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Original Article

Silviculture

Homegardens as a System for Restoration of Legal Reserves: Aspects of Forest Legislation

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ABSTRACT

The homegardens result from collective learning and fulfill environmental services, contributing to the agrobiodiversity conservation and food security. The present study analyzed whether legal mechanisms incorporate concepts on environmental services and if legal frameworks in the state of São Paulo include homegardens as a feasible system for restoration of legal reserve (RL) area. Revisions of Law nº 12.651/2012 and resolutions SMA nº 44/2008 and SMA nº 32/2014 were carried out. For each attribute regarding the environmental services, grades from zero (absent) to two (explicitly described) were assigned. In the legal frameworks, the concepts concerning production, regulation and support were present, with the absence of cultural ones. For the adoption of homegardes as a viable system for restoration in legal reserve area, precepts should be changed regarding the presence of exotic species, management and monitoring practices required in legal frameworks.

Keywords: agrobiodiversity, ecosystems, recovery of degraded areas.

1. INTRODUCTION

In a worldwide scenario with about 10 billion people to be fed until 2050, arises the need for restoring more than 84% of the planet's lands for production and preserving (FAO, 2011). Since 2010, the Conference of the Parties (COP 10) for the Biological Diversity Conservation (CDB) established the ecosystem services (SE) as a key element in the global strategies for preserved areas (Vihervaara et al., 2010). It made the public policies to incorporate concepts about SE on legal instruments becoming one of the impact evaluation pillars related to water supply, environmental services providing and rural ecosystems restoration issues (Maes et al., 2012).

The environmental or ecosystem services are the benefits that people obtain from the nature, direct or indirectly, in order to sustain the life in planet, however, the ecosystem processes (functions) and services not always present biunivocal relation, as a single service may be the product from two or more functions, or a single function may generate more than one service (Costanza et al., 1997). According to the Millennium Ecosystem Assessment (2005), the ecosystem functions can be defined in four services categories: (a) *production or provision* – offers goods, such as food, potable water, wood and fiber; (b) *regulation* – rules weather and pluviosity, water, residues, plants pollinizing and diseases and plagues control; (c) *cultural* – with the cultural values, spiritual, educational and aesthetical, knowledge generation (formal and traditional); (d) *support* – includes the soil formation, photosynthesis, nutrient cycling and the seeds dispersion.

The increase in world food production highlights the demand for ecosystem services, however concentrated only in the provision. It is expected that until 2050 the worldwide food production grows 70% to 100% related to the 2009's levels (FAO, 2011). In a different sense from the traditional agriculture, dominant in the current productive model, the agroecology considers the biological diversity to understand its role in the ecosystem services provided by the agroecosystems (Levidow, 2015). Thus, not only the productive chain and the income are considered, but also the relationship of the human being with the environment to develop sustainable models for the field (Levidow, 2015; Buquera et al., 2018).

In such context, the homegardens are classified as an agroforestry system widely used due to their fundamental social and economic role as one of the oldest system of land use (Almeida & Gama, 2014). Considered as sustainable, the homegardens combine several crop species with multiple uses in a space, which ensure basic needs from familiar farmers, such as nutrition assuring the feed safety and health (Rocha, et al., 2015; Santos et al., 2018). The homegardens are generally unique, because they result from a family learning set passed throughout generations and that can be potentiated (Quaresma et al., 2015). However, such unique character makes it complex to generalize models and processes in the different management systems and incorporate different perceptions about its composition and operation. In such context, although the homegardens could be strategic, linking sustained conservation, restoring and production (Mattsson et al., 2013), they should also be able to restore ecological processes such as the biodiversity and the environmental services as the soil protection and the erosion control, previously carried out by the natural forest (Tynsong & Tiwari, 2010).

In Brazil, the environmental legislation determined that some areas must receive special protection, among them, the permanent preservation areas (APP), legal reserve (RL) and those covered by vegetation from the Atlantic Forest and the Cerrado (Caldeira & Chaves, 2011). For this purpose, public policies and regulations were sanctioned to regulate the anthropogenic actions, searching for the dialogue between the production, restoration and the biodiversity conservation.

Brazil has about 21.1 million hectares to be restored (Soares-Filho et al., 2014). The Brazilian government has a commitment to restore 12.5 million until 2030, formalized by the Decree 8.972 from January 23rd 2017 (Brasil, 2017). According to the same authors, the restoration of legal reserve areas represents about 4.5 ± 1 million hectares, wherein 0.6 ± 0.35 million hectares are occupied by agricultural activities. The possibility of including the homegardens as part of the legal reserve contributes to achieve the legal targets and to regulate the small and medium properties, associating sustainable production and conservation.

In this panorama, many authors discuss the efficiency of legal instruments for the restoration at São Paulo state and the impact caused by the Forest Law

12.651/12 (Oliveira & Engel, 2017; Brancalion et al., 2016). Particularly, they discuss about its efficiency to promote ecological processes focusing their stability and sustainability. On the other hand, although the homegardens are pointed out as resilient systems, capable to generate incomes and ecological sustainability, it still needs analysis about its adoption as a tool able to conciliate production, conservation, restoration with the ecological functions and environmental services provision in APP and RL. However, information regarding the local based ecosystem services is crucial to solve essential political issues, for instance about where and how restoring and the needed resources (Maes et al., 2012).

Based on such considerations, the present study considers that the legal instruments must promote different restoration systems at the APP and RL. Therefore, recognizing the homegardens as a productive and restoring system capable to provide environmental services, to promote ecological and social processes. Their adoption can allow the reduction of restoration costs besides to the conciliation between production and conservation in small rural properties. Thus, the present research aims to answer the following question: Do the current legislations at São Paulo state allow incorporating the homegardens as a method for restoring legal reserve and permanent preservation areas, and if legal instruments effectively include the environmental services in their content?

2. MATERIAL AND METHODS

Initially, a survey and historical of the main legislation implemented in Brazil and in São Paulo state were made aiming to identify the legal frameworks evolution processes. After that, those legal frameworks were analyzed focusing on the restoration of permanent preservation areas (APP) and legal reserves (RL) considering general aspects of homegardens (species composition, density, management) that contribute for including them in such categories of areas. For that, were selected the São Paulo state instruments relating to SMA Resolution 44 from June 30th 2008 (São Paulo, 2008), SMA Resolution 32 from April 3rd 2014 (São Paulo, 2014), and the Brazilian Forest Law 12.651, from May 25th 2012 (Brasil, 2012).

The normative were evaluated based on the presence of concepts associated to the ecosystem services (SE) involving actions that had as main objective the possibility of incorporating the homegardens as sources of environmental services payment. In the second stage, surveys about the theoretical issues involving the environmental services provision were made and a multicriterial matrix was elaborated, containing the guiding concepts and the attributes to compare the legislation in relation to the potential SEs (Table 1). For each attribute, grades from zero to two were applied based on the following criteria: the explicit presence – clearly described in the legal instrument

Table 1. Guiding concepts, attributes and references applied to the legislation analysis based on the provision of ecosystem services (environmental) according to Millennium Ecosystem Assessment (2005).

Concepts	Attributes	Conceptual references
Production	Food production	Vihervaara et al. (2010) Costanza et al. (1997)
	Body water production	
Regulation	Soil protection	Costanza et al. (1997)
	Biological regulation	
	Pollination	
	Invaders control	
Cultural	Cultural and spiritual values	Millennium Ecosystem Assessment (2005)
	Knowledge generation (formal and traditional)	
	Educational and aesthetical values	
Support	Nutrients cycling	Millennium Ecosystem Assessment (2005)
	Organic matter supply	
	Connectivity	
	Water cycling	
	Habitat provision	
	Primary production	
	Soil formation and retention	

(grade 2); the partial presence or description – via indirect conditions or situations that can propitiate ecosystem services generation (grade 1); and the attribute absence or inexistence (grade 0) in the analyzed legislations. In order to evaluate and compare the legal instruments referred to the incorporation of environmental services provision, the grades were plotted in radar graphics allowing their comparison among the same evaluation scale.

3. RESULT

3.1. Environmental and Forest Legislation in Brazil and in São Paulo state

The SMA Resolution 44/2008 regulated the implementation of agroforestry systems in the permanent preservation areas (APP) and legal reserve (RL) in small properties or rural properties. Following the criteria and procedures described on this resolution, the rural farmer can use the agroforestry systems to recompose its RL or areas covered by secondary vegetation of Atlantic Forest at initial stage. However, there is nothing specific about the homegardens or it is unclear about other models of agroforestry systems.

The federal law 12.651/2012 (Brasil, 2012) changed the criteria for the native vegetation protection instituting new rules that drastically reduced and affected the use and management of permanent preservation areas and legal reserve. At the same time, it included the recomposition of legal reserves (RL) with the cultivation of native and exotic species and their consortium in agroforestry systems. On the other hand, every Brazilian farmer must apply to the Rural Environmental Register (CAR, 2018), from which it will be possible to evaluate the areas to be restored in APP and RL. With 84 articles, the Forest Law 12.651/2012 opened a variety of exceptionalities for the small rural properties. Both the Forest Law 12.651/2012 and the state SMA resolution 44/2008 defined that in small rural properties can be used agroforestry systems in APP and RL. However, they impose that such systems need to be subjected to sustainable management plans approved by the responsible environment state agency.

In the state scope, the forest restoration was regulated by the SMA resolution 32/2014. The instrument established directives and guidelines for elaborating, executing and monitoring the ecologic restoration projects, besides indicating criteria and parameters to evaluate their performance along 20 years. In the same way, it considered the restoration importance for the ecological stability and integrity of the natural ecosystems, mainly in the permanent preservation areas, legal reserves and further protected spaces.

Therefore, the SMA 32/2014 (São Paulo, 2014), Article 11, considers the cultivation of exotic species without invader potential as a restoration method, however emphasizing that it is only possible if temporary. In the other hand, the subsection I, in the Article 6°, SMA resolution 44/08 (São Paulo, 2008), defines that maintaining planting density of arboreal species should be, at least, of 600 (six hundred) individuals per hectare. In the same article, the subsection II allows the introduction of 50% of exotic forest species, condition that turns on feasible to consider the homegardens as restoration areas to be included in RL and APP in small properties or familiar rural possession. Therefore, in the state legal frameworks there are mechanisms that make feasible to include the homegardens in the CAR as legal reserve and their use to restore these areas.

3.2. Environmental services: legislation multicriterial analysis

Theoretically evaluating the legal measures, the environmental services are present in the concepts related to production, regulation and support (Table 2). It is noteworthy that the Forest Law and the analyzed resolutions clearly presented the soil preservation issue, emphasizing the leaf litter presence, being essential for the nutrients cycling and humidity retention. The same is observed in the habitat prediction for protecting and preserving the fauna and flora threatened of extinction. But, for the hydric resources' preservation, only the article 4° of the Forest Law 12.651/2012 considers the marginal bands issue in the APP for any perennial and intermittent water course, excluding the ephemerals since the regular river gutter edge. Such change is very important because, while the previous Forest Code required the vegetation preserving of the greater river water course, the current Law 12.651/2012 requires the vegetation maintenance since the medium river water course. Despite the changes, the Forest Law still maintains the preservation of river banks. In the other hand, in the São Paulo state resolutions, the hydric resource preservation, especially those surrounding

Table 2. Legal instruments assessment regarding the incorporation of concepts and attributes associated with the theory of ecosystem services.

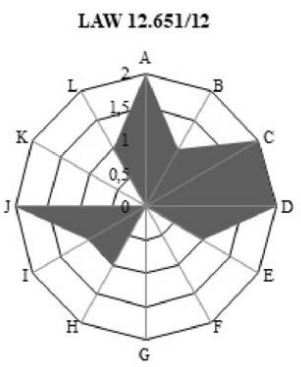
Concepts	Attributes	Forest Law 12.651/12 (Brasil, 2012)	Legal instruments	
			SMA 44/08 (São Paulo, 2008)	SMA 32/14 (São Paulo, 2014)
Production	Food production	Art. 1°-item II Art. 3°-item II, III, IV Art. 11°, Art.21°, Art. 9°, Art.11°-A§1° Art.7° §1°. Art. 20° Art. 21°-item IV	Art. 1° - item I, IV Art. 6°	Art. 1°-item X
	Water bodies production	Art. 4° Art. 41°-item I, d		Art. 5° - item I, VI
Regulation	Soil protection	Art.3°-item XXIV Art. 41°-item I, g Art. 51°	Art. 3° - item IV	Art. 5°-item II
	Invaders control	Art. 22°- item III		Art. 10°-item I Art. 11°§4° Art. 22°
Cultural	Cultural and spiritual values	Art. 6°- item V Art. 41°- item I- F		
	Knowledge generation			
	Educational and aesthetical values			
Support	Nutrients cycling	Art.66- item II	Art. 3° - item V	Art. 5° - item II Art. 16°- item I
	Organic matter supply	Art.7° §1°, Art.17°, Art. 33°§1°		Art. 16°- item I
	Habitat provision	Art. 3°-item III Art.6°- item IV Art. 27° Art.58°-item II Art. 70°- item I		
	Connectivity			Art. 5° - item III
	Soil formation and retention	Art. 6°-item I Art.58°-item IV, V		

the perennial or intermittent springs, appears only in the SMA 32/2014, Art 5° - items I and VI, and is considered as a priority in ecologic restoration projects.

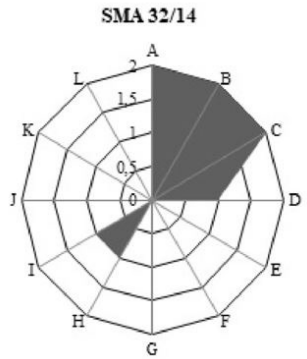
Even if in general the legal framework should have a wider scope, the Forest Law explicitly addresses only 33% (n = 4) of the attributes related to the environmental services, in special regarding the regulation. In turn, both SMA 44/2008 and SMA 32/2014 are also more concentrated in the attributes related to the production and regulation services and, in a small scale, the support. Such panorama shows that, for the analyzed environmental legislation, both the Forest Law and the studied state resolutions still have a lot to add concerning the environmental services in the RL and APP areas.

Comparing the legislations, only Forest Law cover a more extensive attributes related to production and regulation and more slightly, cultural (Figure 1). Although the SMA 44/2008 aims at regulating the agroforestry systems and homegardens use in RL and APP, it is not explicit related to practically none of the concepts covering the environmental services provision. Such issue is worrisome once such regulation should be reformulated, because its effective time has expired, being necessary the publication of a new resolution.

In a relevant manner, especially considering the homegardens socioeconomic importance, it is observed the almost complete absence of issues such as the cultural values and anthropogenic action on improving and increasing such areas quality and conservation. These cultural services concepts are introduced only in the Forest Law 12.651/2012 (Table 2; Figure 1), however it is an essential point because it is related to APP and RL



Concepts	Attributes	Code
Production	Food production	A
	Body water production	B
Regulation	Soil protection	C
	Invaders control	D
Cultural	Cultural and spiritual values	E
	Knowledge generation (formal and traditional)	F
	Educational and aesthetical values	G
Support	Nutrients cycling	H
	Organic matter supply	I
	Habitat provision	J
	Connectivity	K
	Soil formation and retention	L



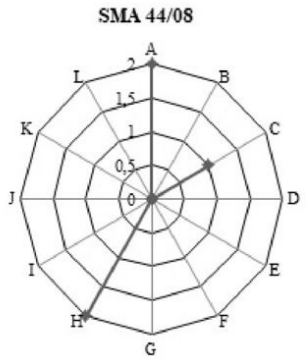


Figure 1. Relation of the analyzed attributes and the used codes and grades graphical representation applied to the attribute's interpretation related to the environmental services provision present in the legal instruments, being: 0 = attribute absence or inexistent; grade 1 = conditions of partial presence or description of attributes that can propitiate the ecosystem services generation; grade 2 = the attribute is explicit presented in the legal instrument. Source: Brasil (2012), São Paulo (2008, 2014).

from small rural properties. On them, the management proceeded in the homegardens by the small farmers is an important component to ensure its ecological, economic and social sustainability. The insertion of such concepts highlights the relevance of adopting homegardens as a potential method for restoring legal reserve and preservation areas, mainly if the legal frameworks incorporate the cultural issues. Although absent even in the SMA 44/2008, that exclusively refers to the agroforestry systems, it was also not addressed in the SMA 32/2014, that regulated specific restoration.

4. DISCUSSION

Generally, there is a resistance of the farmers in delimiting the APP and the RL, since they consider this a partial reduction of the productive area, leading to significant economic losses (Mendes et al., 2012). Many farmers do not realize that ecosystem protection is related to the maintenance of environmental services (Buquera et al., 2018) and that these services are essential for the sustainability and maintenance of agricultural productivity (Jodas & Portanova, 2014). However, if the homegardens in the small rural properties were considered as agroforestry systems capable to be used in the APP and RL restoration, they would need monitoring or regularization to comply the legally stipulated criteria, mainly their floristic composition. Although the SMA 32/2014 does not establish the minimum species number, many sites present a higher proportion of exotic species than natives, what can compromise their acceptation in the APP or RL restoration. As seen in Amazon, about 78% of exotic species and only 22% of native species were present in the homegardens (Almeida & Gama, 2014).

In the homegardens, such association of native and exotic plants make those areas similar to the natural forest systems, close to an ecologically balanced environment; nevertheless, in the wet and arid tropical regions it is common to observe the presence of native species and the dominance of cultivated exotic species (Albuquerque et al., 2005). Exotic species are introduced intentionally due to economic motivation, cultural aspects or by ornamental use (Garcia et al., 2017). The presence of these forest species consortiums in the homegardens directly contributes to local diversity conservation and reduces restoration costs.

In São Paulo state, the Rural Environmental Register (CAR) was consolidated for 100% of rural properties, representing 20.8 million of hectares and small farmers occupy just 4.1% (6.2 million ha). So, to consider homegardens as RL would not impact international commitment's for restoration but could contribute to disseminate the use of this model of agroforestry systems among small producers with social, ecological and economic positive consequences.

5. CONCLUSION

In a general manner, both the Forest Law and the São Paulo state resolutions have defined criteria for the small rural properties on planting the agroforestry systems in their APP and RL. This approach brings to the farmer an opening for incorporate its knowledge on homegardens management and conduction with recognized potential for restoring legal reserve areas. Despite this, the issues related to the large presence of cultivated exotic species is still a limiting factor in legislation and should be revised in the legal frameworks.

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REFERENCES

Albuquerque UP, Andrade LHC, Caballero J. Structure and floristic of homegardens in Northeast of Brazil. *Journal of Arid Environments* 2005; 62(3): 491-506. http://dx.doi.org/10.1016/j.jaridenv.2005.01.003.

Almeida SL, Gama VJR. Quintais agroflorestais: estrutura, composição florística e aspectos socioambientais em área de Assentamento Rural na Amazônia brasileira. *Ciência Florestal* 2014; 24(4), 1037-1048.

Brancalion PHS, Garcia LC, Loyola R, Rodrigues RR, Pillare VD, Lewinsohn TM. A critical analysis of the Native Vegetation Protection Law of Brazil (2012): updates and ongoing initiatives. *Journal of Nature Conservation* 2016; (Suppl. 1): 1-15. https://doi.org/10.1016/j.ncon.2016.03.003.

Brasil. *Lei nº 12.651, de Maio de 2012. Dispõe sobre a proteção da vegetação nativa; altera as Leis nº 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nº 4.771, de 15 de setembro de 1965*. Diário Oficial da República Federativa do Brasil, Brasilia, DF (2012).

Brasil. *Decreto nº 8.972 de 23 de Janeiro de 2017. Institui a Política Nacional de Recuperação da Vegetação Nativa*. Diário Oficial da República Federativa do Brasil, Brasilia, DF (2017).

Buquera RB, Franco FS, Schlindwein MN, Marques PEM. A agroecologia e os serviços ecossistêmicos: um estudo de caso nos assentamentos do Municipio de Iperó/SP. *Revista Brasileira de Agroecologia* 2018; 13(3): 101-113.

Cadastro Ambiental Rural – CAR. *Relatório novembro de 2018* [online]. 2018 [cited 2019 Jan 10]. Available from: http://www.florestal.gov.br/modulo-de-relatorios

Caldeira YC, Chaves RB. *Sistemas agroflorestais em espaços protegidos*. São Paulo: SMA; 2011.

Costanza R, D'Arge R, De Groot RS, Farber S, Grasso M, Hannon B et al. The value of the world's ecosystem services and natural capital. *Nature* 1997; 387(6630): 253-260. http://dx.doi.org/10.1038/387253a0.

Food and Agriculture Organization of the United Nations – FAO. *The state of the world's land and water resources for food and agriculture (SOLAW) – Managing systems at risk*. Rome: FAO; 2011.

Garcia BNR, Vieira TA, Oliveira FDA. Tree and shrub diversity in agroforestry homegardens in rural community in eastern amazon. *Floresta* 2017; 47(4): 543-552. http://dx.doi.org/10.5380/rf.v47i4.48196.

Jodas N, Portanova RS. Pagamento por Serviços Ambientais (PSA) e Agroecologia: uma abordagem crítica à agricultura moderna. *Revista do Direito Público* 2014; 9(3): 129-152.

Levidow L. European transitions towards a corporate-environmental food regime: agroecological incorporation or contestation? Open University, United Kingdom. *Journal of Rural Studies* 2015. http://dx.doi.org/10.1016/j.jrurstud.2015.06.001.

Maes J, Egoh B, Willemen L, Liquete C, Vihervaara P, Schägner JP et al. Mapping ecosystem services for policy support and decision making in the European Union. *Ecosystem Services* 2012; 1(1): 31-39. http://dx.doi.org/10.1016/j.ecoser.2012.06.004.

Mattsson E, Ostwald M, Nissanka SP, Marambe B. Homegardens as a multi-functional land-use strategy in Sri Lanka with focuson carbon sequestration. *Ambio* 2013; 42(7): 892-902. http://dx.doi.org/10.1007/s13280-013-0390-x. PMid:23456780.

Mendes CJ, Neves CU, Berger R. Áreas de preservação permanente e reserva legal: percepção dos proprietários rurais do Município de Otacílio Costa, SC. *Revista Floresta, Curitiba, PR* 2012; 42(4): 671-682. http://dx.doi.org/10.5380/rf.v42i4.17283.

Millennium Ecosystem Assessment. *Ecosystems and human wellbeing: 677 multiscale assessments*. Vol. 4. Washington: Island Press; 2005. Synthesis report 678 series.

Oliveira RE, Engel VL. A restauração florestal na Mata Atlântica: três décadas em revisão. *Ciência, Tecnologia & Ambiente* 2017; 5(1), 40-48.

Quaresma AP, Almeida RCH, Oliveira CM, Kato OR. Composição florística e faunística de quintais agroflorestais da agricultura familiar no nordeste paraense. *Revista Verde de Agroecologia e Desenvolvimento Sustentável* 2015; 10(5): 76-84.

Rocha GBN, Vieira TA, Oliveira FA. Quintais agroflorestais e segurança alimentar em uma comunidade rural na Amazônia Oriental. *Revista de la Facultad de Agronomía* 2015; 114(N. esp. 1): 67-73.

Santos CS, Barros FN, Paula M, Rando J, Nascimento VT, Medeiros PM. What matters when prioritizing a medicinal plant? A study of local criteria for their differential use. *Acta Botanica Brasílica* 2018; 32(0): 297-302. http://dx.doi.org/10.1590/0102-33062017abb0336.

São Paulo. Secretaria de Estado do Meio Ambiente. *Resolução SMA nº 44 de 30 de junho de 2008. Define critérios e procedimentos para a implantação de Sistemas Agroflorestais*. Diário Oficial do Estado, São Paulo, SP (2008 jun. 30).

São Paulo. Secretaria de Estado do Meio Ambiente. *Resolução SMA nº 32, de 03 de abril de 2014. Estabelece as orientações, diretrizes e critérios sobre restauração ecológica no Estado de São Paulo, e dá providências correlatas*. Diário Oficial do Estado, São Paulo, SP (2014 abr. 3); Seção Meio Ambiente.

Soares-Filho B, Rajão R, Macedo M, Carneiro A, Costa W, Coe M et al. Cracking Brazil's Forest Code. *Science* 2014; 344(6182): 363-364. http://dx.doi.org/10.1126/science.1246663. PMid:24763575.

Tynsong H, Tiwari BK. Plant diversity in the homegardens and their significance in the livelihoods of war khasi community of Meghalaya, North-east India. *Journal of Biodiversity* 2010; 1(1): 1-11. http://dx.doi.org/10.1080/09766901.2010.11884713.

Vihervaara P, Rönkä M, Walls M. Trends in ecosystem service research: early stepsand current drivers. *Ambio* 2010; 39(4): 314-324. http://dx.doi.org/10.1007/s13280-010-0048-x. PMid:20799681.