Natureza & Conservação
Brazilian Journal of Nature Conservation
Supported by Boticário Group Foundation for Nature Protection
http://www.naturezaeconservacao.com.br

Essays and Perspectives

The use of nucleation techniques to restore the environment: a bibliometric analysis

*Daniela Boanares**, *Cristiano Schetini de Azevedo*

Programa de Pós-Graduação em Ecologia de Biomas Tropicais. Universidade Federal de Ouro Preto – UFOP, Ouro Preto, MG, Brazil

ARTICLE INFO

Article history:
Received 15 July 2014
Accepted 30 August 2014
Available online 11 November 2014

Keywords:
Bibliometric search
Environmental restoration
Gap analysis
Nucleation
Scientific production

ABSTRACT

The population awareness about environmental conservation is raising and this brought about an increase in the number of environmental restoration studies. Nucleation is a technique used for environmental restoration, where small nuclei of vegetation are established within degraded land. The aim of this paper was to evaluate, by doing a bibliometric analysis, the tendencies and gaps in the study of environmental restoration using the nucleation technique. Data were collected using The Web of Science© and Google Scholar© databases, from 1996 to 2012. Keywords used in the search of papers were nucleation, soil recovery, transposition of soil, bird perches, ecological succession, seed rain, restoration ecology, forest regeneration, degraded area and natural regeneration. Results showed that the number of published studies was low, although increasing in the last decade. The majority of the studies used more than one restoration technique or used natural perches as nuclei. Most of the studies were conducted in the Americas and by Brazilian researches. Many studies were not published as papers in scientific journals, but were available as master thesis or monographs. Natural and artificial perches, soil transposition and natural regeneration were the most successful techniques. The number of nucleation studies must increase and spread through the world, and their results need to be published to help other researches in the environmental restoration.

Introduction

Deforestation is a primordial human activity that is causing global changes in the climate and in land use that affects the biodiversity, carbon storage, environmental connectivity and the nutrient dynamics in the soil (Foley et al., 2005). Revegetation is one of the existing alternatives to mitigate these problems (Pausas et al., 2006).

Revegetation is an ancient practice made by different folks in different times and regions (Rodrigues and Gandolfi, 2001). Most of the revegetation measures involve planting arboreal

* *Corresponding author at:* Instituto de Ciências Exatas e Biológicas, Campus Morro do Cruzeiro, s/n, Bauxita, 35400-000, Ouro Preto, MG, Brazil.
E-mail address: daniboanares@yahoo.com.br (D. Boanares).
http://dx.doi.org/10.1016/j.ncon.2014.09.002

species (Rodrigues and Gandolfi, 1996, 2001). However, there are many problems highlighted by this practice due to the negligence of some ecological premises, like ecological succession (Araújo et al., 2005). This traditional model needs expensive technologies, which turn small projects impossible to be made, and have a strong dendrological view, using frequently exotic arboreal species, allowing local biological invasion and potentiating land degradation (Reis et al., 2003). This occurs because this model was developed for a quick and large vegetal biomass production (Bechara et al., 2007).

Environmental restoration techniques evolved after the appearance of the restoration ecology science (Cole et al., 2010). Today, restoration ecology is a goal to self-sustainability, participating in the restoration of the stability and biological integrity of the ecosystems (Rodrigues and Gandolfi, 2007).

One of the restoration techniques is nucleation (Martins et al., 2007). According to Reis et al. (2010), nucleation is a technique that uses small nuclei of vegetation within degraded land as starting points of vegetation regeneration. This technique tends to facilitate natural successional processes since it involves producers, consumers and decomposers, making it extremely effective (Reis et al., 2007). The vegetation nuclei have the function of attracting animals and plants, allowing other species to colonize the area (Yarranton and Morrison, 1974).

Six different nucleation techniques are normally used in restoration programmes: artificial perches, soil transposition, plantation in islands, Anderson groups, natural perches, and natural regeneration. The insertion of artificial perches in degraded areas helps in the increase of propagules in the substrate (dispersed mainly by birds from nearby forests) to accelerate the plant succession; the same is the goal for the natural perches, but in this case, small trees and bush are planted in degraded areas instead of the installation of artificial devices (Reis et al., 2003). Small portions of soils from non-degraded areas generally have great amounts of seeds and microorganisms within, and they can be transported to degraded areas aiming to accelerate the regeneration process (Espíndola et al., 2006). Anderson groups consist of the plantation of groups of key-tree species (those that naturally occur in the area), helping the increase of genetic variability (Tres & Reis, 2009). Dense groups of different plant species can be equidistant planted in degraded areas, and this technique is called plantation in islands (Corbin and Holl, 2012). In natural regeneration, no human interventions are made, being the area isolated and left to regenerate (Martins, 2001).

According to Martins (2007), the increase in the people's awareness about nature conservancy enabled an enhancement in the number of restoration studies that uses nucleation as a technique. Thus, the goal of this study was to conduct a literature revision about nucleation, pointing out tendencies and gaps, the most successful practices and methods, to help future restoration programmes and researchers.

Methods

The bibliometric search was conducted using The Web of Science© and Google Scholar© databases. The Web of Science© database was chosen because it is considered the most extensive and multidisciplinary database, being extensively used by academics (Azevedo et al., 2005). However, The Web of Science© does not index all scientific journals or other kinds of scientific publications, such as thesis and monographs. Google Scholar© was chosen as a searching database because this kind of scientific publications can be found, and because it provides free and easy access to academics worldwide.

The keywords used in the bibliometric search were nucleation, soil recovery, transposition of soil, bird perches, ecological succession, seed rain, restoration ecology, forest regeneration, degraded area and natural regeneration (papers with these key-words in any part of its text were selected; a search using the Boolean operators "and" and "or" was also run). The search comprised the years 1996 to 2012 (almost all studies were published between these years). Initially, the search resulted in 112 papers in The Web of Science© database, which were all exported to the software Endnote 5©. Then, all abstracts were read and all papers out of the subject were deleted from the results, remaining only 14 papers. The search in Google Scholar© resulted in 17 papers, which were all used. All papers were integrally read and analyzed according to the following parameters: (1) Year of publication; (2) Authors; (3) Journal where it was published; (4) Journals' impact factor; (5) Database (The Web of Science© or Google Scholar©); (6) Technique of nucleation; (7) Study type (theoretical or experimental); (8) success of the technique of nucleation in the study, and (9) Country where the experiment was conducted (if theoretical, the country of the Institution of the first author). The impact factor of the journals was grouped as the follows: [(1) 0.1–0.9; (2) 1.0–1.9; (3) 2.0–2.9; (4) 3.0–3.9; (5) 4.0–4.9 and (6) 5.0–5.9]. Data were analyzed in percentages.

Results

Twenty-three scientific papers and seven scientific materials (Dissertations, Thesis, Monographs, etc.) were published between 1996 and 2012. Papers found only in The Web of Science© database represented 26.09% ($n = 6$); papers found exclusively in the Google Scholar© database represented 39.13% ($n = 9$); papers found in both databases represented 34.78% ($n = 8$) of the sample. When other scientific publications, such as thesis and monographs, were inserted in the Google Scholar© sample, there was an increase in their number, jumping from nine to 16 publications (39.13% to 53.33%; $n = 23$ to $n = 30$).

Considering only the results of the search in The Web of Science©, between 1996 and 2005, only seven papers were published, which represents less than one paper per year (0.7 papers per year). However, between 2006 and 2012, 16 papers were published (2.28 papers per year). The year of 2010 was the most representative, with five papers published (21.74%) (Fig. 1). Considering only the results of the search in Google Scholar© database, between 1996 and 2005, the same seven publications were found. However, from 2006 to 2012, 19 scientific materials were found, almost three publications per year (2.71 publications per year). The year of 2010 was again the most productive, with six publications (20%) (Fig. 1).

Thesis, congress/symposium abstracts, monographs and dissertations appeared in the results only therewith the year