2011). For example, spread of the invasive exotic species *Acacia dealbata* was projected to occur only in the presence of fire when combined with browsing and/or cutting of the native vegetation. Model results indicated relatively little impact of disturbance on forest cover, but substantial differences in forest structure, with relatively old-growth forest stands (>120 years old) being virtually eliminated from the landscape in scenarios with both browsing and cutting. In addition, tree species richness tended to be lower in those scenarios without disturbance, highlighting the importance of anthropogenic disturbance for maintenance of some species within the landscape.

Our modeling results were supported by field experiments and observations (Williams-Linera and Alvarez-Aquino 2010, Williams-Linera et al. 2011 *a*, *b*; Table 4), indicating that restoration of dry forest landscapes can be achieved using both "passive" and "active" approaches, involving natural regeneration and artificial establishment of native trees respectively. However, modeling also revealed that spatial forest dynamics are highly sensitive to variation in the dispersal ability of different tree species, a process that has been relatively little studied (Chazdon et al. 2009). A further key unknown is the extent to which restoration of forest structure and composition will be associated with restoration of ecosystem function (Chazdon et al. 2009), an aspect that was not directly addressed by our current research. With reference to the guiding principles identified by Lindenmayer et al. (2010), our research suggests that restoration of landscape heterogeneity and stand structural complexity may be of particular importance in the FLR of dry forests. We found less evidence of increasing connectivity being critical to biodiversity conservation in this forest type than has been recorded in moist forests located further south in the same region (Echeverría et al. 2007, Newton et al. 2009). However, our research was largely limited to an investigation of tree species; consideration of the animal species associated with dry forest would likely have revealed stronger fragmentation impacts (Chaves et al. 2011).

Principle 3: FLR seeks to enhance human well-being, through restoration of ecosystem services.

Interest in the concept of ecosystem services, or the benefits provided by ecosystems to people, has grown rapidly in recent years, particularly in the wake of the Millennium Ecosystem Assessment (http://www.maweb.org/en/index.aspx). This is illustrated by the current development of an Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES; http://ipbes.net/). Although meeting the needs of local people has always been a central objective of FLR (Maginnis and Jackson 2007), this has not previously been stated with explicit reference to ecosystem services (Appendix 1). The identification of ecosystem service provision as a policy and environmental management objective has major implications for the practice of ecological restoration, as explored by Bullock et al. (2011).

We performed a meta-analysis of 89 restoration assessments undertaken worldwide in a wide range of ecosystem types, to examine whether ecological restoration is generally effective in restoring both ecosystem services and biodiversity (Rey Benayas et al. 2009). Results indicated that ecological restoration increased provision of biodiversity and ecosystem services by 44% and 25% respectively, based on median values of response ratios. This illustrates that ecological restoration is likely to be beneficial to people, but this analysis did not consider the potential costs of restoration. Therefore, we then examined whether FLR is likely to be cost-effective by conducting spatial analysis of ecosystem service values in four dryland forest landscapes (Birch et al. 2010). This was achieved by estimating the net value of ecosystem service benefits under different FLR scenarios, supported by modeling using LANDIS II (Figure 3). The scenarios were: passive (no

Table 4. Summary of restoration trials and experiments undertaken during the ReForLan project.

Study area	Number of restoration trials established	Experimental treatments examined	Mean (+/- SE) early survival (%)
Veracruz	4	Land use history and site effect on mixed plantations	45% ± 7 after 1 year, 35.3% ± 8 after 2 years
	1	Performance of species selected by local people, improved establishment techniques	60% ± 8 after 17 months
Oaxaca	7	Different combinations of tree species and soil types	88% ± 2, range 58-100%
Northern Argentina	1	Tree density, mixtures of different native species, use of exotics as nurse trees, vulnerability to pathogens under different treatments.	Native species: <5 to 30%. Exotic species: usually >30%.
Southern Argentina	2	Herbivory, nurse-shrub protection, seedling age	Zero without nurse shrubs. 36% (± 20) under nurse shrubs without protection 47% (± 24) under nurse shrubs with protection from herbivores
Central Chile	5	Irrigation, nurse plants	47% ± 15

restoration costs); passive with protection (costs of fencing and fire suppression); and active (costs of native tree planting, fencing, and fire suppression). The opportunity costs of lost livestock production, which is the main alternative land use in each of the study areas, were also taken into account.

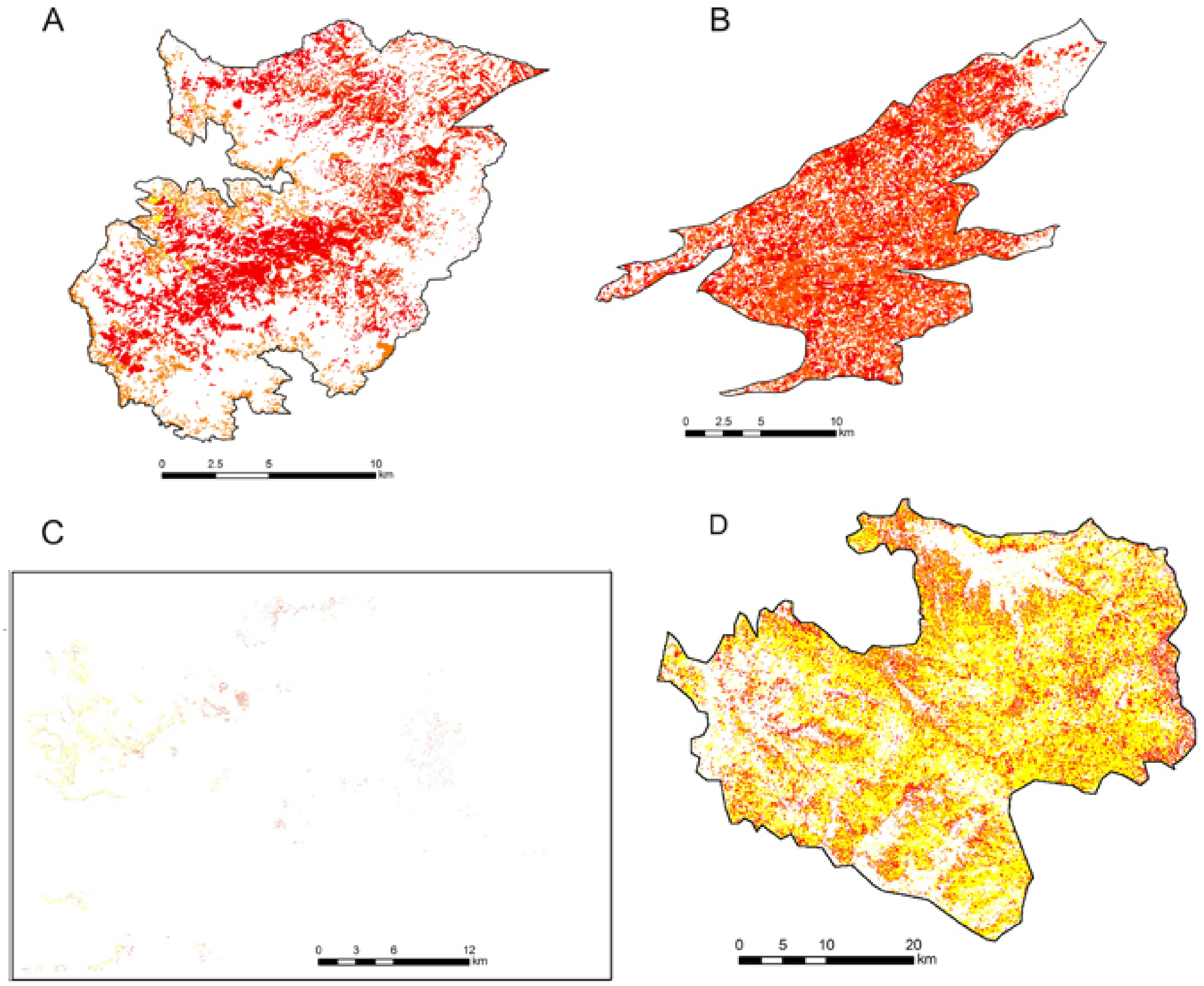
Results showed that passive restoration was cost-effective for all study areas on the basis of the services analyzed, whereas the benefits from active restoration were generally outweighed by the relatively high costs involved (Birch et al. 2010; Figure 4). These findings were found to be relatively insensitive to discount rate but were sensitive to the market value of carbon. Substantial variation in values was recorded between study areas, demonstrating that ecosystem service values are strongly context specific. However, spatial analysis enabled localized areas of net benefits to be identified, indicating the value of this approach for identifying the relative costs and benefits of restoration interventions across a landscape. It should be noted that the analyses were limited to five ecosystem services, namely, carbon storage, timber, non-timber forest products, tourism, and livestock production. Different results might have been obtained had additional ecosystem services been considered.

Our research therefore suggests that FLR can potentially be cost-effective in terms of enhancing provision of ecosystem services, but the extent to which this would actually result in an improvement in human well-being is uncertain. As pointed out by Bullock et al. (2011), both the costs and benefits of ecological restoration should be distributed equitably, but this is not always achieved in practice. For example, Corbera et al. (2007) described a project providing payments for carbon sequestration by afforestation activities in Chiapas, Mexico, in which the poorest farmers, women, and the landless were sometimes excluded from project activities. This example highlights the importance of property rights and local institutions in shaping the distribution of restoration costs and benefits, an issue that was not examined during our current research.

Principle 4: FLR implementation is at a landscape scale; in other words, site-level decisions need to be made within a landscape context.

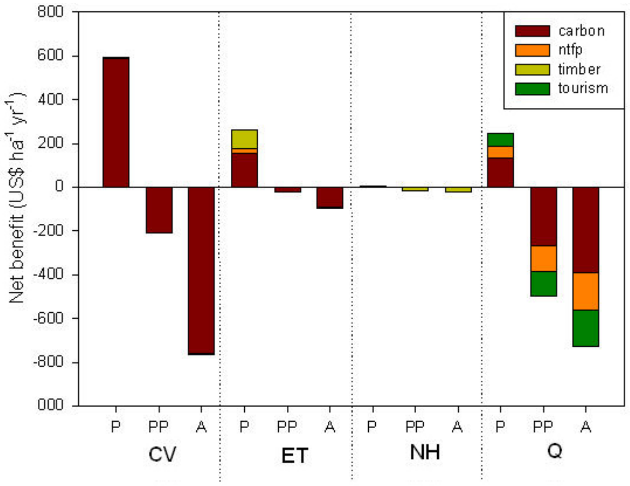
Site-based decisions undertaken during the implementation of FLR should contribute to improving landscape-scale functionality (Maginnis and Jackson 2007). A key decision facing FLR programs is how to identify which sites within a given landscape should be targeted for restoration actions. This raises the question of which criteria should be used as a basis for such site prioritization, an issue that has been little researched previously. To address this knowledge gap, we conducted a Delphi survey to elicit expert opinion from the global community of restoration scientists, with the aim of defining the key ecological criteria and a broad set of indicators (Orsi et al. 2010). In total, 389 criteria and 669 related indicators were provided, highlighting the diversity of opinion that exists within this single stakeholder group. These were later refined through a second round of the Delphi process, leading to the identification of eight definitive criteria along with some 90 related indicators. This highlights the fact that criteria and indicators for prioritizing restoration efforts can successfully be identified using methods such as the Delphi technique, but that the number of relevant variables is large. In addition, the diversity of views expressed suggests that the development of a generally applicable set of criteria and indicators for forest restoration will be difficult to achieve in practice.

Fig. 3. Maps illustrating the areas of net positive value provided by selected ecosystem services under passive forest restoration scenarios for each of the four study areas: (A) El Tablon, Mexico; (B) Central Veracruz, Mexico; (C) Nahuel Huapi, Argentina; (D) Quilpue, Chile. Maps are represented for a 20-year time horizon at 5% discount rate. Higher values are illustrated in red, and lower values in yellow. Note that in the case of Map C, large areas of the study area are illustrated as white, indicating net values of zero. Source: Newton (2011).



We examined the practical implementation of this approach for a landscape in Chiapas, Mexico, by applying selected criteria to generate suitability maps for forest restoration (Orsi and Geneletti 2010). A map was created for each criterion, then these maps were combined using spatial multicriteria evaluation (MCE) techniques to generate a series of restoration options. The performance of each reforestation option was evaluated with respect to both improving the ecological functioning of the landscape and the provision of ecosystem services to people. This enabled different restoration options to be ranked, and preferred options to be identified (Orsi and Geneletti 2010). This research highlighted the value of MCE techniques for incorporating the values of different stakeholders, which were elicited through stakeholder consultation exercises conducted in the different study areas (Ianni and Geneletti 2010, Ianni et al. 2010). Spatial MCE approaches enabled the implications of different values (or weights) held by different stakeholders to be explored through the use of mapping tools, linked with GIS.

Fig. 4. Net benefit of forest landscape restoration (FLR), based on assessment of the values of four ecosystem services (carbon storage (“carbon”), non-timber forest products (“ntfp”), timber production (“timber”) and nature-related tourism activities (“tourism”)). The net benefits were estimated through estimation of the combined net value of these ecosystem services across the study landscapes resulting from FLR, taking the costs of restoration activities into account. Restoration scenarios were: P, passive (no restoration costs); PP, passive with protection (costs of fencing and fire suppression); and A, active (costs of tree planting, fencing, and fire suppression). The four study areas are: CV, Central Veracruz, Mexico; ET, El Tablon, Mexico; NH, Nahuel Huapi, Argentina; Q, Quilpue, Chile. Figure redrawn from the analyses presented by Birch et al. (2010).



CONCLUSIONS

Interest in the ecological restoration of forests is growing, as reflected by the development of international policy targets such as those of the CBD. A further example is “REDD+” (Reducing Emissions from Deforestation and Forest Degradation), which includes among its aims the enhancement of forest carbon stocks through ecological restoration (UNEP 2011). Substantial funding has already been provided to support REDD+ implementation, yet it has attracted criticism for its focus on the single ecosystem service of carbon storage; there is a possibility that other ecosystem services, biodiversity, and social issues could be adversely affected by this initiative (Stickler et al. 2009, Bullock et al. 2011). Potential negative social impacts include loss of livelihoods or access to lands undergoing restoration, a risk that is particularly high in areas where land tenure is insecure. There is therefore a need for forest restoration approaches that will enhance biodiversity and provision of multiple ecosystem services, while also improving human well-being. The FLR approach has been designed to meet this need, but to date, evidence has been lacking regarding its practical implementation. Here we refine the principles of FLR, and critically examine their application through research conducted in multiple landscapes in the drylands of Latin America.

Our research results have highlighted the widespread potential for FLR; tree species of high socioeconomic value were identified in all study areas, and strong dependence of local communities on forest resources was widely encountered, particularly in the case of fuelwood. We demonstrated that FLR can be achieved through both passive and active restoration approaches, and that forest recovery can occur even under scenarios of continuing anthropogenic disturbance. We showed that FLR can be effective in terms of providing benefits both to biodiversity and to human society, through increased provision of ecosystem services. We also demonstrated that FLR can be cost-effective, if the value of increased provision of ecosystem services is taken into account, and if relatively low-cost, passive approaches to restoration are adopted. These results therefore highlight the potential for FLR, and the positive contribution that it could make to achieving international policy objectives relating to sustainable development, biodiversity conservation, and poverty alleviation.

However, our research also encountered a number of challenges to FLR implementation. First among these was the difficulty of achieving strong engagement in FLR activities among local communities. Consistently we found that restoration of native dry forest resources was accorded relatively low priority among such stakeholders, who placed much greater value on the maintenance of agricultural land use practices. Involvement or interest in monitoring activities, which is an essential component of adaptive management, was also found to be highly variable and often very limited. We encountered a form of fatigue for involvement in development projects, which have often failed to provide a legacy in terms of strengthened capacity for community-led initiatives. It is clear that if FLR is to be successfully implemented, local communities must be strongly engaged in the process, and this will only be achieved if they perceive benefits to their participation. Our results support the suggestions made by Chazdon et al. (2009), who called for new collaborative alliances among conservation biologists, agroecologists, agronomists, farmers, indigenous peoples, social scientists, and land managers to develop effective conservation programs and policies in human-modified landscapes. Direct participation of national and local governments will also often be critical for success. We believe that such alliances will be needed for the effective implementation of FLR. In addition, there needs to be an appropriate institutional and regulatory environment to support restoration activities, and to ensure equitable delivery of both costs and benefits at the local scale; this again will require engagement of national and local governments.

Payment for ecosystem service (PES) schemes such as REDD+ could potentially be an important source of revenue for FLR (Bullock et al. 2011), enabling financial incentives to be provided to participants, including compensation for any costs incurred. Our research has indicated that such costs can be significant, particularly in terms of the opportunity cost of reduced cattle production. In our research, we did not examine how an equitable distribution of both the costs and benefits of FLR can be achieved in practice, but we identify this as a key research priority for the future. In addition, we did not examine all ecosystem services of potential value that might be provided by restored dry forest. Hydrological services, such as the provision, flow regulation, and quality of freshwater, could be of particular value in this context, and merit further research attention.

Our research also identified the development of an enabling public policy context for FLR as a key requirement for the approach to be implemented widely (González-Espinosa et al. 2011). As with most rural development actions, FLR projects will often require agreements on long-term use of consolidated land properties that involve local communities, grassroots groups, governmental agencies, urban social organizations, and others (Weiss 2004). Decision making processes should be participatory and democratic, to avoid local and regional conflicts, which have previously limited the success of many conservation initiatives in developing countries (Lele et al. 2010). In all study areas, an overall national-scale legal framework is available that aims to ensure sustainable use of forest resources. However, considerable differences exist among the underlying philosophies, scope, aims, and details of the legal frameworks available within each country, as well as in the potential intervention of both governmental and non-governmental organizations in supporting their implementation (Appendix 5). A number of limitations in the definition and implementation of policies were identified in all study areas, which constrain the long-term adoption of FLR initiatives. Most notable is the top-down application of public policies that do not take into consideration local and long-term needs, capacities, and aspirations, thereby often dooming government projects to failure. Another common feature of the political context relates to the typical overlap of authority of governmental agencies, often causing contradictory or competing actions. In all study areas there is a need for public policies on forest restoration to consider all stakeholders, and to enable them to participate actively in the decision making process. We believe that this is the single largest obstacle that must be overcome, if the undoubted potential of FLR is to be successfully realized in practice.

Responses to this article can be read online at: *http://www.ecologyandsociety.org/vol17/iss1/art21/responses/*

Acknowledgments:

Many thanks to all the participants of the ReForLan project, whose research is summarized here. This publication has been made possible by funding from the European Commission under the ReForLan project: INCO Contract CT-2006-032132. The views expressed in this publication do not necessarily reflect those of the European Commission.

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APPENDIX 1. The definition and key features of FLR.

Definition

The standard definition of FLR used to date describes it as "*a planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded forest landscapes*" (Maginnis et al. 2007, Mansourian 2005). In this context a landscape is defined as "*a contiguous area, intermediate in size between an 'ecoregion' and a 'site', with a specific set of ecological, cultural and socio-economic characteristics distinct from its neighbours*". A forest landscape is considered to be "*a landscape that is, or once was, dominated by forests and woodlands and which continues to yield forest-related goods and services*" (Maginnis and Jackson 2007).

Here we critically evaluate the definition of FLR. First, we note that one of the features of FLR is its active involvement of stakeholders throughout the planning and implementation process (Maginnis et al. 2007). We suggest that this might usefully be emphasized by referring to FLR as a participatory, rather than as a planned process, in its definition.

Secondly, the term 'ecological integrity' requires clarification. Mansourian (2005) defines 'ecological integrity' as '*maintaining the diversity and quality of ecosystems, and enhancing their capacity to adapt to change and provide for the needs of future generations*'. Lamb and Gilmour (2003) further expand on this definition, suggesting that it includes '*ecological authenticity (eg ecological naturalness, viability, health) as well as the functional effectiveness of the restoration process (eg the extent to which key ecological processes are regained)*'. As pointed out by Newton (2007, 2011), terms such as 'authenticity', 'naturalness' and 'health' are poorly defined and are consequently difficult to measure; the same may therefore be said of 'ecological integrity'. Terms that are difficult to operationalise should be avoided (Peters 1991), and we therefore propose that 'ecological integrity' should not be employed either as part of the definition of FLR or as one of its features. For this reason, we propose that FLR be redefined as "*a participatory process supporting the recovery of degraded forest landscapes, to increase their value for both biodiversity and human livelihoods*".

Key features

Maginnis and Jackson (2007) identify four key features of FLR:

1. FLR is a process, which embodies three key principles: (i) it is participatory, (ii) it is based on adaptive management and is therefore responsive to social, economic and environmental change, and (iii) it requires a clear and consistent evaluation and learning framework.

2. FLR seeks to restore ecological integrity; simply replacing one or two attributes of forest functionality across and entire landscape tends to be inequitable and unsustainable.

3. FLR seeks to enhance human well-being, based on the principle that the joint objectives of enhanced ecological integrity and human well-being cannot be traded off against each other at a landscape scale.

4. FLR implementation is at a landscape scale; in other words, site-level decisions need to be made within a landscape context.

Some of these features require further elaboration. First, the reference to adaptive management implies the systematic analysis of different management actions to achieve a desired outcome. Adaptation also involves changing assumptions and interventions in response to the information obtained as a result of monitoring. A monitoring programme is therefore essential if an adaptive management approach is to be effective, together with an appropriate evaluation and learning framework to ensure that lessons are learned from management experience (Salfasky et al. 2002).

The third feature listed by Maginnis and Jackson (2007) focuses on enhancing human well-being. The linkage between human well-being and the condition of ecosystems is currently a major focus of research, as illustrated by the Millennium Ecosystem Assessment (2005). Central to this research approach is the concept of 'ecosystem services', or the benefits provided by ecosystems to humans. FLR should therefore increase the provision of ecosystem services, by restoring those ecological processes and functions on which this provision depends (Fisher et al. 2008). This should be explicitly recognized in the principles of FLR.

Maginnis and Jackson (2007) also suggest 'that the joint objectives of enhanced ecological integrity and human well-being cannot be traded off against each other at a landscape scale'. This depends on an implicit assumption that human well-being and ecological integrity are coincident within a landscape, an assumption that is largely untested. However, it is not difficult to envisage how conflicts could arise: human well-being is heavily dependent on access to food, which is generally more readily obtained from cropland than from forest. Evidence suggests that 'win-win' solutions between human well-being and ecosystem condition may be difficult to achieve in practice; trade-offs may also need to be made between one ecosystem service and another (Tallis et al. 2008).

Principles of FLR

On the basis of these points, we propose that the following fundamental principles of FLR be defined, by revising the features presented by Maginnis and Jackson (2007) as follows:

1. FLR is a flexible process, which embodies three key features: (i) it is participatory, requiring the engagement of stakeholders to be successful; (ii) it is based on adaptive management and is therefore responsive to social, economic and environmental change; and (iii) it requires both an adequate monitoring program and an appropriate learning process.

2. FLR seeks to restore ecological processes at the landscape scale that will ensure maintenance of biodiversity and ecosystem functions, and confer resilience to environmental change.

3. FLR seeks to enhance human well-being, through restoration of ecosystem services.

4. FLR implementation is at a landscape scale; in other words, site-level decisions need to be made within a landscape context.

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APPENDIX 2. Research approach of the ReForLan project.

The ReForLan project was a collaborative research initiative involving ten partner institutions, undertaken during the years 2007-9 (Newton 2008). The overall objective of the project was to identify and promote approaches for the sustainable management of dryland forest ecosystems, by researching ecosystem restoration techniques using native species of economic value. This was achieved by undertaking a programme of multi-disciplinary research that analysed how restoration of degraded dryland landscapes can be achieved in a way that mitigates the effects of unsustainable land use practices, contributes to conservation of biodiversity and supports the development of rural livelihoods, according to the FLR approach. Further details are given in Newton and Tejedor (2011).

The research focused on six dryland study areas in Latin America, including landscapes in Oaxaca, Veracruz and Chiapas, Mexico; northern and southern Argentina; and the Mediterranean region of central Chile (Figure A2.1, Appendix 3). In these areas, native forests have been subjected to intense human pressure in previous decades, resulting in severe deforestation and degradation. Each of these areas is characterized by biodiversity of international conservation importance, with many endemic and threatened species. These areas are also characterised by the presence of substantial and increasing rural populations, often including indigenous communities, who rely on native forest resources for provision of a number of forest products and services (Appendix 4). The restoration of forest resources in these areas is therefore of key importance to the livelihood of local communities.

Overall, the research undertaken during the ReForLan project aimed to identify how dryland forest ecosystems could be restored in ways that both benefit biodiversity and support the livelihood of local communities, and thereby contribute to sustainable development objectives. A conceptual framework was developed at the outset of the project to provide a basis for organising and integrating research activities (Newton 2008). This was based on the consideration of forest restoration as a potential response to environmental degradation caused by unsustainable land use practices. Such response options can usefully be viewed according to the DPSIR framework, which was developed by the European Environment Agency to help analyse the process of sustainable development (EEA 1998). The DPSIR framework is based on the fact that different societal activities (drivers) cause a pressure on the environment, which can cause quantitative and qualitative changes in the state of environmental variables. Such changes can produce a variety of different impacts on natural resources and the services that they provide to human communities. Society has to respond to these changes in appropriate ways in order to achieve sustainable development. According to the DPSIR framework, different indicators of sustainability can be developed relating to driver, pressure, state, impact and response variables; the development of such indicators was one of the outputs of the project (Newton 2011).

The research approach was based on the application of the DPSIR framework to restoration of dryland forest resources (Figure A2.2). The underlying drivers responsible for unsustainable land use patterns can be grouped into demographic, economic, socio-political, technological and cultural factors. For example, key factors underpinning current patterns of land use and land cover change in dryland regions of Latin America include the current policy context, the structure and function of national and international market chains for agricultural and forest products, and the process of globalization. Such factors influence patterns of land use, such as cultivation of crops and animal husbandry, which can have a major effect on the extent and condition of forest resources. Key variables describing the state of forest resources include forest area, the size distribution and connectivity among forest patches, and the composition and structure of forest stands (Figure A2.2). The way that human activities influence these patterns will determine their impact on key ecological processes, such as dispersal, growth, survival, competition, succession and gene flow, which affect biodiversity and the provision of the environmental services on which human communities depend (Figure A2.2). The severity and extent of environmental degradation, and its impact on biodiversity and the provision of environmental services, will determine both the need and scope for forest restoration as a response option.

The ReForLan project was implemented as nine discrete, but interconnected elements (Figure A2.3), namely:

(i) assessment of the deforestation of dryland forest ecosystems over the past three decades, using analysis of satellite remote sensing imagery supported by statistical modelling approaches and GIS;

(ii) assessment of the fragmentation and degradation of dryland forest ecosystems, using analysis of satellite remote sensing imagery supported by statistical modelling approaches and GIS;

(iii) analysis of the patterns of tree species richness in remnant fragments of dry forest, assessed through field survey in each of the study areas;

(iv) experimental analysis of dryland forest restoration techniques, achieved by conducting a series of field experiments and restoration trials in each of the study areas, examining a range of different species and establishment techniques;

(v) socio-economic valuation of dryland forest resources in each of the study areas, achieved using a variety of social survey techniques, including questionnaire surveys, interviews and participatory rural appraisal methods;

(vi) analysis of the impact of forest fragmentation and degradation on patterns of genetic variation and its implication for forest restoration, using a range of molecular markers and quantitative genetic techniques to examine patterns of variation in selected tree species of high socio-economic value;

(vii) exploration of the landscape-scale dynamics and potential for passive restoration of dryland forest ecosystems, using a spatially explicit model of forest dynamics (LANDIS-II);

(viii) identification of priority areas for dryland forest restoration, using spatial Multi-Criteria Evaluation (MCE) approaches;

(ix) development of policy recommendations and management strategies for restoration of dryland forest landscapes, through consultation with a range of stakeholders in each of the study areas.

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Figure 2.1 Location of the study areas included in the ReForLan project.

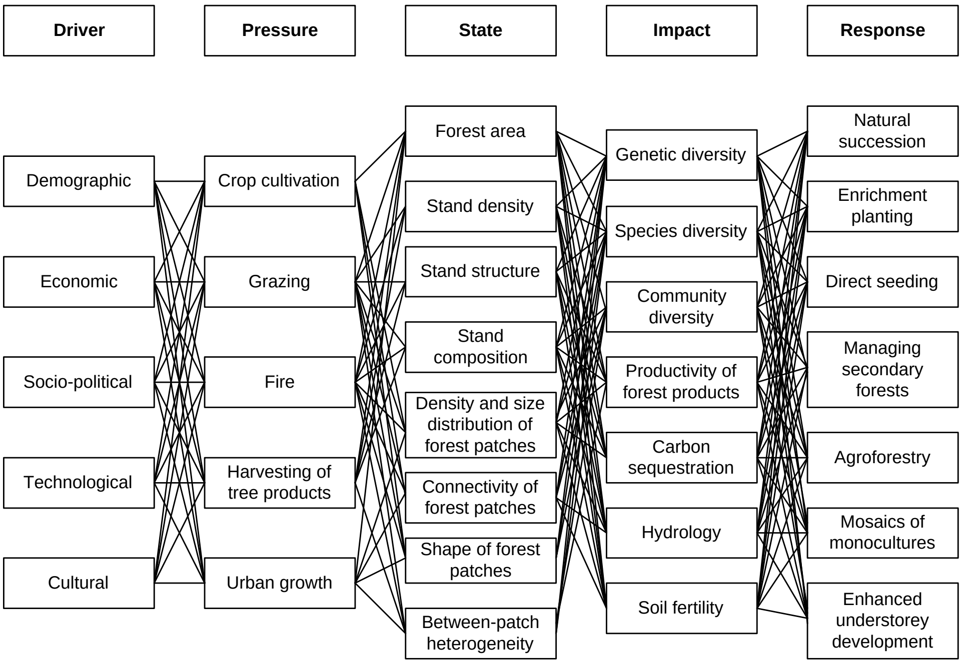

Figure A2.2 Schematic diagram illustrating the context of forest restoration as a response to unsustainable land use practices, according to a DPSIR framework (see text).

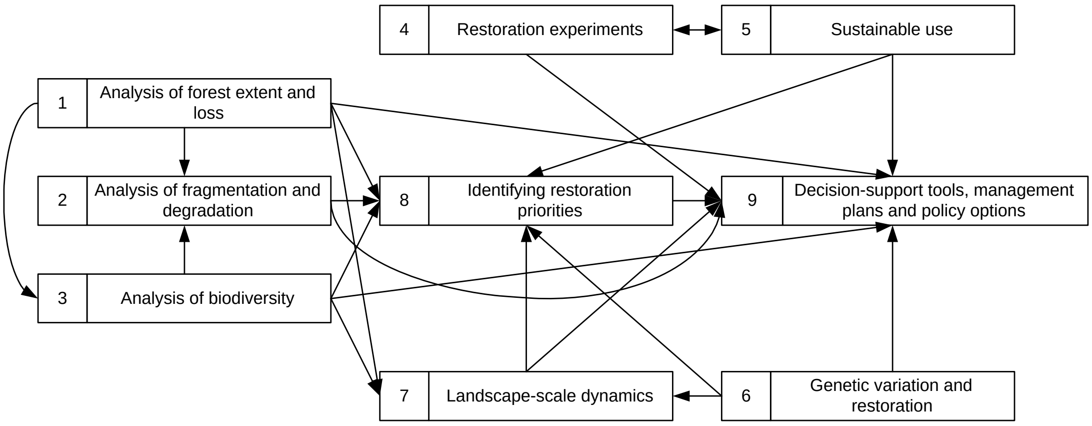

Figure A2.3. Inter-relationships of different elements (Work Packages, numbered 1-9) of the ReForLan project.

APPENDIX 3. Details of study areas included in the ReForLan project.

Abbreviations for climate variables are *MAT* = mean annual temperature, *MAR* = mean annual rainfall, abbreviations for major vegetation types are AF = Austral Forest, APF = Andean Premontane Forest, CF = Chaco Forest, MSF = Mediterranean Sclerophyllous Forest, MDDF= Mediterranean Deciduous Dry Forest, TDF = Tropical Dry Forest, SEPSF = Semi-evergreen Premontane Seasonal Forest, OF = Oak Forest, POF = Pine-Oak Forest, PF = Pine Forest, RP = Riparian Forest, G = Grasslands, SH = Shrublands. * Soil classification in Central Chile and NW Argentina follows the USDA-NRCS system; the FAO-UNESCO system is used in all other cases.

	Southern Argentina	**Central Chile**	**NW Argentina**	**Central Chiapas, Mexico**	**Upper Mixteca, Oaxaca, Mexico**	**Central Veracruz, Mexico**
Latitude	39° 30’–43° 35’	33° 30’–38° 00’	22° 00’–24° 00’	15° 50’– 17° 00’	17° 00’– 18° 00’	19° 17’–19° 25’
Longitude	71° 19’–72° 00’	71° 50’–72° 30’	63° 30’–65° 00’	92° 00’– 93° 30’	97° 00’– 98° 00’	96° 26’–96° 35’
Elevation (m)	800–1500	0-2260	350–750	500–1700	600–1500	40 –1100
MAT (ºC)	12°	13°	21°	19°–26°	16°–18°	24°–26°
MAR (mm yr^{-1})	1500	100–500	900	800–1200	550–900	900
Predominant landforms	Steep and gentle hillsides and rolling plains	Steep hillsides on transversal mountains between coast and Andes, and gentle slopes and some rolling plains.	Steep and gentle hillsides and rolling plains	Steep and gentle hillsides and rolling plains	Steep and gentle hillsides and rolling plains	Gentle hillsides and rolling plains
Predominant soil types *	Andosols	Andisols, entisols, inceptisols	Entisols, inceptisols, mollisols	Lithosols, rendzines, luvisols, and regosols on limestone	Andosols, lithosols on limestone	Haplic phaeozems, lithosols, pelic vertisols

Major vegetation types	AF- steppe ecotone	MSF, MDDF, RF, G, SH	APM, CF, RF	TDF, SEPSF, OF, POF, PF, RF	TDF, OF, POF, PF	TDF, RF
Agricultural cover or main crops	Pastures and rangelands for cattle and sheep grazing	Vineyards, pastures, fruit-growing, livestock grazing	Irrigated sugarcane, soybean, pastures for cattle grazing	Induced pastures for cattle grazing, traditional annual crops, rainfed crops with agrochemicals use, irrigated crops, fruit orchards, shade grown coffee plantations	Traditional annual crops, rangelands for sheep and goat grazing	Irrigated sugarcane, rainfed annual crops, pastures, some fruit orchards
Major forest uses	Exotic tree plantations	Exotic tree plantations, firewood, charcoal	Firewood and timber from native trees	Firewood and timber from native trees, silvopastoral systems	Firewood and timber from native trees	Firewood and timber from native trees
Dependence on firewood	Low	High	Low in cities, high in rural areas	High	High	Low
Use of non-timber forest products	Few	Low	Few	Many	Many	Many
Frequency and intensity of wildfires	Low/low	High/medium	Low/low	High/high	High/high	Medium/medium

APPENDIX 4. **Social, economical, and forest restoration (FR) attributes of the ReForLan study areas.** A = available, N/A = non-available, HV = highly variable. * *Mestizo* literally refers to people of mixed indigenous and Caucasian (typically Spanish) ancestry; it is usually applied to any Mexican who is hispanicized in some degree irrespective of their actual ancestry. ***Ejidos* are pieces of land granted to peasant communities that hold them collectively and use them for farming and extraction of natural resources on the basis of community agreements; members of *ejidos* live within a community in designated areas for their households and other pieces of land are assigned for individual cultivation or communal use.

	Southern Argentina	**Central Chile**	**NW Argentina**	**Central Chiapas, Mexico**	**Upper Mixteca, Oaxaca, Mexico**	**Central Veracruz, Mexico**
Population density	Low	High	Low	Very high	High	Medium
Population dispersion	Concentrated in towns and cities	Concentrated in towns and cities	Concentrated in towns and cities	A few major towns and cities; little scattered	Scattered	Concentrated in towns and cities
Ethnic group	Mostly Caucasian, some mixed indigenous	Mostly *mestizo*, some Caucasian, some mixed indigenous	Mostly mixed Caucasian immigrants, several indigenous groups	Mostly *mestizo**, some indigenous Zoque	Mostly indigenous Mixtec, some *mestizo**	*Mestizo* *
Poverty line	Half above and half below	Mostly above	Half above and half below	Mostly above, HV but rarely below	Mostly below	Mostly above, HV
General education level	Mostly elementary, some higher	Elementary and higher	Elementary and higher	Mostly barely elementary, HV	Mostly barely elementary, HV	Elementary and higher, HV

Land tenure	Private property	Private and state property	Private property	*Ejidos*** and prívate property	*Ejidos*** and prívate property	*Ejidos*** and prívate property
Land property size	Large	Small to large	Medium to large	Small to medium	Very small	Small to medium
Credit lines	Yes, HV	Yes, HV	Yes, HV	Mostly N/A	Mostly N/A	Yes, HV
Vulnerability to global markets	High	Very high	Very high	Moderate to high	Moderate, HV	High, HV
Migration to cities or abroad	Medium to high	Low to high	Low to medium	Medium to high	Medium to high	High
Agricultural intensification	Low	Very high	Very high	Moderate, HV	Low (moderate in plains)	Moderate, HV
Sustainability of current land-uses	Medium/Poor	Medium/Poor	Medium/Poor	Poor	Poor	Medium/Poor
Passive or active FR	Mostly passive	Both	Mostly passive	Both, low	Mostly active	Both
Diverse products through FR	Low	Low	Low	Medium	Medium/high	Medium, HV

APPENDIX 5. Legal and regulatory frameworks, and public policies (PP) relating to forest landscape restoration (FLR) in the different study regions examined by the ReForLan project. After González-Espinosa et al. (2011). Institutional abbreviations of the different project partners: UNCOMA = Universidad Nacional del Comahue (Bariloche, Argentina), FPY = Fundación ProYungas (Jujuy and Salta, Argentina), PUC = Pontificia Universidad Católica de Chile (Santiago, Chile), UACH = Universidad Austral de Chile (Valdivia, Chile), UC = Universidad de Concepción (Concepción, Chile), ECOSUR = El Colegio de la Frontera Sur (San Cristóbal de Las Casas, Chiapas, México), CIIDIR-IPN = Centro de Investigación para el Desarrollo Integral Regional-Instituto Politécnico Nacional (Oaxaca, Oaxaca, México), INECOL = Instituto de Ecología, A. C. (Xalapa, Veracruz, México). Other abbreviations: A = available, N/A = non-available, HV = highly variable, N = nationwide, S/P = state/province level, L/M = local/municipal scale.

	Southern Argentina (UNCOMA)	**Central Chile (Coastal Range and Central Valley) (PUC, UACH, UC)**	**NW Argentina (FPY)**	**Central Chiapas, Mexico (ECOSUR)**	**Upper Mixteca, Oaxaca, Mexico (CIIDIR-IPN)**	**Central Veracruz, Mexico (INECOL)**
PP in favor of FR	Yes (some)	Yes	Yes (some)	No	Yes	No
Some PP unfavorable to FR	Yes	Yes	Yes	Yes	Yes	Yes
Application of PP	Top-down	Markedly top-down	Top-down	Markedly top-down	Markedly top-down	Markedly top-down
Overlap of agencies acting on PP	Yes, high	Yes	Yes	Yes, high	Yes, high	Yes, high
Laws/regulations with sustainability criteria	A, N	A, N	A, N, S/P	A, N, S/P, L/M	A, N, S/P, L/M	A, N, S/P, L/M
Previous planning efforts and results, even if not directly related to FLR	A, N	A, N, S/P	A	A, N, S/P, L/M	A, N	A, N
Stakeholders participate in the	Yes, N	Yes, N, S/P,	Yes, N, S/P,	Yes, S/P,	Yes, S/P, L/M	Yes, S/P,

design and implementation of PP on FLR		L/M	L/M	L/M		L/M
Stakeholders participate in major PP decisions on FLR	Yes, N	Yes, N, S/P, L/M	Yes (?)	No	Yes (?), L/M	Yes, S/P, L/M
Grassroots groups represented	No	Yes (some)	Yes (some)	Yes, L/M	Yes, L/M	Yes, L/M
Grassroots groups implement FLR	Yes	Yes (some)	No	No (a few)	No	No
Community-wide interest in FLR	Low	Low, HV	Low	Yes, HV	Yes, HV	HV
Territorial planning directly addressing FLR	No (former legislation did)	No	Yes	No, but other S/P planning A	No	No
Partner/stakeholder interactions	Yes	Yes	Yes	Yes	Yes	Yes
Partner/stakeholder products	Yes, regional diagnosis, field guides	Yes, regional diagnosis, field guides	Yes, regional diagnosis, field guides, regulatory map	Yes, regional diagnosis, field guides	Yes, regional diagnosis, field guides	Yes, regional diagnosis, field guides
Monitoring of FR by communities	No	No	Yes (some)	No	No	No
Community-wide awareness on FR	No	No, HV	No	No, HV	Yes, HV	Yes, HV
FR already linked to payment for ecosystem services	No	No	No	No, but some communities willing to	Yes	Yes (?)

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