**LAND DEGRADATION IN DOLJ COUNTY, SOUTHERN ROMANIA: ENVIRONMENTAL CHANGES, IMPACTS AND RESPONSES**

**ABSTRACT**

Central and Eastern Europe is experiencing significant land degradation, at the same time as social, economic and political transformation, and within the broader context of global climate change. This paper uses satellite data, primary field data and secondary information on Romania’s social, political and economic dynamics, in a mixed-method case study analysis of the drivers of, and responses to, environmental change and land degradation over the period 1984-2007. The analytical time frame encompasses the Socialist era, as well as transition to European Union membership, allowing identification of the ways in which the dominant political economic and social systems interact with biophysical factors and play out in the landscape. While the Socialist era is often portrayed as environmentally destructive, results indicate that management during this time developed a relatively stable landscape, albeit at an economic and social cost. In the lead up to the collapse of Socialist governance, the landscape altered more, resulting in worsening land degradation and land cover change. Responses to land degradation have taken two main routes: land abandonment and tree planting. While aspects of these responses are now more democratic and participatory, at the same time, they share some common ground with Socialist era approaches.   Building on the positive aspects of Socialist management strategies yields important lessons in addressing land degradation challenges more broadly.

*Keywords:**interdisciplinary; agriculture; remote sensing; Central and Eastern Europe; sustainable land management.*

**INTRODUCTION**

Land degradation in Central and Eastern Europe (CEE) is driven by both global climate change (Cuculeanu et al., 1999; Glinni et al., 2001; IPCC 2007a) and the major political-economic shifts that have and continue to take place following the collapse of Socialism in the late 1980s/early1990s (Stringer et al., 2009). The literature on drivers of change recognizes several biophysical and socio-economic variables that can result in land degradation, all operating at different temporal and spatial scales (Reynolds et al., 2007; 2011). Some approaches consider networks of ‘symptoms’ within different Earth system spheres that result in particular degradation ‘syndromes’ (Petschel-Held et al., 1999); others take a political ecology approach, identifying ‘chains of explanation’ to elucidate drivers and outcomes (Blaikie & Brookfield, 1987). Others still focus on land management decisions that result in particular land use outcomes, grounded in arguments that suggest land users are either inherently rational and apply management practices that maximize profits, or that they try to reduce and spread risks, investing in long-term environmental quality (see Requier-Desjardins et al., 2011). Still others consider how factors such as insecure tenure incentivize short-term planning by causing land users to adopt high discount rates (Quan & Toulmin, 2000). Urgent integrated, empirical interdisciplinary analyses that take a holistic and multi-scale view of the various environmental, political, economic and social components of land degradation and environmental change are essential to enable policy makers to tackle these challenges. Despite its importance, academic research on this issue is sorely lacking.

This paper addresses this research gap through an analysis of land cover changes and degradation in southern Romania. It uses a combination of research methods to identify: how the landscape of the Romanian Plain has changed between Socialism-post Socialism eras; and the potential drivers of and responses to such changes. Triangulated data suggest that land degradation and land cover change were exacerbated in the lead up to the transition to a market economy and political democracy, and that Socialist land use and land cover patterns had created a relatively stable, albeit unsustainable, landscape. By examining the management strategies that enabled a stable and productive system during the Socialist era, valuable lessons may be learned that could help address current land degradation and environmental changes in both CEE and beyond.

**MATERIALS AND METHODS**

**Study area**

Romania has a large rural population and one of the largest agricultural sectors in Eastern Europe (Kuemmerle et al., 2009). Politically, it has undergone an enormous shift from one of the most oppressive Socialist regimes in Europe to becoming an EU member state in 2007 (Stringer & Paavola, 2013). At the international policy level, Romania is a signatory to the United Nations Convention to Combat Desertification (UNCCD, 1994) and a member of the UNCCD’s Annex V, which outlines the specific land degradation and desertification challenges faced by the CEE region. This link to international processes has helped Romania to articulate its priorities in addressing land degradation through production of a National Action Program (Romania NAP, 2000). Moldova, Armenia and Georgia are the only other CEE countries to have developed a NAP to date.

Our study area is located on the Romanian Plain in southern Oltenia. Average annual rainfall in the Oltenia region is approximately 500 mm (NIS, 2002). Drought is a characteristic regional climatic feature, occurring at roughly 15-25 year intervals. Within these cycles are some very dry years but also 1-3 year periods that have seen above normal precipitation (Romania 4th Communication to the UNFCCC, 2006). Despite this, the overall trend is towards rainfall decline. Droughts in the region have worsened over the past 50 years (Kertész & Mika, 1999; Figure 1). Record temperatures and higher wind speeds are also being experienced (Romania NAP, 2000). The Arenosols and sandy Regosols that dominate the landscape are highly vulnerable to wind erosion, so this part of the country is particularly at risk from both desertification and land degradation (Romania NAP, 2000).

Dolj County comprises 104 communes. Our social science data focuses on two of the main population centers: the communes of [Dăbuleni](http://wapedia.mobi/en/D%C4%83buleni) and Mârşani. The landscape around these settlements comprises agricultural plains and dune fields, with sediments primarily from the Danube, Jiu and Olt rivers. Mârşani commune is also actively pursuing strategies to address land degradation.

**Methods**

A mixed-method approach allows analysis and triangulation of a variety of data sources in order to understand the dynamics and impacts of relationships between biophysical, political and socio-economic factors in Romania since the 1980s. The following section details the methods used.

Mapping land cover dynamics using satellite imagery

*Change detection*

Co-registered Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) imagery were used to map land cover change dynamics at approximately seven year intervals (1984-1991; 1991-2000 and 2000-2007; Table I). Image dates were chosen to represent, as closely as possible, landscape changes during the Socialist (defined here as 1984-1991) and post-Socialist eras (1991 onwards). Two occasions during the post-Socialist era were selected; one representing a period of major political change just after the fall of Socialism (1991-2000); the other representing the seven years prior to Romania’s EU membership (2000-2007). Landsat data have a pixel size of 30 x 30 m. Six of seven available spectral bands were used in the analyses spanning the blue, green, red, near-infrared and short-wave infrared regions of the electromagnetic spectrum. All images were collected for the summer season, July 26th-July 28th, minimizing potential differences in cropping patterns and seasonal conditions. All data were from the United States Geological Survey (USGS) Earth Explorer facility (<http://earthexplorer.usgs.gov/>).

Several approaches have been proposed for detecting change from multi-temporal satellite imagery (see Coppin *et al*., 2004 for a comprehensive review). Our study, used the iteratively re-weighted multivariate alteration detection (IR-MAD or IMAD) algorithm (Nielsen et al., 1998; Nielsen, 2007), which is an unsupervised change detection algorithm based on canonical correlation analysis (CCA; Hotelling, 1936). The basic idea of IMAD is to concentrate all the change information into a single difference image. CCA creates two sets of linear combinations of the intensities of all spectral bands, one for each time period. The first two linear combinations have the strongest correlations and are called the first canonical variates (CVs). The second linear combinations have the second largest correlations and are uncorrelated (i.e. orthogonal) to the first CVs. Higher order CVs are similarly defined. The algorithm subsequently performs pair-wise differences between the CVs to generate a sequence of transformed difference images, referred to as MAD variates. Because the MAD variates are orthogonal, different types of change will be associated with different canonical and MAD variates. Unlike simpler arithmetic operations commonly used in a change detection (e.g. differences or ratios), radiometric preprocessing of the data is unnecessary, because the IMAD algorithm is invariant to linear and affine transformations of the original data (Nielsen *et al*., 1998).

A minimum noise fraction transformation (MNF) was subsequently applied to the MAD variates to improve the spatial coherence of the image (see Nielsen *et al*., 1998). Only the first three variates were retained for further analysis as higher order variates have a low signal to noise ratio. Each MAD/MNF variate was correlated with the reflectance of each of the original Landsat bands to determine the type of change that each MAD/MNF variate represented. The MAD/MNF variate most strongly correlated with the Landsat NIR vegetation band (band 4), was subsequently used to identify areas of vegetation change. No other types of land cover change were analyzed.

Clustering of the change pixels was undertaken on the selected MAD variate using fuzzy maximum likelihood estimation (FMLE; Gath & Geva, 1989). The procedure uses an estimation of the approximate chi-square distribution of the standardized variate (i.e. MAD/MNF variate) to enable the exclusion of pixels with a high no-change probability from the clustering process (Canty & Nielsen, 2006). The final change images were interpreted with reference to the original multi-temporal Landsat imagery using a combination of visual interpretation and analysis of the spectral signatures. Output change maps included three classes: vegetation cover loss, vegetation cover gain and no-change, the last of which refers to areas that showed no change in the vegetation cover. The output from the FMLE clustering process was such that identified changes in vegetation cover indicated land cover conversions (i.e. changes in the type of land cover) as opposed to land cover modifications (e.g. changes in species or vegetation health).

*Accuracy assessment*

The accuracy of the change images was tested using the approach of Cohen et al. (1998). No historical photographs or high resolution images could be used as reference data to assess the accuracy of the change images, thus the error matrix (Congalton, 1991) was generated through visual interpretation and analysis of Landsat color composite images for each date. This method has been successfully used in previous studies (e.g. Cohen et al., 1998; Sader et al., 2001).

A total of 675 test pixels were used in the accuracy assessment. Samples were split equally between each of the three change images (1984-1991; 1991-2000 and 2000-2007). Within each change image a stratified random sampling approach, with an equal number of pixels in each of the three change/no change classes, was used to select the test pixels. Each pixel was visually compared with the associated Landsat multi-temporal data to identify whether vegetation change had occurred, and if so, whether it led to loss or gain in the amount of vegetation cover.

Desk-based literature and document reviews

A detailed desk-based literature review of academic and policy documents was undertaken to identify the physical, economic and socio-political characteristics of the study area. Literature was initially identified using keyword searches in the Web of KnowledgeSM database using the search terms ‘Romania and land’, ‘Romania and agriculture’ and ‘Romania and transition’. This revealed a wide range of English language articles that provided contextual environmental information about the country and its transition, with particular focus on agriculture and land. Further articles were identified by mining the reference lists in the initial articles. Documents were reviewed using thematic analysis to elucidate the key drivers of and responses to land cover and land use change over time. The Romania-focused literature was supplemented with a review of journal papers from a similar search using the terms ‘Central and Eastern Europe and land’, ‘Central and Eastern Europe and agriculture’, and ‘Europe and transition’. Romania’s policy documents on land degradation were downloaded from the internet ([www.unccd.int](http://www.unccd.int)).

Primary field data

Field data collection was undertaken during April-May 2007. A household questionnaire survey was administered to household representatives in [Dăbuleni](http://wapedia.mobi/en/D%C4%83buleni) and Mârşani using a random stratified sampling approach (n = 100; 50 per settlement). The questionnaire was translated into Romanian and piloted with five households, after which it was adapted slightly to clarify any questions that appeared unclear. The content covered themes such as land ownership, land use dynamics, changing contributions of agriculture to livelihood strategies, income sources, perceived productivity dynamics, visible environmental changes since the collapse of Socialism, the socio-economic impacts of environmental change, and land management practices. The questionnaire was administered by an interpreter in Romanian. Results were translated into English.

Interviews were conducted (in English) with key informants from Mârşani’s Association of Local Forest Owners (ALFO), private forest enterprises and the Agricultural Research Station in [Dăbuleni](http://wapedia.mobi/en/D%C4%83buleni). These people were recruited because of their key roles in making, executing and enforcing land-use decisions in the study area. Key informants then proposed further interviewees they felt would provide important insights. The mayors of three communes within the region (Mârşani, and nearby Daneţi and Urzica) were interviewed on the basis of their availability during data collection, as was the engineer responsible for the development of the main irrigation system in the area in the 1970s. It was not possible to interview the mayor of [Dăbuleni](http://wapedia.mobi/en/D%C4%83buleni). A focus group was held with eight elderly community members in [Dăbuleni](http://wapedia.mobi/en/D%C4%83buleni) to provide a local historical perspective on the environmental and socio-economic changes. Focus group participants were identified through snowball sampling to identify residents of the required age group, in consultation with questionnaire survey respondents. Focus group members were not involved in the questionnaire surveys.

Analysis of the qualitative primary empirical data included thematic coding of the interviews and focus group data. This was triangulated and cross-checked with the documentary thematic discourse analysis, information from the qualitative and quantitative analysis of the questionnaire, and the spatial extent and patterns of land cover change obtained from satellite imagery.

**RESULTS AND DISCUSSION**

**Visualizing patterns of land cover change**

Information from the satellite data helped to visualize the spatial and temporal changes in the land cover of the study area over the study period. Figure 2 (a-d) shows a series of false color composites of Landsat scenes from 1984, 1991, 2000 and 2007. Vegetated areas appear in shades of green; bare sandy soils are represented by pink and light blue tones. Brown and reddish-brown colors indicate fallow land or sparsely vegetated soils. The 1984 image is used as a representation of the type and the spatial patterns of land cover that were observed in the region during the Socialist era (Figure 2a). Much of the landscape was dominated by vegetated agricultural fields.

Socialism collapsed at the end of 1989, and in 1991 the first land restitution laws (Law 18/1991), resulted in the breakup of many large state-farms. The landscape impacts of this can be seen in the image from 2000 (Figure 2c), which shows several smaller parcels of agricultural land (mainly to the north and east), many of which are devoid of vegetation cover. These small agricultural fields are still visible in 2007 (Figure 2d) although vegetation cover within the region had by then started to increase.

The MAD change detection algorithm was applied to the satellite data to statistically identify changes in vegetation cover. The change maps illustrate a marked difference in the decline of vegetation cover over the periods examined (Figure 3). Observed losses of vegetation cover in the region were substantially lower, and vegetation gains higher, during both the Socialist period (1984-1991) and the period spanning over a decade after the collapse of Socialism (2000-2007), than that observed during the period of major political-economic change (1991-2000; Figure 3b). Much of the vegetation loss between 1991 and 2000 was concentrated in the agricultural fields to the east of the study area and towards the north of Marşani. In contrast, during the 2000-2007 post-Socialist era very little vegetation loss was observed. Instead, there was a distinct shift to vegetation cover gain, particularly north-east of Marşani and Daneţi and in the agricultural areas to the south-east of Dăbuleni (Figure 3c).

Results from the accuracy assessment can be seen in Table II. The overall accuracy for all three change images was >90 %. For all images the error of commission for both vegetation change categories was zero indicating that for the change categories every pixel from the test data was correctly mapped in the image. The error of commission for the no-change category ranged between 13 and 25 % for the change maps. An error of commission means that a pixel that was identified as having no vegetation change in the change image, actually exhibited either an increase or decrease in vegetation according to the visual analysis of the imagery (Congalton, 1991). The reasons for such errors of omission are largely due to the non-change threshold determined during the clustering process. Changes were identified from visual analysis of the imagery but the magnitude of the change was not such that they were included by the algorithm in the change image. Consequently the images represent a conservative estimate of vegetation cover change in the region.

**Environmental change and land degradation: Political drivers and outcomes of environmental changes**

Both the literature and interview data noted that the study area was used for extensive agriculture during Socialism. Land used for arable cultivation increased in particular during 1960-1989 (Blujdea *et al*., 2006). At this time, in line with prevailing government policy, land holdings were confiscated from their owners and amalgamated into large-scale collective farms. Interview and focus group data report that these farms were used to produce grains, melons, early potatoes, grapes and tomatoes, in accordance with top-down government production targets. Most people participating in the questionnaire survey (65 %) had either worked on the collective farms themselves, or other household members had worked there. Respondents explained that the knowledge gained about agriculture during that time is the main source of information guiding their agricultural practices today.

Attitudes towards the environment in Romania during Socialist times were similar to those in much of the rest of CEE during this era, i.e. land was considered to have no intrinsic value but to serve human needs (Mazurski, 1991). This meant that the centrally-administered production targets were not always well-matched to the land capacity and its soil quality. According to interviews with personnel at the [Dăbuleni](http://wapedia.mobi/en/D%C4%83buleni) Agricultural Research Station, intensive fertilizer applications were required in order to maintain the required productivity levels, while an extensive irrigation system was constructed during the period 1970-1974 in order to meet the water demands of the crops being cultivated in the southernmost part of the study area. According to an interview with the irrigation engineer, the system was built over a 75,058 ha area and comprised an elaborate range of canals, channels, drains, pumps, pipes and sprinklers. To further facilitate agricultural production, the area’s consolidated dune fields were leveled using heavy machinery, while 11,000 ha of forest was cleared to provide flat land for cultivation. To reduce aeolian erosion, a network of forest shelter belts was planted over an area of approximately 2000 ha. Overall, the forest shelter belts, irrigation facilities and application of fertilizers appeared to create a stable agricultural system that was able to maintain productivity in line with Socialist policy targets. During interviews, key informants reported that productivity had been ‘good’, while the irrigation system engineer suggested the combination of forest shelter belts and irrigation was very effective in stabilizing the Arenosols and Regosols. While these interventions may have created a reasonably stable and productive landscape, the economic mechanisms employed (including subsidies for inputs and output prices decoupled from market trends) and social disruption (collectivization) meant that it came at an economic, social and environmental price (see Turnock, 2002).

Since the collapse of Socialism in 1989, Romania has been undergoing extensive political, economic and social change. This includes a shift from a centrally planned economy to a market economy (Olejarova et al., 2003), as well as achieving EU membership in 2007. The effects of these changes are visible within the landscape (Figure 2 and 3). Establishment of private land ownership played a central role within the socio-economic and political shifts. As large-scale collective and state farms were disbanded, land was redistributed and returned to its pre-Socialist owners on three different occasions (through Law 18/1991; Law 1/2000; and Law 247/2005). However, the literature suggests that across the country, land parcels received by many owners were often small, degraded, and/or highly fragmented, and typically spread over 3-6 plots (Sabates-Wheeler, 2002). According to the General Agricultural Census (2002), only 30 % of returned land comprised a single parcel. Questionnaire results indicate that following restitution and redistribution, 100 % of respondents became land owners. However, 64 % of these own less than 5 ha of land in total, so have very small plots. Combined with their disparate locations within the area and beyond, respondents noted that it is very difficult to farm the land in an economically viable way.

The collapse of Socialism also increased unemployment across Romania. Key informants explained that this was largely due to the dismantling of state-owned industries and agro-industrial complexes. While people gained land (albeit in small and/or fragmented parcels), they lost their employment and primary source of income. This caused the rural areas to act as safety nets, absorbing many of the unemployed (Fraser & Stringer, 2009). The population influx from urban and agro-industrial areas to the plains surrounding the study area increased local demand for fuel wood for heating, construction and cooking, and according to the interview data, caused many people to fell the trees in the shelter belts. As forests were later privatized, restituted and redistributed, again often in fragmented and disparate parcels, deforestation was further exacerbated. Widespread felling took place by new land owners who would rather harvest and store the wood for their own use than risk other people illegally cutting their trees. This scenario is similar to elsewhere in post-Socialist CEE, such as in Albania (Müller & Monroe, 2008). People were also confused about their responsibilities as forest and land owners, and in the absence of designated pasture, interviewees noted that forest areas were heavily grazed.

During the post-Socialist period, many Romanian citizens returning to the study area subsequently engaged in subsistence agriculture in order to survive (cf. Lerman, 2004). However, use of inputs such as fertilizer and manure was limited, as people were too poor to be able to afford them (cf. Muica & Zavoianu, 1996) and also did not necessarily have the appropriate knowledge regarding the timing of fertilizer application. Such a reduction in inputs compared to those used during the Socialist era is widely supported by secondary national level data that suggest nitrogenous fertilizer use declined by 60 % over the period 1990-2004, whereas phosphorus and potassium fertilizer use decreased by around 90 % over the same time (NIS, 2006). This is thought to have had important negative impacts on productivity in the study area as data from the questionnaire survey indicate that 85 % of respondents considered that yields had either decreased or stayed the same over the past 20 years (since 1987).

The collapse of the irrigation system in the 1990s intensified the challenges to agriculture. During the Socialist period, maintenance and upkeep of the irrigation system had been state responsibility. According to the interview with the irrigation system engineer, this was achieved through state-owned, district-based National Land Reclamation Enterprises (IEELIFs), which were responsible for all phases of irrigation and drainage, from planning and construction, through to operations and maintenance. From the early 1990s, various components of the irrigation networks became the property and responsibility of several different companies, organizations, associations and individuals. As no single institution played a coordinating role, the system quickly fell into disrepair, while the smaller components were stolen in some areas. As stated by another interviewee:

“Now there are three different institutions dealing with irrigation. One is a state company, which manages the pumps and the big infrastructure; another company manages the small irrigation channels and is part state, part private owned. The third company comprises many associations of water users who have to sustain the smaller parts by themselves. The problem we have is a lack of communication between levels, an absence of money and no overall responsibility so the irrigation system doesn’t work as it should” (Interview respondent A, Dăbuleni Agricultural Research Station, May, 2007).

Results from the questionnaire survey show that a lack of irrigation is of key concern to land owners, with 57 % suggesting it is the main farming challenge they face and one of the key drivers of land degradation and abandoned land. A further 8 % of respondents reported drought as their most serious constraint. This is particularly important in the light of changing climatic conditions reported in the study area during the questionnaire survey. Responses summarized in Table III indicate a perceived trend towards hotter, drier and windier conditions. It should nevertheless be noted that people’s recollections of past weather conditions are not necessarily reliable when considered alone (Marx, 2007; Simelton et al., 2013). However, when people’s perceptions were compared with trends outlined in the literature, they showed broad agreement, with an increase in mean annual air temperatures and a decrease in mean annual precipitation over the period 1900-2000 (Romania’s Fourth National Communication to the UNFCCC, 2006; Figure 1). This also matches projections in the IPCC’s Fourth Assessment Report, which suggest higher temperatures and drought in this part of Europe in the future.

Analysis of policy documents indicated that the land degradation problems encountered in the study area (Figures 3 and 4) are recorded in the Romania NAP as primarily the result of poor agricultural practices and deforestation in the period following Socialism’s collapse. However, the role of changing governance structures and transition towards a radically different political and economic system in driving the environmental changes was not mentioned. Despite this, our data suggest that the conditions emerging in the post-Socialist era reflect the interaction of environmental and landscape characteristics (including soils with low nutrient contents; cyclical drought periods and climate variability) with a range of different socio-economic factors (including restitution of small and fragmented plots; agricultural inexperience of ‘new’ land owners; lack of investment in fertilizers and other inputs; changing labor distributions and increased demand for local energy sources resulting from shifts in governance that caused an increase in unemployment, poverty and an inability to purchase energy). These elements combined, led to widespread deforestation, the breakdown of irrigation systems and overgrazing. In turn, these processes appear to have increased the occurrence of land degradation, qualitatively reduced soil fertility (according to people’s perceptions) and caused the reformation and reactivation of dune systems modified during the Socialist era.

**Impacts of and responses to environmental change and land degradation: land abandonment and forestry**

Questionnaire and interview data, along with the literature, clearly support the assertion that Romania’s transition has exacerbated land degradation. 71 % of questionnaire respondents noted that land quality has significantly worsened since 1989. The impacts of this are intensified due to the specific social and economic context in southern Romania.

The population in the study area is largely elderly: focus group discussions and questionnaire data suggested that the average age of adult residents in the study area is 60-70 years old. Many people of working age are employed elsewhere in the towns and cities during the week as there is an absence of alternative local employment opportunities. School-aged children are often left with their grandparents, who tend the land in the absence of other adult family members. The combination of land degradation, a lack of irrigation, agricultural labor shortages and the lack of economic viability of farming small plots, is causing some of the newly-restituted and redistributed land to be abandoned and unused as a response to the degradation and associated socio-economic shifts. This is especially the case for those plots away from the immediate vicinity of the land owners’ homes, as observed in the change images (Figure 2) and in a number of other studies from elsewhere (MacDonald et al., (2000); Gellrich et al., (2007); Vanwambeke et al., (2012); Müller et al., (2009)). Indeed, questionnaire results indicate that up to 40 % of former agricultural land was not being farmed at the time of data collection. It was also clear from observations in the study area that a significant proportion of land was not being cultivated. One elderly man suggested during the focus group in Dăbuleni:

“Everyone here is involved in agriculture in some way, but since the revolution the weather is hotter, the forests have been cut and things have got worse. Many people have stopped farming the land away from their homes but under Communism, when we had irrigation, agriculture was productive here”(Male focus group member, Dăbuleni, April 2007).

This situation is not unique to this part of Romania. For example, Kuemmerle et al. (2009) suggest a land abandonment rate of 21 % in southern Romania more widely. Broadly similar findings are reported in other CEE countries too (Müller & Sikor, 2006; Baumann et al., 2011). Poor land condition offers little incentive for people to buy adjacent plots, and many simply cannot afford to invest in land or the labor, equipment and technology that is required to farm it in an economically viable manner. While some studies suggest that maintaining small farming structures may be a rational economic strategy given the constraints in production factors (in particular capital and labour (Bentley, 1990; Sikor et al., 2009)), this was not the case in the study area. The questionnaire survey results indicated that the majority of households depend primarily on income from pensions and allowances (Table IV), supporting other studies suggesting that the study area is one of the poorest parts of Romania (Bleahu & Janowski, 2002). Repeated suspension of land taxes has encouraged inactive landowners to keep their land rather than sell it, so land markets in this part of Romania remain poorly developed (Duncan & Prosterman, 2000).

A second response to land degradation is a shift towards afforestation and reforestation. This was reported in the area surrounding Mârşani commune. For much of the degraded area, forestry represents the only economically viable land use option. However, the small and disparate plots make it impossible for land owners to access government funds for afforestation and reforestation, largely because funds can only be used for planting more extensive areas. A way forward has nevertheless been developed through a Ministry of Agriculture, Forestry and Rural Development project entitled ‘Support to the Establishment and Development of ALFOs (Associations of Local Forest Owners)’. By forming official institutions through processes of cooperation and association, land owners are able to retain ownership rights of their land, but transfer administrative rights to the Association (Stringer et al., 2009). As ALFOs are entities that are legally recognized by the authorities, by pooling their small plots of land to create a larger area under the single ALFO jurisdiction, members are eligible to access resources for afforestation and reforestation from the national Land Reclamation Fund (Law 18/1992, updated).

As a result of ALFO establishment in the study area, forestry activities at the end of data collection in 2007 were taking place on 1100 ha of degraded land belonging to 981 land owners near Mârşani. The main species planted is *Robinia pseudoacacia.* Interviews with forest enterprise personnel suggested that this species is drought tolerant, fast growing, and produces high quality timber. The academic literature further highlights that *R. pseudoacacia* can improve degraded soils through N fixation and the addition of organic matter (Burner et al., 2005; von Holle et al., 2006), as well as helping to stabilize the soil surface and prevent dune reformation and reactivation. *R. pseudoacacia* has been used successfully in the area in the past when dunes required stabilization (Jonesco-Balea, 1923), and according to interviewees, was commonly used in the Socialist era forest shelter belts.

Similar to land abandonment, which often results in plots becoming overgrown with weeds, forestry also alters the land cover and can help to consolidate loose soils. Unlike land abandonment however, forestry offers additional social benefits and the potential to deliver further economic advantages in the future. According to the interviews, ALFOs have built local capacity in Mârşani, as well as social capital, helping to overcome some of the deep mistrust between people in the study area stemming from the Socialist era that was reported during interviews and focus groups. Participants in the household questionnaire survey in Mârşani reported that they attend regular ALFO meetings, and are interacting more with community members than they had in the past. Through interactions with forestry officials, they are learning more about the regulatory context surrounding land use and forestry. Over the longer term, it is envisaged that there is a solid potential for economic returns from the newly-planted areas, particularly through the harvest and sale of non-timber forest products such as honey (Stringer et al., 2009). There is also the possibility for local fuel wood needs to be met in a more sustainable way, which could have further positive impacts outside the rehabilitated area because if fuel wood demand can be met locally, it may reduce deforestation and subsequent degradation of other parts of the country.

Focus in the Romania NAP is generally on the development of institutional and legislative frameworks, human capacity building, science and technology and rural development (including the creation of job opportunities outside of the agricultural sector). Emphasis is also placed on forestry, through afforestation and reforestation initiatives like that in the study area. This suggests that more participatory structures for cooperation, like ALFOs, can gradually be rolled out to other communes, and that with shifts towards forestry and the maintenance of land cover, a more stable landscape can once again be created; this time underpinned by more open and inclusive social and economic structures and processes. Nevertheless, experiences in other CEE in countries such as Lithuania indicate that this will need to be coupled with active learning, education and training about sustainable land management to ensure sustainable vertical collaboration between local people and government, as well as horizontal collaboration amongst new land owners (e.g. Lazdinis et al., 2007).

**Implications**

Analysis of the changing landscape and the local responses to the current situation, demonstrates that while many present the Socialist era as a time of environmental destruction (Mazurski, 1991; Manser, 1993), it did appear to provide a reasonably stable landscape (Figure 3a), albeit at a social and economic cost. The combination of forest shelter belts and irrigation played a key role in stabilizing the land surface and preventing further erosion. In doing so, it created an agriculturally usable area and employment for many people. However, not all the Socialist land management practices yielded benefits. For example, the vast amounts of fertilizers applied in the study area are likely to have contributed to pollution of the Danube (**Schmidt, 2001**), exerting more extensive detrimental ecological effects on the rivers and ecosystems in the area.

The large-scale state and collective farm structures under Socialism enabled economies of scale but also cooperation (to a certain degree) as people had to associate with one another and work together in their land use activities. The questionnaire survey indicated that 12 % of respondents still share farming activities with their neighbors, friends or family, while 28 % of people felt that a lack of cooperation and associations today represents their key constraint to successful agriculture. Cooperation is nevertheless starting to take place more extensively within the ALFO. However, there is still an element of mistrust and suspicion between people. 63 % of questionnaire respondents considered communities were not very close-knit, and that a lack of cooperation may have worsened land degradation. In light of these findings, we suggest that it is not the Socialist structures *per se* that afforded stability. Rather, it was the steady consistency of the governance regime that helped to prevent land degradation. It allowed both landscapes and social structures to be maintained in a more constant and symbiotic state, with the former managed via the rather oppressive regime and the latter largely supported by vast government subsidies. These assertions match the findings of the satellite change detection analysis. With increasing emphasis on afforestation and reforestation in policies such as the NAP, and funds for the development of ALFOs, environmental managers of the present and future may be able to learn valuable lessons from the approaches of the past in managing land degradation. This has relevance for other CEE Annex V countries of the UNCCD who face similar post-Socialist challenges relating to land degradation, as well as other areas in which investigations have taken place into the relationships between socio-economic and environmental changes (e.g. Abu Hammad & Tumeizi, 2012; Glover & Elsiddig, 2012; Meshesha et al., 2012). However, more new and context specific frameworks are required for understanding land degradation in the CEE context.

**CONCLUSION**

This paper has explored the changes to the Romanian plain between Socialist and post-Socialist eras, alongside the drivers of and responses to the changes, using an integrated approach. While land degradation and desertification are not new in Romania and are thought to have occurred throughout the last 300 years in the study area (Jonesco-Balea, 1923; Fraser & Stringer, 2009), the problem of land degradation worsened with the lead to up to the collapse of Socialism. Although Socialism is generally regarded to have had a negative impact on the environment (an assertion with which we have no evidence to disagree), in light of current climate change projections for the study area (IPCC, 2007a), valuable lessons can be learned from some of the land management strategies used prior to its collapse in responding to current challenges. Careful consideration should be given to the use of adequate, though not excessive, inputs (at more sustainable levels than was the case under Socialism), irrigation, and the development of cooperatives and associations (via more democratic and participatory mechanisms than under Socialism). These approaches could provide important gains in making the area more economically viable and have some existing local grounding through their use in the past. The area may become more productive once again as land use changes towards greater forest cover. If the *R. pseudoacacia* trees help to improve the soil fertility as suggested in the literature (Burner et al., 2005), a longer-term land use strategy could be developed, perhaps alternating land use between forestry and agriculture over a multi-decadal time period to enhance social and economic benefits to the area. Legislation around land titles would need careful reconsideration to allow more flexible land use planning.

Existing theory on drivers of land use change tends to oversimplify the vast range of factors at play and their interactions. ‘Chains of explanation’ put forward by Blaikie & Brookfield (1987) to explain land degradation are perhaps more accurately conceived of as networks of cross-scale interactions that bridge biophysical and socio-economic domains. The Socialist period provides a useful demonstration of how governance factors can play a mediating role, maintaining a stable landscape, even in the face of climatic variability. Changing governance and transition towards new political and economic structures, in the context of climatic variability, have played a key role in shaping today’s land degradation in the study area. We may speculate that it has also played a role in Romania more widely, as well as the rest of CEE. The paucity of studies taking a longitudinal view to explore change in the region leaves considerable research to be undertaken. A mixed methods approach, such as that used in this paper, is vital to enable adequate attention to be paid to both human (economic, social and political) and biophysical factors, as well as the changing temporal and spatial relationships between them.

**ACKNOWLEDGEMENTS**

Fieldwork was undertaken with the support of University of Manchester Simon Research Fellowship.

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**Tables**

Table I. Satellite sensor, date of collection and path and row of datasets used in change detection.

|  |  |  |
| --- | --- | --- |
| Sensor | Date | Path/Row |
| Landsat Thematic Mapper (TM) | 24th June 1984 | 184/29, 184/30 |
| Landsat Thematic Mapper (TM) | 24th June 1991 | 184/29, 184/30 |
| Landsat Enhanced Thematic Mapper (ETM+) | 28th June 2000 | 184/29, 184/30 |
| Landsat Thematic Mapper (TM) | 24th June 2007 | 184/29, 184/30 |

Table II. Accuracy assessment error matrix for each of the change images including overall percentage correct, user’s and producer’s accuracy, errors of omission and commission, and Kappa statistic.

|  |  |
| --- | --- |
| **1984-1991** | *Reference Data* |
| *Change Image* | No change | Vegetation Gain | Vegetation Loss | *Total* | *User's accuracy* | *Commission error* |
| No change | 56 | 5 | 14 | 75 | 74.67 | 25.33 |
| Increase in Vegetation  | 0 | 75 | 0 | 75 | 100 | 0 |
| Decrease in Vegetation  | 0 | 0 | 75 | 75 | 100 | 0 |
| *Total* | 56 | 80 | 89 | 225 |   |   |
| *Producer's accuracy* | 100 | 93.75 | 84.27 |  |  |  |
| *Omission error* | 0 | 6.25 | 15.73 |  |  |  |
| *Overall classification accuracy* | 91.56 |  | *Kappa statistic* | 0.87 |  |   |
| **1991-2000** | *Reference Data* |
| *Change Image* | No change | Vegetation Gain | Vegetation Loss | *Total* | *User's accuracy* | *Commission error* |
| No change | 65 | 3 | 7 | 75 | 86.67 | 13.33 |
| Increase in Vegetation  | 0 | 75 | 0 | 75 | 100 | 0 |
| Decrease in Vegetation  | 0 | 0 | 75 | 75 | 100 | 0 |
| *Total* | 65 | 78 | 82 | 225 |   |   |
| *Producer's accuracy* | 100 | 96.15 | 91.46 |  |  |  |
| *Omission error* | 0 | 3.85 | 8.54 |  |  |  |
| *Overall classification accuracy* | 95.56 |   | *Kappa statistic* | 0.93 |   |   |
| **2000-2007** | *Reference Data* |
| *Change Image* | No change | Vegetation Gain | Vegetation Loss | *Total* | *User's accuracy* | *Commission error* |
| No change | 65 | 9 | 1 | 75 | 86.67 | 13.33 |
| Increase in Vegetation  | 0 | 75 | 0 | 75 | 100 | 0 |
| Decrease in Vegetation  | 0 | 0 | 75 | 75 | 100 | 0 |
| *Total* | 65 | 84 | 76 | 225 |  |  |
| *Producer's accuracy* | 100 | 89.29 | 98.68 | 287.97 |  |  |
| *Omission error* | 0 | 10.71 | 1.32 |  |  |  |
| *Overall classification accuracy* | 95.56 |  | *Kappa statistic* | 0.93 |  |   |

Table III: Climatic changes noted by questionnaire respondents over the period 1987-2007

|  |  |
| --- | --- |
| Type of climatic change observed | Frequency of response (%) |
| Hotter  | 64 |
| Windier | 55 |
| Drier – especially in summer | 80 |
| Lack of seasonality (2 distinct seasons instead of 4) | 44 |

Table IV: Primary sources of household income in the study area

|  |  |
| --- | --- |
| Main income source | Respondents (%) |
| Pension | 35 |
| Salary/self-employed | 15 |
| Agriculture | 4 |
| Remittances from abroad | 3 |
| Combination of allowances and pension | 23 |
| Combination of salary and pension | 19 |
| No income (reliant on family/friends) | 1 |

**Figure Captions**

Figure 1. Precipitation and temperature anomalies spatially averaged over the South Eastern region of Dolj County relative to the period 1957-2007. Data are derived from the Climatic Research Unit (CRU) TS (time-series) gridded data (CRU TS3.10; Harris et al., 2013).

Figure 2. False color composite images (band 7 is red, band 4 is green and band 2 is blue) of the study area from (a) 1984; (b) 1991; (c) 2000 and (d) 2007.  Vegetation appears in shades of green; pink and blue shades indicate bare sandy soils; and browns and reds represent fallow and sparsely vegetated areas.   Readers are referred to the online version for color images.

Figure 3. Change images for the period (a) 1984-1991; (b) 1991-2000 and (c) 2000-2007. Only areas identified as having undergone a change in the vegetation cover are depicted. Change areas are overlain on a grey-scale Landsat image to facilitate spatial orientation. Readers are referred to the online version for color images.