

STRATEGIC MEASURES FOR REDUCING LAND-USE EMISSIONS IN ROMANIA

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ABSTRACT

Sustainable land management implies using the land resources considering an optimal equilibrium between the economic growth and the environmental protection. Land-use emissions represent the second highest contribution to greenhouse gas emissions after the emissions from fossil fuels. Their causes are multiple, but mainly due to deforestation, practicing a bad land management, cultivating certain types of crops, using fertilizers and pesticides. Their reduction represents a goal of European Union, and consequently of Romania, that could be achieved by analyzing the evolution of land-use emissions and their impact on mankind and on natural capital, and by assuming concrete policies and strategies in the field of sustainable land management. This paper presents some observations regarding the land-use changes in Romania after 1990 and an analysis of the evolution of net emissions/removal in European Union, and proposes some strategic measures for reducing land-use emissions in Romania, so needed in the current context of climate change. The results indicate the existence of a negative situation in the case of Romanian net emissions/removal generated by the forest land. The strategic measures for diminishing land-use emissions in Romania should focus on designing a better legislative, justice and administrative frameworks, on educating landowners and other stakeholders regarding sustainable land-use, on investing in greener technologies and inputs, on reducing the energy use, and on improving the land tenure system for assuring food security.

KEYWORDS: *Data analysis, land-use emissions, mitigating climate change, sustainable land management.*

JEL CLASSIFICATION: *Q15, Q24, Q53.*

1. INTRODUCTION

The quantity of emissions generated by the activities developed in different sectors of economy has exponentially increased worldwide in the past centuries. This increase of emissions has caused negative effects on the earth's climate that are nowadays manifesting on human society, biodiversity and life on Earth. These impacts contribute to climate change which is acknowledged by scientists and governments who design strategies for mitigating and/or adapting to climate change. Among the impacts of climate change are the increases in global temperature, changes in the length and presence of seasons, the occurrence of extreme weather events, and so on. The greenhouse gas (GHG) emissions are generated by several sectors of economy, among which agriculture had an important share in the past years. In what way the land is used, the changes in its structure, the fertilizers and pesticides shared to improve soil quality, how intensively is used the land, the type of crops cultivated, and the size of deforestation represent important issues required to be considered to achieve a sustainable land management by the farmers, as well as by the

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governments, the ecologists, the civil society. Improper management of land in the past has led to increasing greenhouse gas emissions which caused visible changes in nature's behavior that rise the questions of what is the amount of emissions generated by the land use, how could be diminished and how the sustainable land management should be made. The sustainable land management implies the use of land resources respecting a balance between the economic growth, the social inclusion, and the environmental protection. Considering this context, the analysis of land-use emissions is important in order to design useful strategies for the future of mankind and to achieve the sustainable development. This paper focuses on analyzing the land use emissions in Romania by doing a comparison with the European Union Member States in order to propose some measures of diminishing the land-use emissions in Romania. The data on land use and emissions generated by land-use are obtained from FAOSTAT database and from the Romanian Institute of Statistics. The paper has three objectives: to analyze the change of land-use in Romania after 1990, to make and to discuss the comparison of the emissions generated by the EU Member States, and, finally, to propose some strategic measures of diminishing land-use emissions in Romania taking into account its necessity for mitigating climate change. The results of this research would represent a starting point in designing the future strategic objectives for achieving sustainable land management in Romania.

2. LITERATURE REVIEW

In the past years the sustainable land management has become an important goal at the EU's strategic level and not only. In order to manage better the land, the decision factors should know first what is not done properly and what are the impacts generated by each decision made for land use. In what regards the negative impacts of land use, the greenhouse gas emissions represent a worldwide effect with devastating actions on the planet. That is why many studies have focused on analyzing the land-use emissions and their impacts. It was estimated that during 1990s the land-use and land-use change caused approximately 1.6 Gt CO₂-e emissions globally during the 1990s, and about 33% carbon dioxide emitted during 1850-1998 mainly due to deforestation (Watson et al., 2000). During 1990-2011, in European Union the agriculture represented 10% of the total GHG emissions while in Romania the agriculture represented about 15% of GHG emissions of all sectors, indicating a descending trend for EU because of CAP's measures for environmental protection and an increasing trend in the case of Romania (Zaharia & Antonescu, 2014), mainly because of uncontrolled increased of fertilizers and pesticides. Many studies have estimated the land-use emissions by using the IPCC methodologies (Flynn et al., 2012; Don et al., 2012). Don et al. (2012) showed that it is difficult to estimate the balance of GHG emissions for bioenergy crops because of lack of data, and that the annual energy crops like maize, wheat and barley, have a low GHG efficiency because "the CO₂ savings due to bioenergy production are compromised by GHG emissions during feedstock production". They propose to reduce the GHG emissions by chosen better the type of crop, by improving the yield and by applying a better crop management (Don et al., 2012). Davis et al. (2014) consider that is not enough to know the quantity of land-use emissions but it is also required to assign those emissions to activities and products, and that this correlation can be made by distributing land-use emissions in space and time considering the production and the area as proxies, the policies for permanence, the space and time of consuming the products and their impacts on other countries. Also, some studies present estimations of emissions generated by the land conversions which indicate for example a minimum of 591 tonne CO₂/ha when conversing tropical forest into arable land and a minimum emissions of 260 tonne CO₂/ha when conversing temperate forest into arable land (Overmars et al., (2011). The conversion of forest area in other type of land use is very important to analyze because deforestation generates a high amount of GHG emissions. Another important point in the scientific literature regarding the emissions generated by the land-use change is its correlation with biofuels, meaning that it must be

overcame the negative effects of land use change by using the land in a sustainable way even though many years from now on must pass in order to truly see the benefits of using biofuels (Kim et al., 2009). Furthermore, it is required to determine how to handle with risks and uncertainties for a proper land management. Plevin et al. (2010) have shown that the policies in which the risks are associated with the uncertainty have better results in reducing the GHG emissions of land-use. Besides the studies which analyze the land-use emissions it has been conducted also ones on the benefits and measures taken for sustainable land management. Cowie et al. (2011) acknowledge the benefits of sustainable land management on human and biodiversity communities and highlight its importance on stabilizing and regulating carbon stocks. Another important issue that is highly discussed internationally is the consideration of externalities in all strategic plans, because land management implies activities of assessing land potential and of establishing suitable land exploitation (Beinat & Nijkamp (Eds.), 1998). So, mainly, the researchers highlight the necessity of applying sustainable land management for assuring the food security and safety for the future by improving the land access, the land-use, and the whole land tenure system.

3. RESULTS AND DISCUSSION

3.1 Land-use changes in Romania after 1990: some observations

Romania has recorded big changes regarding the land use since 1991 when it was adopted the Land Law no. 18/1991 which restored the property rights on the land after the fall of the communism and established the rules for sharing the land taken from agricultural production cooperatives to the entitled persons (Law 18/1991). Since 1991, this law had both positive and negative effects, and has contributed at increasing the changes in the land use. Other factors determinants of the land-use change were and still are the migration of rural population to urban areas, the deforestation, the development of urban areas, of tourism activities and of infrastructure, and the measures taken to achieve sustainable land management and sustainable development in general. As can be observed in table 1, during 1991-2012, the agricultural area has registered a 1.24% decrease and the forests area has increased with 1%. Unfortunately, the negative effects of deforestation are huge, because it generates carbon dioxide into atmosphere that contributes to greenhouse gases and eventually to climate change. So, the dynamic of forest area is very important when analyzing the land-use emissions for Romania. Since 2007 the arable land has decreased with 0.33% because, on one hand, were registered changes in the land covered with buildings which increased until 2012 with 9.72% and, on other hand, has increased the land degradation with 7.87% during 2007-2012. As the dynamic of land use shows it, since 2007, when Romania became a member state of European Union, the use of land did not become more favorable for achieving sustainable development, but instead have emerged new challenges in the area of land management.

Table 1. Land-use change in Romania

Land category	Land use in Romania (ha)			The dynamics (%)		
	1991	2007	2012	1991-2012	1991-2007	2007-2012
Total	23839071	23839071	23839071	0	0	0
Agricultural area	14798278	14709299	14615057	-1.24	-0.60	-0.64
Arable land	9423503	9423255	9392262	-0.33	0.00	-0.33
Pastures	3309827	3329984	3270610	-1.18	0.61	-1.78
Meadows	1467857	1531491	1544957	5.25	4.34	0.88
Vineyards and vine nurseries	285835	217968	210475	-26.36	-23.74	-3.44
Orchards and fruit tree nurseries	311256	206601	196753	-36.79	-33.62	-4.77
Non-agricultural land, total	9040722	9129772	9224014	2.03	0.98	1.03

Land category	Land use in Romania (ha)			The dynamics (%)		
	1991	2007	2012	1991-2012	1991-2007	2007-2012
Forests and other forest vegetation	6680090	6740865	6746906	1.00	0.91	0.09
Land covered with waters, ponds	893404	849920	836856	-6.33	-4.87	-1.54
Land covered with buildings	:	685735	752361	-	-	9.72
Ways of communication and railways	:	390085	388262	-	-	-0.47
Degraded and unproductive land	:	463167	499629	-	-	7.87

Source: National Institute of Statistics, Romania, www.insse.ro (2014)

There are not only anthropic factors which have influenced these changes, but also natural ones like land degradation. The main goal, also the hardest, is to identify the changes caused in the land use by each anthropic or natural factor in order to further propose a sustainable land use. Besides these changes between different land use categories, must be also considered the neglected agricultural areas for each land-use category when the land use emissions are analyzed. Nevertheless, the solutions for achieving sustainable land management and reductions of land-use emissions must come from all decision makers in the field, whether they are public authorities or landowners, in order to ensure the food security and safety in the present and for the future.

3.2 Evolution of land-use emissions

Land-use emissions must be analyzed before any strategic decision taken in the areas of sustainability and land management, because these should represent one of the national indicators for determining the achievement of a certain level of sustainable development. In order to analyze the land-use emissions was made a comparison between the net emissions/removal of Romania and those of the rest EU Member States. In the analysis were used the data of four category of land-use taken into consideration by FAOSTAT, namely, forest land, crop land, grassland, and also the burned biomass, because all these generate an important amount of greenhouse gas emissions. For a better understanding of Romania's status in what concerns the land-use emissions, we analyzed their evolution during time and space. It is possible to do this comparison between the countries because, in order to calculate the net emissions/removal in the case of land-use, FAOSTAT (2013) uses for all analyzed countries a unique methodology, summarized by the general formula:

$$\text{Net emissions/removal (Gg CO}_2 \text{ yr}^{-1}) = \text{Land-use area (ha)} * \text{Carbon stock change in the living biomass pool of land (t C/ha)} * \text{Conversion factors (-44/12 to convert from carbon mass to CO}_2 \text{ emissions, and } 10^{-3} \text{ to convert tons in Gg)} \quad (1)$$

EU28 generates an important amount of land-use emissions which have an increasing trend during 1993-2010. Of course, the Member States have increased or decreased the total emissions during the analyzed period, as could be seen in figure 1. In 1993, Estonia, UK, Hungary and Sweden had the highest and positive net emissions/removal while in 2010 the EU countries with the highest and positive net emissions/removal were Estonia, Finland, Lithuania and Austria. In 1993 9 EU countries had recorded positive net emissions/removal while in 2010 only 8 countries recorded a positive value, even though in the past years the reduction of GHG emissions represent an important goal in the EU 2020 strategy. Also, UK, Sweden and Romania are EU countries which changed their positive situation regarding the net emissions/removal into negative ones during 1993-2010, being shown that these countries do not give importance to the high amount of land-use emissions.

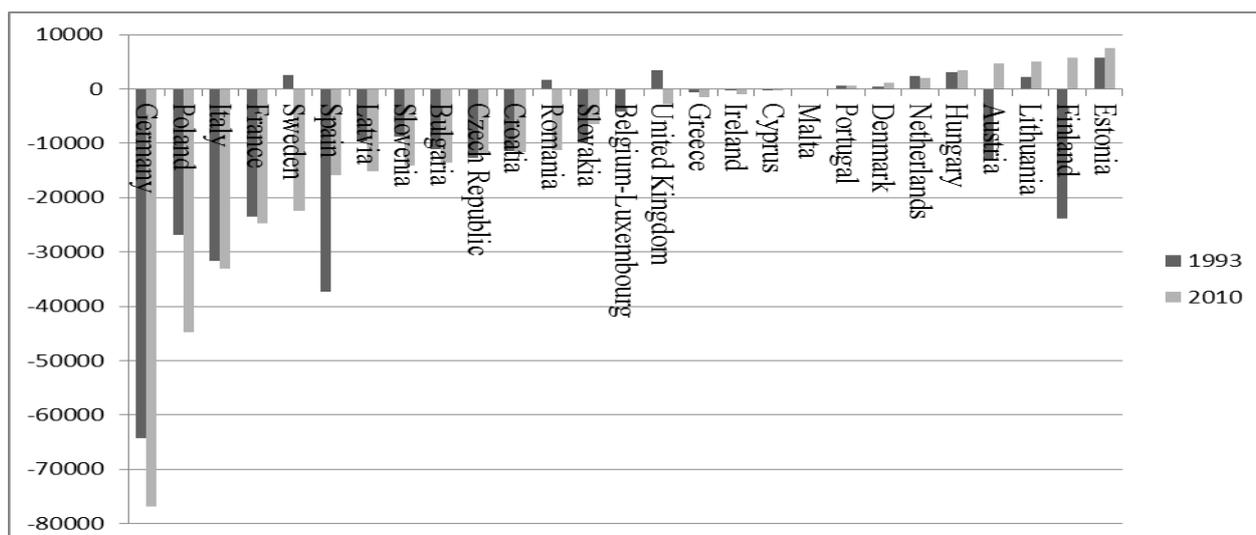


Figure 1. Land-use emissions in 2003 and 2010 for EU28 Member States

Source: based on data from FAOSTAT (2013)

More specifically, it could be observed that Romania had a decreasing trend during 1992-2010, because in 1992 the net emissions/removal had a positive value of 1621.22 gigagrams CO₂eq while in 2010 their value was negative, of -11203.7 gigagrams CO₂eq. This situation is not good for Romania, because the positive values represent gains of carbon in the pool of land and uptake from the atmosphere while the negative values represent losses of carbon and emissions into the atmosphere (Federici, 2011). This means that would increase the greenhouse gases in the atmosphere when the value of the net emissions/removal from land-use is negative, like it happened in the case of Romania in the last decade. Romania was situated in 1992 on the 9th place in the European Union in what concerns the amount of emissions generated by land-use while in 2010 on the 16th place, meaning that during 1992-2010 the land-use emissions have increased drastically because the net emissions/removal have decreased until a high negative value of them. In figure 1, is illustrated the net emissions/removal for the total land-use. In 2010, the net emissions/removal of Romania recorded a higher negative value than the EU's mean of -10254.02 gigagrams CO₂eq (FAOSTAT, 2013). In 2010, the Romanian net emissions/removal represented about 4.04% of all EU28 net emissions/removal. By analyzing the net emissions/removal for each category of land used at EU level, we observed that the highest share of emissions is generated by forest land which is the only category of land with negative values of net emissions/removal, fact that emphasizes the high amount of emissions generated by deforestation. The dynamics of EU's net emissions/removal per each category of land-use are presented in table 2.

Table 2. Total EU's net emissions/removal per each category of land-use

Land-use, in:	Net emissions/removal (CO ₂ eq Gigagrams)			Dynamics (%)				
	1992	2010	2012	1992-2012	1992-2010	1992-2005	2005-2010	2005-2012
Forest land	-329069.1	-363900	-	-	10.58	25.87	-12.14	-
Cropland organic soils	83259.37	83492.65	83492.65	0.28	0.28	0.28	0	0
Grassland organic soils	2437.11	2437.12	2437.12	0	0	0	0	0
Burning biomass	912.1569	418.8153	1527.261	67.43	-54.09	41.13	-67.47	18.64

Source: FAOSTAT (2013)

The EU's net emissions/removal of grassland organic soils recorded only positive values for all member states with an increase of only 0.0003% during 1992-2012. In 2012, Bulgaria, Croatia, Cyprus, Malta, Romania, and Slovenia are the only EU's countries with a zero net emissions/removal in the case of grassland organic soils while the highest positive values which exceeded the EU's average net emissions/removal of 90.26 gigagrams CO₂eq are recorded by Germany, Ireland, UK, Poland, France, Netherlands and Finland. In the case of cropland organic soils, the EU's average net emissions/removal was 3092.32 gigagrams CO₂eq in 2012 and this mean was exceeded in 9 Member States. Romania is under the EU's average by 62.64%, almost in the middle of the ranking. The EU's emissions from burning biomass have recorded also positive values and relatively big fluctuations in the carbon stock during 1992-2012. From this comparison at EU's member states it can be concluded that the main challenge of the policy makers is identifying the ways of transforming the negative values of net emissions/removal from forest land into positive ones and finding a consent in this direction from all world countries, especially from the ones which generate a lot of greenhouse gas emissions mainly due to deforestation. In 2010, in European Union, only Austria, Estonia, Portugal, Finland, Malta and Luxemburg have recorded positive values of net emissions/removal from forest land and the EU's average was -13477.77 gigagrams CO₂eq while, in 1992, only three countries (United Kingdom, Romania, Malta) recorded positive values and the EU's average was -14399.53895 gigagrams CO₂eq. The amount of all land-use emissions, their impact in the atmosphere, and eventually on humankind require an increased attention on land management and the implementation of transparent, concrete and properly regulated actions in order to control and manage land-use emissions from past until future.

3.3. Strategic measures for diminishing land-use emissions in Romania: a common effort

Since the scientists and the governments of states realized the negative impact of greenhouse gas emissions on Earth and the effects generated by these on future human activities, the policy makers started to create, to implement and to improve the strategies regarding the reduction of GHG emissions. EU's 2020 strategy (European Commission, 2010) requires the reduction of all GHG emissions by 20% until 2020 compared to 1990 levels emphasizing by that the importance of this subject at the level of each member state and of EU's policy makers. Also, according to Prentice et al. (2001), the land-use emissions represent about 10-30% of the total CO₂ emissions and its causes may include fertilization effects and bad land management practices. Considering the high share of land-use emissions in the total GHG emissions all EU's member states, including Romania, must take actions for analyzing and diminishing these emissions. Romania must design and implement a strategy or even concrete actions for reducing land-use emissions even more as the analysis performed has seen a rise in emissions from land use after 1990 going from positive values of net emissions/removal to negative values, that is from a relatively good situation to a very bad situation of Romanian land management from this point of view. Efforts in this direction should not come only from the government and public authorities, but primarily from direct decision makers, namely the landowners. The policy makers should help them by creating and promoting a transparent and an improved legislation, and even by designing and applying some schemes and economic instruments for promoting the reduction of land-use emissions in Romania. So, this must be a common effort because the emissions affect social welfare, and, thus, can be seen as being a negative externality. The first steps in achieving the diminution of land-use emissions are:

- Designing the strategy or the measures which are required to be implemented in order to reduce land-use emissions by researching the current status of land resources, the impact of past land reforms and policies, the knowledge of land owners regarding the sustainable land use, and by improving the land legislation and the function of local and central administration. This analysis must be reinforced by consulting and winning the support of specialists in the field, of landowners and of civil society.

- Implementing the strategy or the measures by using different tactics, information campaigns, by educating people, by adopting penalties for those landowners who do not take action to reduce emissions, by applying environmental taxes, by imposing carefully a limit concerning property rights on land use considering the fact that emissions from an inappropriate management of the land affects not only the owner but also other people, by sustaining the change of old technologies, by creating a consultancy group which should be representing a bridge between the competent authorities, researchers and landowners.
- Evaluating and improving this strategy or measures for better results in reducing the land-use emissions and for improving land management.

These could be achieved only by creating a stable political and economic environment, by improving Romanian administration in order to have proper employees, who must have knowledge in land-use management and ways of reducing land-use emissions, by adopting new legislation in the field which must be easy to understand, with a few loopholes as possible and with a transparent framework. Also, the policy makers should establish a better land tenure system in order to increase the land productivity and by that to ensure food security for the future. The state of land resources will be more important in the future given the fact that the human population is growing, so its needs are increasing and are diversifying while the capacity of support of the environment will be reduced. This will mean that the challenges regarding land use management will increase and the insurance of food security and safety can be accomplished by finding solutions to improve land use, to reduce their degradation, to protect the water, soil and air resources, to educate people, to explain more clearly the rights and obligations of landowners regarding sustainable land management and to adopt punitive measures if the taken obligations are not met. The landowners must create a long-term plan of land-use resources regarding the use of nutrients, the use of energy, the land monitoring, protection and reconstruction measures, the cost and benefits of positive and negative externalities. So, among the measures of sustainable land use can be found the improvement of the ways of land access, the protection of land resources, the reconstruction of degraded areas, the diminution of land-use emissions, the use of crops and fertilizers, and the education of landowners regarding sustainable land management.

4. CONCLUSIONS

The reduction of land-use emissions represents no longer an option but a necessity, because they contribute to climate change with an important share. The negative impact of land-use on air concentration is caused by bad land management, the crops used, the land-use changes, the fertilizers and pesticides and by deforestation. The policy makers must know the evolution and status of the land-use emissions in order to diminish them for achieving a sustainable land management. The total net emissions/removal generated by land-use in European Union indicates that are only 9 Member States from 28 which have a positive value of this indicator. Romania had positive values of the net emissions/removal until 2001 when the indicator's values became negative with continually decreases. The net emissions/removal generated by the forest land suggest the existence of a negative situation in the case of the Romanian, this being also because it is much harder and requires a much more time to take the carbon from atmosphere once it is emitted than to prevent its release. This means that the EU policymakers and Romania which have negative net emissions/removal should take actions for transforming them into positive ones in order to diminish land-use emissions and the total greenhouse gas emissions. These actions will contribute at achieving sustainable development and at fulfilling the goals of the European strategy for reducing the greenhouse gas emissions. Romania should design healthy legislative and justice frameworks for land management, professionally formed authorities, an integrated consultancy group, and a stable political and economic environment that underpin the creation, implementation, evaluation and improvement of a strategy or of important measures adopted for diminishing land-use

emissions. To achieve these goals it is required a common effort from the part of governments, administrative capacity, landowners and civil society. It would not be easy, but it is necessary for mitigating and adapting to climate change and achieving sustainable land management and sustainable development.

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