An exploratory analysis of land abandonment drivers in areas prone to desertification

C. Kosmas [a],[*], O. Kairis [a], C. Karavitis [a], S. Acikalin [j], M. Alcalá [b], P. Alfama [c], J. Atlhopheng [d], J. Barrera [e], A. Belgacem [f], A. Solé-Benet [g], J. Brito [c], M. Chaker [h], R. Chanda [d], M. Darkoh [d], O. Ermolaeva [i], V. Fassouli [a], F. Fernandez [e], C. Gokceoglu [j], D. Gonzalez [b], H. Gungor [j], R. Hessel [k], H. Khatteli [f], N. Khitrov [i], A. Kounalaki [a], A. Laouina [h], L. Magole [d], L. Medina [b], M. Mendoza [b], K. Mulale [d], F. Ocakoglu [j], M. Ouessar [f], C. Ovalle [e], C. Perez [e], J. Perkins [d], A. Pozo [e], C. Prat [b], A. Ramos [b], J. Ramos [b], J. Riquelme [e], C. Ritsema [k], V. Romanenkov [i], R. Sebego [d], M. Sghaier [f], N. Silva [c], M. Sizemskaya [i], H. Sonmez [j], H. Taamallah [f], L. Tezcan [j], J. de Vente [g], E. Zagal [e], A. Zeiliguer [i], L. Salvati [l]

[a] Agricultural University of Athens, Greece
[b] Institut de Recherche pour le Développement, Mexico
[c] National Institute for Agriculture Research and Development, Cape Verde
[d] University of Botswana, Botswana
[e] Instituto de Investigaciones Agropecuarias, Chile
[f] Institut des Regions Arides, Tunisia
[g] Estacion Experimental de Zonas Áridas (EEZA-CSIC), Spain
[h] University of Mohamed V, Chair UNESCO-GN, Morocco
[i] Moscow State University of Environmental Engineering, Russia
[j] Eskisehir Osmangazi University, Turkey
[k] Alterra, Wageningen UR, The Netherlands
[l] Consiglio per la Ricerca e la sperimentazione in Agricoltura, Rome, Italy

ARTICLE INFO

ABSTRACT

The abandonment of land is a global problem with environmental and socioeconomic implications. An approach to assess the relationship between land abandonment and a large set of indicators was illustrated in the present study by using data collected in the framework of the European Union DESIRE research project from 808 field sites located in 10 study sites in the Mediterranean region, Eastern Europe, Latin America, Africa and Asia. A total of 48 indicators provided information for biophysical conditions and socioeconomic characteristics measured at the plot level. The selected indicators refer to farm characteristics (family status, land tenure, present and previous types of land-use, soil depth, slope gradient, tillage operations) and to site-specific characteristics including annual rainfall, rainfall seasonality and water availability. Classes were designated for each indicator and a sensitivity score was assigned to each class based on existing research or empirically assessing the importance of each indicator to the land abandonment issue. Questionnaires for each process of land degradation were prepared and data were collected at field site level in collaboration with land users. Based on correlation statistics and multivariate analyses more than ten indicators out of 48 resulted as significant in affecting land abandonment in the studied field sites. Among them, the most important were rainfall seasonality, elderly index, land fragmentation, farm size, selected soil properties, and the level of policy implementation. Results contribute to the development of appropriate tools for assessing the effectiveness of land management practices for contrasting land abandonment.

© 2014 Elsevier B.V. All rights reserved.

1. Introduction

Taken as a process active in both developed and emerging countries, land abandonment is a socioeconomic issue with environmental implications at both global, regional and local scales (Strijker, 2005). Land abandonment can be defined in various ways according to the territorial

* Corresponding author at: Agricultural University of Athens, Department of Soil Science, Ierà Odos 75, GR-11855 Athens, Greece. Tel./fax: +30 210 5294097.
E-mail address: lsos2kok@aua.gr (C. Kosmas).

context and emphasis on environmental or agricultural issues. Rudel (2009) qualifies land abandonment as a change of land use to a lower economic state, which is per se not a worse situation as land can retain (at least partially) its functioning. Abandonment does not necessarily mean that land is no longer used, either by agriculture or any other rural economic activity. It means a change in land use from the traditional or recent pattern to another, less intensive pattern. As an example, the transition to a lower economic state from an intensive cropping to a less intensive land use could be more sustainable in the present socioeconomic context. By concentrating on agricultural systems, land abandonment means the (partial or complete) abandonment of agricultural activities and may reflect a transition into rural systems with possibly lower productivity (e.g. Koulouri and Giourga, 2007). Land abandonment occurs when the agricultural system is affected by external drivers or because of its own dynamics toward extensification or intensification.

Although studies were carried out to define causes and consequences of land abandonment at the local scale (Corbelle-Rico et al., 2012; Helming et al., 2011; Strijker, 2005), a comprehensive approach aimed at identifying regional-scale drivers using indicators deserves further investigation. The necessity of elaborating indicators is a research priority claimed by United Nations Convention to Combat Desertification (UNCCD) (COP, 2009). Many attempts have been made to assess land degradation processes, efficiency of land management practices and implementation of existing policies using indicators (EEA, 2005; Kosmas et al., 1999; Recatala et al., 2002; Rubio and Bochet, 1998; Salvati et al., 2008). Indicators generally simplify reality to make complex processes quantifiable so that the information obtained can be disseminated (EEA, 2005). The identification of reliable indicators will ensure the most effective use of restricted data provided by monitoring systems. The most useful indicators, however, are those which allow the identification of land abandonment drivers while there is still time and scope for remedial action (Sluiter and de Jong, 2007; Van Doorn and Bakker, 2007).

Various authors have simultaneously used the terms 'abandoned land' and 'grazing land', but grazing or hunting of an abandoned land may be considered as a traditional use (Baudry, 1991; Kosmas et al., 2000; López-Bermúdez et al., 1996; Martinez-Fernandez et al., 1995).

In the Mediterranean basin, abandoned agricultural land is generally found in unfavorable environmental conditions such as higher elevations, steep slopes, shallow soils, dry climatic conditions as well as marginal agricultural areas (MacDonald et al., 2000). Sloping croplands in semi-arid or dry sub-humid areas under intensive cultivation for a long period have been subjected to degradation due to soil erosion and shallow unproductive soils have been formed (Bakker et al., 2005; Kosmas et al., 2000). The analysis of land-use evolution in a Mediterranean area for the last 4000 years showed a drastic increase in agricultural land by replacing forested land (Marathianou et al., 2000). Many of the areas that once supported forests were cleared in order to sustain agriculture because of inadequate measures for environmental protection.

From the socioeconomic perspective, parallel employment of farmers or older landowners has a greater probability of abandoning agricultural land (Baudry, 1991; Van Doorn and Bakker, 2007). Land abandonment is also associated to depopulation due to out-migration of rural people (Christof et al., 2011). Although the European Union (EU) Common Agricultural Policy (CAP) supports economically less favorable areas for the local population in order to avoid abandonment of the land, the availability of better-paid jobs in neighboring urbanized areas stimulates agricultural abandonment (Gellrich et al., 2007; Kosmas et al., 2000).

Based on these premises, the aim of the present study is to propose an exploratory framework for the assessment of land abandonment drivers in a sample of vulnerable and non-vulnerable areas to desertification with different ecological and socioeconomic characteristics using a large set of indicators.

2. Methods

2.1. Description of the investigated field sites

A total of 10 study sites were selected in various places of the Mediterranean and Eastern Europe, Latin America, Africa and Asia for a total of 808 observation field sites (with an average of 80 sites per study area). The study sites were located in the following major land uses: 478 in cropland, 245 in pastures, and 85 in forested areas. This study is a part of the extensive fieldwork carried out in the framework of the DESIRE research project. More specifically, data were collected from the following study sites: (i) Crete island—Greece, (ii) Guadalentin basin—SE-Spain, (iii) Eskisehir plain—Turkey, (iv) Novij Saratov—Russia, (v) Zeuss Koutine—Tunisia, (vi) Boteti area—Botswana, (vii) Santiago island—Cape Verde, (viii) Mamora Sehoul—Morocco, (ix) Secano Interior—Chile, and (x) Cointzio catchment—Mexico. (See Fig. 1.)

Data were collected from a variety of environmental, social and economic conditions. The study sites are located in areas affected or sensitive to land degradation and desertification by a variety of processes and causes such as soil erosion, overgrazing and forest fires. The climatic conditions of the study sites are characterized as arid, semi-arid or dry sub-humid with rainfall ranging from 280 to 650 mm heterogeneously distributed along the year in the large majority of the cases.

The available soils are formed mainly on sedimentary and unconsolidated parent materials, free of rock fragments to moderately stony in 84% of the sites. Soil organic matter content in the soil surface has been identified as low to very low in 77% of the sites. Soils were moderately to severely eroded in 72% of the sites. Vegetation cover types include cereals (33%), olives (18%), vines (19%) and cotton (10%) generating a poor vegetation cover in the majority of the cases. The agricultural structure has been characterized as owner-farmed in 64% of the study field sites with variable farm size ranging from 2 to more than 100 ha.

Table 1
List of candidate indicators related to variables possibly affecting land abandonment in the investigated study sites.

Biophysical indicators	Socioeconomic indicators
Climate	Agriculture
Annual rainfall	Farm ownership
Annual potential evapotranspiration	Farm size
Rainfall seasonality	Land fragmentation
Rainfall erosivity	Net farm income
Soil	Parallel employment
Parent material	Cultivation practices and husbandry
Rock fragments on soil surface	Tillage operations
Slope aspect	Tillage depth
Slope gradient	Tillage direction
Soil depth	Frequency of tillage
Soil texture	Grazing control
Soil water storage capacity	Grazing intensity
Exposure of rock outcrops	Land management
Organic matter surface horizon	Fire protection
Degree of soil erosion	Sustainable farming
Vegetation	Reclamation of mining areas
Prevalent land cover	Soil erosion control measures
Vegetation cover type	Soil water conservation measures
Plant cover	Terracing (presence of)
Water runoff and fires	Land-use
Drainage density	Land use intensity
Impervious surface area	Period of existing land use
Burned area	Water use
Desertification risk	Irrigation percentage of arable land
	Runoff water storage
	Demography and tourism
	Elderly index
	Population density
	Population growth rate
	Tourism intensity
	Institutional
	Farm subsidies
	Policy implementation