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Abbreviations and Acronyms

ARD	Agriculture and Rural Development
CAP	EU Common Agricultural Policy
CCA	Climate Change Action
CH_4	Methane
CO_2	Carbon Dioxide
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EIP	European Innovation Partnership
EPIC	Environmental Policy Integrated Climate (EPIC) Model
ESU	Economic Size Unit
EU	European Union
EU-15	The 15 Member States of the European Union prior to enlargement in 2004 and 2007
EU-27	The 27 Member States of the European Union (now actually 28 since Croatia acceded in July 2013)
GCM	Global Circulation model
GDP	Gross Domestic Product
GHG	Greenhouse gas
GVA	Gross Value Added
HNV	High Nature Value
ICAS	Institute of Forest Research and Management
ICPA	National Research and Development Institute for Soil Science, Agro-chemistry and Environment
INHGA	National Institute for Hydrology and Water Management
IPCC	Inter-governmental Panel on Climate Change
MECC	Ministry of Environment and Climate Change
MARD	Ministry of Agriculture and Rural Development
N	Nitrogen
N_2O	Nitrous Oxide
NIS	National Institute of Statistics
NMA	National Meteorological Administration
NMS	New Member States
NRDP	National Rural Development Programme
RAS	Reimbursable Advisory Service
UAA	Utilised Agricultural Area
WUO	Water User Organisation

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Executive Summary

Climate change is a huge challenge for the ARD sector in Romania. On the one hand, agriculture is a source of greenhouse gas (GHG) emissions and must therefore be expected to contribute towards the climate change mitigation goals of the Europe 2020 Strategy. On the other hand, the ARD sector is highly vulnerable to the impacts of climate change since the capacity of the "rural space" to provide adequate food supply; deliver ecosystem services; support economic growth, and; provide a safe living environment for rural communities is *directly dependent* upon favourable climatic conditions.

However, there are opportunities in the EU Common Agricultural Policy (CAP) for helping to address these challenges during the next programme period of 2014-2020 – in particular, the new rural development policy (Pillar II of the CAP) which has been significantly strengthened regarding actions for climate change mitigation and adaptation.

This rapid sectoral analysis aims to contribute to the successful mainstreaming of climate action into Romania's post-2013 rural development policy – namely the *National Rural Development Programme (NRDP) for Romania 2014-2020* that will be co-financed by the European Agricultural Fund for Rural Development (EAFRD).

This report is one of six rapid sectoral analyses[1] undertaken within the framework of Component B of the World Bank's Romania Climate Change Reimbursable Advisory Service (RAS) Programme. The title of Component B is "Identify and integrate climate actions into the 2014-2020 sector Operational Programmes".

Characteristics of the Agricultural and Rural Development (ARD) Sector

Compared to other EU Member States, the ARD sector in Romania is an extensive sector occupying 59.8% of total territory and providing a home to 44.9% of the total population. A relatively high proportion of national Gross Added Value (32.4%) and employment (41.5%) is also generated in rural areas. However, the ARD sector in Romania is also diverse and complex with much variability in socio-economic context and human / institutional capacity.

Rural areas in Romania are characterised by low quality infrastructure and relatively undeveloped basic services (health and education systems, finance and credit facilities etc.) compared to the urban areas.

The total area of agricultural land in Romania is 15.9 million hectares, of which around 13.3 million ha (approximately 56% of total territory) is currently being used. Around 1.5 million ha of utilised agricultural covered by economically viable / marginally viable irrigation systems, although only about 800 000 ha is currently functional. The rehabilitation of public and private irrigation infrastructure serving 100,000 ha and 300,000 ha, respectively, was finalized in 2012.

Livestock production in Romania declined rapidly following the collapse of the socialist regime and has continued (except for poultry) to follow a downward trend ever since.

The ARD sector is comprised of two distinct and clearly defined sub-sectors with i) around one half of the agricultural land managed by a small number of very large-scale, capital intensive and technologically advanced farms, and; ii) the other half of agricultural land occupied by communities of very small-scale farmers practicing more traditional farming methods and largely producing for their own consumption.

[1] The other sector reports are energy, transport, urban, water and forestry

There are a total of 3.86 million agricultural holdings in Romania, of which 96.6% fall into this "small-scale, subsistence farm" sub-sector. These small farms provide an important socio-economic buffer and basic livelihood for a significant proportion of the rural population. They also have an important role to play in maintaining the vitality of rural communities and providing important social, cultural and environmental services to the wider Romanian society. In the short-term context of 2014-2020 it is reasonable to assume that this small-scale farm sector will continue to persist, but in the longer-term there is a clear governmental commitment to structural reform of the highly polarised agricultural sector and a decline in the number of small farms is likely.

Romania has a diverse rural environment and an abundance of natural resources. Water resources are not in short supply, but there is a need for good management to ensure sustainability. However, while the overall situation appears good because of over-capacity there are areas of water scarcity in many basins where summer droughts are a significant concern. In particular the basins of Jiu, Arges-Vedea, Buzau-Ialomita, Siret, Prut-Barlad, and Dobrogea-Litoral face significant scarcity, with the last one being the most water-scarce basin in Romania. This situation will become more serious as the impacts of climate change become more pronounced.

Pollution of groundwater with nitrates continues to be a serious problem and is largely associated with the poor management of livestock manure and human waste in rural areas.

Vulnerabilities and Risks from Climate Change in the ARD Sector

Romania's temperate continental climate is changing and is predicted to be significantly different in the next 50-100 years.

The average annual air temperature is increasing and Romania should expect a continued steady increase in annual average temperature similar to that projected for the whole of Europe. There is some variation in the projections of the different models used, but compared to the period 1980-1990 further rises in annual average temperature should be expected of between:

- 0.5°C – 1.5°C by 2029, and;
- 2.0°C – 5.0°C by 2099 (depending upon global scenario).

The total amount of annual precipitation is decreasing and a continued reduction in mean annual precipitation of 10-20% should be expected by the end of the century, although this is likely to vary greatly between i) the north and south of the country, and ii) the mountains and lowland areas.

The pattern of precipitation is also expected to continue to change with a greater frequency of shorter, more intense and localised rainfall events. Rainfall patterns may also become more chaotic and difficult to predict.

Romania is already increasingly encountering the negative impacts of climate change (including extreme events) and the modelling of future climate trends suggests that these negative impacts will continue to become more severe. These impacts include:

- the increased incidence of severe flooding;
- the increased intensity and frequency of drought;
- increased risk of soil erosion and desertification.

Overall the ARD sector appears highly vulnerable to the impacts of climate change and it is expected that the livelihoods of many rural people will be more and more affected by the changing climatic conditions that are predicted.

But the risk of impact is not equally distributed. There are regional differences in the likelihood of negative impacts such as drought and extreme rainfall events, as well differences in the vulnerability, resilience and adaptive capacity of rural actors and communities to climate change. Differences which are further accentuated by the huge polarity in farm size and structure that is characteristic of the ARD sector in Romania.

Probably one of the most affected groups of producers will be subsistence farmers in the lowlands, especially in southern and south-eastern Romania.

Key vulnerabilities are:

- reduced agricultural productivity;
- water supply for rural consumers;
- other social (e.g. human health) and economic hazards for rural communities and households, and;
- environment and the 'health' of natural ecosystems.

Although there has been a significant reduction in GHG emissions from agriculture in Romania in recent years, there remains the very real possibility that GHG emissions will increase again as the agricultural economy improves – especially if livestock numbers increase and / or crop production becomes significantly more intensive again.

Mitigation measures therefore need to be put in place in the ARD sector that limit / cap GHG emissions. The big question remains whether the necessary mitigation can be balanced with the inevitable longer-term demands upon agriculture for increased food production. An appropriate mix of actions is therefore needed to manage, offset and avoid emissions across the whole ARD sector.

Adaptation is clearly also a high priority – progressive climate change is occurring and significant impacts upon the ARD sector are developing. The ARD sector needs to start responding more rapidly to prepare for future impacts and there is a need to build both the resilience *and* adaptive capacity of the two ARD sub-sectors (the large commercial farms *and* the communities of small-scale subsistence farms).

Existing National Strategies, Policies and Initiatives of Relevance to the ARD Sector

The *National Climate Change Strategy for Romania 2013-2020* (recently approved by Government Decision no. 529/2013 in July 2013) provides clear guidance on appropriate climate action in the ARD sector and identifies the EU budget (Multi-annual Financial Framework) for 2014-2020 as playing an important role in "catalysing the specific investments that will be needed to meet climate targets and to ensure climate resilience".

The *Strategy* contains two main components on mitigation and adaptation - agriculture is identified as a priority sector in both components.

There are also various other existing strategies of specific relevance to climate action in the ARD sector, including the draft *National Strategy on Drought Effects Mitigation and on the Prevention and Combating the Land Degradation and the Desertification* (elaborated in 2008, but not yet approved).

In June 2006, the Ministry of Agriculture and Rural Development drafted a *National Strategic Plan (NSP) for Rural Development* in preparation for EU accession in 2007 and the launch of the *National Rural Development Programme (NRDP) for Romania 2007-2013* that was co-financed by the European Agricultural Fund for Rural Development (EAFRD).

The fight against climate change was mentioned in the *NSP* as an important priority for Romania and the mitigation of greenhouse gas emissions was set as a key priority for the *NRDP 2007-2013*. A total of 8 measures were programmed in the *NRDP 2007-2013* that are targeted at, or directly relevant to, climate change mitigation and adaptation, as well as the transition to a low carbon economy.

The total financial allocation to these 8 measures was 6 399.1 million EUR, of which 46.2% (2 958.9 million EUR) had been committed to beneficiaries (i.e. absorbed) by the end of 2012. Whilst this only gives a **very general** indication of the success to-date of targeting NRDP measures / funding at climate action, good experience has been generated with the implementation of individual measures that should be built upon and developed when programming the forthcoming *NRDP 2014-2020*.

Priorities for Climate Change Mitigation and Adaptation in the ARD Sector

The table below presents a set of interventions selected through the analysis for mitigation and adaptation in the ARD sector. All of the interventions have the potential to be initiated (to some extent) in the forthcoming programming period of 2014-2020 and are clustered in terms of: a) Short-Term Priority – immediate potential to support under the *NRDP 2014-2020*, and; b) Medium-Term Priority – accompanying action to *NRDP 2014-2020* with longer-term horizon.

Short-Term Priority – immediate potential to support under the *NRDP 2014-2020*

Sectoral Focus	Action	Type of action
General Actions for Supporting Mitigation and Adaptation	Improve awareness of climate change amongst farmers and rural communities, to articulate clear and simple messages for farmers and rural communities related to the trends, risks and uncertainties that are associated with the changing climate.	Education / Training
	Target research and advisory support at climate change mitigation and adaptation in the ARD sector, to i) develop greater understanding of what climate actions are relevent and effective in the specific context of the Romanian ARD sector, and ii) communicate this knolwedge via a functional farm advisory and extension system.	Research & Analysis / Education / Training
Priority Actions for Mitigation	Support farmers with the continued reduction of GHG emissions and the adoption of low carbon technologies, to encourage them to adopt technologies and farm management practices which directly contribute to reducing emissions – this includes improvements in the efficiency of energy use and the better management of carbon and nitrogen flows in the agricultural ecosystem.	Policy / Investments / Incentives
	Support for the reduction of soil carbon losses and increased carbon sequestration, to encourage farmers to adopt technologies and farm management practices which directly contribute to reduced soil carbon loss and increased carbon sequestration. Priority actions for support include: i) afforestation of low quality and unproductive land must also be	Policy / Incentives

	encouraged, especially in those areas where soils are most vulnerable to degradation and loss; ii) organic farming, and; iii) zero / conservation tillage techniques.	
	Support for the increased production of renewable energy in rural areas, to encourage i) farmers and other rural businesses and ii) communities to invest in the production of renewable energy including energy crops; rural biogas production from livestock manure, and; investment in the small- and large-scale technologies available for solar and wind power generation.	Policy / Investments
Priority Actions for Adaptation	Investment in irrigation infrastructure in the most vulnerable regions. Priority action is needed at the national level to improve / rehabilitate the economically viable irrigation infrastructure in south, south-east and east of Romania where the occurrence of drought is predicted to be most frequent and to reach the highest intensity values. The comprehensive conditions attached to EAFRD-financed investments in irrigation (Article 46 of EC Regulation No. 1305/2013) aim to avoid maladaptation to climate change, for example by expanding irrigation in catchments already suffering from water stress and where climate change projections indicate reduced precipitation.	Investments
	Better management of the climate-related risks in the ARD sector, to introduce relevant risk management tools for that underpin the confidence of farmers to continue managing and investing in their farms in the face of the uncertainty associated with extreme weather events. Specific tools for consideration include: i) insurance schemes against natural disasters and against pest and disease of livestock and crops, and ii) the setting-up of farmers' mutual funds for stabilizing incomes in case of price volatility or losses from natural disasters or livestock/crop diseases.	Policy / Incentives

Medium-Term Priority – accompanying action to *NRDP 2014-2020* with longer-term horizon

General Actions for Supporting Mitigation and Adaptation	Assess the economic feasibility of investments and incentives for climate action in the ARD sector, to develop greater understanding of the economic feasibility and cost-effectiveness of the various mitigation and adaptation actions that are appropriate to the Romanian ARD sector.	Research & Analysis
Priority Actions for Adaptation	Support for accelerated adaptation by farmers and rural communities. This is a complex action that includes two complementary objectives: i) to encourage farmers and rural communities to adopt technologies and practices which build their resilience / adaptive capacity to deal with the uncertainties of climate change, and; ii) to promote and foster innovation co-operation and other bottom-up initiatives amongst local communities, including farmers and other businesses, which build their resilience / adaptive capacity to deal with the uncertainties of climate change	Policy / Education / Training / Investments / Incentives

These actions present a major challenge to the ARD sector in terms of science, policy and practice – a challenge that is complicated by the variability in socio-economic context of rural areas and the highly polarised structure of agriculture. For example, very different approaches are required to address contrasting vulnerabilities in the sector such as large-scale crop production in the lowland areas of south and south-east Romania, compared to small farmers in geographically remote and economically disadvantaged communities in the mountains where access to relevant information and advice is currently very limited.

Opportunities for Mainstreaming Climate Actions in the *NRDP 2014-2020*

There is a comprehensive suite of mitigation and adaptation measures eligible for EAFRD co-financing under the *National Rural Development Program (NRDP) for Romania 2014-2020*. In broad terms the menu of actions supported by the EAFRD Regulation (EC Regulation No. 1305/2013) include "knowledge transfer and innovation" under Priority 1; "investments" in farm modernisation and competitiveness under Priorities 2 and 3, and; the encouragement of sustainable land management via "area-based compensatory payments" under Priorities 4 and 5. Of course the measures selected for inclusion in the *NRDP 2014-2020* will not be able to address all climate-related challenges faced by farmers and other rural stakeholders. Prioritization and careful targeting of the *NRDP* measures will therefore be needed.

The main entry point for climate actions in the *NRDP 2014-2020* is under priority 5 of the new EC rural development proposals, namely: *"promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in the agriculture, food and forestry sectors"*. But since climate change mitigation and adaptation are also cross-cutting objectives for the EAFRD, climate actions should also be introduced under other priorities.

A basic intervention logic for the mainstreaming of climate actions in the *NRDP 2014-2020* is included in the report. Some examples of climate-related measures that can be financed in the *NRDP 2014-2020* are listed below – note that the Article numbers are taken directly from EC Regulation No. 1305/2013 published in December 2013:

EAFRD Measures		Actions eligible for EAFRD financing
Article 14	*Knowledge transfer and information actions*	Actions related to improving knowledge transfer and information on climate-related issues, including general awareness-raising; practical training courses; new agro-meteorological services; internet-based decision tools and information exchange platforms etc.
Article 17	*Investments in physical assets*	Investments in technologies which reduce the exposure of individual farms to climate change impacts, such as on-farm water storage installations; more efficient irrigation systems; investments in livestock buildings to cope with heat stress etc.
Article 22	*Afforestation and creation of woodland*	Afforestation of degraded and unproductive agricultural and non-agricultural land
Article 20	*Basic services and village renewal in rural areas*	Various actions for the climate proofing of local development plans, measures to adapt small scale infrastructure such as local water supply, energy production etc.
Article 28	*Agri-environment-climate*	Area-based compensatory payments for a wide range of land management practices relating to mitigation and/or adaptation, including novel crop rotations; under-sowing and cover crops; hedges and buffer strips; extensification of livestock production etc.

Article 29	*Organic Farming*	Area-based compensatory payments for the conversion to, and maintenance of, organic farming methods
Article 36	*Risk management*	Development of risk analysis models and mutual funds to stabilise farm incomes and compensate for losses from climate-related hazards

It must be kept in mind that the ARD sector in Romania is a complex sector and the successful mainstreaming of climate action into the *NRDP 2014-2020* will require the careful tailoring of measures. A "one-size fits all" approach to mainstreaming climate action in the *NRDP 2014-2020* will not be appropriate – a flexible and localised approach should be encouraged as much as possible and the potential of bottom-up, community-based initiatives should not be under-estimated (for example, utilising the LEADER-approach).

Broad-based Actions in the Face of Uncertainty

Significant uncertainty exists in the ARD sector regarding a) the direction and magnitude of climate change; b) its impacts upon agriculture and the wider rural community, and; c) the effectiveness and economics of different actions and strategies for mitigation and adaptation. This uncertainty is inevitably reflected in this rapid sectoral analysis and some very broad-based actions have been recommended that reflect a generic understanding of the most appropriate actions for supporting farmers, including small-holder farmers, to maintain viable and productive systems in the face of climate change.

But uncertainty does not mean that action should be postponed and the immediate opportunity to embed climate action in the programming of the NRDP 2014-2020 must be fully and effectively acted upon for the short- to medium-term benefit of the ARD sector.

But in parallel further work does need to be done sharpen the generic recommendations in this rapid sectoral analysis. In particular:

1. A **robust evidence base** needs to be built-up that ensures all future policy decisions relating to mitigation and adaptation in the ARD sector are cost effective. For example, impact studies are needed that integrate climate, land use and macroeconomic policies, whilst financial and socioeconomic analyses are needed to evaluate the cost-effectiveness of deploying the various technologies. This will require the Romanian government and research institutions to work more closely together to develop evidence and inform policy.
2. A **more strategic approach** is needed that reconciles and integrates the climate challenges faced by the ARD sector with the need to also significantly reform the sector towards "a more export-driven, high-value and climate-resilient agriculture, with rural living conditions more closely aligned to urban";
3. A **macro-economic model** for the impacts of climate change upon the ARD sector would be useful, but there is an inevitable trade-off that needs to be resolved between a single complex model that allows exploration of multiple policy questions and a suite of simple models that seek to answer the same questions individually.

1. Introduction

Romania joined the European Union (EU) in 2007 and, after Poland, is the 2nd largest of the "new" EU Member States with a total area of 238,839 km^2 and an estimated population of 21.4 million inhabitants[2].

Climate change is a huge challenge for the agriculture and rural development (ARD) sector in all 28 Member States of the European Union (EU) - including Romania.

On the one hand, agriculture is a source of greenhouse gas (GHG) emissions and must therefore be expected to contribute towards the climate change mitigation goals of the Europe 2020 Strategy – namely to achieve:

i) a reduction in GHG emissions of at least 20% below 1990 goals;
ii) at least 20% of energy consumption to come from renewable energy sources, and;
iii) at least 20% increase in energy efficiency.

On the other hand, the ARD sector is highly vulnerable to the impacts of climate change since the capacity of the "rural space" to provide adequate food supply; deliver ecosystem services; support economic growth, and; provide a safe living environment for rural communities is *directly dependent* upon favourable climatic conditions.

European farmers, foresters, rural businesses and other local people therefore need to start paying much greater attention to climate change and the growing uncertainty that it will bring to their day-to-day lives and longer term strategies for production, management, investment and community development.

The EU Common Agricultural Policy (CAP) has an important role to play in supporting appropriate climate action in the ARD sector. This role will be strengthened significantly in the 2014-2020 programme period as follows:

1. With the reform of Pillar I of the CAP, 30% of direct payments to farmers in all Member States, including Romania will be linked to a "greening payment". In order to receive this payment farmers will have to follow requirements for a) crop diversification on arable land; b) the maintenance of permanent grassland, and; c) the maintenance of "Ecological Focus Areas" (5% of cultivated land must be planted with hedges, trees, buffer strips etc.) – all of which are relevant to climate action;

2. In the new rural development policy (Pillar II of the CAP), two out of the six rural development priorities in the proposed EAFRD regulation refer specifically to climate change mitigation and adaptation. Climate action is also an important cross-cutting objective that should touch upon all rural development measures that are implemented

3. Furthermore, Member States are recommended to spend a minimum of 30% of the total EAFRD funding for rural development programmes on environmental actions, including climate change mitigation and adaptation.

[2] Estimated from the January 2012 population census

The integration of such climate actions into the CAP aims to bring benefits for the economy and society as a whole by ensuring that:

- the productive capacity and viability of the ARD sector is maintained;
- agricultural systems are developed with greater resilience to environmental, climatic and economic risks, and;
- essential biodiversity and ecosystem services dependent on land management continue to thrive.

This report is one of six rapid sectoral analyses[3] undertaken within the framework of Component B of the World Bank's Romania Climate Change Reimbursable Advisory Service (RAS) Programme. The title of Component B is "Identify and integrate climate actions into the 2014-2020 sector Operational Programmes".

The specific objective of this report is to contribute to the successful mainstreaming of climate action into Romania's post-2013 rural development policy – namely the EAFRD co-financed *National Rural Development Programme (NRDP) for Romania 2014-2020*.

The report is addressed first and foremost towards those policy-makers in the Romanian government that are directly or indirectly involved in the programming of the *National Rural Development Programme (NRDP) for Romania 2014-2020*. As such this report builds upon a number of working documents produced by the European Commission on the theme of mainstreaming climate change in 2014-2020 rural development policy (EC, 2013a; EC, 2013b; EC, 2013c).

The report contains 6 main sections:

- An introduction to the characteristics of the agricultural and rural development (ARD) sector in Romania. Note that the Forestry sector is covered in another sector report;
- An overview of the vulnerabilities and risks from climate change in the ARD sector in Romania, beginning with an introduction to the changes in baseline climate that are currently observed and predicted;
- A brief review of existing national strategies, policies and initiatives of relevance to the ARD sector in Romania, including a description of the EAFRD measures related to climate action that were included in the *NRDP for Romania 2007-2013*;
- The identification and description of priorities for climate change mitigation and adaptation in the ARD sector in Romania;
- An introduction to the opportunities for mainstreaming climate actions in the forthcoming *NRDP for Romania for 2014-2020*, including a basic intervention logic (the foundation of all strategic programming for the EAFRD) and some examples of specific climate actions that can be supported by the EAFRD;
- A closing section highlighting the uncertainties regarding the findings of this rapid sectoral analysis and the need for further work.

An extensive list of references is provided.

[3] The other sector reports are energy, transport, urban, water and forestry

2. Characteristics of the Agricultural and Rural Development (ARD) Sector

2.1 Rural Economy and Quality of Life

Romania is a predominantly rural country with agriculture playing an important role in the rural economy, including the generation of employment.

According to the modified OECD definition of "rural" areas that is used by the EC[4] to allow comparison between EU Member States, 59.8% of the total national territory and 45.7% of the population in Romania is classified as predominantly rural (EC, 2012). Population density in these predominantly rural areas is 71.6 inhabitants / km^2, which is significantly higher than the EU-27 average of 48.3 inhabitants / km^2. At the same time it is estimated (2011) that the population of predominantly rural areas in Romania is declining by an average of 4.5% / year with population declines in individual counties varying from 1.0 - 11.6% / year (EC, 2013d).

The relatively high share of the population living in rural areas reflects the large number (compared to the EU countries) of less densely populated, smaller-scale settlements that exist in Romania, rather than large-scale urban concentrations. **Many of these small rural communities contribute relatively little to economic growth, but play a vital role in preserving the social fabric / cultural identity of the rural areas, as well as the delivery of a range of ecosystem services that are of great national and international significance.**

A relatively high proportion of national Gross Added Value[5] (32.4%) and employment (41.5%) is also generated in predominantly rural areas in Romania, compared to averages of 17.2% and 21.7% respectively for all predominantly rural areas in the EU-27 (EC, 2012). However, rural incomes are relatively low and the gap with urban areas is widening. GDP per rural capita is significantly lower than found in most other Member States and approximately 50% of the average for the EU-27 - it is also only 30-40% of that generated in the urban areas (EC, 2012). More than 70% of the Romanian poor live in rural areas and the rural relative poverty[6] rate is 42%, compared to 18% in urban areas.

Agriculture and forestry are significantly more important sources of employment in Romania than in any other Member States with 32.6% of the population employed in agriculture and forestry compared to an average of only 5.3% in the EU-27 (EC, 2012). However, the productivity of this labour force is very low (2,464 Euro / employee in 2012) – around 20% of the national average and 26% of the EU average (EC, 2012).

An estimated 37.1% of farmers in predominantly rural areas have "other gainful activities" (EC, 2012), in other words, sources of income in addition to work on the farm. There are numerous sources of potential alternative employment including construction, forestry, tourism-related activities etc.

The Institute of Agricultural Economics proposed a typology (Rusu, 2006) that takes account of the increasing disparities in the economic development of rural areas observed during the last 15+ years. The typology uses 10 indicators relating to agriculture, forestry, tourism, industry and labor force, and identifies that 3 types of rural area exist in Romania:

[4] In 2010, the European Commission agreed on a new typology of predominantly rural, intermediate and predominantly urban regions based on a variation of the previously used OECD methodology.
[5] Gross Value Added (GVA) is a baseline context indicator for the structure of the economy that is calculated by Eurostat for all EU Member States - it is defined as the value of output (at basic prices) less the value of intermediate consumption (at purchasers prices).
[6] Defined as households with incomes that are less than 60% of the national median disposable income.

1. Rural areas with **mainly agricultural resources and poor or medium economic situation** – located mainly in the lowland plain areas (25% of rural area and 26% of rural population);

2. Rural areas with **resources for a medium diversified economy and medium economic situation** – no specific location (40% of rural area and 43% of rural population);

3. Rural areas with **resources for a diversified economy and medium economic situation** – located in the Carpathians Mountains and Black Sea coast (35% of rural area and 31% of rural population).

There is substantial potential for economic growth in the rural areas of Romania, but this potential is not equally distributed since there are big differences between the economic 'base' of different rural territories in Romania.

Rural areas in Romania are characterised by very low quality infrastructure. For example according to data from the National Institute of Statistics (NIS) only 13.6% of rural communities were connected to a drinking water supply in 2012 and the majority of rural households continue to use water pulled / pumped from shallow wells, whilst only 10.6% of rural roads are considered of "adequate standard" with asphalt cover and only few potholes. Around 29% of rural roads are gravel / dirt roads.

The basic social infrastructure (health and education systems, finance and credit provision etc.) is also much less developed than in urban areas. For example, only 7.4% of the total number of kindergartens registered at national level in the 2012-2013 school year are located in rural areas, whilst the number of rural inhabitants per doctor is estimated to be 1,722 - almost 7 times more than in urban areas (MARD, 2013).

All of these factors affect the quality of life in rural areas, hamper economic development, increase out-migration and exacerbate health and environmental problems.

2.2 Agriculture

According to the 2010 Agricultural Census (EUROSTAT, 2010), the total area of agricultural land in Romania is 15.9 million hectares[7], of which around 13.3 million ha (approximately 56% of total territory) is currently being used – so-called Utilised Agricultural Area (UAA).

Out of the total UAA:

- 8.3 million ha (62.4%) is arable land
- 4.5 million ha (33.9%) is permanent grassland and meadow
- 0.3 million ha (2.3%) is permanent crops, and
- 0.2 million ha (1.4%) is kitchen gardens.

Cereal grains, particularly maize and wheat, are the most important crops occupying around 60% of all arable land, followed by potatoes, sugar beet and industrial crops. Romania is noted for its vegetable production, with tomatoes, onions, cabbages and peppers among the crops grown. Orchards and vineyards are also important.

During the 1960s and 1980s the previous socialist regime constructed irrigation facilities in the semi-arid south and south-east of the country covering around 3.2 million ha of arable land, much of it operated with subsidised electricity and little consideration of real costs. With the collapse of the

[7] National sources suggest that 14.7 million hectares is a more reasonable estimate of the total area of agricultural land

former regime, the economics of irrigation changed completely, the irrigated area declined significantly and much of the irrigation infrastructure fell into disrepair. Very little investment has been made in the rehabilitation / modernisation of irrigation systems for the last 20+ years and none governed by a comprehensive strategy responding to real demand.

Around 1.5 million ha (9.4% of total UAA) is now estimated to be covered by economically viable / marginally viable irrigation systems, although only about 800,000 ha is currently functional. Since most irrigation in Romania is "supplementary" the actual area irrigated varies greatly from year to year depending upon annual rainfall (and until 2010 also the availability of governmental subsidy). From 2000-2011 the greatest area irrigated was 569,000 ha in 2003 and the smallest area irrigated was 46,000 ha in 2005 (World Bank, 2012). The public infrastructure serving about 100,000 ha, plus the infrastructure owned by water users' organizations (WUOs) and covering over 300,000 ha, was rehabilitated in 2008-2012.

Key obstacles to using the existing irrigation infrastructure are: i) its low hydraulic efficiency; ii) the high cost of electricity consumed for pumping, and; iii) high water tariffs. **Irrigation in Romania is mainly used by larger-scale commercial producers who can afford to pay for the water, however there is currently little evidence of farmers' demand – or willingness to pay – for more irrigation.**

Livestock production in Romania declined rapidly following the collapse of the socialist regime and has continued (except for poultry) to follow a downward trend ever since, thereby placing Romania significantly below the average performance in EU-27 (see 2005-2012 data in Table 1 below).

Table 1: *Livestock production data in Romania for the period 2005-2012*

	Cattle-Beef	Pig-Pork	Sheep-Goat	Poultry
Population ('000 heads)-2012	2009	5234	8,834	312,726
Evolution 2005-2012 (%)	-29.8	-20.7	+16.1	+7.1
EU-27	-3.6	-8.1	NA	NA
Production of meat ('000 to)-2012	28.8	425.6	1.3	NA
Evolution 2005-2012 (%)	-86.1	-8.8	-4,500%[8]	NA
EU-27	-6.8	0.04	NA	NA
Consumption per capita (kg) 2012	1.3	13.2	0.06	14.6
Evolution 2005-2012 (%)	-85.9	-38.6	-4,700%	+8.6
EU-27	-8.9	0	NA	NA

Source: MARD (2013)

The overall pattern of land use and agricultural production in Romania is not significantly different from that observed across the EU-27. However, the main characteristic of Romanian agriculture which sets it apart from other Member States is a) its highly polarised structure, and b) the huge number of small-scale farms.

According to MARD (2012), out of a total of 3.86 million holdings - less than 0.4% are large scale commercial units (average size of 421 ha accounting for 48.9% of UAA), whilst the remaining 99.6% are small-scale holdings of average size of 1.77 ha and accounting for 51.1% of UAA.

[8] The production of sheep-goat meat decreased between 2005 and 2012 by 45 times, which indicate a reduction of 4,500%. The same stands for the consumption of sheep-goat meat.

The ARD sector is therefore actually **comprised of two distinct sub-sectors**. One sub-sector consists of large-scale, capital intensive and technologically advanced farms. Whilst in contrast, the other sub-sector consists of small-scale farms which practice more traditional farming methods – often on a part-time basis.

In the current *National Rural Development Programme (NRDP) for Romania 2007-2013* (MARD, 2007), these small-scale holdings are further broken down as follows:

1. **Semi-subsistence farms** are defined as being between 2 and 8 ESU[9]. These comprise approximately 359,000 holdings covering 20.5% of UAA. Average size for the farms between 2 and 4 ESU is 4.9 ha, and 9.4 ha for farms between 4 and 8 ESU. Semi-subsistence farms were targeted for support by the current *NRDP 2007-2013* in order to encourage their greater market integration and development into larger-scale "family farms".

2. **Subsistence farms** are defined as smaller than 2 ESU, comprising an estimated 3.8 million holdings and estimated to cover 45% of the UAA. Most of these units lack legal personality (although there are some exceptions) and lie in the farm size range of 0-5 ha farm with an average size of 1.63 ha. Subsistence farms were not eligible for many forms of support under the current *NRDP 2007-2013*.

Subsistence farming is recognized by the Romanian System of National Accounts (SNA) as "household production for its own final consumption" and forms a distinct sector of the so-called Non-Observed / Non-Registered economy. About 80% of individual holdings are estimated to use more than 50% of their output for self-consumption (MLFEO, 2007).

The specific situation of subsistence farmers in Romania is an extreme example in Europe. There is currently no other EU Member State where such a huge number of very small-scale farms have persisted to such an extent. On the one hand, the fragmentation of land ownership and low levels of capital investment by small-holders has undoubtedly in some regions (notably the highly productive lowland areas) been blocking agricultural development and the exploitation of Romania's considerable competitive advantage by impeding the structural adjustment and modernization of crop and animal production.

On the other hand, small-holdings across the whole territory of Romania continue to provide a very important socio-economic buffer in times of economic uncertainty by providing a basic livelihood for a significant proportion of the rural population, as well as a supplementary source of cheap, wholesome food for their networks of family members in the urban areas.

Furthermore these same small-holders also have a fundamentally important role to play in maintaining the vitality of rural communities and providing important social, cultural and environmental services (public goods) to wider society. Since many small-scale farms are located in the mountain and sub-mountainous areas, they are also essential for the maintenance of traditional farming practices (pastoralism) on the wealth of 'high nature value' (HNV) grasslands that are characteristic of Romania. Without the maintenance of these HNV pastures and meadows many internationally-important wildlife habitats and species would be lost (Oppermann *et al.*, 2012).

In the short-term context of 2014-2020 it is reasonable to assume that this small-scale farm sector will continue to persist, but in the longer-term there is a clear governmental commitment to structural reform of the highly polarised agricultural sector and a decline in the number of small farms is likely.

[9] The economic size of farms in the EU is defined as Economic Size Units (ESU), where 1 ESU is equivalent to an annual turnover of approximately 1 200 EUR

2.3 Environment and Natural Resources

Romania's water resources are equivalent to 2,000 m^3 / inhabitant / year[10] and are far below the European average of 4,500 m^3 / inhabitant / year – thereby highlighting the need for good management to ensure resource management and sustainability. The total theoretical annual surface water resources amount to 140 billion m^3 - of which about 50 billion m^3 are derived from internal rivers and 90 billion m^3 from the Danube. Of this only about 40 billion m^3 can be fully utilized with the current status of water infrastructure development.

The groundwater resources are estimated to be about 12 billion m^3 annually, almost equally divided between phreatic and deep aquifers. Romania has 1,200 reservoirs with a total water storage capacity of 11 billion m^3. However, many of these reservoirs are small and only around 400 have a storage capacity of over 1 million m^3. Of these only 240 are large reservoirs with capacity of hundreds of millions of cubic metres.

Water availability in Romania is characterized by high variability in space and time. Most river flow stems from the mountain areas. Catchment discharges per unit area are much higher in the mountains (40 litres / second / km^2) compared to the lowlands where discharge flows drop to under 1 litre / second / km^2. The flow rate also varies significantly throughout the year from the (sometimes severe) floods in spring and early summer to very low values during summer and early autumn. During heavy rainfall on small catchment areas, the runoff can create high flow rates reaching 1000 - 2000 times the minimum flow, thereby resulting in highly localised and devastating flash floods.

The economic and social changes in Romania have led to a substantial change in the demand for water from the main users: population, agriculture and industry (see Table 2).

Table 2: *Demand for water (billion m^3) in Romania as actual abstraction (1990-2012, selected years)*

	1990	**1991**	**1995**	**2001**	**2005**	**2008**	**2010**	**2011**	**2012**
Population	2.22	1.7	1.9	1.67	1.14	1.13	1.03	1.00	1.05
Agriculture	6.93	2.3	1.9	1.05	0.49	1.08	0.75	0.96	1.09
Industry	8.36	6.8	6.5	4.78	3.67	5.01	4.45	4.64	4.35
Total	**17.5**	**10.8**	**10.3**	**7.50**	**5.30**	**7.22**	**6.22**	**6.60**	**6.49**

Source: National Administration of Water (ANAR)

Between 1990 and 2012 the annual demand for water decreased from 17.5 billion m^3 to 6.5 billion m^3 - equivalent to 37% of the 1990 demand. The water used for agriculture (irrigation) was the most affected (falling to 16% of the demand in 1990), while the demand for population and industry decreased in 2012 to about 50% of the demand of 1990.

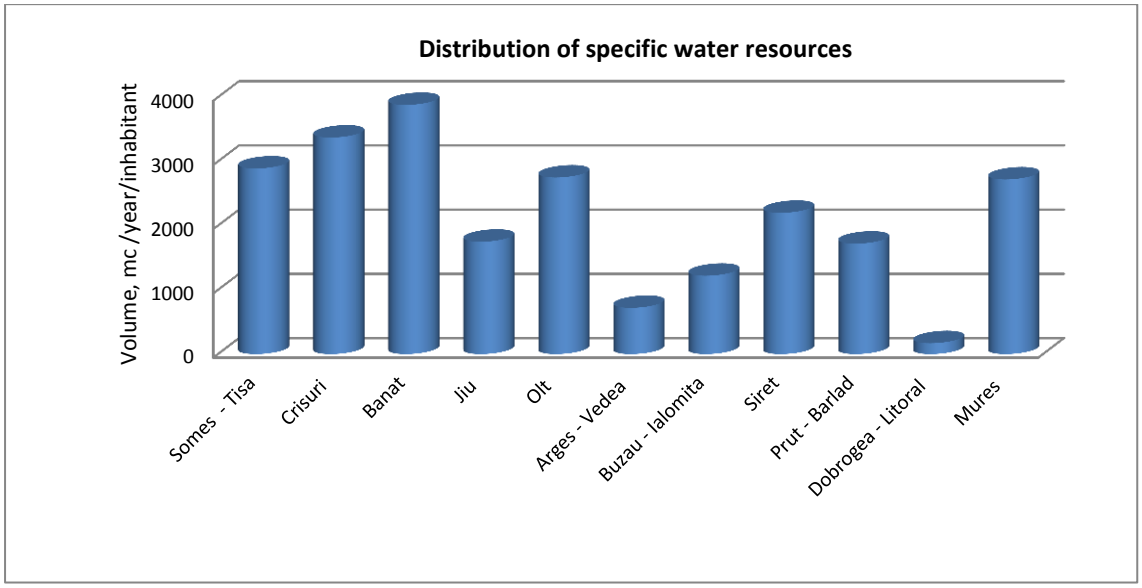
It is clear from these figures that a large amount of water available annually in Romania is not utilized, either because much of it flows during flood periods or there is insufficient storage capacity to allow for an efficient multi-annual management of water stock.

However, while the overall situation appears good because of over-capacity there are areas of water scarcity in many basins where summer droughts are a significant concern. In particular it can be seen from Figure 1 that the basins of Jiu, Arges-Vedea, Buzau-Ialomita, Siret, Prut-Barlad, and Dobrogea-

[10] Based on updated population data from 2011 census

Litoral face significant scarcity, with the last one being the most water-scarce basin in Romania. This situation will become more serious as the impacts of climate change become more pronounced

Figure 1: *Per capita utilizable water resources in Romania's internal river basins*



Source: INHGA (2011)

Regarding water quality, although the use of manufactured fertilisers is relatively low in Romania (and well below EU-15 and EU-27 averages), the pollution of groundwater with nitrates is a serious problem in Romania, especially in the south of the country where there are regions with groundwater in excess of 40 mg nitrate per litre (EC, 2010).

This problem is largely associated with the poor management of livestock manure, notably pigs and cattle. The majority of these livestock are kept by individual farm households with very poor facilities for the collection, storage and spreading of manure management. In addition to causing water pollution, this manure is also a source of CH_4 and N_2O emissions.

Romania has a diverse natural environment with various rivers, mountains and lakes contributing to a high level of biodiversity. In particular, the Carpathian Mountains and one of the most important wetlands in Europe, the Danube Delta, provide a unique natural heritage.

One of the most striking features of the ARD sector in Romania is the importance of traditional agriculture and traditional agricultural practices for creating and maintaining the biodiversity of species-rich semi-natural grasslands – notably in the more marginal, mountainous areas where agricultural productivity is limited by high altitude, poor soils and steep slopes. Studies of the meadows associated with *just one* village in southern Transylvania identified 11 different semi-natural plant communities, including 4 types of plant association that are listed as being of European Community interest under the EU Habitats Directive with 12 plant species classified as "vulnerable" or "rare" on the Romanian Red List of Vascular Plants (Huband, 2008; Sârbu *et al.*, 2004).

This so-called "high nature value" (HNV) farming is characterised by low intensity land use; presence and/or utilization of semi-natural vegetation, and; diversity of land cover and land use. A total of 2.4 million hectares of semi-natural grasslands were categorised as 'high nature value' (HNV) grasslands in the *2007-2013 National Rural Development Programme (NRDP)* and over 70% of this total area was entered into agri-environment commitments relating to the maintenance of traditional farming practices.

3. Vulnerabilities and Risks from Climate Change in the ARD Sector

3.1 Changes in the Baseline Climate

Romania has a transitional temperate continental climate with four distinct seasons. Routine climatic variation occurs due to influences from:

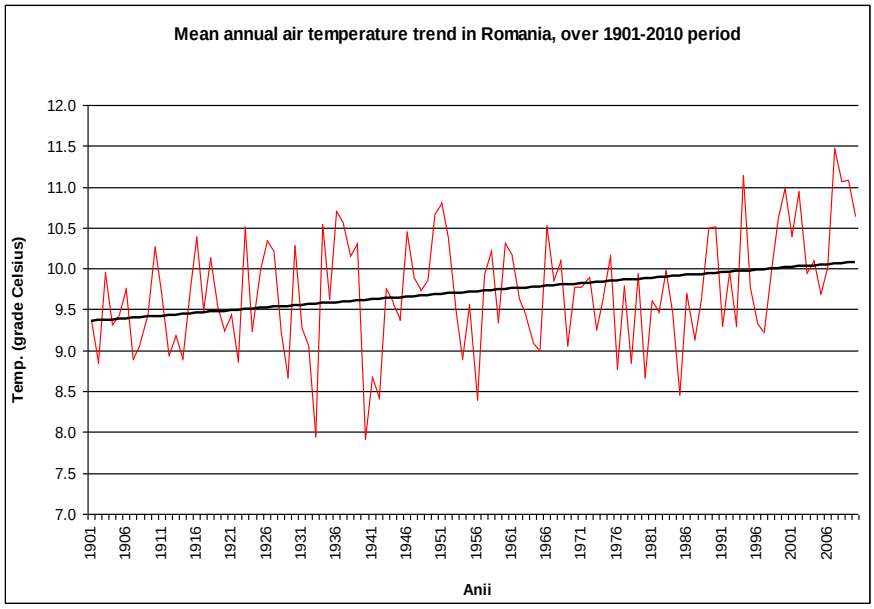
a) Neighbouring climatic zones – notably oceanic influences from the West, Mediterranean influences from the South-west and less temperate influences from the north and north-east. For example, during the winter the country is frequently affected by Arctic anticyclones which bring specific features of the sub-polar Scandinavian climate;
b) Geographical elements such as the position of the main mountain ranges, latitude, elevation etc. For example, the average annual temperature currently varies from 8°C in the north to 11°C in the south, and from 2.6°C in the mountains to 11.7°C in the lowland plains.

In addition to these existing sources of climatic variation, the influence of climate change is also now becoming more and more apparent as the temperate continental climate progressively becomes **warmer**, **drier**, **more variable** and **prone to extreme events** (MECC, 2010).

Temperature

The average 'whole-country' annual air temperature for Romania rose by 0.5°C during the period 1901 – 2010.

Figure 2: *Mean annual air temperature trend in Romania (1901-2010)*



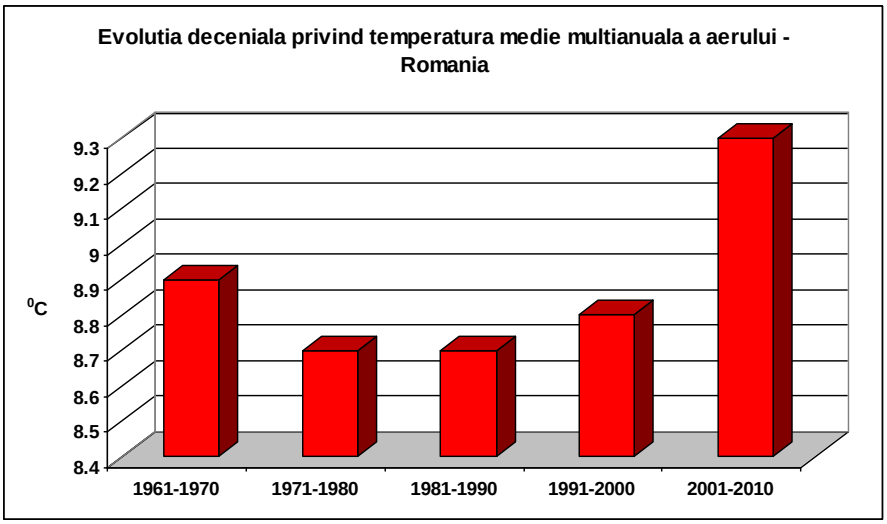
Source: NMA

But this long-term trend does not tell the full story:

1. Firstly, there are differences in the change in mean annual air temperature for different regions. Warming is more pronounced (up to 0.8°C) in the south and east of the country, whilst less warming (even slight cooling) is evident in the mountainous and sub-mountainous regions of the Carpathians.

2. Secondly, the rate of warming appears to be increasing in recent years (see Figure 3). For example, data collected in 94 weather stations between 1961 and 2010 shows an increase of the average temperature in summer, winter and spring of around 2°C (in the eastern side of Romania the temperature increase exceeds 2 °C during winter). At the same time there is a slight trend towards a decreased average temperature in autumn.

Figure 3: *Mean multi-annual air temperature trend in Romania (1961 – 2010)*



Source: NMA

According to assessments presented by Working Group I of the Fourth IPCC Report (IPCC, 2007), Romania should expect a **continued steady increase in annual average temperature** similar to that projected for the whole of Europe. There is some variation in the projections of the different models used, but compared to the period 1980-1990 **further rises** in annual average temperature should be expected of between:

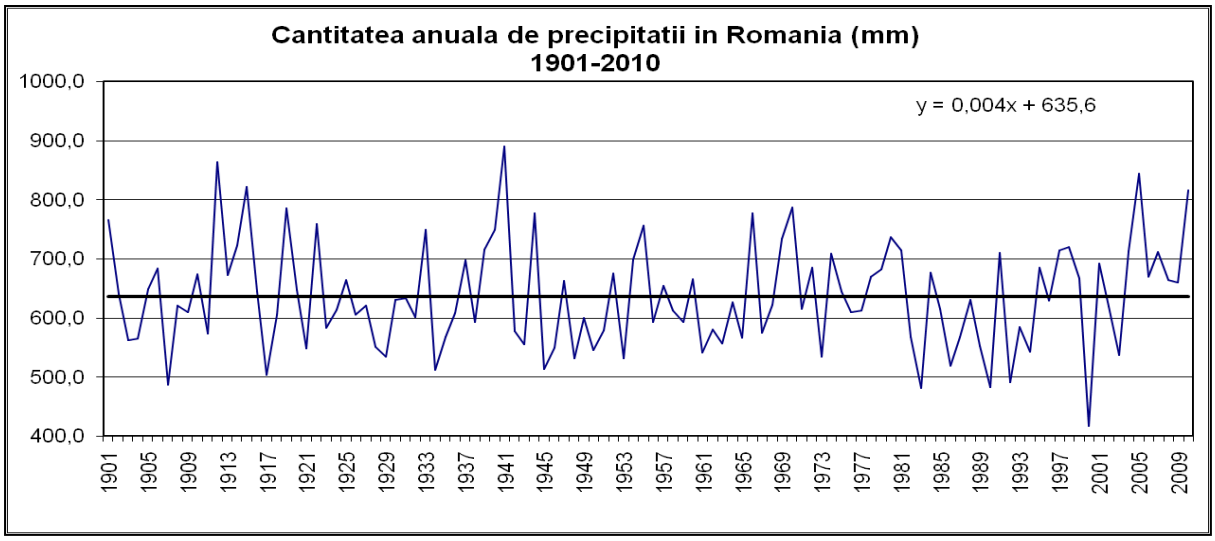
- 0.5°C – 1.5°C by 2029, and;
- 2.0°C – 5.0°C by 2099 (depending upon global scenario).

Similar projections have been generated at national level by the National Administration for Meteorology (MECC, 2010). These projections also predict that areas outside of the Carpathians are likely to experience the greatest temperature increases in winter, while the south and south-east of the country will experience the greatest temperature increases in summer. Projections also show an increased frequency, duration and intensity of 'heat waves'.

Precipitation

Long-term data for 1901-2010 shows that the total amount of annual precipitation (mm) in Romania has been decreasing since 1960, especially in the south and south-east of the country.

Figure 4: *Annual precipitation (mm) in Romania (1901 – 2010)*



Source: NMA

But this long-term trend again masks considerable variability, as well as some more subtle localised trends. For example, data collected from 104 weather stations between 1961 and 2007 shows that the **pattern of precipitation during the year** is also changing in some regions, including:

- an increase in the length of the periods of time without precipitation in the south during winter and in the west during summer;
- an increase of the number of "very rainy" days with more than 10 mm/day of precipitation in the north of the country, especially in autumn, and;
- significant decreases in the thickness of snow layers (accumulated winter precipitation) in the north-east, centre and west of the country.

According to projections in the Fourth IPCC Report (IPCC, 2007), Romania should expect a **continued reduction in mean annual precipitation** of 10-20% by the end of the century, but this is likely to vary greatly between i) the north and south of the country, and ii) the mountains and lowland areas.

The pattern of precipitation is also expected to continue to change with a **greater frequency of shorter, more intense and localised rainfall events**. Rainfall patterns may also become more chaotic and difficult to predict.

In conclusion - Romania's temperate climate is changing and is predicted to be very different in the next 50-100 years. This is hugely significant to the ARD sector, although it is also obvious that the effects of the changing climate upon temperature, precipitation and the occurrence / frequency of extreme events will continue to vary from region to region.

3.2 Impact of Climate Change on the ARD Sector

The impacts of climate change may be positive or negative, but those currently encountered by the ARD sector in Romania are predominantly negative. These include:

- Increased incidence of flooding
- Increased intensity and frequency of drought

- Increased risk of soil erosion and desertification
- Reduced agricultural productivity
- Other social and economic costs

According to McCallum *et al.* (2013), Romania suffered average annual "weather related losses" of 8,452 million US dollars from 1980 to 2011 – equivalent to 0.26% of GDP - of which 34% was linked specifically to drought. The modelling of future climate trends suggests that such negative impacts will continue to become more severe. Annex 1 contains a summary of relevant national and international projects which are currently underway or have been completed, and which provide further detailed information on climate change impacts and vulnerabilities.

Increased Incidence of Flooding

Flooding is an increasing problem for the ARD sector in Romania with an estimated 1.3 million hectares at risk potentially affecting approximately 500,000 inhabitants.

Flooding occurs frequently due to melting snow, blockage of rivers by ice and heavy torrential rains, but during the last 20 years the occurrence of severe floods has increased due to a number of additional factors. These include the over-exploitation of forests and modification of local hydrology; the lack of well-maintained flood prevention infrastructure (thereby increasing the incidence and intensity of flooding), and; the effects of climate change.

The main areas affected by flooding have been located along the Danube, plus on the Romanian Plain (Siret, Arges, Olt and Jiu Rivers) and the Banat-Crisana Plain (Somes Cris and Mures rivers). In mountainous and hilly areas where river beds are steeply sloping (100-200 m/km) and in narrow floodplains, powerful floods may be accompanied by intensive erosion of river banks resulting in landslides that block valleys.

During the last 10 years, Romania has been hit by severe floods virtually every year. The floods, both large scale and flash-floods, have led to human, economic and social losses, including disruption of local infrastructure and services for weeks or even months. From 2005-2010, a total of 142 people were killed by floods, 27,000 houses and thousands of km of national roads were damaged and hundreds of thousands of hectares of land were inundated. The total cost of these damages has been estimated at around €6 billion. The major floods of 2005 and 2006 had a particular impact in terms of population affected, loss of life and destruction to infrastructure and private property.

In late April 2005, about 100,000 ha were flooded in Timis county and the agricultural production could not resume that year because the water was standing for many weeks. In the same year, the Siret River flooded about 40,000 ha and completely destroyed a village. In 2006, the Danube River flooded about 30,000 ha, destroyed two villages and threatened low areas in Braila and Galati.

Recent years have also highlighted that Romania is particularly vulnerable to flooding (particularly flash floods) because of the extensive forest cuts in the hilly areas and high intensity of rainstorms. Well-managed forests are particularly important for reducing the risk of local flooding by attenuating surface run-off and peak flows following intensive rainfall events.

Increased Intensity and Frequency of Drought

In the ARD sector, one of the most negative impacts observed to-date is the increasing incidence of water deficit and drought due to the combined effect of reduced precipitation and rising temperatures, especially in the south and south-east of the country (Mateescu *et al.*, 2013).

Drought is characterized by the absence of rainfall in at least 14 consecutive days during the cold season (October-March) and at least 10 consecutive days during the warm season (April-September). If precipitation occurred during these periods, but did not exceed a certain threshold, then drought identification can be subject to different interpretations. The most harmful are spring droughts caused by limited snowfall during winter and thus low water reserves in the soil. Once a spring drought occurs, even abundant rains in later months cannot mitigate its negative consequences.

The occurrence of moisture stress during flowering, pollination, and grain-filling is harmful to most crops and particularly maize, soybeans, and wheat. Increased evaporation from the soil and accelerated transpiration in the plants themselves due to elevated temperatures will also cause / accentuate moisture stress. Although droughts may last from a few days to several months, they affect the outcomes of the entire agricultural production year.

Since 1901 until now, Romania has seen in every decade one to four extremely droughty/rainy years with an increasing number of droughts being more and more apparent after 1981 (see Table 3).

Table 3: *Years of extreme drought and rain in Romania (1901-2010)*

DECADE	20TH CENTURY	
	EXTREMELY DRY YEARS	EXTREMELY RAINY YEARS
1901-1910	1907-1908	1910
1911-1920	1917-1918	1911, 1912, 1915, 1919
1921-1930	1923-1924, 1927-1928	1929
1931-1940	1934-1935	1937, 1939, 1940
1941-1950	1945-1946, 1947-1948, 1949-1950	1941, 1944, 1947
1951-1960	1952-1953	1954, 1955, 1957, 1960
1961-1970	1962-1963, 1964-1965	1969, 1970
1971-1980	1973-1974, 1975-1976	1972, 1974, 1975, 1976
1981-1990	1982-1983, 1985-1986, 1987-1988	1981, 1990
1991-2000	1992-1993, 1997-1998, 1999-2000	1991 1997
	21ST CENTURY	
2001-2010	2000-2001, 2001-2002, 2002-2003, 2006-2007, 2008-2009	2005, 2006, 2010
2011-2020	2011-2012	

Source: Adapted from Mateescu *et al.* (2013)

Since 2000 there have been 6 growing seasons (2000-2001, 2001-2002, 2002-2003, 2006-2007, 2008-2009 and 2011-2012) with a large rainfall deficit in which drought diminished crop yields significantly. 2007 was the driest year and associated with the lowest yields of cereals and other annual crops, while 2010-2011 was most favourable with average yields between 1.5 and 3 times higher compared to 2007.

More recently, November 2011 was the droughtiest month in the last 52 years in Romania, with a monthly mean rainfall of only 1.2 mm as against the multi-annual mean of 43.9 mm. July 2012 was also the warmest month in the last 52 years in Romania, the monthly mean temperature being 23.7 °C as against the multi-annual mean of 19.2 °C – a positive deviation of 4.5 °C. (Mateescu *et al.*, 2013).

Increased Risk of Soil Erosion and Desertification

The increased incidence of heavy rain storms, with high intensity and short duration, will generate increased short-term surface runoff and the risk of increased soil erosion by water on sloping land - particularly in those areas with the most vulnerable soil types.

On the other hand, with an increasing trend towards more frequent and intense drought there is likely to be increasing soil aridity, which combined with hot winds, will increase the risk of wind erosion and soil degradation particularly in south, south-east and east of Romania. This includes the risk of desertification, marginalisation and abandonment of agricultural land in the areas where soils are most light and vulnerable to erosion.

Desertification is a complex phenomenon and the consequence of a set of important processes which are active in arid and semi-arid environments where water is the main limiting factor for agriculture and other land uses. Desertification occurs when certain environmental factors trigger irreversible change in the plant-soil system. Climate change itself does not trigger desertification directly, but it impacts upon other processes - for example, the increased wind erosion of light arid soils – which do trigger desertification.

There is particular concern about the risk of desertification in southern and eastern Romania where recent studies have provoked a serious warning that some 13 counties (Timiș, Mehedinţi, Dolj, Olt, Teleorman, Giurgiu, Călăraşi, Constanţa, Ialomiţa, Brăila, Tulcea, Galaţi and Vaslui) face the risk of desertification even during the current decade.

3.3 Key Vulnerabilities and Risks for the ARD Sector

"Vulnerability" to climate change is the degree to which any system is susceptible to, and unable to cope with, the negative impacts that climate change imposes upon it.

"Resilience" is the opposite of vulnerability and is defined by the IPCC as "…the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change".

The extent to which the ARD sector in Romania is either "vulnerable" or "resilient" to the negative impacts of climate change is not well understood – but needs further investigation and consideration.

The "risk" of the ARD sector system being significantly affected by the negative impacts of climate change is linked to criteria such as:

- the likelihood of the negative impacts occurring;
- the timing of the impacts (short- or long-term);
- the magnitude of the impacts;
- the persistence and reversibility of the impacts, and;
- the system's potential and capacity for adaptation.

But these criteria are also highly variable. As described in 3.1 above, the effects of the changing climate upon temperature, precipitation and the occurrence / frequency of extreme events vary from region to region – but this variability is also laid on top of the variability in the resource base, economic development and social structure of the regions which in turn influences both i) the resilience of rural actors / communities to climate change, and; ii) also their capacity to adapt[11] to the related risk and uncertainties.

[11] Adaptive capacity is "…the ability of individuals, organisations or entire sectors to design or implement effective strategies / actions to adjust to information about potential climate change and / or its consequences / damages". Adaptive capacity is strongly linked with resilience.

Furthermore there are substantial differences in resilience and adaptive capacity associated with the huge polarity in farm size with large-scale commercial farms facing different challenges from climate change to the very small-scale subsistence farmers.

For example, large-scale farms commonly have very specialised production systems and are highly vulnerable to the impact of frequent and long periods of drought upon crop yields and farm profits. But they are well-informed professionals with good technical and financial resources and have a good capacity and many options to adapt their farming systems, including the diversification of cropping systems, adoption of new technologies and use of irrigation.

Small-scale subsistence farmers are also socially and economically very vulnerable to adverse climate events with farming directly engaging around one-third of the working population and supplying significant proportions of the household diet. In some cases individual farmers and / or local communities are also highly specialised in the production of specific crops, such as onions or potatoes, which further increases their vulnerability hugely.

In other cases some intrinsic resilience can be found within communities of small farmers due to their low inputs and recycling of resources, existing low carbon economies, diversity of production, strong social relations and (in some regions) alternative sources of off-farm income. The resilience and adaptive capacity of these more diverse communities has the potential to be further developed if obstacles such as low educational standards, geographical / social isolation and lack of access to investment capital can be overcome.

Reduced Agricultural Productivity

Agricultural production is inextricably tied to climate, making the ARD sector one of the most climate-sensitive of all economic sectors. As already noted, the impact of climate change upon the ARD sector in Romania is a particularly immediate and important problem because the majority of the rural population depends either directly or indirectly on agriculture for their livelihoods.

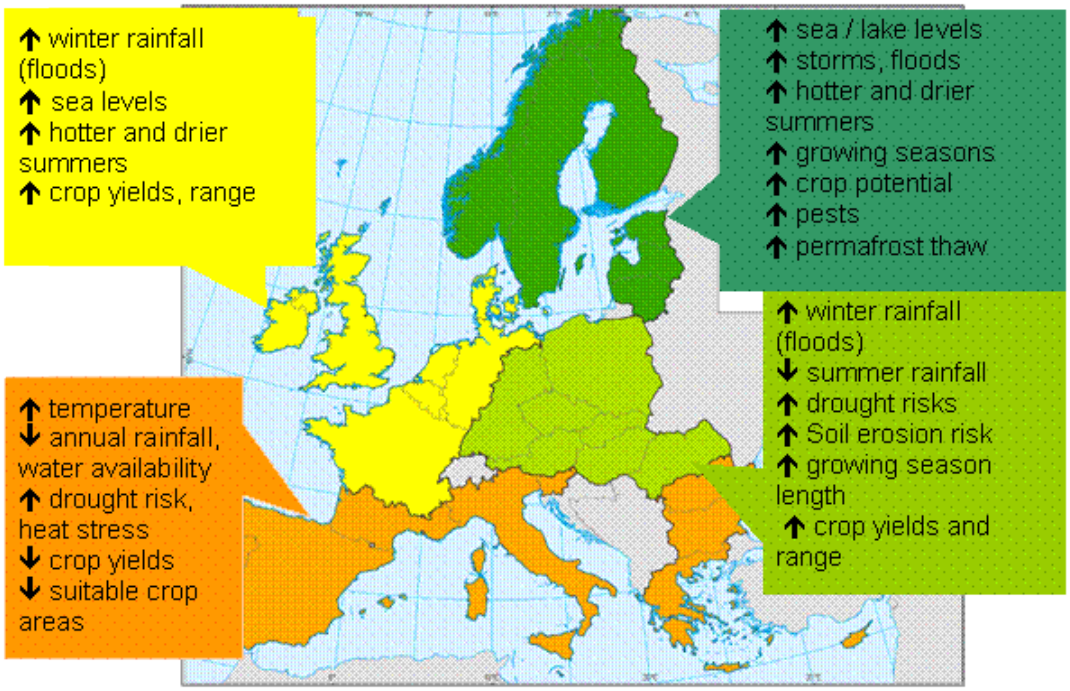
Analysis of the potential impact of climate change upon the ARD sector is a complex task. For example, according to Olesen *et al.* (2011) climate change affects crop production in many different ways – both directly and indirectly:

1. **directly** though the effects of increasing CO_2 concentration on crop productivity;
2. **directly** through effects of temperature, rainfall, radiation, humidity etc. on crop development and growth;
3. **indirectly** through shifts in suitability of different crops, primarily a northward expansion of warm-season crops;
4. **directly** through damages caused by extreme events such as extreme heat waves, hail and flooding;
5. **indirectly** through changes in crop nutrition and occurrence of weeds, pests and diseases, and;
6. **indirectly** through degradation of the resource base (e.g. soil erosion).

At a European level, climate change is expected to impact more and more on food supply and security. According to Iglesias *et al.* (2007), global warming is expected to generate mixed effects that are unevenly distributed across the EU. Under a moderate warming scenario, Europe overall is expected to even benefit from small increases in crop productivity, but there will be regional variations. Northern Europe and the mountains (most notably the Alpine regions) could initially see an increase in productivity and an expansion of crops and crop land, but Southern regions will be

negatively impacted by heat stress and water scarcity. Yet, even the former are expected, over time, to see these initial benefits outweighed by more frequent flooding and soil instability.

Figure 5: *Expected climate change implications in EU agriculture*



Source: European Commission

The crops that experience the most severe impacts are typically rain-fed crops grown in the traditional summer season, such as maize, sunflower, vegetables and fruits. Some crops, however, may benefit from the direct effects of climate change (as well as elevated CO_2 levels) – notably those that will benefit from a longer, warmer growing seasons such as autumn-sown winter wheat or grasslands (meadows and pastures). There are also potential benefits for irrigated crops, assuming that sufficient water is available.

According to the sixth national communication of Romania to the UNFCC (MECC, 2013a), "In the near future (2011 - 2040), under climate change conditions, stronger and more spatially extended droughts will likely affect Romanian territory in the growing season, with significant impact on agriculture activities". The report continued to identify key vulnerabilities in the adaptability of agriculture as the ageing of farmers, lack of infrastructure for irrigation, low productivity of small farmers, fragmentation of land ownership and youth migration from rural areas.

In particular, yields of grain and other crops are predicted to decrease across the southern and south eastern part of Romania due to increased frequency of drought (JRC, 2012). While losses may be partially offset by beneficial effects from carbon dioxide, crop production will be further threatened by increases in competition for water and the prevalence of pest and diseases and land losses through desertification.

Perennial crops (orchards and vineyards) are also very vulnerable with partial or total loss of crop and premature ageing of plantations. Reductions in grassland / forage productivity due to drought will have knock-on effects to livestock productivity / viability.

Not forgetting also the direct impact of increased heat stress / water shortage upon the productivity, conception rates and health of farm animals. This includes the potential health risks for livestock and

humans, including the resurgence of some transmissible diseases (anthrax, tetanus, rabies and chronic respiratory disease).

Overall, the potential impacts of climate change in Romania are likely to greatly increase the risk of crop failure and reduce the financial security of farmers in many areas, especially the south and south-east of the country.

However, it must be noted that the combined effects of changes in temperature and precipitation regimes in different climate change scenarios are not yet well understood, thus additional work is required for impact assessment at regional level. Down-scaling the predictions of Global Circulation models (GCM) and taking into account the local conditions of the area of interest will improve the accuracy of crop yield estimations in the new conditions of climate change.

Water Supply for Rural Consumers

Water supply in rural communities will be adversely affected because the warmer and shorter winters will lead to the decrease of the seasonal snow volume and to the early and fast snow melting, leading to shortages in summer months. There is already evidence of this occurring in those mountain areas (e.g. the Rucar-Bran corridor) where there is increased demand for water due to tourism and serious shortages of water occur at weekends and peak holiday periods due to the influx of visitors.

Supply will also suffer from a lowering of groundwater table in summer months, due to reductions in the surface flow regime. Higher summer temperatures will lead to increased evapo-transpiration and therefore higher water demands in agriculture, during the same period when supplies will suffer a shortfall. The domestic water demands and supply will experience the same (but less pronounced) effect.

It is also likely that hotter and drier summers will also cause a deterioration in the quality of water resources, thereby effectively reducing the supply.

Other Social and Economic Hazards

Climate change brings many other hazards to rural communities other than the direct impacts outlined above of flooding on rural infrastructure or drought upon agricultural productivity. For example, there are many direct hazards for human health. The higher frequency and longer duration of heat waves has a serious impact upon the health of the elderly. There is also the risk of increased disease, including the reoccurrence of diseases that have been eradicated. The need for good food hygiene to avoid food poisoning etc. is also increased greatly in hot weather. These are all factors which in turn place great pressure upon rural health services, which are already very stressed and over-burdened in normal weather conditions.

There are multiple indirect effects of climate change upon rural communities and households. For example:

- local ecosystems yield many useful (and economically important) products for rural communities, including fruits, mushrooms and herbs for harvesting. The abundance and distribution of these will change as the climate becomes warmer and drier;
- forest fires will become a new risk in rural areas and impact negatively upon the local availability of wood for fuel and construction;

- around 36% of all electricity in rural areas is produced by small-scale hydro-electric plants which may be affected by drought and declining river flows;
- many rural communities are already disadvantaged by the poor quality of rural roads – public transport is slow, many modern goods and services are not available and it is difficult to reach new markets with local products. These disadvantages will become even worse with the negative impacts of heavy rainfall and flooding upon dirt / gravel roads.

Environment

According to McCallum *et al.* (2013), there is already clear evidence throughout the EU to show that biodiversity is directly responding to climate change and will continue to do so. Species respond individualistically, with direct impacts including changes in phenology, species abundance and distribution, community composition, habitat structure and ecosystem processes.

Climate change is also leading to indirect impacts on biodiversity through changes in the use of land and other resources, notably water. For example in Romania it is anticipated that the flora and fauna in the aquatic ecosystems (rivers and lakes) as well as in those dependent on precipitation and river flows (such as wetlands) will suffer from a quantitative reduction in summer water flows, and from increased frequency of floods and droughts. Higher summer temperatures leading to water quality degradation (through decreases in dissolved oxygen, eutrophication and algal blooms) will also adversely affect the environment. Changes in aquifer levels will also adversely affect the water balance in wetlands, which are sustained by groundwater in the low flow season.

These indirect impacts may be more damaging than the direct impacts due to their scale, scope and speed. They will further reduce the resilience of ecosystems to climate change and their capacity to deliver essential services, such as climate regulation, food, clean air and water, and control of floods or erosion.

3.4 The Need for Mitigation and Adaptation in the ARD Sector

According to *Romania's Greenhouse Gas Inventory 1989-2011* (MECC, 2013b), the agriculture sector accounted for 14% (16 679.72 Gg CO_2 equivalent) of the total GHG emissions estimated for Romania in 2010. This exceeds the regional and EU averages (see Figure 6) which are around 10%. N_2O emissions account for the largest proportion (52%) of Romanian agriculture's total CO_2 equivalent emissions, followed by the CH_4 emissions that account for the remaining 48%.

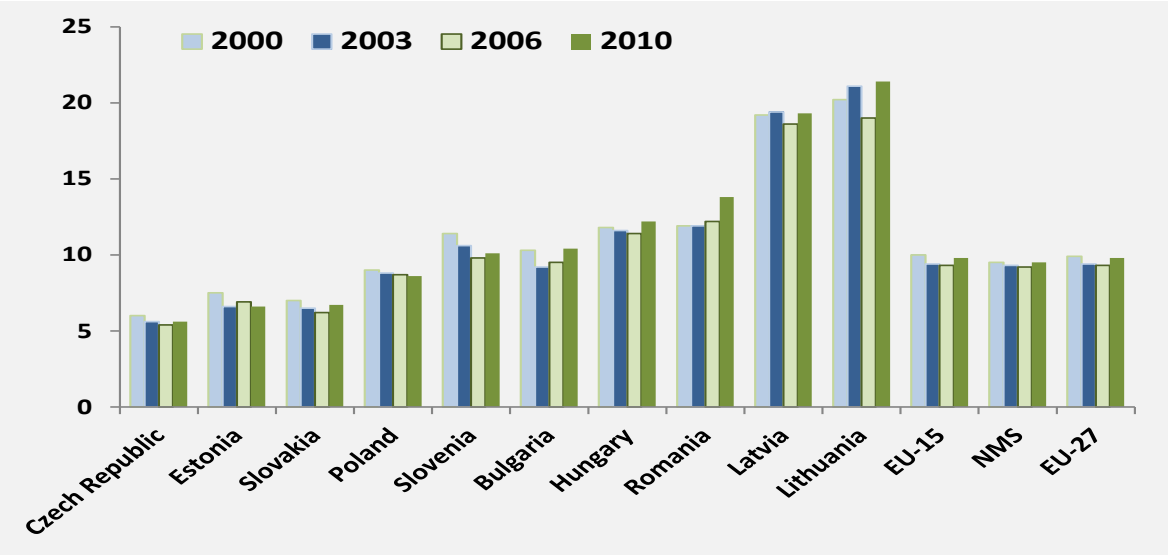
N_2O emissions are derived from i) manure management (production and storage), and; ii) agricultural soils (notably due to denitrification following the application of inorganic fertilisers or manure). Domestic livestock are the major source of CH_4 emissions from agriculture, both from enteric fermentation and manure management. It is also likely that the continued use of open pit latrines in many rural households and villages is contributing to CH_4 emissions. Some N_2O and CH_4 emissions are also derived from the field burning of agricultural residues (this is also a source of NO_x and CO emissions).

On the plus side, agriculture's GHG emissions were 53% in 2010 lower compared to emissions in 1989 due to:

- the decline in livestock numbers;
- the reduced area of rice cultivatation (another potential source of CH_4 emissions);
- the decreased intensity of crop production, notably the reduction in the application of inorganic nitrogen fertiliser applied.

However this also highlights the very real possibility that agricultural GHG emissions will increase again as the agricultural economy improves – especially if livestock numbers increase and / or crop production becomes more intensive again.

Figure 6: *GHG emissions from agriculture in the countries of Central and Eastern Europe (percentage of total emissions, 2000-2010)*



Source: Eurostat

Mitigation measures therefore need to be put in place in the ARD sector. Opportunities for mitigation in the ARD sector fall into three broad categories, based on the underlying mechanism:

- **Directly reducing emissions** – improvements in the efficiency of energy use, plus the management of carbon and nitrogen flows in the agricultural ecosystem, can help to reduce emissions of CO_2, CH_4 and N_2O from the ARD sector;
- **Offsetting emissions with carbon sequestration measures** – agricultural ecosystems hold large reserves of carbon and can store more through a range of practices suited to local conditions;
- **Avoiding (or displacing) emissions** – notably through the production of renewable energy sources and the avoidance of agricultural management practices that it is known will contribute to significant GHG emissions e.g. the cultivation of old grasslands.

There is also an important need for adaptation in the ARD sector to address the progressive climate change observed and predicted over the coming decades However, there are several socio-economic factors which are influence the ability of farmers and other members of the rural community to adapt – these include:

- Overall socio-economic context (i.e. farmers with limited resources have the lowest capacity to adapt);
- Characteristics of the agricultural production system (type of production; size of holding; level of intensity; diversity of cropping etc.);
- The availability of other sources of income;
- Access to information, skills and knowledge concerning climate change and adaptation solutions;
- Access to technology and infrastructure.

4. Existing National Strategies, Policies and Initiatives of Relevance to the ARD Sector

4.1 National Policy Framework for Climate Action

In order to effectively implement coherent and complementary climate actions in the ARD sector, Romania needs to have a clear policy framework for both sector specific and territorial actions at national, regional and local level. Building-up this policy framework is a step-by-step process, but positive progress is being made with the on-going development of the national climate change strategy for Romania which provides useful strategic guidance for the ARD sector.

The first *National Climate Change Strategy for Romania* was drawn up for 2005-2007 and briefly detailed the importance / effects of climate change adaptation on various sectors including agriculture and forestry.

In response to the 2007 European Commission Green Paper[12] on *Adapting to climate change in Europe - options for EU action*, the Ministry of Environment developed a *Guide on the Adaptation to the Climate Change Effects* (MoE, 2007) which provided more detailed recommendations on measures for reducing the risk of negative effects of climate change in 13 key sectors of the economy, including agriculture, biodiversity, water resources and forests.

Regarding recommendations for agriculture, the *Guide* focused upon the selection of appropriate crop species, varieties and hybrids for changing climatic conditions; the efficient use of water resources, including better management of irrigation; more optimal use of crop rotations; improved soil management etc.

The *National Climate Change Strategy for Romania 2013-2020* (recently approved by Government Decision no. 529/2013 in July 2013) is a more comprehensive document (MECC, 2013c) that updates previous documents and aims to provide an action framework and guidelines for all priority sectors to develop an individual action plan in line with national strategic principles.

The *Strategy* contains two main components on mitigation and adaptation[13]. Agriculture is again identified as a priority sector in both components.

The adaptation component integrates a lot of new information from extensive consultation with experts and stakeholders and includes sections on Adapting to Climate Change Effects, Institutional Cooperation, Taking Action, Resources, and Sector Level Challenges and Actions.

The *National Climate Change Strategy for Romania 2013-2020* **provides clear guidance on appropriate climate action in the ARD sector** and identifies the EU budget (Multi-annual Financial Framework) for 2014-2020 as playing an important role in "catalysing the specific investments that will be needed to meet climate targets and to ensure climate resilience".

[12] See here for further information: http://europa.eu/legislation_summaries/environment/tackling_climate_change/l28193_en.htm

[13] Translated, English language versions of both components of the *National Climate Change Strategy 2013-2020* (MECC, 2013c) have been provided by MECC

4.2 Project-based Initiatives for Research / Exchange of Experience

There is a growing knowledge base in Romania regarding national / regional specific actions for climate change mitigation and adaptation in the ARD sector. A comprehensive review of this knowledge base is beyond the scope of this sectoral analysis, however a brief summary of existing research and other initiatives is included in Annex 2.

4.3 Sector Specific Strategies and Action Plans

There are several existing ARD sector specific strategies of relevance to climate action:

National Strategic Framework for Sustainable Development of Agriculture, the Food Sector and Rural Areas during the period 2014-2020–2030 – finalised in 2013 this presents a comprehensive framework for guiding national public policy options regarding development of the ARD and food processing sector. Supported by a *Medium- and Long-term Vision document (2020/2030 horizon)* prepared by the World Bank.

National Strategy on Sustainable Development: Horizons 2013-2020-2050 – a broad strategic framework adopted in 2008 that sets high level national objectives for all sectors. Key strategic objectives for the ARD sector are:

- *Horizon 2013* - enhance the economic vitality of Romania's rural areas while maintaining social balance by means of the sustainable development of agriculture and forestry;
- *Horizon 2020* - strengthen production structures in agriculture and forestry while promoting the economic and social development of the rural areas in order to further reduce the existing disparities and to attain the current average performance level of the other EU Member States;
- *Horizon 2030* - achieve full implementation of EC policies and practices in agriculture and forestry, including those relating to climate change mitigation and adaptation.

National Strategy on Drought Effects Mitigation and on the Prevention and Combating the Land Degradation and the Desertification (elaborated in 2008, but not yet approved) – this strategy aims to mitigate the increasing social, economic and environmental impacts of drought via the elaboration of drought management strategies / actions; introduction of measures to protect and restore the capacity of water-stressed natural ecosystems, agricultural crops and other drought and desertification affected assets, and; the improvement of water and soil resource management.

Agricultural farm modernization programme – adopted in 2008, this national programme offered financial support for the replacement of outdated tractors and agricultural equipment with more energy-efficient and less polluting equipment and technologies.

National Strategic Plan for Agriculture and Rural Development 2007–2013 (adopted in 2006) - this plan identifies development priorities for agriculture, forestry and rural areas in the context of Romania being a new EU member State from 2007. The plan is implemented through the *National Rural Development Programme (NRDP) for Romania 2007-2013* which is reviewed in more detail in section 4.4 below.

Programme for the Stimulation of Energy Crops, including Biofuels (adopted in 2006) – based on an EU support programme for the promotion of energy crops this national payment scheme was operated in Romania during 2007-2009 and led to an increase of the cultivated area for energy crops to 27,000 ha in 2007 and 39,000 ha in 2008.

Strategy for Rehabilitation of Irrigation Infrastructure (approved by MARD in 2013) –developed under the Irrigation Rehabilitation and Reform Project financed by the World Bank and the Government of Romania and implemented through the Romanian Ministry of Agriculture and Rural Development from 2004-2012. The Strategy only encompasses those irrigation schemes with proven economic viability where the farmers interest in continue irrigation has been demonstrated.

4.4 Measures implemented in the *NRDP 2007 - 2013*

In June 2006, the Ministry of Agriculture and Rural Development drafted a *National Strategic Plan (NSP) for Rural Development* in preparation for EU accession in 2007 (see section 4.3 above) and the launch of the *National Rural Development Programme (NRDP) for Romania 2007-2013* that was co-financed by the European Agricultural Fund for Rural Development (EAFRD).

The fight against climate change was mentioned in the *NSP* as an important priority for Romania and the mitigation of greenhouse gas emissions (GHGs) was set as a key priority for axis 2 (sustainable land management) of the *NRDP*, together with the increased production / use of renewable energy sources that was set as a priority under axis 1 (competitiveness) and axis 3 (economic diversification and quality of life). The *NRDP 2007-2013* specifically mentions solar, wind, biomass and geothermal energy, but gave most attention to the cultivation and processing of agricultural / forestry biomass as a substitute for conventional energy sources – including reference to the need to develop a domestic biofuel market in order to meet EU membership requirements.

This commitment to climate / energy-related actions was strengthened with the allocation of an additional 53.9 million EUR from the EAFRD during revision of the *NRDP* following the 2008 CAP Health Check and adoption of the European Economic Recovery Package (EERP). This comprised a total of 18.19 million EUR allocated to climate action and 35.72 million EUR allocated to renewable energy.

A precise breakdown of EAFRD funding that has spent on climate actions in the 2007-2013 programme period is not currently available, but Table 4 provides a summary of expenditure upon the measures implemented in the *NRDP 2007-2013* with **potential** to support climate action (mitigation, adaptation and renewable energies).

It can be seen that a total of 8 measures were programmed in the *NRDP 2007-2013* that were targeted at, or relevant to, climate change mitigation and adaptation, as well as the transition to a low carbon economy.

The total financial allocation to these 8 measures was 6,399.1 million EUR, of which 46.2% (2 958.9 million EUR) had been committed to beneficiaries (i.e. absorbed) by the end of 2012.

Of course, this only gives a **very general** indication of the success to-date of targeting *NRDP* measures / funding at climate action, but good experience has been generated with the implementation of individual measures that should be built upon and developed when programming the forthcoming *NRDP 2014-2020*.

For example, one of the most important actions targeted specifically at climate change mitigation and adaptation was **first afforestation of agricultural land**. This measure referred explicitly to the importance of afforestation for a) carbon sequestration; b) prevention of soil erosion and other natural hazards, such as floods, and; c) the increased production of a renewable energy source.

The target for afforestation was 50,000 ha of degraded agricultural lands, but to-date the uptake of measure 221 has been negligible with less than 500 ha afforested and only 11 452 EUR absorbed out of a total of 229.3 million EUR allocated! The problem was that the measure was badly designed and too difficult to access. For the *PNDR 2014-2020*, the eligibility criteria need to be clarified and implementation procedures improved.

On the other hand, the highest level of absorption (76.5%) observed to-date has been for **agri-environment payments**. These are area-based compensatory payments that were targeted in the *PNDR 2007-2013* at the maintenance of extensive farming practices and the avoidance of fertilizer and pesticide application on high nature value grasslands. These grasslands are important for carbon sequestration and the maintenance of functional ecosystems that deliver important environmental services and support the livelihoods of millions of small-scale farmers.

Agri-environment payments will continued to be financed as a compulsory measure during the 2014-2020 programme period and according to Article 29 of the new EAFRD Regulation will be renamed as "agri-environment-climate payments" and must include a specific focus upon "the promotion of the necessary changes into agricultural practices that make a positive contribution to the environment *and* climate." It is encouraging therefore that these payments have proved so popular to-date with farmers and they will be an important climate action for promoting in the *PNDR 2014-2020*.

A useful source of further information on climate-relevant rural development measures used by other EU Member States during the 2007-2013 programming period is the Synthesis Report from the European Network for Rural Development (ENRD) on *Addressing Climate Change within the post Health Check Rural Development Programmes (2007-2013)* (ENRD, 2010).

Table 4: *Summary of measures implemented in the NRDP 2007-2013 with potential to support Climate Actions (mitigation, adaptation and renewable energies)*

NRDP Measure	Type of Climate Actions Eligible for Support	Potential Effects of the Eligible Climate Actions	Financial Allocation 2007-2013 (mill EUR)	Public Expenditure 2007-2012 (mill EUR)
121 – Modernisation of agricultural holdings	Investment in new agricultural equipment and facilities, including: storage facilities for fertiliser / manure, field machinery for spreading fertiliser / manure, and; waste water management / treatment	**Mitigation** - although targeted at supporting implementation of the EC Nitrates Directive many of the eligible investments are also important for reducing CH_4 and N_2O emissions	1 149.8	521.2 (45.3% absorption)
	Investment in farm level water storage and irrigation equipment / facilities	**Adaptation** – improved efficiency of on-farm water use		
	Investments in short rotation coppice to i) produce biomass and ii) improve efficiency of its use as sustainable on-farm energy source	**Low C economy** – increased production of a renewable energy source		
123 – Adding value to agricultural and forestry products	Investment in production / processing techniques for water saving	**Adaptation** – improved rural water use efficiency	1 177.5	402.3 (34.2% absorption)
	Investment in the production and use of agricultural / forestry biomass as a renewable energy source, including production of biofuels	**Low C economy** – increased production and use of renewable energy sources		
125 - Improving and developing the infrastructure related to the development and adaptation of agriculture and forestry	Investment in farm level water storage and irrigation equipment / facilities, including rehabilitation of existing farm level infrastructure where i) primary infrastructure has been improved; and ii) economic viability and high usage can be demonstrated	**Adaptation** – improved efficiency of on-farm water use	574.8	80.0 (13.9% absorption)
	Investment in the promotion and increased use of renewable energy sources	**Low C economy** – increased use of renewable energy sources		
143 - Providing farm advisory and extension services	Advisory support to specific measures including 214 (agri-environment) and 221 (first afforestation of agricultural land)	Potential for advisory support to on-farm mitigation / adaptation	13.5	3.3 (24.4% absorption)

NRDP Measure	Type of Climate Actions Eligible for Support	Potential Effects of the Eligible Climate Actions	Financial Allocation 2007-2013 (mill EUR)	Public Expenditure 2007-2012 (mill EUR)
214 - Agri-environment payments	Support for maintenance of high nature value (HNV) grasslands, establishment of green cover crops and organic farming	**Mitigation** - potential for carbon sequestration and promotion of low GHG emissions via the maintenance of extensive farming practices and avoidance of fertilizer and pesticide application **Adaptation** – reduced soil erosion and maintenance of high biodiversity semi-natural habitats / biotopes	996.4	761.8 (76.5% absorption)
221 - First afforestation of agricultural land	Tree planting and other actions for establishment of new forests on marginal agricultural land	**Mitigation** – carbon sequestration **Adaptation** - preventing of soil erosion and other natural hazards, such as floods **Low C economy** – increased production of a renewable energy source	229.3	0.01 (negligible absorption)
312 - Support for the creation and development of micro-enterprises	Investments in equipment for producing energy renewable sources (other than biofuels) with focus upon sustainable energy supply at a local level with positive results on local non-agricultural employment and environment. Can be used in combination with measure 123	**Low C economy** – increased production and use of renewable energy sources	531.8	210.8 (39.6% absorption)
322 - Village renewal and development, improving basic services for the rural population and upgrading of the rural heritage	Complementary action to measure 312 above – supports investments in renewable energy production and supply in public buildings in rural areas (e.g. renovation of a rural school)	**Low C economy** – increased production and use of renewable energy sources	1 726.0	979.5 (56.7% absorption)
		Totals	**6 399.1**	**2 958.9 (46.2% absorption)**

5. Priorities for Climate Change Mitigation and Adaptation in the ARD Sector

5.1 General Actions for Supporting Mitigation and Adaptation in the ARD Sector

Improve awareness of climate change amongst farmers and rural communities

As a first key step towards addressing the response of the ARD sector to climate change it is important to acknowledge the top–down "gradient" in the knowledge on climate change impacts on agriculture with a higher level of understanding in national governmental / research institutes and a very much lower level of knowledge at regional and local level.

Rural people, including farmers and other businesses, do not have a good understanding of the consequences of climate change on their enterprise and livelihoods. Furthermore, the flow of relevant knowledge from "top to bottom" is impeded by:

- the over-centralisation of climate change issues in the Ministry of Environment and Climate Change (MECC) which means that policy makers in other institutions are not sufficiently informed about the risks associated with the climate change impacts on the ARD sector;
- the "gap" that has developed in Romania (and many other European countries) between agricultural research and practice;
- the current lack of a fully functional agricultural extension and advisory service in Romania following the dismantling of the national agricultural advisory service in recent years, and;
- the continuing low standards of education in many rural areas.

Rural communities are undoubtedly aware of, and sensitised to, what they perceive as increasingly variable weather – but clear and simple messages need to be articulated and communicated related to the trends, risks and uncertainties that are associated with their perceptions of a changing climate.

Public awareness should be raised regarding a range of climate-related risks. Messages should be tailored according to the localized risks and vulnerabilities ranging from heat waves, seasonal water scarcity, drought and desertification to local flood hazards.

Proactive information campaigns should be organised involving the central and regional offices of the Ministry of Agriculture and Rural Development (MADR); the Agricultural Chambers; the county and local branches of the Paying Agencies (APIA and APDRP) and all key farmers / producer organisations.

There are numerous popular TV programmes, newspapers and magazines serving rural interests. These should all be targeted. Civil society organisations and other NGOs should also be engaged.

Where appropriate, information campaigns should also be linked to capacity-building for emergency planning. Some rural communities will inevitably be at greater risk of extreme events and climate-related emergencies than others.

Climate information services will also have a role to play in supporting these communication campaigns. The National Meteorological Administration (NMA) already has a range of relevant information services, but these focus mainly upon national and regional forecasting. New information tools need to be developed that communicate and raise awareness of the risks associated with climate

change - for example, hazard maps that clearly communicate the risk of drought, heat waves, water scarcity, localised flooding etc.

The agro-meteorological research activities of the NMA are continuously improving and a range of modeling / GIS techniques are used to monitor the spatial extent of extreme weather phenomena and to assess the most vulnerable areas. The information provided covers agricultural areas ranging from regional, sub-regional and national level depending on specific needs of the end-users.

This information is already extremely useful for assisting farmers with their day-to-day management decisions, especially on the larger-scale, commercial crop production units. However, the needs of many other farmers are not being met. For example, an early warning system (e.g. mobile telephone / SMS-based) for extreme weather events, notably thunderstorms, would be extremely valuable for mountain farmers and shepherds when livestock are grazing on high altitude pastures in summer and autumn. One thunderstorm in 2001 killed 70 sheep and 4 people in the mountains in Neamt county, eastern Romania.

Target research and advisory support at climate change mitigation and adaptation

Much greater understanding is needed of what climate actions are relevent and effective in the specific context of the Romanian ARD sector, and this knowledge needs to be communicated via a functional advisory and extension system that engages with the entire ARD sector, not just specific components of it.

Targeted research

Applied research is needed across a range of domains to both develop new, and enhance existing, practices and technologies for climate change mitigation and adaptation. This requires a multi-faceted and cross-sectoral approach. Immediate priorities for applied research include:

1. **The continued study of climate variability, climate change and climate prediction** by the Climatology Department of the National Meteorological Administration (NMA). Key research topics continue to be:

    - analysis of the main characteristics of Romanian climate variability using long term observations (trends, shifts, extreme events);
    - connection between Romanian climate and large-scale mechanisms (atmospheric circulation, North Atlantic Oscillation, etc.);
    - projection of climate predictions to the Romanian context using statistical downscaling models, and;
    - the validation of global/regional climate models on large-scale and regional scale.

2. **The analysis of existing food and farming systems to identify their vulnerability / resilience to different climate change scenarios**. The farming systems that currently prevail in Romania have adapted to current climate conditions over long periods of time, however relatively little is known about how well they will stand up to progressive climate change. Work must continue with the use of dynamic simulation models - combined with different climatic scenarios forecast by the global climatic models – to model of the impacts of climate change upon crop growth, development and yield. This work should be extended to include the economic modelling of whole farm systems that not only takes account of the direct effects of climate change in Romania, but also the indirect effects of climate change at a global level (e.g. volatility of world market prices).

On-going collaborative research between the Agro-meteorological Laboratory of the NMA and other research institutes such the National Research and Development Institute for Soil Science, Agro-chemistry and Environment (ICPA) should be encouraged. Existing research has tended to focus upon winter wheat and maize in the south and east of Romania, but should be extended to other crops and farming systems.

3. **Researching new technologies and better practices (whatever their origin)**. Many broad-scale analyses (e.g. JRC, 2012) identify regions and crops in the EU that will be sensitive to progressive climate change, but there is little scientific knowledge about: a) how current farming systems in Romania can actually be adapted, and; b) which current farming systems and agricultural practices have the greatest potential to enable adaptation.

   On the one hand, there is clearly much potential for the development of new technologies and more climate-proof farming practices. Investment in conventional crop breeding and biotechnology to address the progressively changing climate (e.g. heat, drought, water logging, increased and disease pest attack) will inevitably be an important part of Romania's effort to adapt its farming systems.

   Existing research work by research institutes, such as the Research Institute for Cereals and Industrial Crops (Fundulea) and Research Institute for Fruit Growing (Piteşti-Mărăcineni (fruit trees), should therefore be expanded. This should include the development of collaborative, multi-partner research projects since crop breeding for future climate scenarios will have a significantly greater chance of success if conducted with farmers, taking account of their ability and willingness to adopt new risks and / or methods. Other high priority research topics include increased efficiency of water use by crops and the development of specific measures to counter land degradation and desertification.

   As climates effectively migrate within the EU, the transfer of best practices from one region / country to another will be crucial and this should also be considered as a high priority for research. For example, there will be many best practices relating to dryland farming from the Mediterranean region that become increasingly relevant to Romania. Indeed, there may be some promising practices already grounded in local knowledge, traditional rural practices and customs from Romania that simply need re-discovering.

Targeted advisory support

Farmers and rural communities confronted by the risks and uncertainties of climate change will need on-going, robust and targeted technical support on a range of issues. Unfortunately, the agricultural advisory system in Romania is currently very weak following the dismantling / decentralization of the governmental agricultural advisory and extension system in 2010.

An appropriate advisory and extension system needs to be rebuilt. Most of the former advisory network continues to perform as Chambers of Agriculture subordinated to the local public administration of the County Councils, but recent joint projects by the World Bank and Romanian Ministry of Agriculture and Rural Development (MARD) have also introduced some additional actors to the market:

- Training and Information Centres (TICs) set up in the main regions in Romania, as knowledge resource bases for improvement and updating the professional capacity of the extension, food safety and research specialists;

- Integrated Agricultural Offices (designed on the model "one stop shop") established in 4 pilot areas, that bring together under a single roof, agricultural advisory and administration services, and;
- Socio-economic guidance service capacities and mechanisms established in 15 counties, seeking to increase the ability of the agricultural population to sustainably manage its income and assets with respect to the available national and EU support programmes.

All of these actors – if sustained – have a role to play in supporting climate change mitigation and adaptation.

Assess the economic feasibility of investments and incentives for climate action

Knowledge of the economic feasibility and cost-effectiveness of different mitigation and adaptation actions needs to be improved. For example, Smith *et al.* (2007) estimate that less than 35% of the total biophysical potential for agricultural mitigation at a global level is likely to be achieved by 2030 due to various economic constraints, notably the transaction costs associated with starting-up mitigation actions.

Lessons need to be gleaned from the existing experiences with investment support and compensatory payments in the *NRDP 2007-2013* (as well as from other EU Member States) since it is obvious that farmers will need clear financial incentives to engage with many climate actions.

5.2 Priority Actions for Mitigation in the ARD Sector

Although there has been a significant reduction in GHG emissions from agriculture in Romania in recent years, at a European level agriculture continues to be the most important source of nitrous oxide (N_2O) and methane (CH_4) emissions and in accordance with the *Europe 2020 Strategy* it is anticipated that all Member States will continue to promote the reduction of GHG emissions from the ARD sector.

Furthermore there is also considerable potential in the ARD sector for a) carbon sequestration in agriculture and forestry, and b) the production of biomass (including biofuels) as an alternative to fossil fuels.

The priorities for mitigation highlighted below are broadly in accordance with the strategic objectives of the *National Climate Change Strategy 2013-2020*. However, the big question remains whether the necessary mitigation can be balanced with the inevitable longer-term demands upon agriculture for increased food production. An appropriate mix of actions is therefore needed to manage, offset and avoid emissions across the whole ARD sector.

Support farmers with the continued reduction of GHG emissions and the adoption of low carbon technologies

Investments and incentive schemes are needed to encourage farmers to adopt technologies and practices which directly contribute to reducing emissions – this includes improvements in the efficiency of energy use and the better management of carbon and nitrogen flows in the agricultural ecosystem.

For example, nitrogen (N) applied to cultivated soils as inorganic fertilizers and organic manures is not always used efficiently by crops. Surplus N remaining in the soil is – under certain conditions - particularly susceptible to microbial denitrification and loss to the atmosphere as nitrous oxide (N_2O).

Improving the efficiency of N use can therefore greatly reduce N_2O emissions. Typical practices that improve N use efficiency include:

- adjusting fertiliser N application rates to match crop needs;
- avoiding N applications in excess of immediate plant requirements.
- applying fertiliser and manure N when it is least susceptible to loss i.e. when crops are growing most actively.

One important short-term priority for the mitigation of GHG emissions is therefore continued investment in the up-grading and modernisation of i) facilities (both large and small-scale) for the storage of livestock manures, and; ii) equipment for the spreading of fertilisers and manures. This will greatly help to improve the efficiency of N use, reduce N_2O emissions and also have additional positive benefits for water quality due to the reduced risk of nitrate leaching.

Grazing ruminants such as cattle and sheep, are important sources of GHG emissions. According to Steinfeld *et al.* (2006), global livestock production is responsible for 18% of all GHG emissions, including 9% of all carbon dioxide emissions, 45% of methane emissions and 65% of nitrous oxide emissions.

Cattle and sheep grazing semi-natural grassland at low stocking densities release large quantities of methane because the vegetation soon becomes mature, developing higher concentrations of cellulose which produces larger amounts of methane. This contrasts with animals which are either grazed at high density on intensively-managed grasslands (which accumulate less cellulose), or; are kept indoors and fed on cereals.

This raises some interesting questions about the mitigation of GHG emissions from grazing livestock in Romania – a large proportion of which (if not the majority) are associated with small-holdings and the extensive grazing of semi-natural grasslands.

On the one hand there is an argument that the best way to mitigate the impact of livestock production upon climate change is to increase the efficiency of the livestock sector by promoting more intensive livestock systems. On the other hand, it is argued (e.g. Grayson, 2008) that although extensively grazed sheep and cattle generate greater amounts of methane per animal than their intensively reared counterparts, this is offset by the lower densities at which they are stocked. Therefore extensive livestock farming systems, such as commonly found in Romania, produce less CH_4 than conventional livestock systems. Further research into this issue is warranted.

Support for the reduction of soil carbon losses and increased carbon sequestration

Soil carbon sequestration by farmers is estimated to have a high economic mitigation potential (Smith *et al.*, 2008). It also has good potential to be promoted in Romania through existing interest in organic farming and zero / conservation tillage techniques. The afforestation of low quality and unproductive land must also be encouraged, especially in those areas where soils are most vulnerable to degradation and loss.

Enhancing soil carbon content also has important benefits in terms of water storage (combating water stress), soil biodiversity (maintaining soil fertility) and soil aggregate stability (combating soil erosion).

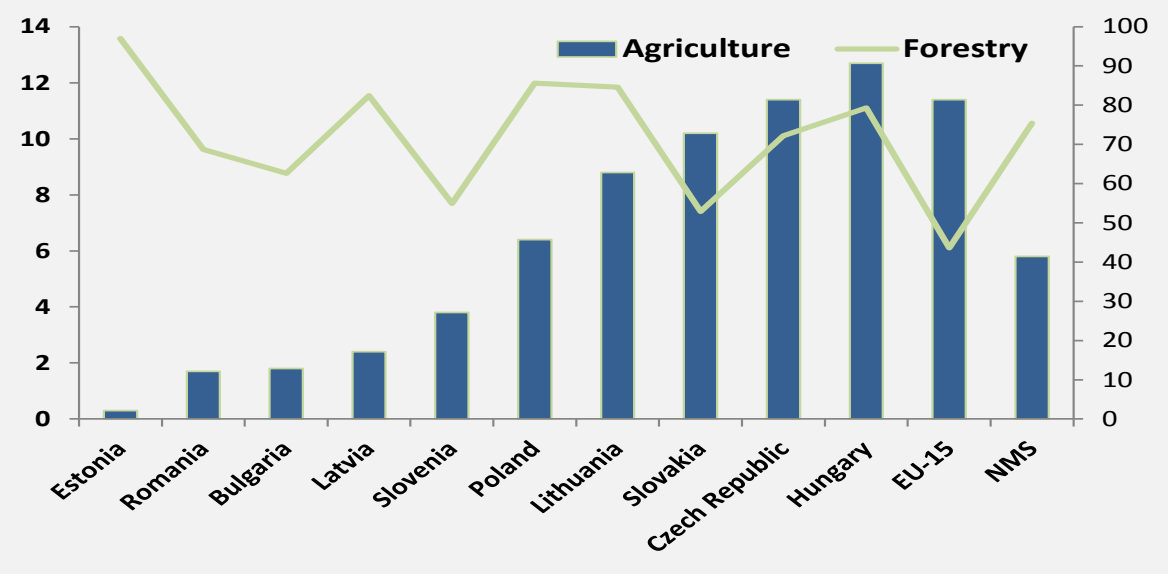
However, there are uncertainties. Appropriate levels of incentive for the adoption of soil carbon sequestration by farmers remains unclear and influenced by a range of potential barriers to adoption.

The effectiveness, variability and permanence of different practices for soil carbon sequestration still needs to be evaluated in the Romanian context and is likely to vary according to individual agricultural systems based on climate, edaphic, social setting / behaviour, economic conditions, and historical patterns of land use and management. More research is needed.

Support for the increased production of renewable energy in rural areas

Agriculture has to-date only made a very small contribution (1.7% in 2010) to total renewable energy production in Romania – this is one of the lowest contributions in the region and sits well below EU-15 and New Member State averages (see Figure 7 below).

Figure 7: *Contribution of agriculture and forestry to the production of renewable energy in the countries of Central and Eastern Europe (% of total renewable energy production per country, 2010)*



Source: Eurostat

Farmers and other rural businesses have many opportunities for the production of renewable energy from crop residues and dedicated energy crops; rural biogas production from livestock manure, and; investment in the small- and large-scale technologies available for solar and wind power generation (not discussed further here).

There is untapped potential for small-scale, community-based initiatives where the full socio-economic benefits of investment in appropriate technologies are retained locally. The LEADER approach promoted by EU rural development policy could be used to support this.

Crop residues can be used as a source of fuel, either directly or after conversion to fuels such as ethanol or diesel. These bio-energy feedstocks still release CO_2 upon combustion, but the carbon is of recent atmospheric origin (via photosynthesis) rather than from fossil carbon. The net benefit of these bio-energy sources to the atmosphere is equal to the fossil-derived emissions displaced, less any emissions from producing, transporting, and processing.

The straw remaining after the harvesting of cereal crops, such as wheat, is a potentially very important fuel source. It occurs in large quantities, is renewable, and has low sulphur and zero emissions of carbon dioxide.

GHG emissions could be reduced by substituting fossil fuels with energy produced from agricultural feed stocks (e.g. crop residues, dung, energy crops), which would be counted in sectors using the energy. The contribution of agriculture to the mitigation potential by using bioenergy depends on relative prices of the fuels and the balance of supply and demand.

The energy production and GHG mitigation potentials of dedicated energy crops depends on availability of land, which must also meet demands for food as well as for nature protection, sustainable management of soils and water reserves, and other sustainability criteria.

Large-scale production of modern bioenergy crops, partly for export, could generate income and employment for rural regions. Nevertheless, these benefits will not necessarily flow to the rural populations that need them most. The net impacts for a region as a whole, including possible changes and improvements in agricultural production methods should be considered when developing biomass and bioenergy production capacity. Although experience around the globe (e.g. Brazil, India biofuels) shows that major socioeconomic benefits can be achieved, new bioenergy production schemes could benefit from the involvement of the regional stakeholders, particularly the farmers.

The anaerobic digestion of animal manures can release significant amounts of CH_4 and this can be exploited in rural biogas production. Some small-scale plants have already been piloted in Romania and have proved successful.

5.3 Priority Actions for Adaptation in the ARD Sector

In addition to the cross-cutting general actions to support mitigation and adaptation outlined in Section 5.1, further priority actions for adaptation therefore promotion climate change adaptation in the ARD sector fall into three main categories:

1. Investment in irrigation infrastructure and improved water management in the south and south-east of Romania where drought will be most frequent and intense;
2. Support for accelerated adaptation by farmers and rural communities to the progressive climate change that is increasingly observed;
3. Better management of the risks in the ARD sector that are associated with climate variability and extreme events.

These actions present a major challenge in terms of science, policy and practice – a challenge that is complicated by the variability in socio-economic context of rural areas and the highly polarised structure of agriculture. For example, very different approaches are required to address contrasting vulnerabilities in the sector such as:

a) **large-scale crop production in the lowland areas of south and south-east Romania** where the increased frequency of drought is likely to significantly reduce the yields of grains and other crops. While losses may be partially offset by the beneficial effects of increased CO_2 concentrations, crop production will be further threatened by potential increases in the prevalence of pest and diseases and through the loss of productive land due to desertification, and;
b) **small farmers in geographically remote and economically disadvantaged communities in the mountains** where access to relevant information and advice is currently very limited. Although many small farming communities in Romania are intrinsically resilient to social and economic change, they are highly dependent upon their traditional agricultural systems and therefore very exposed to increasing climate variability and extreme events.

Investment in irrigation infrastructure in the most vulnerable regions

Priority action is needed at the national level to improve / rehabilitate the economically viable irrigation infrastructure in south, south-east and east of Romania where the occurrence of drought is predicted to be most frequent and to reach the highest intensity values (extreme/Co-300 m3/ha and severe/600-900 m3/ha) (Mateescu *et al.*, 2013).

As of July 2013, the strategy of the Ministry of Agriculture and Rural Development (MARD) for supporting investment in irrigation infrastructure and improved water resource management was as follows:

1. Continued construction of the inter-basin Siret – Bărăgan channel between the Buzau and Ialomiţa rivers for water supply and irrigation use;
2. Rehabilitation of publically-owned irrigation infrastructure serving approx. 823,000 hectares of agricultural land (but only where irrigation is economically viable);
3. Changing the supply of 3 existing irrigation systems serving approximately 56,000 hectares of agricultural land the Siret and Prut rivers to the Siret – Bărăgan channel;
4. Establishing new irrigation works to serve 425,000 hectares adjacent to the Siret – Bărăgan channel.

All plans for the expansion of irrigation infrastructure and facilities (including on-farm tertiary infrastructure) must be prepared with reference to the relevant River Basin Management Plan (RBMP).

Further work will need to be done with the RBMPs to assess the specific levels and types of irrigated agriculture that can be sustained in each of the river basins. This exercise should entail quantitative assessments of water availability and crop water needs under different climate scenarios, and is best conducted in a Decision Support System framework, so that the trade-offs between different choices can be explicitly analysed and discussed with the stakeholders.

Wastewater reuse in irrigation should be encouraged in accordance with the EU guidelines, especially in water-scarce basins. A new EC directive on water reuse us understood to be due for proposal by 2015.

In the areas where groundwater over-abstraction is leading to serious depletion of aquifers, the use of groundwater should be reserved for domestic water supplies.

Support for accelerated adaptation by farmers and rural communities

Support for accelerated adaptation to climate change at farm and community level is urgently needed. One of the most pressing tasks is to reduce the effects of extreme weather events, such as droughts and floods. Land and water management practices therefore need to be improved, including the rehabilitation and better management of irrigation services.

Innovation, co-operation and bottom-up initiatives need fostering and promoting amongst local people, including farmers and other businesses. Not all solutions can be expected to come from the top-down.

This is a huge undertaking and must be deeply embedded in public policy, including the *National Rural Development Programme 2014-2020*. Actions for the accelerated adaptation of agricultural

holdings and rural communities must be built upon a solid base of relevant applied research and advisory support (see Section 5.1 above).

There is also a strong need for **fostering and promotion of innovation, co-operation and bottom-up initiatives by local people, including farmers and other businesses.**

Typical changes in cropping systems already observed across the EU are (Olesen *et al.*, 2011):

- Minor to moderate changes in the cultivation timing - mainly shifts in sowing dates (e.g. earlier sowing of spring crops)
- Changes in cultivation / tillage practices
- Tendency of farmers to reduce crops that are unsuitable under the changing climatic conditions and to introduce new crops to the crop rotation
- Increase of interest in the cultivars that are able to cope better with drought and other weather extremes
- Widespread effort to promote techniques that preserve soil water, especially in the most drought prone regions
- Modernization and rehabilitation of existing, economically viable irrigation infrastructure, mostly located in areas with high risk of drought
- Some expansion of irrigation, especially in the most arid zones. But interestingly although an expansion of irrigation is the most obvious response in those regions where water resources are most limited, there has actually been marked drop in the area under irrigation in these regions when farmers have chosen to change their cropping systems to include crops which demand less water
- Efforts to introduce cultivation techniques reducing soil erosion. This may be a response to a higher frequency of more intense precipitation leading to water erosion, but also the result of more frequent droughts as a prerequisite of wind erosion over the area.

Farmers in Romania need more information, training and advisory support on how to adapt their agricultural production to the increasing risks, uncertainties and impacts of climate change. This information, training and advisory support must be delivered according to the demands and circumstances of specific localities or individual farms since the impacts of climate change are variable.

It cannot be assumed – in the short- to medium-term at least – that all impacts of climate change upon Romanian agriculture will be negative. There may be some areas that experience positive impacts. There may be a shift, for example, in the distribution of less-favoured areas with some current less-favoured areas benefiting from the effects of climate change (and no longer needing support), whilst new areas may come to be considered as less-favoured and thus be eligible for support.

There must be an enhancement of cooperation, as well as constant transfer of technology, know-how and best practices. Exchange of knowledge and experience should also include a database of case studies that showcase different approaches to climate change adaptation in agriculture.

All of which requires a solid foundation of sound knowledge about farming and food systems; learning from community-based approaches; generation and use of new technologies; changes in agricultural and food-supply practices, including diversification of production systems; improved institutional settings; enabling policies and infrastructural improvements, and above all a greater understanding of what is entailed in increasing adaptive capacity.

Some general recommended actions at farm / local level for supporting / promoting adaptation in the ARD sector include:

- Promote the use of agro-meteorological services by farmers;
- Promote the use of available information sources by farmers to support the adaptation of their production systems, including the selection of crops and cultivars that are better adapted to the changing growing conditions;
- Introduce new / alternative technologies for addressing extreme weather events;
- Promote the use of farm advisers with specialist climate change-related knowledge (based upon relevant applied research);
- Develop Best Practice Guides for agriculture and climate change, especially non-irrigated agriculture;
- Encourage on-farm experimentation to modify soil management techniques, test novel crop rotations, select new crops, and diversify production to suit the new climatic conditions;
- Introduce animal husbandry techniques / technologies that reduce stress in livestock caused by extreme weather;
- Develop crop / farm insurance products and promote their use;
- Develop and implement local action plans (at commune level) for climate change adaptation, including local / communal water management schemes;
- Develop and implement land management plans, especially for those areas that are most vulnerable to soil loss and degradation;
- Support the preparation and use of irrigation planning / scheduling.

Better management of climate-related risks

Climate change will mainly be experienced by farmers and other members of the rural population through the increasing intensity and frequency of extreme weather events. This will introduce new risks and uncertainties for rural people that come on top of the 'traditional' sources of uncertainties, such as animal and crop diseases, normally associated with rural life.

Climate change will amplify existing vulnerabilities and instabilities in the ARD sectors. The increased frequency and intensity of drought, for example, will undermine the confidence of farmers to adopt new practices and invest in new technologies. Many local communities will be increasingly subject to the disruption of day-to-day life due to water shortages, flooding and heat waves – as well as the risk of loss of life and long-term declines in livelihood due to the loss of their productive assets (e.g. soil). Local authorities will face unexpected costs due to damaged infrastructure. In many regions of Romania these increased risks and uncertainties will intensify existing cycles of poverty and vulnerability.

The concept of managing "climate-related risk" must be firmly embedded in decision-making processes that take place at all levels of the ARD sector. There needs to be a paradigm shift in attitudes to the risks and uncertainties associated with climate change that ranges from farming households through local and regional administrations to national government.

The effective management of climate-related risk and shock should be both: i) holistic involving prevention, response and planning, and; ii) tailored to local context. There is, for example, huge potential for the direct engagement of local communities in mapping local hazards, assessing local risks and vulnerabilities and developing local adaptation plans.

This is clearly linked to many of the priority actions already mentioned above including the need to improve awareness of climate change amongst farmers and rural communities; target research and advisory support at climate change mitigation and adaptation; assess the economic feasibility of investments and incentives for climate action, and; support accelerated adaptation by farmers and rural communities.

New policy / financial instruments will also need to be created to manage the economic consequences of the impacts of climate change in the rural areas. Relevant risk management tools for agriculture include: i) insurance schemes against extreme climate events and / or against pest and disease of livestock and crops linked to changing climate, and ii) the setting-up of farmers' mutual funds for stabilizing incomes in case of price volatility or losses from extreme climate events or livestock/crop diseases.

Both of these instruments are eligible for supporting under the EAFRD as of part of a new 'risk management toolkit' that has been introduced for the 2014-2020 programming period. The new proposed new EAFRD Regulation offers flexibility for such instruments to be i) carefully tailored to the specific context of Romania on the basis of the needs of specific rural areas and farmers, and; ii) combined with other complementary rural development measures, such as knowledge transfer, investments in physical assets, diversification into non-agricultural activities, etc.

Risk management is a rapidly developing policy area and there are many opportunities to develop new and innovative approaches, including the development of tools for the use of index-based systems for climate-related loss assessment in agriculture.

One innovative risk management tool that could be very appropriate for the large number of small-scale subsistence farmers in Romania is "Weather Index Insurance" (IFAD, 2010). This is a financial product that has been developed and tested in developing countries, such as India and Mexico, for managing the covariate risk[14] associated with extreme weather events. Weather Index Insurance triggers pay-outs based on a meteorological index correlated with agricultural losses (e.g. rainfall or modelled water stress), rather than actual observed losses. Basing pay-outs on an objectively measured index overcomes problems, such the high cost of verifying the losses of individual producers, which make traditional crop insurance unfeasible to introduce for smallholder farmers.

[14] Covariate risks are those risk that affect large numbers of people at one time

6. Opportunities for Mainstreaming Climate Actions in the *NRDP 2014 – 2020*

6.1 Mainstreaming Climate Actions

Strategic programming of the *NRDP 2014-2020* involves a number of key steps beginning with the development of a *Partnership Agreement* which establishes the binding terms between the Member State and the European Commission.

The *Partnership Agreement* covers all of the European Structural and Investment (ESI) Funds and provides a good opportunity to 'lock-in' climate mitigation and adaptation issues / considerations right at the start of the strategic programming process. These issues / considerations need to be developed in full consultation with all relevant government departments and stakeholders.

In accordance with the new EAFRD regulation for 2014-2020 (EC, 2013e), there is a comprehensive suite of mitigation and adaptation measures eligible for co-financing under the *National Rural Development Program (NRDP) for Romania 2014-2020*. However, the *NRDP* measures will not be able to address all climate-related challenges faced by farmers and other rural stakeholders. Prioritization and careful targeting of the *NRDP* measures will therefore be needed.

The main entry point for climate actions in the *NRDP 2014-2020* is under priority 5 of the new EC rural development proposals, namely: *"promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in the agriculture, food and forestry sectors"*. But since climate change mitigation and adaptation are also cross-cutting objectives for the EAFRD, climate actions should also be introduced under other priorities.

In order to ensure that farmers, foresters and other rural stakeholders will be in a position to achieve this, all Member States are further encouraged to i) provide them with the required skills and knowledge (also agreed to be very important in Romania), and; ii) to spend a minimum of 30% of their total EAFRD expenditure on climate change mitigation and adaptation.

The experts consulted during the preparation of this rapid sectoral analysis acknowledged that this mainstreaming of climate actions into Romanian rural development policy will require a significant shift of emphasis towards climate action in the planning and implementation of the *NRDP 2014-2020* compared to the *NRDP 2007-2013*. It is important to ensure that this policy shift is not only in line with *EU2020*, but also the *Romanian National Strategy for Climate Change 2013-2020*, the upcoming national strategy for the ARD sector (currently under development), as well as the cross-compliance and 'greening' components of the EU direct payment system for farmers.

6.2 Basic Intervention Logic for the *NRDP 2014-2020*

At the time of writing (December 2013), the *Romanian Partnership Agreement for the 2014-2020 Programming Period* is still at the first draft stage, and work on the strategic programming of the *National Rural Development Programme (NRDP) for Romania 2014-2020* has only just started.

A basic intervention logic is proposed in Table 5 for using the available EAFRD funding to effectively mainstream relevant climate actions in the *NRDP 2014-2020*. This intervention logic incorporates the following elements:

1. The Thematic Objectives (TOs) that are expressed at the level of the Romanian Partnership Agreement for 2014-2020;

2. The Rural Development Priorities for 2014-2020 that are expressed in the EAFRD regulation (EC, 2013e);
3. The Focus Areas that are elaborated for each Rural Development Priority in the EAFRD regulation, and;
4. The potential measures (with relevant Articles from the EAFRD regulation) for inclusion in the *NRDP 2014-2020.*

Table 5: *Basic intervention logic for potential climate actions in the National Rural Development Programme (NRDP) for Romania 2014-2020*

Romanian Partnership Agreement for 2014-2020	**National Rural Development Programme (NRDP) for Romania 2014-2020**		
Thematic Objectives (TOs) for all ESI Funds	**EAFRD Priorities for Rural Development**	**EAFRD Focus Areas**	**Potential Measures for mainstreaming climate action in the NRDP 2014-2020 (with reference to the relevant EAFRD Articles)**
TO 1 - Strengthening research, technological development and innovation	**Priority 1** - Fostering knowledge transfer and innovation in agriculture, forestry and rural areas *(this is a cross-cutting priority that aims to support all other EAFRD priorities)*	**1A** - Fostering innovation, cooperation and the development of the knowledge base in rural areas	Foster innovation and promote knowledge exchange relating to climate change mitigation and adaptation in the agricultural and rural development sector. Potential measures include: • Knowledge transfer and information actions (Article 14) • Advisory services, farm management and farm relief services (Article 15) • Co-operation, operational groups and related projects (Article 35) • Investments in physical assets (Article 17) • European Innovation Partnership (EIP) (Articles 55-57 and all measures above in combination)
		1B - Strengthening the links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance	
TO 3 – Enhancing the competitiveness of SMEs, the agricultural sector, fishing and aquaculture	**Priority 3** - Promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture	**3A** - Improving competitiveness of farmers by better integrating them into the agri-food chain through quality schemes, adding value to agricultural products, promotion in local markets, short supply circuits and producer groups	Support the adaptation of farm businesses to the potential impacts of climate change by i) better integrating farmers into local / regional markets and ii) helping farmers to cope with the economic effects of extreme climate-related events. Potential measures include: • Setting-up producer groups (Article 27) • Co-operation (Article 35) • Risk management (Article 36) • Crop, animal and plant insurance (Article 37)
		3B – Supporting farm risk prevention and management	

Thematic Objectives (TOs) for all ESI Funds	EAFRD Priorities for Rural Development	EAFRD Focus Areas	Potential Measures for mainstreaming climate action in the NRDP 2014-2020 (with reference to the relevant EAFRD Articles)
TO 4 - Supporting the shift towards a low-carbon economy in all sectors	**Priority 5 -** Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors	**5B** – Increasing efficiency in energy use in agriculture and food processing	Promote the use of energy efficient production and processing equipment – notably through modernisation and investments in physical assets (Article 17)
		5C – Facilitating the supply and use of renewable sources of energy	Increase the supply and use of renewable sources of energy by the agriculture, food and forestry sectors. Potential measures include: • Investments in physical assets (Article 17) • Farm and business development (Article 19) • Basic services and village renewal in rural areas (Article 20) • Investments in new forestry technologies (Article 26)
		5D – Reducing greenhouse gas and ammonia emissions from agriculture	Reduce (or at least avoid future increases of) nitrous oxide and methane emissions from agriculture by promoting improvements in the storage and treatment livestock wastes and the management of agricultural land. Potential measures include: • Investments in physical assets (Article 17) • Agri-environment – Climate payments (Article 28)
		5E – Fostering carbon conservation and sequestration in agriculture and forestry	Promote afforestation and the management of agricultural land for carbon sequestration (including the maintenance of permanent grasslands, encouragement of zero tillage on arable land etc.). Potential measures include: • Investments in physical assets (Article 17) • Afforestation and creation of woodland (Article 22) • Agri-environment – Climate payments (Article 28)

Thematic Objectives (TOs) for all ESI Funds	**EAFRD Priorities for Rural Development**	**EAFRD Focus Areas**	**Potential Measures for mainstreaming climate action in the NRDP 2014-2020 (with reference to the relevant EAFRD Articles)**
TO 5 - Promoting climate change adaptation, risk prevention and management	**Priority 4** - Restoring, preserving and enhancing ecosystems related to agriculture and forestry	**4A** – Restoring, and preserving and enhancing biodiversity, including in Natura 2000 areas, areas facing natural or other specific constraints and high nature value farming, and the state of European landscapes	Restore, maintain and enhance a range of valuable ecosystems and landscapes on agricultural and forestry land. Potential measures include: Investments in physical assets – non-productive investments for environmental purposes (Article 17) Agri-environment – Climate payments (Article 28) Organic farming (Article 29) Natura 2000 and Water framework directive payments (Article 30)
		4B - Improving water management, including fertiliser and pesticide management	Reduce the risk of i) agricultural pollution by crop nutrients and pesticides agricultural land and ii) the degradation / erosion of valuable soil resources. Potential measures include: Investments in physical assets (Article 17) Agri-environment – Climate payments (Article 29) Organic farming (Article 29) Payments to areas facing natural or other constraints (Article 31)
		4C - Preventing soil erosion and improving soil management	
TO 6 - Protecting the environment and promoting resource efficiency	**Priority 5** - Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors	**5A** - Increasing efficiency in water use by agriculture	Increase water storage / supply and improve the efficiency of irrigation equipment and techniques. Potential measures include: • Investments in physical assets (Article 17) • Agri-environment – Climate payments (Article 28)
TO 9 - Promoting social inclusion and combating poverty	**Priority 6** - Promoting social inclusion, poverty reduction and economic development in rural areas	**6C** - Fostering local development in rural areas	Promote bottom-up, community based climate action through LEADER local action groups and their co-operation activities (Articles 42-44)

6.3 Examples of Specific Climate Actions that can be supported by the EAFRD

Table 5 above identifies a number of potential measures (with reference to the relevant articles) from the EAFRD regulation (EC, 2013e) for mainstreaming climate actions in the *NRDP for Romania 2014-2020*. These measures are explained in further detail below.

However, it must be kept in mind that the ARD sector is complex and the successful mainstreaming of climate action into the *NRDP 2014-2020* will require the tailoring of measures to take account of:

i) the huge variability in socio-economic context and human / institutional capacity;
ii) the fact that effects of the changing climate upon temperature, precipitation and the occurrence / frequency of extreme events will continue to vary from region to region, and;
iii) the very specific characteristics of Romanian agriculture – notably its highly polarized structure and very large number of small-scale farmers which occupy around two-thirds of agricultural land.

A "one-size fits all" approach to mainstreaming climate action in the *NRDP 2014-2020* will not be appropriate – a flexible and localised approach should be encouraged as much as possible and the potential of bottom-up, community-based initiatives should not be under-estimated (for example, utilising the LEADER-approach).

Article in EAFRD Regulation	Rural Development Measures	Examples of Climate Actions: Mitigation	Adaptation
Art. 14	Knowledge transfer and information actions	Actions related to improving knowledge transfer and information on energy efficiency in agricultural installations, environmentally sustainable new practices like new sowing cycles, climate change risks and adaptation tools. Relevant actions can address both mitigation and adaptation.	
Art. 15	Advisory services, farm management and farm relief services	Training/advisory services, guidance documents, thematic groups related to topics like those mentioned above. Relevant actions can address both mitigation and adaptation.	
Art. 17	Investments in physical assets	Actions which reduce input intensity, energy demand and emissions, such as energy efficiency installations in buildings, use of renewable energy sources, manure storage facilities and biogas digesters.	Actions which reduce the exposure of holdings to climate change impacts, such as on-farm water storage installations for drought periods, highly efficient irrigation systems, investments in farm buildings and installations to cope with heat and water stress.
Art. 19	Farm and business development	Support to young farmers to introduce efficiency-oriented measures to optimise production processes. These may relate to on-farm or off farm non-agricultural activities.	Business plans including climate adaptation considerations and cost estimations. This is also relevant to Articles 38, 39, 40 (see below).
Art. 20	Basic services and village renewal in rural areas	Climate proofing of local development plans, measures to adapt small scale infrastructure (water supply, energy production etc.). Relevant actions can address both mitigation and adaptation.	
Art. 22	Afforestation and creation of woodland	In general, all afforestation measures are beneficial to mitigation. Where possible, attention should be given to measures with an optimal input/output ratio (i.e. investments in relation to carbon capture) taking in account location, soil quality, rapidness of tree growth etc.	Forest management actions to preserve and improve the ecosystem services provided by forests which help with climate resilience (e.g. reduction of flood risk, erosion protection and soil buffering/filtering functions).
Art. 28	Agri-environment-climate	Area-based compensatory payments for a wide range of land management practices that are beneficial for mitigation. For example, relevant actions might include support for biomass-based renewable energy production; increased carbon sequestration in arable soils through conservation- and zero-tillage	Area-based compensatory payments for a wide range of land management practices which reduce the impact of climate hazards, including new crop rotations; under-sowing and cover crops; hedges and buffer strips; extensification of livestock production etc.

Article in EAFRD Regulation	Rural Development Measures	Examples of Climate Actions: Mitigation	Adaptation
		systems; cultivation of perennial grasses and restoration of agricultural wetlands, and; reducing the use of inorganic nitrogen fertilizers.	
Art. 29	Organic farming	Area-based compensatory payments for organic farming are beneficial for mitigation by reducing N_2O and CH_4 emissions though the avoidance of synthetic fertilizers and pesticides; recycling of manures and crop residues; use of crop rotations based upon fertility-building with leguminous crops etc.	Area-based compensatory payments for organic farming are also beneficial for adaptation by encouraging the adoption of crop diversification (variation in season and space); use of local resources that are adapted to local conditions (e.g. local livestock breeds and crop varieties), and; promotion of a generally more holistic perspective on agriculture.
Art. 30	Natura 2000 and Water framework directive payments	Particular attention and explicit referral to actions reducing material input and emissions and enhancing the carbon storage potential.	Particular attention and explicit referral to actions which reduce the impact of climate hazards, such as increasing natural water retention and storage or restoring riparian vegetation.
Art. 31	Payments to areas facing natural or other specific constraints	Considering carbon sequestration potential of constrained areas to be maintained (i.e. areas with low-output, high-value semi-natural pastures).	Designation of areas especially affected by temperature increase and stress, erosion, fires, floods, pests and diseases or areas where topography accentuates climate change impacts as areas 'facing specific constraints'.
Art. 35	Co-operation	Networks, exchanges and pilot projects on climate change and agriculture/rural development. (See also Articles 15 and 16). Relevant actions can address both mitigation and adaptation.	
Art. 36	Risk management		Development of i) risk analysis models for assessment and management of changing climate hazards, and; ii)creation or modification of insurance / compensation funds and schemes
Art. 42-44	LEADER	Introduction of climate proofing and climate mainstreaming as an integral element of Local Development Strategies, promoting of "climate resilient regions". Inclusion of climate change actions and awareness in the activities of Local Action Groups.	
Art. 55-57	European Innovation Partnership (EIP) for Agricultural Productivity Sustainability	Funding for creating closer links between scientific research and agricultural practice in order to foster and promote innovation. Key aims of the EIP include: • Efficient, productive, climate and environment friendly agriculture (including forestry), and; • Improved processes to preserve the environment, adapted to climate change and mitigation	

7. Broad-based Action in the Face of Uncertainty

Significant uncertainty exists in the ARD sector regarding a) the direction and magnitude of climate change; b) its impacts upon agriculture and the wider rural community, and; c) the effectiveness and economics of different actions and strategies for mitigation and adaptation.

This uncertainty is inevitably reflected in this rapid sectoral analysis and some very broad-based actions have been recommended that reflect a generic understanding of the most appropriate actions for supporting farmers, including small-holder farmers, to maintain viable and productive systems in the face of climate change.

But uncertainty does not mean that action should be postponed and the immediate opportunity to embed climate action in the programming of the NRDP 2014-2020 must be fully and effectively acted upon for the short- to medium-term benefit of the ARD sector.

But in parallel further work does need to be done sharpen the generic recommendations in this rapid sectoral analysis. In particular:

1. A **robust evidence base** needs to be built-up that ensures all future policy decisions relating to mitigation and adaptation in the ARD sector are cost effective. This will require the Romanian government and research institutions to work more closely together to develop evidence and inform policy.

   For example, impact **studies are needed that integrating climate, land use and macroeconomic policies** in models such as EPIC (the Environmental Policy Integrated Climate model). EPIC is a process-based agricultural systems model composed of simulation components for weather, hydrology, nutrient cycling, pesticide fate, cultivation practices, crop growth, soil erosion, crop and soil management and economics. There needs to be an assessment of the full costs and benefits of climate actions for mitigation and adaptation to ensure that net benefit is delivered.

   Financial and socioeconomic analyses are needed to **evaluate the cost-effectiveness** of deploying the various technologies. Marginal Abatement Cost Analyses can reveal costs and benefits in addition to carbon savings from various technologies. Given the public good nature of many of the interventions e.g. carbon sequestration public and private costs/benefits should be assessed to guide policy interventions.

2. A **more strategic approach** is needed that reconciles and integrates the climate challenges faced by the ARD sector with the need to also significantly reform the sector towards "a more export-driven, high-value and climate-resilient agriculture, with rural living conditions more closely aligned to urban".

3. A **macro-economic model** for the impacts of climate change upon the ARD sector would be useful, but there is an inevitable trade-off that needs to be resolved between a single complex model that allows exploration of multiple policy questions and a suite of simple models that seek to answer the same questions individually.

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Annexes

Annex 1: *National and international projects / studies that provide further information on climate change impacts and vulnerabilities relevant to the ARD sector in Romania*

Title	Organisation(s)	Year	Further Information	EN	RO
AVEMAC - Assessing Agriculture Vulnerabilities for the design of Effective Measures for Adaption to Climate Change	Joint Research Centre, European Commission	2012	A pan-European study to address the lack of information on vulnerabilities, risks, and needs for the adaptation of European agriculture under a changing climate in the next decades	X	
CLIMDHYEX ("Changes in climate extremes and associated impact in hydrological events in Romania")	Supported by the *Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFSCDI)* as a 3 year Complex Exploratory Research Project (PCCE)	2012-2015	To improve the knowledge and understanding of the complex mechanisms controlling the variability of the most important weather/climate extremes occurring in Romania at various time scales, to estimate the uncertainty associated to their projections in the future perturbed climate and to quantify climate change impact on hydrological regime, focusing on extremes events. – work in progress. Further information at http://www.inhga.ro		X
ECLISE	INHGA (FP7-ENV-2010-1 Proposal No:265240 – ECLISE) 75% financed by EU and 25% financed by national budget (UEFISCDI, Contract Nr.142 EU)	2011-2014	Establishing a European Service to address the needs of the EU-member states on climate information. This service should involve the national services into a European approach and to offer a clear perspective regarding the use of the results achieved by the previous research projects on climate change. Work in progress.		
BALWOIS **-** Water Observation and Information System for Balkan Countries	A Balkan community of stakeholders in water protection and water management ranging from scientists, private sector, experts, NGO's, to decision makers and large public - the Institute for Soil Science, Agricultural Chemistry and Environment (ICPA) is an active RO participant	2004-2013	Further information at: http://cms.balwois.com and various documents provided by ICPA	X	

Title	Organisation(s)	Year	Further Information	EN	RO
"Optimal Strategies for Climate Change Action in Rural Areas" (OSCAR)	European Commission DG Clima / University of Hertfordshire, UK	2013	On-going study for EU-27 (including Romania) to provide regional specific guidance on how to design climate change mitigation and adaptation measures in future Rural Development Programmes – further information at: http://ec.europa.eu/clima/events/0061/index_en.htm	X	
CLIMSAVE – pan-European project developing a user-friendly, interactive web-based tool for assessing climate change impacts and vulnerabilities for a range of sectors, including agriculture	Co-ordinated by the Environmental Change Institute at the University of Oxford (UK) with 18 Partners, including TIAMASG Foundation (RO)	2010-2013	Funded under EU 7th Framework Programme – more information from: http://www.climsave.eu/climsave/index.html	X	
"Water scarcity and droughts; coordinated actions in European regions" (WaterCoRe) - provides a new "platform" for information exchange on water deficit, drought and climate change problems. It has also produced two new publications: *Good Practices Handbook* and *Good Practices Guide* on sustainable water management, plus an e-learning programme	Coordinated by the Ministry of Environment, Energy, Agriculture and Consumer Protection of Hessen (DE) – partners from 7 EU countries are participating including the Environmental Protection Agency, Covasna and the National Meteorological Administration, Bucharest	2010 - 2013	Co-financed by the INTERREG IVC programme – more information from: http://www.watercore.eu/project.asp	X	
Danube Floodrisk Project	Lead partner was the Ministry of Environment, Romania with 19 partner institutions in other Danube countries	2009-2012	Further information at: http://www.danube-floodrisk.eu	X	
CC-WaterS – the main objective of the project was to identify and evaluate the climate change impacts on the availability and safety of public water supply, with reference also to necessary land use changes. The project included 5 thematic Working Groups on Climate Change; Water Resources; Land Uses and Water Safety; Socio-Economic Evaluation, and; Water Supply Management Measures	Coordinated by the Municipality of the City of Vienna (AT) – partners from 9 EU countries are participating including from Romania the National Institute of Hydrology and Water Management; National Meteorological Administration, and; Institute of Geography, Romanian Academy	2009 - 2012	Funded by the European Regional Development Fund (ERDF) – more information from: http://www.ccwaters.eu/	X	
ENSEMBLES	A number of 79 partners (universities and research institutions from all European countries formally acceded to the ENSEMBLES Contract and the ENSEMBLES Consortium Agreement. In addition, 30 affiliated partners participated in the project.	2008-2012	Overall goal of ENSEMBLES is to maintain and extend European activities in the provision of policy relevant information on climate change and its interactions with society. Further information at http://www.ensembles-eu.org/	X	

Title	Organisation(s)	Year	Further Information	EN	RO
Enhancement of water resources management in Mures River Basin	Financed from EEA Grants. Partnership INHGA, Mures River Basin Administration, DHI Norway, Water and Energy Directorate Norway	2009-2011	The general purpose of the project was to strengthen the institutional capacity of the water management authorities to secure the environment protection through a sustainable use of the water resources in the Mures River basin.		X
"Assessment of potential impacts of climate change on agro-climatic zoning in Romania for fruit production"	Fruit Trees Research & Development Institute Piteşti Mărăcineni	2007-2010	Further information at: http://www.icdp.ro/ro-index.php?target=ro-climpactpomi-info		X
Schimbări climatice în România şi efectele asupra agriculturii (Climate Change in Romania and effects on Agriculture)	Sandu, I., Mateescu, E. and Vătămanu, V.	2010	Published by Sitech, Craiova		X
"Central and Eastern Europe Climate Change Impact and Vulnerability Assessment" (CECILIA) - assessment of climate change impacts and vulnerability in Central and Eastern Europe with studies on air quality in urban areas, water management and water quality, hydrology, agriculture and forestry	Coordinated by the Charles University (CZ) with partners including the National Meteorological Administration and National Institute of Hydrology and Water Management, Bucharest The National Meteorological Administration was involved in a study on *"Climate Change Impacts on Agriculture and Forestry sectors"* which a review of the impact of climate change upon agriculture in south-east Romania	2006 - 2009	Project funded under EU 6th Framework Programme – more information from: http://www.cecilia-eu.org	X	
"Climate Change and Variability: Impact on Central and Eastern Europe" (CLAVIER) - the main objective of this project was to investigate the linkages between climate change and its impact on weather patterns, air pollution, extreme events and water resources in Central and Eastern Europe. Romania was one of three CEE countries studied in detail in the "Impact on the hydrological and agricultural regime" project	Coordinated by the Max Planck Institute for Meteorology (DE) with partners including National Institute of Hydrology and Water Management, Bucharest; Babes-Bolyai University, Cluj, and; Institute of Geography, Romanian Academy, Bucharest	2006 - 2009	Project funded under EU 6th Framework Programme – more information from: http://www.clavier-eu.org/?q=node	X	

Annex 2: *Summary of existing national / international initiatives of relevance to increasing resilience, encouraging adaptation and/or promoting a low carbon economy in the ARD sector in Romania*

Title	Organisation(s)	Year	Further Information	EN	RO
Planul sectorial ADER 2020 (Sectoral research and development plan funded by the Ministry of Agriculture and Rural Development)	Academy of Agricultural and Forestry Sciences Gheorghe Ionescu Sisesti (ASAS), Bucharest	2011-2014	Further information at: http://www.umpp.asas.ro/wcmqs/		X
"Drought Mitigation in Vulnerable Area of the Mures Basin" - MIDMURES	National Meteorological Administration, the Institute for Soil Science, Agricultural Chemistry and Environment (ICPA), the National Institute of Hydrology and Water Management and the National Institute for Aerospace Research	2011-2012	Further information at: http://midmures.meteoromania.ro/	X	
EU.WATER - Transnational integrated management of water resources in agriculture for European water emergency control	Co-ordinated by Province of Ferrara (IT) with partners in 8 European countries, including Institute for Soil Science, Agrochemistry and Environment Protection (ICPA), Bucharest	2009-2012	Further information at: http://www.eu-water.eu/index.shtml and http://www.eu-water.eu/images/regionalreports/Abstract_CountryReport_RO_romanian.pdf		X
"Ways to reduce impact of climate change on wheat production in South Romania"	National Agricultural Research & Development Institute – Fundulea	2007-2010	Further information at: http://incda-fundulea.ro/cercet/contr51073.html#73eng	X	
Research and extension of management agro-pedo-climatic risks by derivatives on climatic factors	Academy of Economic Sciences Bucharest	2008-2010	Further information at: http://derivate-factori-climatici.ase.ro/Prezentare.aspx		X
Development of new organo-minerals fertilizers and implement an integrated management for environmental protection, conservation and sustainable use of natural resources	University of Craiova	2009-2010	Further information at: http://www.icpa.ro/proiecte/Makis_135080.pdf		X
"Integration of anaerobic fermentation and methane capture in manure management in order to reduce pollution and achieve a valuable fertilizer"	University of Agricultural Sciences and Veterenary Medicine - Timisoara	2009	Further information at: http://www.biocombustibil-tm.ro/index.html	X	X
"Accelerating genetic progress for drought resistance in wheat, using molecular markers"	National Agricultural Research & Development Institute – Fundulea	2008-2009	Further information at: http://www.incda-fundulea.ro/cercet/pr29.html#eng	X	X
ADAGIO – Adaptation of agriculture in European regions at environmental risk under climate change	Co-ordinated by Institute of Meteorology - University of Natural Resources and Applied Life Sciences, Vienna (AT) with partners in 11 countries, including TIAMASG Foundation (RO)	2007-2009	Funded under EU 6th Framework Programme – more information from: http://www.adagio-eu.org/index.html and various documents provided by ICPA	X	

Title	Organisation(s)	Year	Further Information	EN	RO
New technologies, modern conventional high biomass recovery-obtain Bio gasoline, Biobenz	University of Agricultural Sciences and Veterenary Medicine – Cluj Napoca	2006-2008	Further information at: http://www.zecasin.ro/biobenz.html		X
Information system for agricultural management consulting under the Nitrates Directive on the protection of waters against pollution caused by nitrates from agricultural sources	Research Institute for Soil Science and Agrochemistry (ICPA), Bucharest	2006-2008	Further information at: http://www.icpa.ro/proiecte/sicomant/index.htm		X
Tools, guidelines and indicators for integrating environmental issues into agricultural policies, water management in rural areas: the top down approaches to involve local communities	National Institute of Research - Development Institute for Soil Science, Agrochemistry and Environment Protection - ICPA Bucharest	2005-2008	Further information at: http://www.icpa.ro/TOGI/index.html		X
PICCMAT – Policy Incentives for Climate Change Mitigation Agricultural Techniques An EU-wide project aiming to inform stakeholders and the general public on climate change and agriculture, on the potential actions to undertake, and to sensitize on the issues raised by this new challenge	Ten specialised organisations covering 10 European countries	2007-2008	Funded under the EU FP6 programme. Further information at: http://climatechangeintelligence.baastel.be/piccmat/	X	
"Building a new genetic basis of cereals for the future"	National Agricultural Research & Development Institute – Fundulea	2005-2007	Further information at: http://www.incda-fundulea.ro/cercet/ceex2.html#2eng	X	
ACCRETe - Agriculture and Climate Changes: how to Reduce human Effects and Threats Aimed to raise awareness of the mutual relationship between agriculture and climate change, together with the potentially negative consequences for food production. Elaborated a *Code of Action for Reducing the Impact of Climate Change in Agriculture* with recommendations for farm-level mitigation and adaptation	Co-ordinated by the Province of Parma (IT) with 10 partners in 6 countries, including National Meteorological Administration, Bucharest	2005-2007	Financed by INTERREG IIIB, further information at: http://accrete.inmh.ro/index.html	X	X