Restauración del paisaje: oportunidad para compatibilizar actividades productivas y conservación

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Restauración del paisaje: relevancia global

RESTORATION ECOLOGY

The global tree restoration potential

Jean-Francois Bastin[1]*, Yelena Finegold[2], Claude Garcia[3,4], Danilo Mollicone[2], Marcelo Rezende[2], Devin Routh[1], Constantin M. Zohner[1], Thomas W. Crowther[1]

The restoration of trees remains among the most effective strategies for climate change mitigation. We mapped the global potential tree coverage to show that 4.4 billion hectares of canopy cover could exist under the current climate. Excluding existing trees and agricultural and urban areas, we found that there is room for an extra 0.9 billion hectares of canopy cover, which could store 205 gigatonnes of carbon in areas that would naturally support woodlands and forests. This highlights global tree restoration as our most effective climate change solution to date. However, climate change will alter this potential tree coverage. We estimate that if we cannot deviate from the current trajectory, the global potential canopy cover may shrink by ~223 million hectares by 2050, with the vast majority of losses occurring in the tropics. Our results highlight the opportunity of climate change mitigation through global tree restoration but also the urgent need for action.

Photosynthetic carbon capture by trees is likely to be among our most effective strategies to limit the rise of CO_2 concentrations across the globe (*1*–*3*). Consequently, a number of international initiatives [such as the Bonn Challenge, the related AFR100, and the New York Declaration on Forests (*4*, *5*)] have established ambitious targets to promote forest conservation, afforestation, and restoration at a global scale. The latest special report (*1*) by the Intergovernmental Panel on Climate Change (IPCC) suggests that an increase of 1 billion ha of forest will be necessary to limit global warming to 1.5°C by 2050. However, it remains unclear whether these restoration goals are achievable

measurements (data file S1) (*8*) of tree cover across all protected regions of the world (fig. S1) (*9*, *10*). Using global environmental layers (table S1) (*11*), we examined how climate, edaphic, and topographic variables drive the variation in natural tree cover across the globe. The focus on protected areas is intended to approximate natural tree cover. Of course, these regions are not entirely free of human activity (*11*), presenting slightly lower tree cover than expected in some regions or higher tree cover than expected in other regions because of low fire frequency, but these ecosystems represent areas with minimal human influence on the overall tree cover. We

mental conditions, with minimal human activity (Fig. 2A). This work is directly underpinned by our systematic dataset of direct tree cover measurements (entirely independent of climate and modeled remote sensing estimates) (*13*) across the globe (fig. S1) (*10*).

Across the world's protected areas (fig. S2), tree cover ranged between peaks of 0% in dry desert and 100% in dense equatorial forest, with fewer values falling between these two extremes (figs. S2 and S3). We paired these tree cover measurements with 10 global layers of soil and climate data (table S1) (*11*). Our resulting random forest model had high predictive power [coefficient of determination (R^2) = 0.86; intercept = −2.05% tree cover; slope = 1.06] (Fig. 1); rigorous *k*-fold cross-validation (fig. S4A) (*11*) revealed that our model could explain ~71% of the variation in tree cover without bias (R^2 = 0.71; intercept = 0.34% tree cover; slope = 0.99) (fig. S3, B and C). Our *k*-fold cross-validation approach also allows us to generate a spatially explicit understanding of model uncertainty (figs. S5 and S6) (*11*). Across all pixels, the mean standard deviation around the modeled estimate is ~9% in tree cover (28% of the mean tree cover) (figs. S5 and S6) (*11*). As such, these models accurately reflected the distribution of tree cover across the full range of protected areas. We then interpolated this random forest model across all terrestrial ecosystems using all 10 soil and climate variables to project potential tree cover across the globe under existing environmental conditions.

The resulting map reveals Earth's tree carrying capacity at a spatial resolution of 30 arc sec

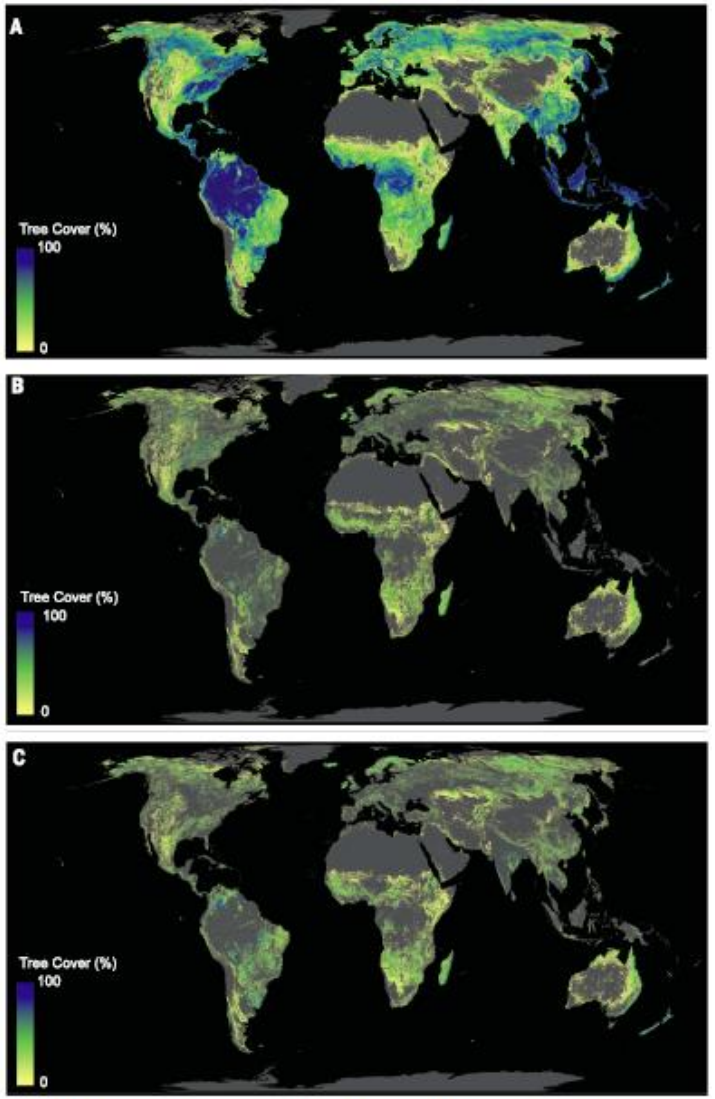

Fig. 2. The current global tree restoration potential. (**A**) The global potential tree cover representing an area of 4.4 billion ha of canopy cover distributed across the world. (**B** and **C**) The global potential tree cover available for restoration. Shown is the global potential tree cover (A), from which we subtracted existing tree cover (*15*) and removed agricultural and urban areas according to (B) Globcover (*16*) and (C) Fritz *et al.* (*17*). This global tree restoration potential [(B) and (C)] represents an area of 0.9 billion ha of canopy cover (table S2).

Bastin et al. (2019) Science 365, 76–79

Restauración del paisaje: relevancia global

ECOLOGY

Restoring forests as a means to many ends

An urgent need to replenish tree canopy cover calls for holistic approaches

By Robin Chazdon and Pedro Brancalion

Earth is approaching environmental thresholds that, if crossed, will create serious disruptions to ecosystems, economies, and society (*1*). To avoid the devastating effects of climate change and biodiversity loss, humanity must protect and restore native ecosystems (*2*). International conventions and organizations support forest restoration as a method for mitigating hazardous environmental shifts, but questions remain as to where and how to focus such restoration efforts. On page 76 of this issue, Bastin *et al.* (*3*) describe a new approach that advances our understanding of global tree distribution.

Prevailing views on how to assess forest cover and restoration opportunities might actually hinder rather than promote the large-scale action needed. Traditional methods for evaluating changes in forest cover are based on a dualistic (forest/nonforest) classification of land use that applies a subjective threshold to the 0 to 100% canopy-cover gradient (*4*). Bastin *et al.* move beyond this strict dichotomy with the use of direct photo-interpretation measurements that account for wooded lands that lie outside forest areas. The authors identify the global potential for enhanced tree canopy cover on the basis of variations in natural levels of tree cover, which has immediate implications for restoring forest cover. Test scenarios that assess how future climate change will affect global canopy cover emphasize the urgency of taking action now, as shifting responses of forests to climate change are already under way and will become far more pronounced.

This urgency of restoring tree cover does not justify short-term fixes that fail to produce environmentally and socially beneficial long-term outcomes. An assessment of the biophysical capacity for restoring global tree cover provides a necessary but insufficient foundation for evaluating where tree cover can be feasibly increased. The kinds of trees as well as how and where they are grown determine how and which people benefit. In some contexts, increasing tree cover can elevate fire risk, decrease water supplies, and cause crop damage by wildlife. Reforestation programs often favor single-species tree plantations over restoring native forest ecosystems. This approach can generate negative consequences for biodiversity and carbon storage (*5*), threaten food and land security, and exacerbate social inequities. How restored lands are governed determines how reforestation costs and benefits are distributed.

Without attention to these social and environmental issues, efforts to rapidly increase tree cover are likely to prove ineffective in the long term. Initiated by Germany and the International Union for Conservation of Nature in 2011, the Bonn Challenge has garnered 58 commitments to restore 170 million hectares of forest land by 2020. The Global Deal for Nature (*6*) proposes that 30% of Earth's surface be formally protected and an additional

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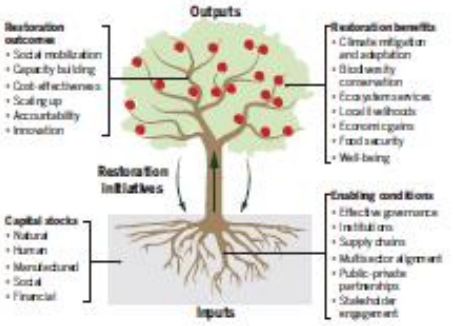
Restoration systems deliver multiple benefits

A forest restoration system integrates structures (trunk and roots) that assimilate and distribute resources (soil) to initiate and sustain restoration outcomes (branches). The system ultimately delivers myriad benefits for nature and humanity (fruits). Restoration outcomes and benefits in the system, stable as enabling conditions, and increase capital stocks.



"The kinds of trees as well as how and where they are grown determine how and which people benefit. In some contexts, increasing tree cover can elevate fire risk, decrease water supplies, and cause crop damage by wildlife. Reforestation programs often favour single-species tree plantations over restoring native forest ecosystems. This approach can generate negative consequences for biodiversity and carbon storage, threaten food and land security, and exacerbate social inequities."

Chazdon & Brancalion (2019) Science 365, 24-25

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COMMENT · 02 APRIL 2019

Restoring natural forests is the best way to remove atmospheric carbon

Plans to triple the area of plantations will not meet 1.5 °C climate goals. New natural forests can, argue Simon L. Lewis, Charlotte E. Wheeler and colleagues.

Simon L. Lewis, Charlotte E. Wheeler, Edward T. A. Mitchard & Alexander Koch

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- ”on average, natural forests are 6 times better than agroforestry and 40 times better than plantations at storing carbon”
- Por lo tanto , hoy diferenciación bosques naturales y plantados es de gran relevancia global

Restauración del paisaje: importancia monitoreo

- Qué es o debiera ser considerado un bosque es un tema controvertido: implicancias para restauración a escala de paisaje

- FAO (1998), los "bosques" tienen un mínimo 10% de cubierta forestal arbórea (>5 m) y una superficie >0.5 ha, y se dividen en "**bosques naturales**" y "**bosques plantados**"

- Diferenciar bosques naturales de plantaciones a grandes escalas es aún un desafío técnico para la comunidad que trabaja en sensores remotos (Zhao et al. 2016; Curtis et al. 2018): **clave** para medir el éxito de la restauración (monitoreo) a escala de paisaje

Discrepancias a nivel global

ENVIRONMENTAL SCIENCE

Perpetuating the myth of the return of native forests

Tracy Van Holt[1,2]* and Francis Edward Putz[3]

Viña *et al.* imply that native forests account for China's marked increase in tree cover and that tree plantations play a minimal role. All 71 tweets linked to the article reinforce the idea that China's native forests are returning, whereas a review of their methodology indicates that it is not likely accurate. Referring news articles ($n = 19$) were dominated by terms associated with native forests, whereas tree plantations were rarely mentioned.

The results presented by Viña *et al.* (*1*) relating to China's marked forest recovery are interesting but beg many questions. Surprisingly, the authors use "tree cover" and "forest cover" interchangeably, and they do not mention "plantations" at all in their paper, which implies that the increased forest cover is entirely recovered native forests. However, we know that this cannot be true. It is possible for Viña *et al.* (*1*) to make this claim because they use the Food and Agriculture Organization (FAO) definition of forest that aggregates tree plantations and native forests, because FAO does not classify tree plantations as an "agricultural" land use (*2*). This aggregation is worrisome and even more so because it was not explicitly explained in the article by Viña *et al.* (*1*). We are

Even a plantation with a very large number of trees and a closed canopy does not make a forest. Given that monocultural plantations are so distinct from native forests in terms of their role in the biosphere, and the important ecosystem services that native forests provide to human beings that are not provided by plantations, these two

Las estimaciones de superficie forestal dependen mucho de los criterios y métodos

Source	FAO RSS (2010) (25)	Globcover (2009) (26)	Hansen *et al.* (2013) (13)	Sexton *et al.* (2013) (14)	Global Drylands Assessment (2016)		
Sensor	Landsat	MERIS	Landsat	Landsat	Very high resolution		
Method	Sampling	Wall-to-wall	Wall-to-wall	Wall-to-wall	Sampling		
Year	2005	2008	2000	2010	2015	2015	2015
Forest	Yes	—	—	—	Yes	—	—
Tree cover	—	≥15%	≥10%	≥10%	—	≥20%	≥10%
Africa	67	83	216	114	286	253	364
Asia	43*	148	154	200	213 (97*)	242	299
Europe	22*	49	97	116	63 (26*)	78	92
N. America	166	155	173	196	204	201	238
Oceania	29	28	55	55	114	71	124
S. America	123	46	205	268	197	192	208
Total	450	509	900	949	1079 (917*)	1037	1327

*Without Russian Federation.

Bastin et al. 2017

Discrepancias a nivel local

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Catastro confirma un aumento de la superficie de bosques en Chile

Según el estudio realizado por la Conaf, el 45% del territorio nacional continental cuenta con cobertura vegetal, lo que ha sido destacado por organismos como la FAO.

por UPI - 05/07/2011 - 19:45

Twittear 5 | Me gusta 0 | 1 | Post | 8+1 0

El catastro vegetacional que mantiene y actualiza la **Corporación Nacional Forestal (Conaf)** ratificó que el 18% del territorio nacional continental está cubierto por bosque nativo y que desde la muestra base tomada en 1996 a la fecha, las plantaciones forestales en el país han aumentado en alrededor de 500 mil hectáreas.

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Según el Gobierno, la superficie de bosques en Chile ha aumentado en 500 mil hectáreas

El Catastro Vegetacional que lleva a cabo la Conaf, y que dio a conocer el Ministerio de Agricultura, sostiene que el 45% del territorio nacional continental cuenta con cobertura vegetal.

05.07.2011

#BOSQUENATIVO

Seguir a @soyvalparaiso

De acuerdo al Ministerio de Agricultura, y pese a los últimos informes sobre el avance de la desertificación, en Chile se ha producido un aumento en la superficie de bosques. Y quizá la

La Segunda online

domingo, 06 de abril de 2014

ECONOMÍA

Superficie de bosques sube en Chile a 17,3 millones de hectáreas

Las cifras fueron dadas a conocer por el ministro de Agricultura, Luis Mayol, quien además señaló que la superficie nacional de bosque nativo cambió de 13.599.610 a 14.181.747 hectáreas.

POR: La Segunda Online — miércoles, 29 de enero de 2014

De acuerdo a cifras dadas a conocer por el Ministerio de Agricultura y la CONAF la superficie de bosques creció a más de 17 millones de hectáreas.

Reg Environ Change
DOI 10.1007/s10113-016-1010-7

ORIGINAL ARTICLE

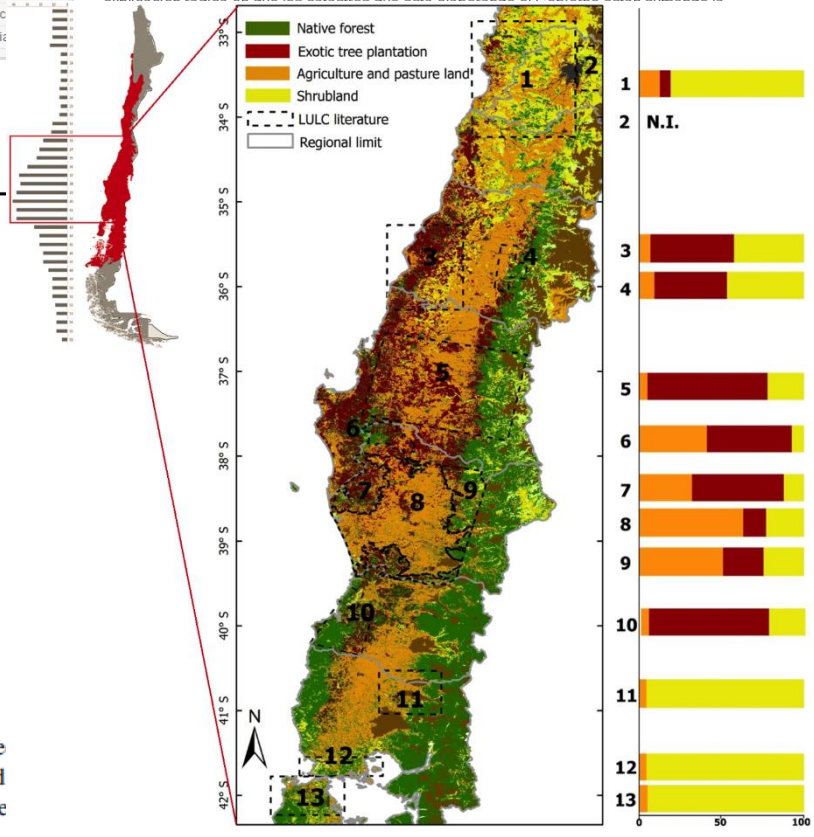
Native forest loss in the Chilean biodiversity hotspot: revealing the evidence

Alejandro Miranda[1,2,5] · Adison Altamirano[1] · Luis Cayuela[3] · Antonio Lara[4,5] · Mauro González[4,5]

Received: 17 September 2015 / Accepted: 12 June 2016

Abstract The understanding of the spatial and temporal patterns in land use and land cover (LULC) change is a key issue for conservation efforts. In the Chilean hotspot, different

19 % of native forest (782,120 ha) betwe
The highest net forest loss was observed
period. This decreased in the 1990–2000 pe



Indicadores de éxito de restauración del paisaje

Ecological Indicators 102 (2019) 752–759

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Original Articles

Spatial congruence among indicators of recovery completeness in a Mediterranean forest landscape: Implications for planning large-scale restoration

Adison Altamirano[a,b,*], Alejandro Miranda[a,c], Paula Meli[d], Joris Dehennin[e], Bart Muys[e], Marco Prado[a], Germán Catalán[a,k], Cecilia Smith-Ramírez[f,g,h], Marcela Bustamante-Sánchez[g,i], Fulgencio Lisón[a], José María Rey-Benayas[j]

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ARTICLE INFO

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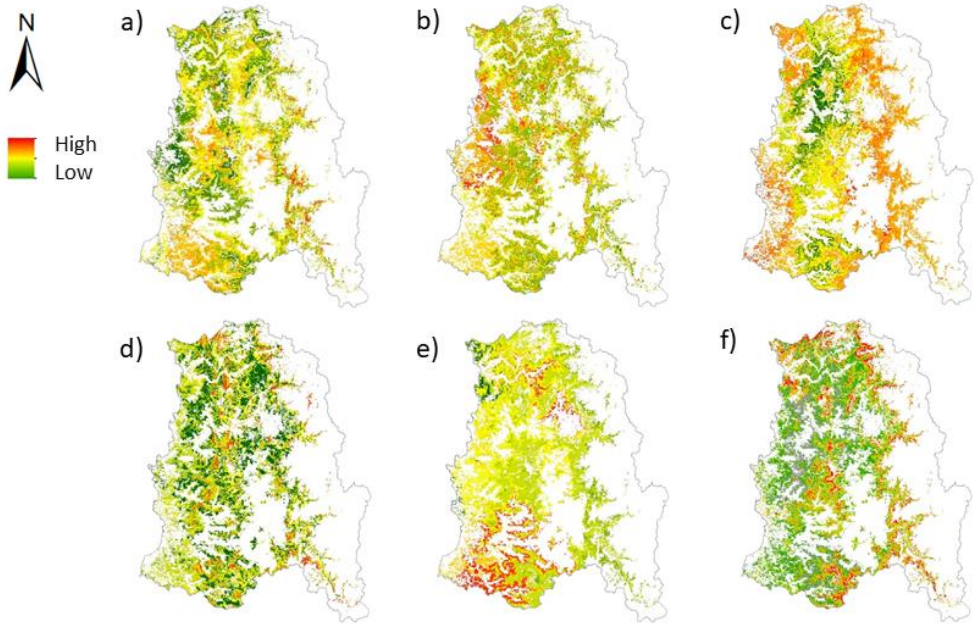
Landscape forest restoration
Vegetation recovery

ABSTRACT

Natural regeneration has been proposed as a cost-effective forest restoration approach for both small and large-scale initiatives. However, attributes for assessing the success of forest restoration through natural regeneration may vary among them in spatial patterns depending on the scale of analysis and on environmental gradients. Here we analysed the spatial patterns of recovery completeness (i.e. how similar attributes in restored forests are



a) basal area (BA)
b) quadratic mean diameter (QMD)
c) adult species density (ASD)
d) adult species richness (ASR)
e) seedling species richness (SSR)
f) spatial congruence of indicators

- Baja congruencia espacial de RC de los indicadores. Máxima SC de todos los indicadores < 10%

- Implica que si usamos indicadores separadamente para planificar restauración a escala de paisaje área resultante sería muy distinta

- Una de las principales ventajas de regeneración natural (i.e. costo-eficiencia; Birch et al., 2010) se ve comprometida dependiendo de los indicadores elegidos

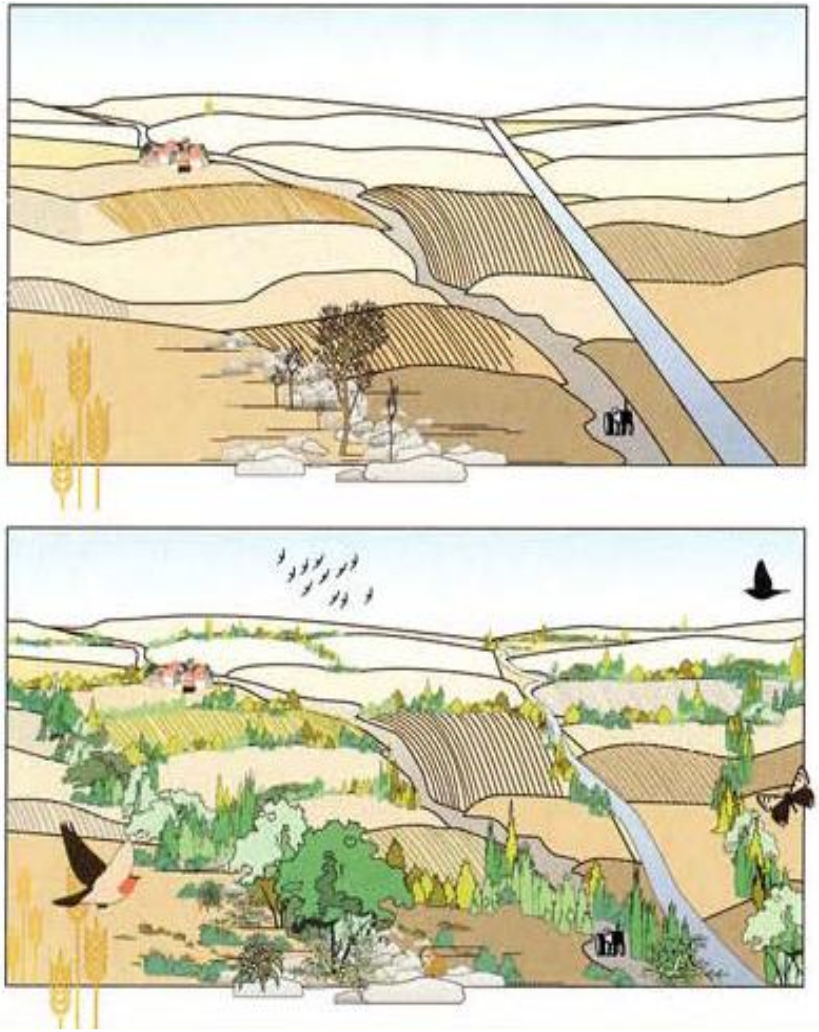
-Potencial de regeneración natural para restaurar los múltiples beneficios podría ser reducido.

Propuesta de restauración del paisaje

-Transformar paulatinamente áreas de producción (e.g. agrícolas) a través de renaturalización

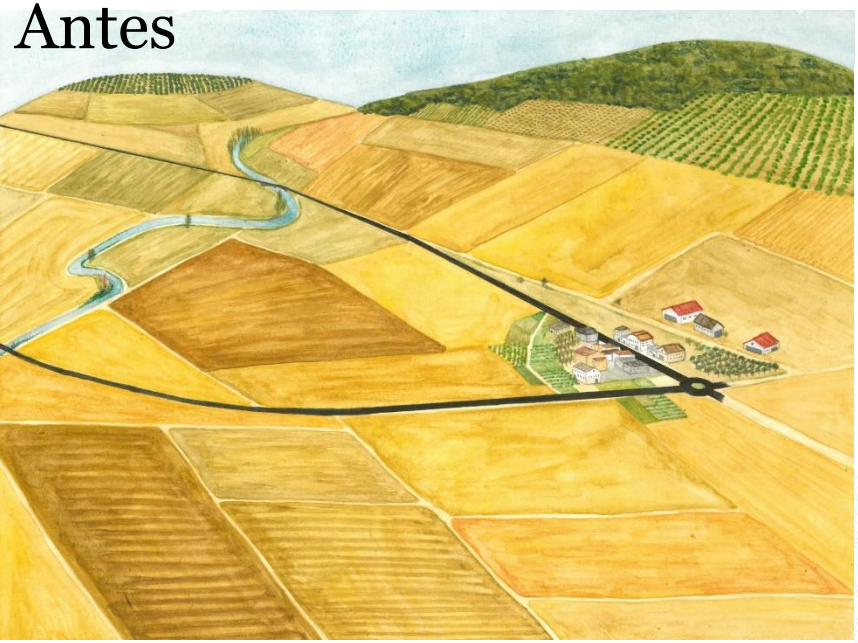
-Busca compatibilizar producción con conservación a través de la mejora en la provisión de servicios ecosistémicos

-Revegetación estratégica aprovechando elementos lineales del paisaje (lindes, ríos y arroyos, caminos y carreteras) y espacios “muertos” (e.g. rotondas de carreteras)



Propuesta de restauración del paisaje

Antes



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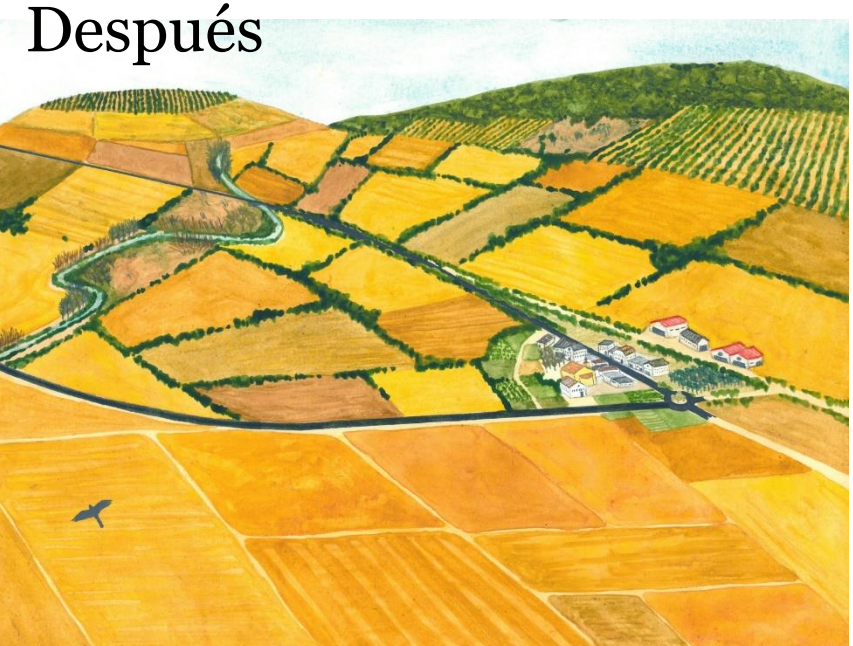

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Figure 1. *In Switzerland, farmers have to manage 7% or more of their land as "ecological compensation areas" (eg extensively managed meadows or wildflower strip fallows) in order to qualify for government subsidies in the form of direct payments.*

Aviron et al. 2009

Rey Benayas & Bullock 2015
(dibujo de Alejandra Toledo)

Propuesta de restauración del paisaje

Ambio
https://doi.org/10.1007/s13280-019-01149-2

RESEARCH ARTICLE

Landscape restoration in a mixed agricultural-forest catchment: Planning a buffer strip and hedgerow network in a Chilean biodiversity hotspot

José M. Rey Benayas, Adison Altamirano, Alejandro Miranda, Germán Catalán, Marco Prado, Fulgencio Lisón, James M. Bullock

Received: 30 May 2018 / Revised: 21 August 2018 / Accepted: 14 January 2019

Abstract Guidance for large-scale restoration of natural or semi-natural linear vegetation elements that takes into account the need to maintain human livelihoods such as farming is often lacking. Focusing on a Chilean biodiversity hotspot, we assessed the landscape in terms of existing woody vegetation elements and proposed a buffer strip and hedgerow network. We used spatial analysis based on Google Earth imagery and QGIS, field surveys, seven guidelines linked to prioritization criteria

studies have addressed the topic of large scale restoration planning (Thompson 2011; Morandin and Kremen 2013; Schulz and Schröder 2017); however, further discussion about how to plan such restoration, especially taking into account the need to maintain human livelihoods such as farming, is needed. Agricultural land had spread over ca. 38% of the total global land area by 2014 (FAOSTATS 2017), to the detriment of natural vegetation. Agriculture is the major cause of deforestation (FAO 2016), and the

Directrices para restauración del paisaje: basadas en evidencia científica

(1) Restaurar la vegetación leñosa de las franjas de protección ribereña a ambos lados de todos los cursos de agua de acuerdo con las leyes, reglamentos y jurisdicciones relevantes.

(2) Restaurar las cercas vivas (donde faltan) en todos los límites de los potreros > 2 ha*, siempre que los límites del potrero no sean adyacentes a las franjas de protección a remanentes de bosque nativo

(3) Asegure anchuras de cercas vivas de un máximo de 5 m (para no afectar otros servicios que provee el área, e.g. producción alimentos)

(4) Priorice límites de potreros o las franjas de protección que conectan restos de bosques nativos ≥ 0.5 ha (definición de “bosque” de FAO)

* Desincentiva a propietarios debido a efectos financieros negativos que se perciben

Directrices para la restauración del paisaje (guidelines)

(5) Priorice los límites de potreros que son perpendiculares a la pendiente. Esto maximizaría los beneficios relacionados con la escorrentía y la retención de agua, incluida la reducción de la erosión del suelo y la contaminación difusa, y la mejora de la retención de nutrientes (Maringanti et al. 2009).

(6) Priorice la restauración activa (es decir, la plantación) en sitios a distancias relativamente largas (> 50 m) a partir de franjas de protección existentes, cercas vivas o restos de bosques nativos. Se propone que los sitios ubicados a distancias relativamente cortas de estas fuentes de semillas se dejen para restauración pasiva (es decir, regeneración natural) para reducir costos (Rey Benayas et al. 2008; Forget et al. 2013).

Propuesta de restauración del paisaje

Presupuesto estimado para cercas vivas = USD 6900 por ha plantada (USD 1609 por km² de paisaje)

Muchas gracias!

Contacto

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