From Forest Nursery Notes, Winter 2009

54. © Vegetation succession in reclaimed coal-mining slopes in a Mediterranean-dry environment. de las Heras, J. M., Nicolau, J. M., and Espigares, T. Ecological Engineering 34:168-178. 2008.

ECOLOGICAL ENGINEERING 34 (2008) 168–178

available at www.sciencedirect.com

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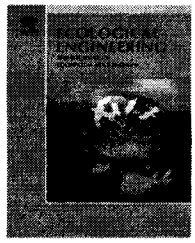

Vegetation succession in reclaimed coal-mining slopes in a Mediterranean-dry environment

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ARTICLE INFO

Article history:
Received 27 February 2008
Received in revised form
16 July 2008
Accepted 16 July 2008

Keywords:
Drylands
Inhibition
Local disturbances
Restoration
Soil erosion
Teruel coalfield

ABSTRACT

Mining reclamation results obtained in the Teruel coalfield (Mediterranean-dry Spain) during the last 30 years have been quite limited. In order to improve restoration operations we conducted a study to analyse the trajectories of ecological succession and identify the main driving forces that control vegetation dynamic in reclaimed artificial slopes. A total of 87 slopes of different ages and restoration treatments were classified and characterized after recording different variables related to topography, restoration techniques, vegetation, local disturbances and soil erosion. Successional trends were inferred from gradient analysis as well as the factors, mechanisms and processes implied. We found a wide variety of plant communities and successional trajectories. Initial conditions (soil quality and revegetation treatments) as well as the environmental scenario (climatic conditions and vicinity of preserved propagule sources) were the main driving forces directing vegetation succession. Soil erosion triggered by external run-on coming from surrounding structures was also identified as a key factor determining the evolution of vegetation in these dry environments. Other local disturbances (grazing and fungal pests) can favour vegetation transition in communities dominated by highly competitive non-native sown species to more diverse shrub communities. Some practical considerations for future reclamation projects are suggested.

1. Introduction

Failures in reclamation have been common in spite of the significant development of mining reclamation techniques during the last decades (Haigh, 2000); consequently, there are still poorly understood aspects (Plass, 2000). A deeper knowledge of the driving forces of community succession in reclaimed areas would improve their evolution towards ecosystems that contribute to provide territorial stability and facilitate the regeneration of fundamental ecological processes (Sänger and Jetschke, 2004).

In temperate areas, favourable conditions for spontaneous succession bring high potential for using it in reclamation processes (Prach and Pysek, 2001; Pietrzykowski and Krzaklewski, 2007). In these areas the main factors that control ecological succession are the following: regional meso-climatic differences, landscape factors related to the presence of preserved nearby vegetation, and local factors related to nutrient cycling and physico-chemical soil characteristics (Wiegleb and Felinks, 2001; Novak and Konvicka, 2006; Prach et al., 2007). Often, severe soil deficiencies and toxicity are the most relevant constraints (Bradshaw, 1997).

In reclaimed areas under dry climates, other factors related to water shortages and soil erosion may also affect vegetation dynamics (Whisenant, 2002; Martinez-Ruiz et al., 2007). Overland flow can be a driving force in these cases, since it

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0925-8574/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecoleng.2008.07.017