SNSIM

Procedia
Environmental Science, Engineering and Management
http://www.procedia-esem.eu

Procedia Environmental Science, Engineering and Management **3** (2016) (3) 113-118

20th International Trade Fair of Material & Energy Recovery and Sustainable Development, ECOMONDO, 8th-11th November, 2016, Rimini Fiera, Italy

GRASSLAND RECOVERY IN A LANDFILL SITE IN ALTA MURGIA*

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Abstract

This study is focused on evaluating the early vegetation dynamics in a restored landfill site in Alta Murgia National Park. While testing the effectiveness of different sowing methods, our aim was to identify the role of natural dynamics in the early successional stage of herbaceous communities. For this purpose, plant data were collected in the restored area as well as in the surrounding grassland patch. Cover values of vascular plant species were recorded and used to compute species richness and diversity, as well as to investigate the variation in plant life forms and bio-ecological parameters. Although the artificially sown species were not successful in grassland recovery, due to unfavourable abiotic conditions and natural competition, over 75% of the native species found in the whole area were effectively colonizing the restored surfaces.

No significant differences in species richness and diversity were found among restored sites, while more species-rich communities were found on landfill margins. These results underline the role of adjacent plant assemblages in natural colonization of restored surfaces, also providing cues for the application of cost-effective methods for vegetation recovery, as well as for planning strategies for habitat conservation and monitoring.

Keywords: grassland restoration, habitat conservation, plant community, succession dynamics

1. Introduction

Semi-natural grasslands of the Western Palaearctic region are among the most species-rich habitats in the world, having accumulated a huge amount of biodiversity during millennia of low-intensity land use (Dengler et al., 2014; Wilson et al., 2012). Today, many of these grassland ecosystems of high conservation value are threatened by several pressures associated with human activities (Cousins and Eriksson, 2008). This is the case of the

*Selection and peer-review under responsibility of the ECOMONDO

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calcareous grasslands of Alta Murgia uplands, where several conservation issues related to anthropogenic activities remain unsolved (Perrino and Wagensommer, 2013). To date, grasslands cover ~29800 ha and represent what remains from the ~80000 ha existing at the beginning of the 20th century (Mairota et al. 2013).

Therefore, recovery of grasslands in human landscapes has become one of the cornerstones of biodiversity conservation policy in Europe (Eggenschwiler et al., 2009). A major aim of grassland restoration projects is to recover grassland species richness (Walker et al., 2004). To achieve these aim, the recovery of native perennial grass cover is often given high priority to rapidly provide ecosystem services of erosion control and recovery of traditional landscapes (Conrad and Tischew, 2011; Kirmer et al., 2011; Tropek et al., 2010). On the other hand, methods enabling the effective recovery of native grassland plant communities on newly created soil surfaces are not straightforward. In general, a compromise is required in order to facilitate natural grassland colonization without the need for expensive sowing techniques.

Moreover in this context, few studies have taken into account the restoration processes in Alta Murgia plateau, where dry grassland vegetations of conservation concern occur. Among the most interesting grassland plant communities occurring in this area, those belonging to the classes *Festuco-Brometea*, *Lygeo-Stipetea* and *Helianthemetea* are listed in Habitat Directive 92/43/EEC.

Our study was first focused on evaluating the early vegetation dynamics on restored landfill surfaces in the Alta Murgia National Park. In particular, while testing the effectiveness of different sowing methods, our aim was to identify the role of natural dynamics in the early successional stage of herbaceous communities.

2. Materials and methods

This study was carried out in a restored landfill site in the northwestern portion of Alta Murgia plateau, in Apulia region. The landfill, which has been abandoned since 1992, was restored during 2015 within a project in charge of the municipality of Minervino Murge (BT). After first steps of cleaning-up and waste removal aimed at permanently securing the dump, capping was carried out using several layers (clay, HDPE geomembrane, drainage geonet), then the site was covered with native fine-grained soil for vegetation recovery. With the aim of enabling grassland recovery, three different methods were used according to the soil morphology occurring in the area: 1) no seeding on flat surface; 2) seed sowing on steep surface stabilized with jute matting; 3) hydroseeding on sub-vertical surface of a reinforced soil wall. For both seeding methods, a four-species mix of non-native perennial grasses (*Lolium perenne*, *Festuca rubra*, *Poa pratense*, *Dactylis glomerata*) was spread in October 2015.

In order to investigate vegetation dynamics, plant data were collected in June 2016 in the three different restoration surfaces, as well as in the surrounding grassland patches within a 20m buffer. For each area, cover values of vascular plant species (%) were recorded and used to compute species richness (S) and Shannon's diversity (H') indices.

Species were classified according to main life form categories (Raunkiaer, 1934): phanerophytes (Phan), chamaephytes (Cham), perennial grasses (H grass), perennial forbs (H forb), biennials (Bien), annual grasses (T grass), annual forbs (T forb) and geophytes (Geo). Specific Ellenberg-Pignatti's Indicator Values (EIVs) (Pignatti et al., 2005) were also computed for each species assemblage. EIVs are based on ecological requirements and specific plant traits of adaptation to soil pH (R), moisture (U), nitrogen (N), light (L), temperature (T) and continentality (C).

3. Results and discussion

As a first result, no one of the grass species artificially sown for restoration purpose was observed in the areas, though their seedlings were previously found growing during winter observations. This result indicates a loss of vitality of selected grass species during spring, which may be explained by both the unfavourable local abiotic conditions and by the competition with spontaneous weeds. Perennial grass species are known to be less efficient in suppressing competitive weeds during the early colonizing stage, while sowing annual species would have been more suitable for this purpose (Miglécz et al., 2015). Moreover, as a rapid weed suppression is known to be feasible at higher sowing rate, additional hay transfer would have enhanced a more rapid suppression of weeds even at low density sowing (Török et al., 2012).

Among the overall number of 159 species found in the whole explored area, 121 species (76.6%) were effectively colonizing the restored surfaces. As expected, plant communities occurring within the restored areas are characterised by a high proportion of ruderal weed species, which are well adapted to quickly colonize newly created soil surfaces. In particular in these areas, the grass layer was primarily dominated by the biennial weed *Silybum marianum*, in association with the annual grasses *Lolium rigidum* and *Avena barbata*. High proportions of *Conium maculatum* and *Dasypyrum villosum* were respectively observed on the flat surface and on the reinforced soil wall. In contrast, adjacent semi-natural grasslands were dominated by both annual (*Aegilops geniculata*, *Dasypyrum villosum*) and perennial grasses (*Dactylis glomerata* subsp. *hispanica*), with high cover value of typical grassland forbs (e.g., *Trifolium stellatum*, *Thapsia garganica*, *Asphodeline lutea*).

When compared with adjacent grassland area, all restored surfaces (flat, slope, wall, margin) showed considerably higher percentage in annual grasses and biennials (Fig. 1). With regard to plant bio-ecological traits, a strong increase in nitrophily (N) value was found in all restored sites, thus indicating a larger amount of ruderal weeds (Fig. 2). These results support the general finding that, after soil disturbance, a wide set of weed species with effective dispersal in space or time can rapidly establish on newly created open soil surfaces (Bischoff et al., 2009).

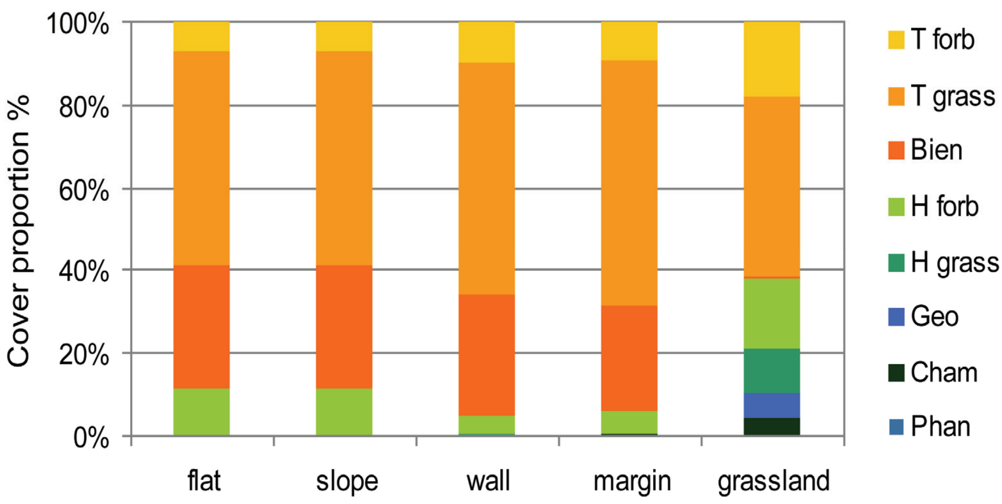

Fig. 1. Life form cover proportion (%) in the sampled areas

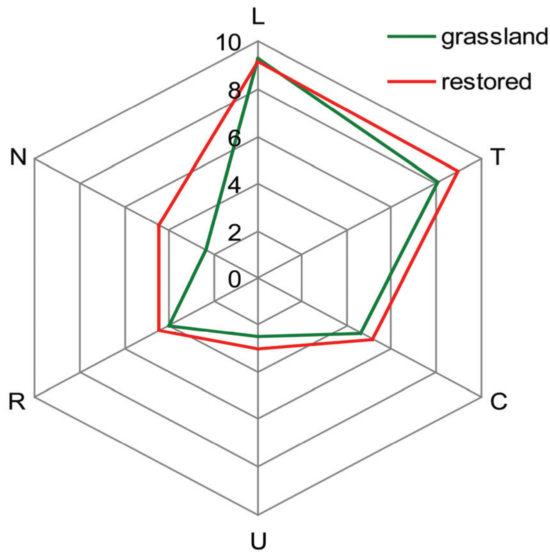

Fig. 2. Diagram of Ellenberg's bio-ecological values in the restored area (mean values measured in restored sites) and in the adjacent grassland patch

Despite the difference in soil morphology and restoration method, no significant variation in species richness and diversity was found among the three restored surfaces (Fig. 3). Indeed, while soil surface characteristics may have a role in driving species diversity in old restored communities, these may have no effect in recently restored ones (Deák et al., 2015). Vegetation composition on recently created surfaces could rather be driven by random species establishment processes, due to both local propagule banks and spatial dispersal (Rebele, 1992).

More species-rich communities were found at the margin between the landfill and the semi-natural grasslands (Fig. 3). This result indicates that the adjacent grassland community can act as an important source habitat from which species can colonize after restoration (Winsa et al., 2015).

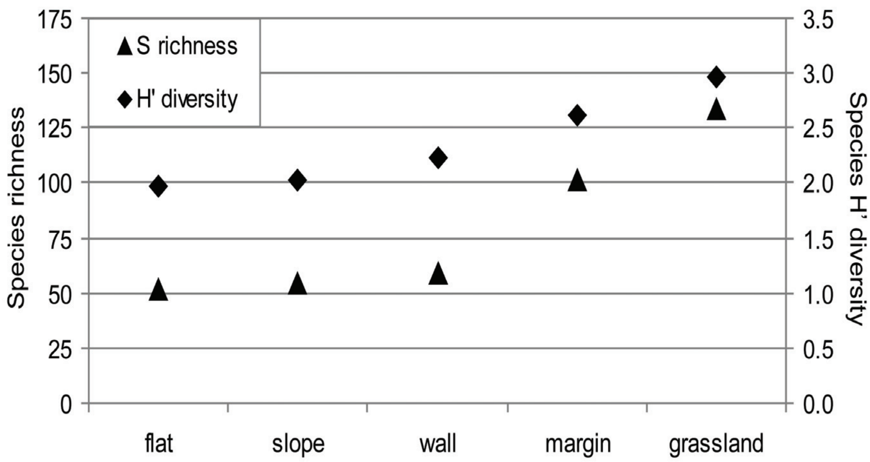

Fig. 3. Species richness (left Y axis) and diversity (right Y axis) in the sampled sites

In consideration of the natural instability of early stage ruderal plant assemblages, these results enable to envisage a quick natural evolution of studied herbaceous communities towards native grassland vegetation.

This preliminary study underline the predominant role of natural colonization by species from adjacent habitat patches, whose results are far superior to those of artificial sowing activities. This is specially important when assessing the feasibility of sowing high-diversity mixtures of native seeds, which tend to increase cost and time in many restoration projects. With reference to the study area, as well as to several dry landscapes in the Mediterranean, the application of more cost-effective sowing methods, e.g., hay transfer (Klimkowska et al., 2010; Török et al., 2012) is moreover suggested for restoration experiments.

6. Concluding remarks

The reported findings represent a starting point for monitoring restoration dynamics across time, which would provide a better understanding of successional processes in the poorly investigated study area.

This information is moreover needed for implementing cost-effective restoration actions in Mediterranean context, as well as for planning conservation strategies for habitat and species of European concern.

Acknowledgements

This study was carried out within the project "*Bonifica, messa in sicurezza permanente e ripristino ambientale dell'ex-discarica Monte Guardianello*" funded by the municipality of Minervino Murge (BT), in charge of Arch. R. Sarcinelli.

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