OSCAR

Guide to Integrating Climate Change Policy Needs into Rural Development Programmes

Version 5.1: 26 February 2013

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Acknowledgements

This manual has been developed on behalf of the Directorate-General for Climate Action (DG CLIMA) of the European Commission (EC) by an international consortium of researchers led by the Agriculture and Environment Research Unit at the University of Hertfordshire (UK) along with Wroclaw University of Environmental and Life Sciences (WUELS) in Poland and Solagro in France. The team are grateful to all those stakeholders who have taken the time to engage with the project, contribute their ideas, and comment on earlier drafts of this work. For further information on the manual development team, please see Appendix 1 at the rear of this volume.

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Forward

Anthropogenic climate change (i.e. that resulting from human activities) is probably the most serious environmental challenge facing us today. Human activities have been shown to make a significant contribution to increased concentrations of atmospheric greenhouse gases (GHGs), which in turn alter the way in which thermal radiation is absorbed by the planet and re-radiated, changing global temperatures and climatic patterns. As a consequence we are faced with two parallel imperatives in order to deal with what could be a very damaging situation.

1. **Climate change mitigation:** The emission of GHGs must be reduced and the sequestration of atmospheric carbon increased (removal from the atmosphere to soil and vegetative stores).
2. **Climate change adaptation:** We must make changes to the way we do things so as to ensure that the ecosystem services upon which we rely are sustained as conditions change.

Rural areas, businesses and communities have a key role to play in both these processes (with agriculture alone accounting for 9% of Europe's GHG emissions), and as such suitably designed Rural Development Programmes (RDPs) can be beneficial in maximising climate change benefits whilst continuing to achieve their other objectives.

With the current RDP period ending in 2013, and new regulations due to be in place for the beginning of 2014, there is a clear opportunity to develop more holistic programmes, which tackle a wide range of rural issues (including climate change). Consequently, the European Commission (DG CLIMA) engaged the University of Hertfordshire (UK), in collaboration with Solagro (France) and Wroclaw University of Life Sciences (Poland), to develop a formal system for integrating climate change policy objectives into Rural Development Programmes, through the OSCAR (Optimising Strategies for Climate change Action in Rural areas) project. The result is this manual and its associated decision support software, which adopt a Life Cycle Assessment (LCA) approach, coupled with an innovative Adaptive Capacity Impact Assessment, to evaluate RDP options in terms of their potential for climate change mitigation and adaptation, together with their practicality and impact on productivity.

How to use this manual

This manual is comprised of two core elements, and is intended to be a flexible tool; however, it is envisaged that in the main it will be used to fulfil the following two roles:

1. **Background material (Section 1):** This section provides an overview of the key issues surrounding climate change and the role to be played by Rural Development Programmes in addressing the situation. As such, it constitutes a brief reference source, which provides the foundation for the manual and places it in context. Rather than being used throughout the RDP formulation process, it is envisaged that this part of the document will either be read at the start of using the manual, or as an occasional reference source. Indeed, should the user feel sufficiently informed on some aspects, it is perfectly acceptable not to spend time on those sections of the manual.

2. **Guidance on using the OSCAR RDP evaluation system (Sections 2 and 3):** These sections provide background on the 'conceptual framework' for the OSCAR system (Section 2) together with a 'step-by-step guide' to using it (Section 3). This latter section links with the decision support software accompanying this manual. It is envisaged that these sections (particularly Section 3) will be used most intensively, since they provide instructions for using the OSCAR RDP evaluation system, together with a consideration of how the various elements relate to each other and how they contribute to the overall RDP development process.

1. Introduction

1.1. Climate Change

There is now ample evidence of a general warming of the earth's climate, with the Intergovernmental Panel on Climate Change (IPCC) pointing to an increase of around 0.74°C in mean surface temperature in a century[1], whilst the linear warming rate over the 50 years to 2005 was almost double that over 100 years[2]. It is clear then, that the planet is warming at an accelerating rate. The United Nations Climate Change Conference in Cancún (2010) recognised the importance of keeping the global increase in temperature to less than 2°C (above pre-industrial levels) to avoid what they described as “irreversible, possibly catastrophic” environmental damage (the so called 2C target[3]). Predictions however, suggest that without urgent action, a further temperature increase of between 1.8 and 4°C (and maybe more) is possible by the end of the century[4], which is likely to cause significant direct and indirect environmental changes[5], many of which could impact on human activities. For example, significant amendments have already been reported in global precipitation patterns[2], with northern Eurasia and eastern North and South America receiving increased rainfall, whilst regions such as The Mediterranean and southern Africa have become drier; and severe weather (e.g. heavy rainfall, severe drought, extreme temperatures, etc.) has become more prevalent in some areas[2]. Potentially this could have serious implications for global and local food production, as it threatens the productivity of some significant areas, placing greater onus on others (including northern Europe) to feed the planet's growing population.

Environmental changes of this sort inevitably impact on local ecological systems, but what is becoming increasingly clear is that both terrestrial and marine ecosystems are being affected by climate change on a much wider scale. For example, spring (i.e. egg laying, leaf growth, etc.) is occurring earlier, and the spatial ranges of plant and animal species are being amended. In some cases this may simply mean that (in the northern hemisphere) a given species can be found further north, whilst being lost from habitat on the southern margins of its range, but in some cases species ranges may be diminished as habit is squeezed. The planets human population is not immune to the impact of changing climate either, with a number of problems already being reported (other than those directly related to physical environmental changes – e.g. inundation due to sea level rise). Of particular relevance to this study are changes in land management practices relating to agriculture, horticulture and forestry, including the earlier planting of spring crops, increased pressure on water resources (e.g. for irrigation and human consumption), and changes in the weed, pest and disease pressures experienced by the crop production and livestock industries.

As well as the general implications described above, the latest IPCC report[6], details the predictions for change on a regional basis, and reveals a number of significant processes for Europe. For example, it is suggested that mean annual temperatures are likely to increase by more than the global average; although, this is a process (like many others) which is spatially variable, with winter temperatures rising most in the north and summer temperatures most in the south[3,6]. A split is also likely to be present in the impact pattern on annual precipitation, with the north (where extreme rainfall events and floods are also likely to become more common) getting wetter, the south drier, and central Europe wetter in the winter and drier in the summer (see Figure 1). Clearly, therefore these patterns will result in the impacts of climate change (e.g. on food production) being spatially variable.

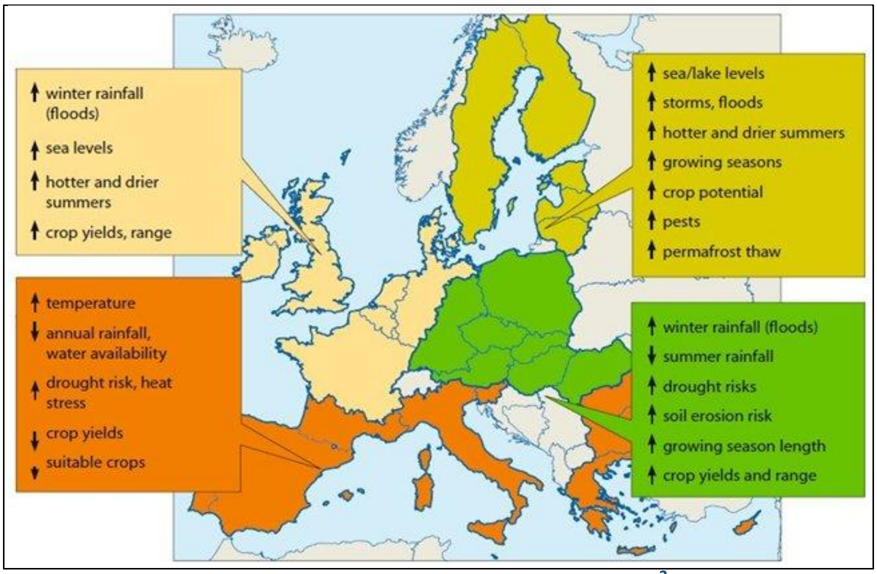


Figure 1: Climate change issues in the EU[3]

1.1.1 Rural greenhouse gas sources and sinks

Although there are natural processes which result in the release of atmospheric greenhouse gasses (GHGs - including carbon dioxide, methane, ozone and water vapour), it is now generally accepted that the scale of increase in average planetary temperature now being observed, can only be explained as being driven by anthropogenic emissions. The Kyoto Protocol identifies six such gases (or in some cases groups of gases), each of which has a different potential to cause 'global warming', known as its global warming potential (GWP). This is expressed on a standardised scale of 'equivalent tonnes of CO_2' (t CO_2e), normally over a 100 year period (GWP_{100}):

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydorflurocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Hexafluoride (XF_6)

The fluoride compounds are generally associated with industrial processes; and as a result, although they can be emitted within rural areas, the major gasses of concern within this environment are carbon dioxide, methane and nitrous oxide, the major rural sources and sinks relating to each of which are discussed in further detail below.

1.1.1.1 Carbon dioxide (CO_2)

Anthropogenic sources of atmospheric carbon dioxide (CO_2) may be low in comparison with natural sources (e.g. the natural decomposition of organic matter), but whereas natural sources tend to be balanced by natural sinks, anthropogenic activities lead to a change in the overall balance, resulting in a greater concentration of atmospheric CO_2. It is as a result of such processes, that the current (as of 2005) level of atmospheric CO_2 (379 ppm) is well above the natural range observed over the past 650,000 years (180 to 300 ppm[7]).

The main (75%[8]) source of anthropogenic CO_2, is the combustion of fossil fuels (e.g. coal, oil and gas), a process which occurs both directly and indirectly as a result of rural land management activities. Fossil fuels are used directly in the operation of a wide range of land management machinery, particularly (in this context) those used in conducting operations such as soil tillage and agro-chemical application[9,10,11,12,13,14]. Direct fossil fuel consumption is therefore, largely dependent upon the type and number of land management operations that take place, which are of course themselves, crop, site and production system dependent; and as a result different products (crop or livestock based) from different locations will have different CO_2 emission rates associated with the fuel consumed in producing them. Further up the supply chain, fossil fuels are used extensively in the manufacture of agro-chemicals (e.g. pesticides and fertilisers) and farm machinery, as well as in the transportation of such products. Indeed, indirect uses of this sort can often be the most significant source of pre-farm gate GHG emissions associated with food produce[9,10]. Beyond the farm gate, fuel is again consumed during the processing, storage (e.g. refrigeration) and transportation of products, all of which contributes to their overall GHG emission profiles.

The other main sources (globally) of atmospheric CO_2 relate to perturbations in the natural cycling of carbon between atmospheric and terrestrial media, and the sinks associated with them. This generally occurs as a result of changes in land use, principally deforestation, although this is usually associated with tropical regions, not least because in the EU the forested area has increased[15]. Nevertheless, where such processes do occur, the organic matter stored within vegetative matter is released (either by combustion or decomposition), and soil carbon (within forest soils) is oxidised to form CO_2. Similarly, the conversion of grassland into arable land results in the oxidation of considerable amounts of soil carbon, and wetland drainage exposes vast stores of organic matter to atmospheric oxygen, instigating rapid decomposition and CO_2 release.

These latter sources highlight the major carbon stores which can be managed within rural environments to mitigate emissions, namely soil carbon and vegetative carbon. Clearly, if anthropogenic activities can reduce the size of these two sinks, then anthropogenic activities in the form of appropriate land management, can reverse that process, albeit that the rates of carbon sequestration are generally lower than the rates of carbon release which result from the land management practices discussed above. The conversion of intensive farmland to either less intensively managed land or forest, and the recreation of wetland environments, all have the potential to increase the global store of soil and/or vegetative carbon. This is done by increasing the extent to which vegetative photosynthesis removes CO_2 from the atmosphere, and locks it up in vegetation or soil. It is precisely such activities which are targeted by some of the measures within the EU's Rural Development Programme[16].

1.1.1.2 Methane (CH_4)

Methane (CH_4) is a potent GHG with a GWP_{100} of 25, and the current atmospheric concentration (1,774 ppb – 2005) is far above the natural range recorded over the past 650,000 years (320 to 790 ppb[17]). Around 30% of atmospheric CH_4 is released from sources such as fossil fuel mining and burning, the bulk however (70%) is released as a result of biogenic processes[8]. Most notably, methanogenic microorganisms within anaerobic environments release CH_4 during the process of fermentation. The most significant natural environment in which this occurs is wetland soils, where the high water-table means that methanogenesis occurs close to the soil surface, allowing methane to escape to the atmosphere in gaseous form. As a result, wetlands can act as both a source of CH_4 and a sink for CO_2, meaning that a complex balance may exist between the two properties.

Of the other major sources of relevance to European rural environments, many have been significantly impacted by human activities, despite being biogenic processes, through (in particular) the expansion of livestock farming and wet rice cultivation (i.e. artificial wetland creation). Although rice is grown within the EU, and as a result such agricultural systems could be a significant source of CH_4 in some local areas, the overall area given over to this crop is limited. Consequently, there can be little doubt that the main rural anthropogenic sources of CH_4 are those associated with livestock farming[18]. Ruminant livestock emit methane as part of their normal digestive processes, since enteric fermentation of such animals produces CH_4 as a consequence of microbial fermentation; however, the amount of CH_4 produced in this way is dependent on the type and number of animals, and their diet. In addition, livestock manures and slurries contribute to emissions of CH_4 during storage, with the method of storage, temperature and manure type, all having a significant impact on the volume of gas emitted[8,19]. In contrast, losses of CH_4 from other (non-rice) arable systems and woodland, are generally considered negligible[20,21,22,23,24].

Methane is removed from the atmosphere in a number of ways, albeit that most (being atmospheric processes) are beyond anthropogenic control; the most prominent of these being the reaction of CH_4 with hydroxyl radicals. However, as is the case for CO_2, the above sources allude to a significant sink which is within the scope of rural management, namely the soil. The methanotrophic bacteria that reduce emissions from soils with low water-tables, are also available to reduce atmospheric CH_4, so although wetland soils act as a CH_4 source, others may act as a sink, particularly woodland soils, where there is often an optimal moisture level for communities of methanotrophic bacteria to thrive.

1.1.1.3 Nitrous oxide (N_2O)

Nitrous oxide (N_2O) is a powerful GHG (with a GWP_{100} of 298), which is emitted from soils as a result of two main processes, namely microbial nitrification and denitrification[25]. Both are difficult to predict and subject to considerable site-specific variation, as ultimately[9,26] N_2O release is controlled by land management practices (e.g. nitrogen fertiliser regime), local site conditions (e.g. soil type and the amount of rainfall), the presence of plant biomass (such as crop residues and clover), and whether or not irrigation takes place (which can alter the balance between denitrification and nitrification by affecting the amount of water filled pore space in the soil). N_2O is also released from manures deposited during grazing, and where manures and slurries are stored; the former being dependent on the type of stock and the time the animals remain outside, whilst the latter is dependent on the length and method of storage, the N content of the diet and the efficiency with which it is utilised[11,24,27,28]. The principle means by which N_2O is removed from the atmosphere is through its stratospheric destruction[29].

1.1.2 Mitigation 'v' adaptation

Much current climate change policy (see Section 1.2 below) is aimed, not unreasonably, at reducing the extent to which climate change occurs and therefore, the scale of the impact that we may have to face (mitigation). As such, headline targets have been set for reductions in greenhouse gas emissions, and legislation implemented to back them up. The activities required in order achieve this generally come at a cost (real costs or income foregone), although some may provide financial as well as GHG emission benefits. As a result, estimates suggest that by 2050 the cost to the global economy of stabilising levels of atmospheric greenhouse gases at around 500-550ppm CO_2e may be around 1% of annual gross domestic product[30], although estimates do vary. This is clearly a considerable amount, but not excessive (it is for example considerably less than annual military spending[31]); and it pales into insignificance when compared to the expected cost of inactivity (i.e. the damage caused by climate change if mitigation does not occur). The Stern Report for example[30], estimates the cost of inactivity to be at least 5% of global GDP per annum, and when a wider range of risks and impacts are included in the estimate, it could be 20% or higher.

Clearly then, problem prevention has a great deal to recommend it; but it is now inevitable that some degree of climate change will occur (even if only due to gasses already emitted) even if significant steps are taken to mitigate against it. As a result, climate change adaptation will also be needed in order to protect communities and the economy from climate change impacts. Globally, this could cost something like $49 to $171 billion per annum[32], but will be essential if the vital ecosystem services upon which we depend (e.g. food and water supply) are to be maintained. A holistic approach to climate change policy therefore must, out of necessity, integrate include both mitigation and adaptation activities, since the former has the potential to minimise, although not eliminate, the need for the latter.

1.2 Climate change policy

Perhaps unsurprisingly, given the potential for deleterious impacts (see Section 1.1 above), increasing atmospheric concentrations of greenhouse gases are a serious cause for concern around the world, such that climate change has come in for considerable political and legislative attention since the United Nation's (UN's) World Meteorological Organization (WMO) organised the First World Climate Conference in 1979. At a global level, the UN (WMO and UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988, leading in 1992 to the UN Framework Convention on Climate Change (UNFCCC) being agreed at the Earth Summit in Rio de Janeiro. Although, this in itself set no GHG emission limits, it established the basis for later 'updates' in which such limits were set; most notably the Kyoto Protocol of 1997 (in force from 2005).

The EU has been playing a leading role in both attempting to bring other major nations (e.g. the USA and China) on-board in terms of climate change mitigation, and by setting ambitious targets for the performance of its own Member States. The Kyoto Protocol's goal of reducing GHG emissions (for 37 developed nations) by 5.2% below 1990 levels, resulted in a target for the first 15 EU nations of reducing emissions by 8%. However, in order to try and keep the global temperature increase below the 2°C limit discussed above (see Section 1.1), the EU has set a significantly more stringent target for its members, of reducing GHG emissions by 20% (below 1990 levels) by 2020 (a target that could be raised to 30% if other nations 'do their fair share'), and has the long term goal of reducing emissions by 80-95% by 2050. If such targets are to be met, then policy initiatives across the board must play their part.

Central to the EU's drive for GHG emission reductions is the European Climate Change Programme (ECCP), the first of which was initiated by the European Commission in 2000 (covering the period to 2004) to examine and implement the policies required for the EU to meet its Kyoto Protocol obligations, through a process of stakeholder consultation[33]. As such therefore, it was less of a policy in its own right, but rather a vehicle for guiding a broad range of policies in a holistic manner. In 2005 this was followed by the Second European Climate Change Programme (ECCP II), which was set up to explore further options, work now being led by the Directorate-General for Climate Action (DG CLIMA - established in early 2010). Significantly (for this proposal) ECCP II stresses the importance of integrating efforts with the EU's Rural Development Programme, to enable agriculture and forestry (in particular) to contribute to meeting overall climate change objectives[33]. Therefore, although the bulk of EU and Member State climate change policy concentrates on major GHG emission sources, such as transport and direct energy use, or in terms of agriculture, those emissions most closely related to Pillar 1 of the CAP (e.g. methane emissions from ruminant livestock), it is clear that Pillar 2 activities (Section 1.3) are also expected to play a role in meeting our climate change commitments.

1.3 The role of European (EU) Rural Development Programmes

Although plans for the post-2013 period are still (at the time of writing) at the proposal stage, it seems likely that many of the elements which have been fundamental to rural development policy in recent years, will remain central in the coming period. In particular the two pillar system of the CAP (see Figure 2) is expected to stay, and indeed the split in funding between the two is also likely to remain similar.

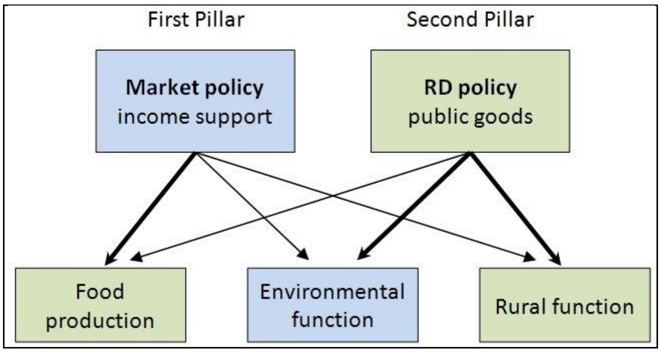


Figure 2: Complementary nature of the two pillars of the CAP[34]

What is certain to become much more of driving force behind RDP formulation however, is the need to ensure complementarity, consistency and conformity both within programmes and with other policies and strategies, thus ensuring the maximum possible benefit from limited resources. Indeed, this has been made an explicit requirement in many recent EU policy documents. The principles established in Europe 2020[36] for example, are intended to guide a wide range of funding streams (including those under the European Agricultural Fund for Rural Development - EAFRD, European

Regional Development Fund - ERDF, European Social Fund - ESF, and others) such that a Common Strategic Framework (CSF)[35] establishes thematic objectives which should be addressed by each one, and reflected by Member States in their respective Partnership Contracts or Agreements (the mechanism proposed by Member States for delivering a series of integrated funding programmes - see Figure 3).

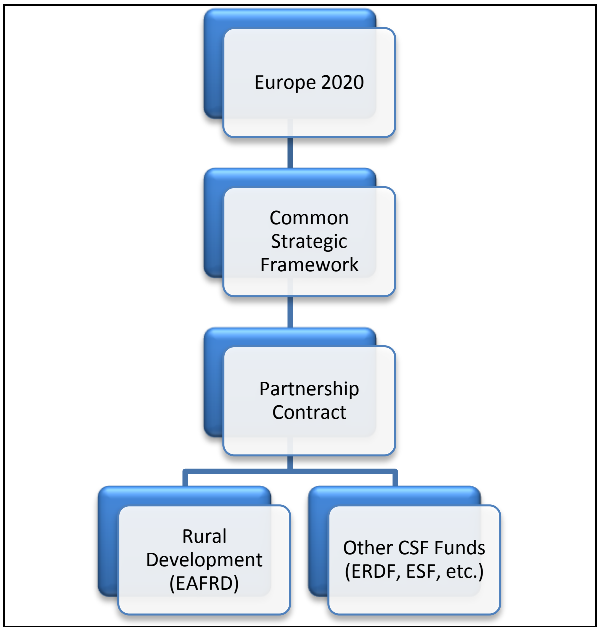


Figure 3: Rural development in the post-2013 framework

The importance of measures to address climate change concerns is also likely to be stressed to a much greater extent than has previously been the case. This is in no small part as a result of the need for the CAP to reflect those parts of the Europe 2020[36] strategy with particular climate change relevance, including the need to ensure that the 20/20/20 targets[37] are achieved. As a strategy which is intended to inform every aspect of European policy, it s no surprise that when the CAP's take on it ('The CAP Towards 2020'[38]) came out, the importance of climate change fed through into this as well. 'The CAP Towards 2020' is considerably more overt in its references to climate change than has previously been the case, with both mitigation and adaptation being specifically mentioned. Clearly then, the integration of all facets of climate change policy and best practice into Rural Development Programmes, is going to be of fundamental importance in the 2014-2020 period, and will need to be taken into account when selecting future measures and operations. The OSCAR manual and software have a valuable role to play in this, by providing support at various stages of the RDP development process (see Section 2.3).

2 Conceptual Framework

2.1 Integrating policy demands

Although initially focused on structural problems within the farming industry, the EU's rural development policy has since evolved (due to changing needs) into a wide ranging programme which seeks to address multiple objectives within both agriculture/forestry and wider rural communities. It covers such diverse concerns as the environment, competitiveness within the agricultural and forestry industries, the wider rural economy and the quality of life for rural communities, with the full range of issues that these encompass. As such, Managing Authorities are faced with the need to select a suite of measures which will balance the competing demands for resources in as holistic a manner as possible, whilst addressing the bespoke, region specific needs of their areas of influence. In addition however, there is increasing pressure for all policy instruments to consider, and where appropriate address, a number of cross-cutting imperatives so as to result in holistic overall strategies which avoid detrimental contradictory drivers and complement each other to increase the likelihood of successful outcomes.

Within the context of this manual, the key cross-cutting policy goals of influence are those associated with climate change, namely the need to mitigate emissions of greenhouse gasses (i.e. reduce climate change) and to increase the scope for adaptability within rural systems (i.e. increase their ability to cope with those changes which do occur). Additionally however, the inevitable interactions which occur between eco-system services (see Section 2.2) mean that great care is needed to ensure that actions taken to address one issue (e.g. climate change) do not result in unintended (and undesirable) impacts in other regards through pollution or impact swapping.

Pollution swapping:

A side-effect of some environmental policies or measures which results in either a decline in the emission of one pollutant at the expense of an increase in another, or the reduction of pollution in one part of a system only to increase it elsewhere. For example, the use of constructed wetlands for sediment removal, phosphorus retention and/or nitrogen removal may inadvertently result in increased emissions of atmospheric nitrous oxide, methane and carbon dioxide[39], all of which are greenhouse gasses.

This manual, checklist and associated software are intended to support the formulation of Rural Development Programmes in the post-2013 period, by guiding users through the process of ensuring that such programmes support the Commission's stated climate change objectives (see Section 1.2) whilst minimising other detrimental environmental impacts, thereby allowing multiple drivers to be considered alongside each other (see Figure 4).

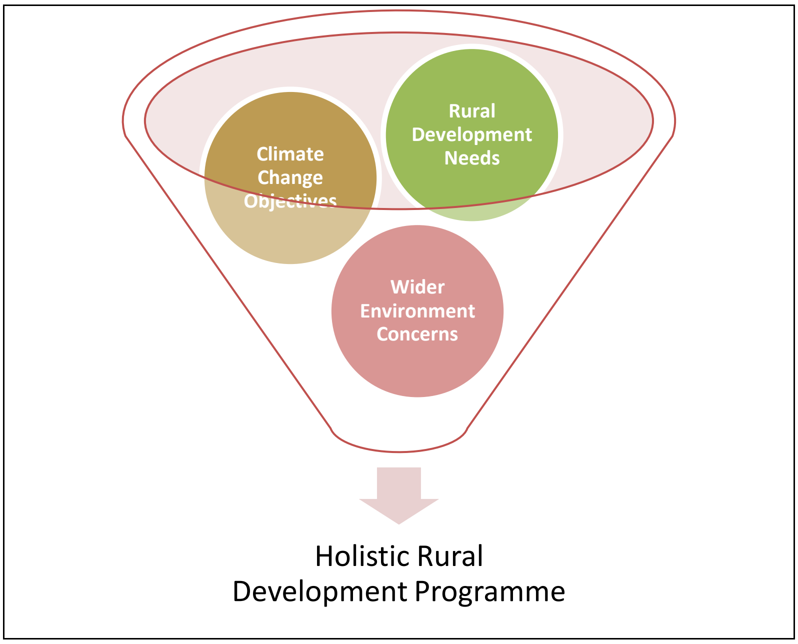


Figure 4: Integrating policy demands

2.2 OSCAR, climate change and ecosystem services

As human beings we derive a number of benefits (goods and services), both tangible and intangible, from the ecosystems around us, often referred to as 'ecosystem services'. Indeed we are reliant on the continuing provision of those services, and therefore the functioning of those ecosystems, for our very survival. Numerous different ecosystem service classifications are available in the published literature[40,41] each of which has been designed for a specific purpose and/or audience, although one of the most familiar around the world is that developed for the Millennium Ecosystem Assessment[40] (see Table 1). This divides services into 'provisioning', 'regulating', 'cultural' and 'support'; and many of the categories appearing in this system are found repeated in the work of other authors.

Climate change, together with a number of other anthropogenic forces, has the potential to threaten the ability of ecosystems to continue to deliver the goods and services we need, as a result of their being stressed beyond the point at which they can adapt to the situation (their adaptive capacity). For example, food production systems may be threatened by reduced rainfall and higher temperatures, placing many crops under increased stress and reducing yields. Equally, other ecosystems may provide an opportunity to mitigate climate change impacts, as a result of the role they play in carbon cycling (by increasing sequestration), and as a result may become increasingly important if the EU is to meet its climate change commitments.

As well as their impact on net greenhouse gas emissions (mitigation), the OSCAR RDP evaluation system is based upon an evaluation of the impact of both climate change and the Measures (and Operations) selected by Managing Authorities for inclusion in their programmes on adaptive capacity, in relation to a range of key ecosystem services. It utilises a bespoke set of ecosystem services developed specifically for this project (albeit based on those found in the published literature), which are in turn used to identify a series of Regional Variation Categories (RVCs – see

Table 2), which describe a region's potential vulnerability to the impacts of climate change, in that they combine desired ecosystem services with climate change predictions.

Table 1: Example ecosystem services

Provisioning Services *Products obtained from ecosystems*	**Regulating Services** *Benefits obtained from regulation of ecosystem processes*	**Cultural Services** *Non-material benefits obtained from ecosystems*
• Food • Fresh water • Fuel wood • Fibre • Biochemicals • Genetic resources	• Climate regulation • Disease regulation • Water regulation • Water purification • Pollination	• Spiritual and religious • Recreation & eco-tourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage
Support Services *Services necessary for the production of all other ecosystem services*		
• Soil formation • Nutrient cycling • Primary production		

Taken from the Millennium Ecosystem Assessment[40].

Table 2: Example OSCAR Regional Variation Categories and their associated ecosystem services

OSCAR Regional Variation Category	Example related ecosystem services
Soil erosion	Provision of useable soil resources (food production)
Loss of soil organic carbon	
Risk to pollinators	Ability to pollinate crops (food production)
Water provision	Provision of environmental and human resource water supplies
Water quality dilution	
Water quality filtration	
Flooding	Prevention of flooding
Risk of forest fires	Prevention of fires
Risk to biodiversity in Nature 2000 sites	Provision of biodiversity, cultural, educational resources
Landscape impact from soil erosion and forest fires	Provision of cultural, landscape and recreational resources

2.3 The OSCAR RDP formulation process

The OSCAR Manual is intended to support and feed into Rural Development Programme formulation processes as established to meet the requirements of relevant EU legislation, and aid in ensuring that climate change objectives are both taken into account in these processes and not negatively affected by selected programmes. Nevertheless, it is recognised throughout this manual, that to a considerable degree, all Rural Development Programmes will reflect the broad rural development priorities set both nationally and by the EU; and therefore, although it is possible to provide guidance in relation to the narrower issues associated with climate change, this will need to be evaluated in light of those broader priorities.

The importance of climate change is increasingly being recognised (Section 1.3), as is the need for complementarity, consistency and conformity both within programmes and with other policies and strategies. Therefore, providing a sound basis on which to do this, in terms of being able to make scientifically supported decisions as to the best way to meet rural development objectives whilst contributing to climate change mitigation and adaptation without resulting in other threats to ecosystem services, is central to the OSCAR system. The OSCAR 'Guide to Integrating Climate Change Policy Needs into Rural Development Programmes' has been developed to provide a logical step-by-step process (see Figure 5) in a series of six stages which build on each other to provide a holistic understanding of the important issues within a given country or region and the rural development measures which may best address them, as well as their potential impact and cost-effectiveness.

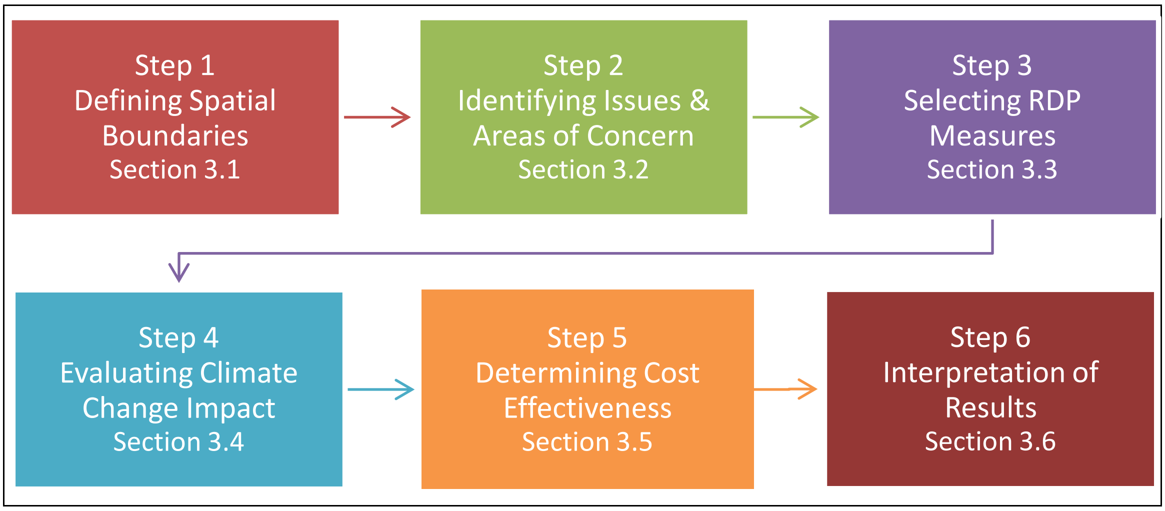


Figure 5: Structure of the OSCAR RDP formulation process

Step 1: **Defining spatial boundaries:** The process of defining the spatial boundaries of the Rural Development Programme under formulation, so as to provide a sound foundation for all subsequent steps.

Step 2: **Identifying issues & areas of concern:** Regional Variation Categories (RVCs) are used to identify sensitive ecosystem services (relating to both climate change mitigation and adaptation) within the area of concern, highlighting those liable to be most at risk.

Step 3: **Selecting RDP measures:** Identifying measures for potential inclusion within post-2013 Rural Development Programmes.

Step 4: **Evaluating climate change impact:** Determining the climate change impact of the selected measures in terms of mitigation (emission reduction and sequestration) and adaptation capacity.

Step 5: **Determining cost effectiveness:** Examining the cost effectiveness of the measures selected based on Marginal Abatement Cost (MAC_{GHG} – for mitigation) and Marginal Adaptation Cost (MAC_{ADAPT} – for adaptation) curves.

Step 6: **Interpretation of results:** Using the results from the above steps to formulate RDPs which take the requirements of climate change policy into account.

2.4 OSCAR & European rural development policy

As discussed above (Section 1.3), the structure of European policy underlying rural development is changing, to ensure greater complementarity between the various Structural and Cohesion Funds (EFS, ERDF, EAFRD and EMFF), and the OSCAR system has a role to play at a number of the stages which result in policy being translated from high level policy documents such as Europe 2020[36] down to national and/or regional Rural Development Programmes (Figure 6).

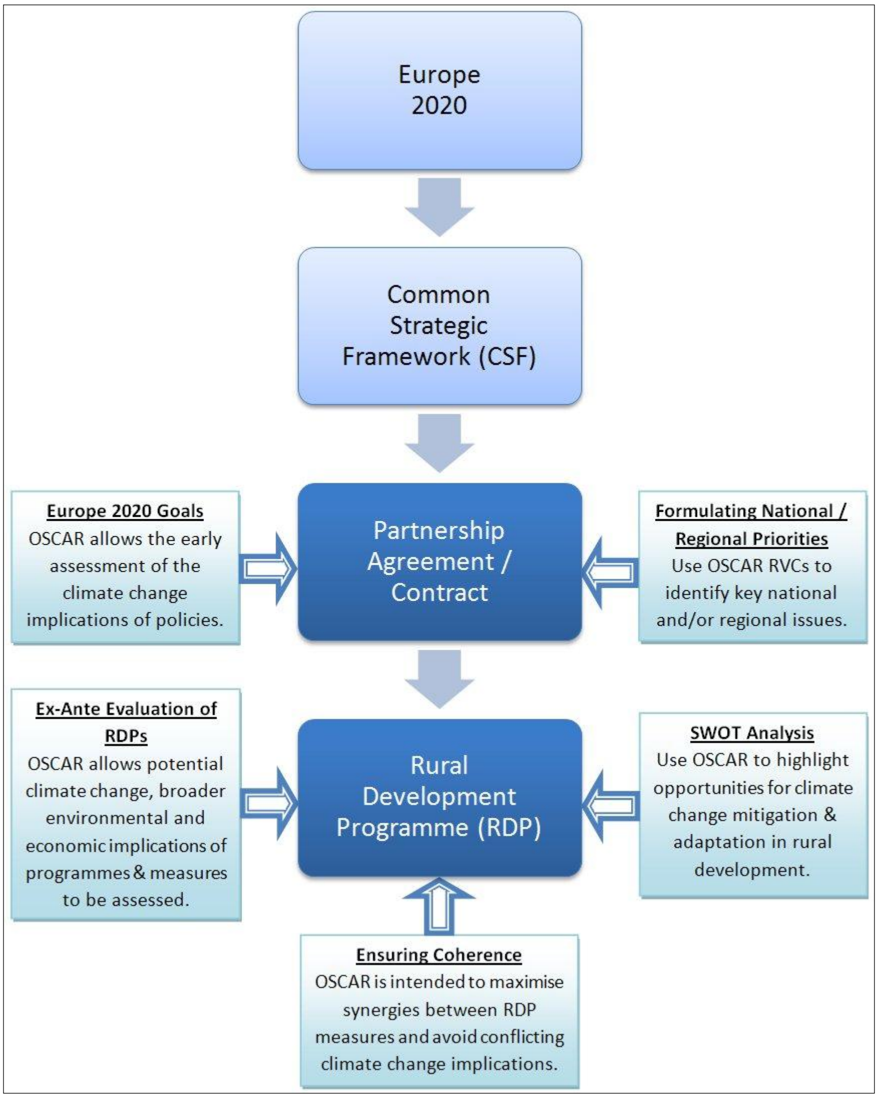


Figure 6: OSCAR & European rural development policy

In particular, the RVCs represented in the OSCAR software allow key environmental and ecosystem issues of concern to be identified at the national and/or regional scale; thereby permitting them to be considered when setting priorities for inclusion in Partnership Agreements/Contracts (see Section 3.2). In addition, it permits the knock on effects of high level decisions to be considered (in as far as rural development options are concerned), ensuring that the requirements of Europe 2020[36], for example, which stresses the need to ensure that the needs of climate change mitigation and adaptation are taken into account in the development of all policies, are met.

Subsequently, Managing Authorities can take advantage of the OSCAR utilities in a number of ways. Firstly, in terms of the completion of SWOT (strengths, weaknesses, opportunities and threats) analyses, OSCAR highlights particular areas (in terms of RVCs) where there are not only threats in terms of climate change emissions and/or the ability of systems to adapt, but also significant opportunities in terms of resolving those issues, and making a contribution to national and EU climate change commitments. Secondly, it permits ex-ante evaluations of the potential implication of rural development packages for climate change together with broader environmental and economic objectives. And thirdly, OSCAR aids in ensuring coherence between policies by highlighting areas in which options introduced for rural development reasons may also result in climate change benefits or disbenefits.

3 The OSCAR RDP evaluation mechanism

The text below is a brief description of the activities to be undertaken at each stage of the OSCAR RDP evaluation process, and how these can be supported using the associated decision support software; however, not all users will need to go through all six steps. More detailed instructions for using the software (including video guides) can be found embedded within that system.

3.1 Step 1: Defining spatial boundaries

Article 7 of Council Regulation (EC) No 1698/2005[42] gives Member States the freedom to implement Rural Development Programmes at an "appropriate territorial level", and it is envisaged that this will continue in the post-2013 period (as indicated in Article 7 of COM(2011) 627 final/2[43]). As such, what might constitute the 'appropriate level', and therefore the spatial scale on which Managing Authorities will be operating, will vary considerably both between and within Member States, with in some cases Programmes being developed at the national level whilst in others it may instead be done sub-nationally. The first step therefore, in establishing a basis on which to evaluate RDP options, is to define the spatial boundaries of the area in which they are to be applied. In doing so, it becomes possible to ensure that selected Measures/Operations make a valuable contribution to achieving the area specific goals established at a policy level. If the OSCAR software accompanying this manual is to be used to achieve this then the following guidance may be used, if not go to Section 3.2 once this step has been completed.

3.1.1 Defining spatial boundaries in the OSCAR software

The OSCAR decision support tool establishes geographical boundaries by reflecting the way Member States implement Rural Development Programmes at present (which isn't expected to change). As such, Managing Authorities should define their area of interest by selecting individual NUTS regions (levels 0 to 3 – see Appendix 2) or combinations thereof, as the basis for all subsequent evaluations. Having opened a new or existing OSCAR file, this is done within the 'Regional Profile' element of the software, through the 'Explore and select regions' () or 'Edit regional profile' () options. In order to simplify subsequent data display and evaluation processes, it is recommended that the highest possible NUTS level (not including areas beyond the scope of the RDP) should be selected wherever possible, as opposed to combining smaller areas.

> **Tip:**
>
> ***Selecting national RDPs:*** double-click on the relevant country in the NUTS0 areas list.
>
> ***Selecting sub-national RDPs:*** double click on those NUTS1 areas fully within the area covered by the RDP, followed by any additional NUTS2 and NUTS3 areas needed to complete the required area.

> **Tip:**
> Select and deselect areas by clicking on them and then the  icon or  icon respectively.

3.2 Step 2: Identifying issues & areas of concern

Given the variation in natural/manmade characteristics and baseline conditions found across Europe, it is inevitable that the effects of climate change in terms of both mitigation (GHG emission reduction and increased carbon sequestration) and adaptation, will also vary. For example, it is recognised that factors including soil type, temperature, moisture content, pH, and content of available carbon and nitrogen can all influence the emission of greenhouse gasses from soils[44,45,46]. Equally, the scope for a system to adapt to climate change is a function of many interacting properties, including physical, economic and social factors, all of which vary spatially. For example, the availability of potable water supplies for human consumption is a function not only of natural factors such as rainfall, infiltration rates, groundwater availability and so on, but also of local population densities, and the economic wealth of individuals and/or nations which may make them more or less able to adapt. As a direct consequence of this variability, in evaluating what benefit rural development measures may be (or conversely what harm they may be doing), it is essential to do so on the basis of an informed understanding of the systems (ecosystem services) likely to be at most risk within a given region; and in developing this understanding, there are two parallel strands which must be addressed; namely:

- **Identifying issues of concern:** allowing particular attention to be given to those issues in rural development programme formulation (i.e. Measure/Operation selection).

- **Identifying areas of concern ('hotspots'):** identifying specific geographical regions in which specific RVCs are a concern, allowing for the possibility of spatially differentiated programmes.

Clearly, there are a number of ways this could be done, and indeed in which it may have been done in the formulation of previous Rural Development Programmes, including using GIS (geographical information system) based systems to map characteristics liable to increase risk, or utilising the expert knowledge of people familiar with region. However, regardless of the method used, what is key is to be able to identify those issues and areas most in need of focus within the programme being developed.

3.2.1 Identifying issues & areas of concern in the OSCAR software

Within the OSCAR decision support tool, issues and areas of concern are identified on the basis of a series of Regional Variation Categories (RVCs - see examples in Table 2) each of which is derived from a combination of spatially variable factors.

- **Mitigation RVCs:** Describe the risk of an increase in greenhouse gas emissions based on the combination of one or more spatial properties (e.g. soil type, mean annual rainfall, land use, etc.) to highlight areas where there is the potential for high GHG emissions.

- **Adaptation RVCs:** Describe the sensitivity of a given ecosystem service (see Section 1.4) to the potential impacts of climate change. Unlike mitigation RVCs, these are based on an indicator framework, since adaptive capacity, rather than being a 'fixed' quantifiable property, is an emergent property of a system.

There are a number of ways in which RVC data for the area of interest can be obtained within the software, so as to inform subsequent thinking, and these are described in the following sections.

Tip:

It is worth remembering that different Mitigation RVCs are broken down into different numbers of categories as a result of variations in both the level of differentiation available in the source data and the number of layers combined in order to determine the appropriate RVC.

3.2.1.1 Browsing RVC data in Google Earth

Colour coded maps of many of the RVCs included within the OSCAR system (together with an overview map) are available in Google Earth format from within the decision support software accompanying this manual. These maps cover the whole of the EU at NUTS3 level, and clicking on any area of the map will bring up a box detailing the percentage of land falling into each category (low, moderate or high – based on three equally sized bands covering the range from the lowest to the highest) and the average RVC category for that area.

Tip:

Google Earth can be downloaded free from the Google Earth website (www.google.com/earth).

In addition, although internet access will initially be required in order to view maps, this will no longer be needed if they have been saved to the user's computer.

Access to the maps can be obtained by clicking on 'Explore and select regions' ( ) under the 'Regional Profile' banner, and then the 'Google Earth' icon ( ) at the top of the page. Maps can then be selected from the list, and will be displayed in Google Earth if it has been installed on the user's computer.

Please note: These are large files and may take some time to display.

3.2.1.2 Obtaining reports on specific NUTS regions

The OSCAR decision support software allows users to obtain detailed reports on the RVC characteristics of any NUTS area in the EU (or entire RDP region if comprised of a single NUTS region – reports cannot currently be generated for combinations of NUTS regions). These reports summarise the proportion of land falling into each RVC band, and use colour coded graphs and tables to provide a clear indication of those RVCs which are particularly worthy of consideration when formulating, evaluating or amending a Rural Development Programme (Figure 7). Click on 'Explore and select regions' ( ) under the 'Regional Profile' banner, then by clicking on any region in the tables and then the 'Region info' icon ( ) above that table, a report is generated.

CO_2 Fossil Fuel (CFF)

Carbon dioxide from field operations

Average class:	2
Range:	0 - 4
Distribution:	
0	20%
1	30%
2	37%
3	4%
4	8%

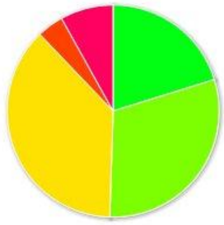


Figure 7: Example area-based RVC report

3.2.1.3 'Hotspot' identification

For the selected RDP region (consisting of one or more NUTS areas) a hotspot report may be generated by clicking on any of the 'Hotspot report' icons (◉). This identifies, for a range of RVCs (through the tabs at the top of the page):

- **Regional hotspots:** The percentage of each of the component NUTS3 areas which falls into the high risk band.
- **Average values for regions:** The average risk class for each of the component NUTS3 areas.

As such, these tables highlight those regions within the selected RDP region for which there may be specific problems worthy of consideration (e.g. Figure 8). Subsequently clicking on any of the NUTS3 area names brings up the appropriate area-based RVC report as described above (Section 3.2.1.2).

NUTS3	CFF	CST	DEN	DLA	FFR	FLO	LAN	LER	N2K	POL	SER	SOS	FLA	WPS	SCS
Hartlepool and Stockton-on-Tees	4	0	0	0	0	0	0	0	0	0	0	0	0	0	78
South Teesside	1	0	0	0	0	0	0	12	0	0	0	0	0	0	81
Darlington	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99
Durham CC	0	8	6	0	0	0	0	31	0	0	0	0	0	0	48
Northumberland	0	7	5	0	0	0	0	30	0	0	0	0	0	0	38
Tyneside	0	0	0	0	0	0	0	2	0	0	0	0	0	0	30
Sunderland	0	0	0	0	0	0	0	6	0	0	0	0	0	0	62
West Cumbria	0	1	1	0	0	0	0	59	0	0	0	0	0	0	49
East Cumbria	0	9	6	0	0	0	0	53	0	0	0	0	0	0	59
Halton and Warrington	0	8	4	0	0	0	0	38	0	0	0	0	0	0	47
Cheshire CC	0	2	1	0	0	0	0	51	0	0	0	0	0	0	64
Greater Manchester South	0	3	2	0	0	0	0	22	0	0	0	0	0	0	16
Greater Manchester North	0	5	3	0	0	0	0	43	0	0	0	0	0	0	35
Blackburn with Darwen	0	8	7	0	0	0	0	46	0	0	0	0	0	0	50
Blackpool	0	0	2	0	0	0	0	24	0	0	0	0	0	0	39
Lancashire CC	0	8	6	0	0	0	0	54	0	0	0	0	0	0	47
East Merseyside	0	1	1	0	0	0	0	42	0	0	0	0	0	0	42
Liverpool	0	0	0	0	0	0	0	5	0	0	0	0	0	0	7
Sefton	0	12	11	0	0	0	0	29	0	0	0	0	0	0	0
Wirral	0	0	0	0	0	0	0	25	0	0	0	0	0	0	63
Kingston upon Hull, City of	0	12	9	0	0	0	0	0	0	0	0	0	0	0	4
East Riding of Yorkshire	8	4	2	0	0	0	0	2	0	0	0	0	0	0	21
North and North East Lincolnshire	7	7	0	0	0	0	0	0	0	0	0	0	0	0	28
York	24	0	0	0	0	0	0	0	0	0	0	0	0	0	9
North Yorkshire CC	5	3	2	0	0	0	0	34	0	0	0	0	0	0	52
Barnsley, Doncaster and Rotherham	10	3	1	0	0	0	0	13	0	0	0	0	0	0	4
Sheffield	0	9	8	0	0	0	0	34	0	0	0	0	0	0	25
Bradford	0	4	3	0	0	0	0	47	0	0	0	0	0	0	25

Figure 8: Example 'hotspot' identification table

Similar reports may be generated from the area-based RVC reports (Section 3.2.1.2), and are obtained by using the links in the top left of the report pages to access summary tables for (for example) all NUTS1 regions in a given country (see Figure 8). Clicking on those regions for which high scores (reds) are present, allows a subsequent focusing-in on areas of specific concern, in order to determine in which areas specific ecosystem services are threatened. Clicking on 'Details' against any region provides the detailed region breakdown as discussed above.

Country	CFF	CST	DEN	DLA	FFR	FLO	LAN	LER	N2K	POL	SOC	SOE	SER	SOS	FLA	WPS	SCS
+le de France [Details]	2	2	5	12	9	2	0	6	4	8	2	2	1	19	19	12	1
Bassin Parisien [Details]	2	2	6	10	10	2	0	9	6	14	2	2	1	21	15	11	2
Nord - Pas-de-Calais [Details]	2	2	7	14	2	1	1	8	1	7	2	3	2	19	10	12	1
Est [Details]	2	2	8	7	18	2	1	9	6	11	2	3	1	25	5	10	2
Ouest [Details]	2	2	7	8	5	2	0	10	4	10	2	2	2	21	20	11	2
Sud-Ouest [Details]	2	2	6	7	22	2	1	12	4	21	2	3	1	25	4	10	1
Centre-Est [Details]	2	2	6	5	23	2	2	12	7	15	2	3	1	29	2	9	1
MÚditerranÚe [Details]	2	2	5	4	35	1	2	11	14	37	2	3	1	27	1	12	1

Figure 9: Example 'hotspot' browsing.

Tip:

In the first instance reports are generated for the NUTS area level one up from the area-based report being viewed. Browsing however, allows movement between levels.

3.3 Step 3: Selecting RDP measures

In order to obtain a base-line state from which to determine the impact on climate change, it is necessary to compile a preliminary list of Operations which may be suitable for RDP inclusion. Many Managing Authorities will be starting from a position of having had a pre-existing Rural Development Programme consisting of a range of Measures (and therefore Operations) selected from those permitted under the relevant EU legislation[16,42], and will be in a position to use this as the basis for evaluation (to the extent that it conforms to current legislation), whilst others may be starting afresh. In either case, it is the practical Operations are which of significance rather than the Measures under which they may be introduced, and in doing so it becomes possible to evaluate options against a number of criteria. In relation to their climate change impact, four main criteria are considered to be of particular importance within the OSCAR framework.

i. **Mitigation potential:** Each potential Rural Development Programme Operation may impact on climate change mitigation as a result of increasing or decreasing emissions of greenhouse gasses or carbon sequestration, and can do so in many different ways. The extent to which these processes can be minimised/maximised will be key in determining the effectiveness of a programme of Measures/Operations, not least in relation to the role they may play in meeting GHG emission targets.

ii. **Adaptation potential:** Similarly, the impact that particular Operations may have in relation to increasing (or decreasing) the adaptive capacity of ecosystem services, will be central to determining the role that a RDP may play in maximising our ability to cope with climate change.

iii. **Productivity:** In many cases, RDP Operations will have little or no impact on the productivity of rural systems (including agricultural productivity), but for others however (for example those which result in an extensification of agricultural production) may have a significant impact. Where this is the case, it may in turn impact on other aspects affecting rural development and wider policy. For example, where productivity is reduced, it may both impact on the economic viability of rural businesses and result in production moving elsewhere to compensate. It is therefore essential to consider such processes if a RDP is to meet multiple objectives.

iv. **Practicality:** If the Operations to be encouraged through the implementation of a RDP are to have the desired impact, it is essential that uptake reaches the required level. Consequently, an evaluation of practicality issues is required, encompassing both barriers to uptake and (conversely) drivers which may encourage implementation on the ground.

3.3.1 Selecting RDP measures in the OSCAR software

The OSCAR decision support software accompanying this manual, allows users to explore, the impact that selecting different Measures (and subsidiary Operations) may have on the above issues. This is done through the 'Measures & Operations' section (click on the 'Edit RDP operations' icon ( ) on the front page of the software, which provides a link to an extensive database of Operations which may be promoted by Rural Development Programmes in order to achieve the goals established at Commission level. As such it allows users to undertake a number of activities.

3.3.1.1 Browsing operations

The Operations contained in the OSCAR database are categorised in terms of both the general category to which they belong (e.g. 'Land management: Woodland & forestry') and the RDP Measure (or Measures) to which they relate (pre-2014 and post-2013), and can be browsed in either way. When any option is clicked on in the list on the left of the screen, a simplified report on its key characteristics is provided, including:

i. **Summary:** This table summarises the impact of an Operation over a period of 1 to 250 years, in terms of mitigation, adaptation and production. In addition. In addition there is a graphic reflecting the quality of the data and science that has been used to calculate the impacts – see Figure 10 for example. (Note: the data shown in the examples below are based on a 100% uptake rate. This can be adjusted in the properties of any operation and/or a default setting for all operations can be set in the settings section of the software).

> **Tip:**
> In the report, a GHG emission reduction is displayed as a negative number whilst an increase is displayed as a positive number.

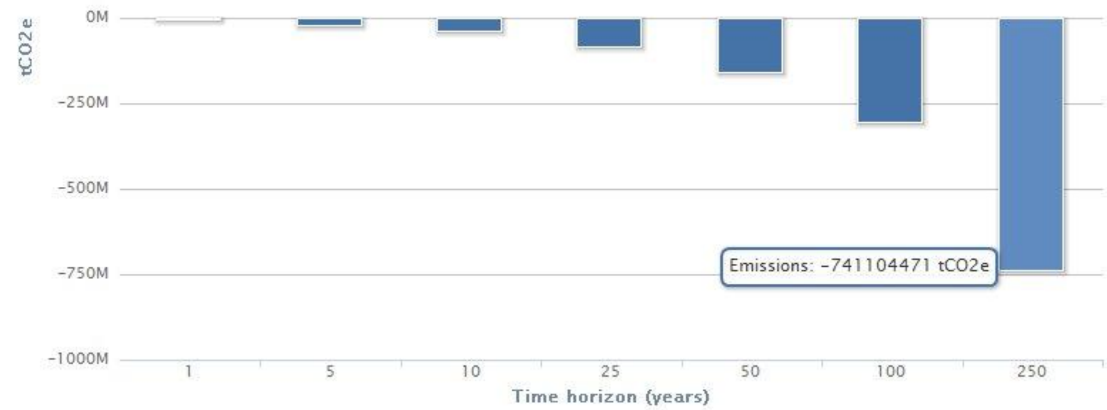
Criterion	Data	Data Quality
Mitigation (1 year to 250 years)	-4199467 to -741104471 tCO2e	
Adaptation (regional risk reduction)	1.4	
Production (total per annum)	€-6109869830	

Figure 10: Example summary data for a RDP Operation.

ii. **Mitigation:** Where suitable data is available, a graph is provided showing the estimated net change in GHG emissions over 7 time horizons (1 - 250 years) in tonnes of CO_2 equivalent (see Figure 11). Hovering over any bar in the graph will reveal the associated value.

Mitigation

The chart and table below show the carbon balance for this operation for the region(s) currently selected over different time horizons.



To view how this carbon balance varies with different regions (within those selected), click on 'Regional breakdown' for a specific time horizon.

	Time horizon (years)						
	1	**5**	**10**	**25**	**50**	**100**	**250**
tCO2e (total)	-4199467	-20997336	-39788109	-85789293	-158602090	-304227686	-741104471
tCO2e/ha	-6.3	-31.5	-59.8	-128.9	-238.3	-457	-1113.3
	Regional breakdown	Regional breakdown	Regional breakdown	Regional breakdown	Regional breakdown	Regional breakdown	Regional breakdown
	Note: Carbon sequestration is included in the carbon balance for the operation.						

Figure 11: Example mitigation data for a RDP Operation.

Clicking on the 'Regional breakdown' option, reveals a more detailed report based on where any perceived benefits (total or per ha) will be felt over the selected RDP area.

iii. **Adaptation:** A similar evaluation is carried out for the impact of Operations on adaptive capacity. However, as the evaluation of adaptive capacity is based on an indicator framework, as opposed to quantifiable figures (see Section 3.2.1), for each Operation an indicator score is provided of the change in the risk to adaptive capacity (there are no units, it is simply a relative score to reflect potential risk reduction), where positive scores represent an improvement. This score is a function of all the ecosystem services impacted (the score for each ecosystem service can be -100 to +100, thus an operation can score greater than 100 or less than -100 if there is an impact on two or more ecosystem services). See Figure 12 for example.

Adaptation

The table below shows the potential risk reduction for this operation for the region(s) currently selected.

To view how this risk reduction varies with different regions (within those selected), click on 'Regional breakdown'.

Risk reduction:	50.1
	Regional breakdown

Figure 12: Example adaptation data for a RDP Operation.

Clicking on the 'Regional breakdown' option, reveals a more detailed report based on where any perceived benefits or disbenefits (total or per ha) may be felt over the selected RDP area.

iv. **Productivity:** A Production Impact Assessment (PIA) is undertaken to determine the likely impact (positive or negative) of the implementation of RDP Operations on agricultural production where this is appropriate. This is based on the productive capability of the land within a region for different enterprises. GIS has been used to generate yield regional variation classes, which then allow the potential impact on yield within a region to be calculated. Impacts on the yield of different enterprises are then normalised using a typical gross margin (in Euros: €) for the outputs from each enterprise (which can be adjusted by the user in the settings section of the software). This is displayed as both total impact per annum and impact per hectare per annum (see Figure 13 for example).

Production

The table below shows the potential impacts on production for this operation for the region(s) currently selected.

To view how this impact varies with different regions (within those selected), click on 'Regional breakdown'.

Production impact (total) per annum:	€-6109869830
Production impact per hectare per annum:	€-9179
	Regional breakdown

Figure 13: Example productivity data for a RDP Operation.

Clicking on the 'Regional breakdown' option, reveals a more detailed report based on where any change in production (total or per ha) may be felt over the selected RDP area.

v. **Practicality:** This data has been collated from case-studies undertaken in a number of areas around Europe (in which site-specific expert knowledge was sought from land managers, advisers and researchers) and published literature where appropriate. It should however, not be taken as a definitive list of issues, applicable to all areas, but should be reviewed in light of knowledge pertinent to the specific RDP being formulated. Nevertheless, this section of the report provides brief details of practical considerations which may be of relevance in implementing an Operation, including for example whether training would be required to allow on the ground application. In addition, this section allows the need (if any) for training, education and/or advice to be provided if the maximum benefit is to be achieved. A table is provided in which relevant data can be amended. If sufficient training is being provided to ensure that maximum benefit from an option is achieved (or no training is needed), then the 'Sufficient training provided' box should be set to 'Yes', if this is not the case, then it should be set to 'No' (click on 'Change' and double click on the 'Yes/No' box to toggle between states. If insufficient training is being provided, the 'TEA Reduction Factor' must be set in order to reflect a best estimate of the reduction in Optio efficacy as a result (Note: this can only be done on a case-by-case basis and must therefore be estimated by the appropriate Managing Authority). In addition, if the cost of providing sufficient training is known, this too can be entered for subsequent reflection in MAC curves (see section 3.5).

Practicality

Training, Education and Advice (TEA)

If Training, Education and Advice (TEA) is important to ensure successful practical implementation of the operation (and to achieve its potential benefits), then please adjust the TEA data below to reflect its relative importance:

TEA provided	Yes	Change
TEA Reduction Factor	0%	Change
TEA Cost (€)	0	Change

Figure 14: Example practicality data for a RDP Operation.

vi. Operation properties: In this section the properties of an operation, with respect to scaling up techniques and costs, are displayed, and the user is allowed to reflect more closely the area specific conditions in their region (which may vary considerably over time). The 'Scaling up technique' can be set to 'Boundary feature' (if a linear feature) or more normally 'Hectare' (if an area based Operation), and is associated with a 'Scaling up value' which is the extent to which an Operation may be applied over a given area (area based Operations) or the width of the feature if linear. The 'Uptake rate' refers to the amount of an Operation might be taken up compared to the 'Total area to which this operation applies'. Where costs are entered (for subsequent reflection in MAC curves - see section 3.5), these are either the cost to the Managing Authority on a per hectare basis, or for one off investments the total cost to the Managing Authority.

Operation properties

The table below shows the properties of this operation with respect to scaling up techniques and costs. This data is used to scale up impacts within the region(s) selected and for undertaking a cost-benefit analysis (MAC curves). This data can be adjusted for the specific circumstances of your assessment.

Scaling up technique	Boundary feature (average field size)	Change
Scaling up value (width of boundary - metres)	10	Change
Uptake rate (%)	100	Change
Total area to which this operation applies (ha):	665669	
Cost - annual area (€)	0	Change
Cost - single investment (€)	0	Change

Figure 15: Example Operations properties for a RDP Operation.

Clicking on the detailed report icon ( ) or link adds data to the above report on the ecosystem services which are impacted by an operation, and the extent to which that impact occurs. It is these figures which contribute to the figures in the basic report as discussed above. This is either based on net emissions (t CO_2e - mitigation) or an 'Impact Factor' (on a scale of 0 (low) to 1 (high) - adaptation). **Note:** In some cases this may be considerable data.

The above reports provide the user with a means of rapidly identifying those Operations, and therefore the Measures they are associated with, which may address those Regional Variation Categories which have been identified as potentially being a cause for concern in the area under consideration (Section 3.2).

3.3.1.2 Compiling Rural Development Programmes

For those Managing Authorities who have identified potential Operations for future inclusion in a Rural Development Programme through the above process (see Section 3.3.1.1), it is possible to select a series for further evaluation, by adding them to a list of 'My RDP Operations'. Equally, those wishing to base a future Rural Development Programme on that which has gone before, and those who have established a draft programme of measures through other means, can add 'Operations' to their list based on these pre-existing arrangements. In essence, this list then serves as a draft RDP structure for more detailed evaluation in terms of their value in contributing to climate change policy objectives and cost effectiveness (section 3.4. onwards).

Tip:

Options can be added to 'My operations' by:

- Clicking the select icon ( ) at the top or bottom of the relevant Operation page.
- Clicking the icon to add the Operation being viewed.
- Clicking the icon to add all the Operations in a selected category.
- Options can be deselected by clicking the deselect icon ( ) at the top or bottom of the relevant Operation page.

3.4 Step 4: Evaluating climate change impact

By this stage, it is likely that a number of potential Measures (and therefore Operations) will have been identified which meet the objectives set in terms of rural development. Many of these will also have climate change implications, such that judgements have to be made as to which of the Operations that meet broader rural development objectives, most effectively meet climate change objectives as well. Clearly then, Operations and/or Measures must in some way be ranked in terms of (in as far as the OSCAR methodology is concerned) their climate change mitigation and adaptation characteristics. In doing so it becomes possible to make value judgements as to the best way to allocate funds (within the constraints applied by EU Rural Development legislation), so as to obtain the maximum benefit from scarce resources (see Section 3.5 below), taking into account the region specific circumstances of the area in which the programme is to be applied. This data, together with an understanding of related rural development and other policy objectives, can consequently be used to inform programme formulation. There are a number of ways which specific users may have established in order to achieve this, and it is perfectly acceptable to continue to use these if still appropriate, but if the OSCAR decision support software is being used, the following section will be of guidance.

'Operation properties' are added to the operation report discussed in Section 3.3.1.1 once they are added to 'My RDP Operations'. These detail some of the assumptions made in the OSCAR model, and can be amended in light of region specific experience by clicking on the link or the Edit Operation Properties icon ( ).

3.4.1 Evaluating climate change impact in the OSCAR software

The OSCAR decision support software allows the above processes to be carried out through the 'My RDP Operations' section, where the impact of individual operations can be 'quantified' on a site-specific basis and their potential impacts compared.

3.4.1.1 Impact ranking and comparison

The overall evaluation of the selected Operations is assessed by using the tabs at the top of the viewing pain when looking at the 'My RDP Operations' section, where six tabs are available.

i. **Ranked:** This tab reveals a table which ranks Operations, based on their position on a linear scale (-100 to +100) determined by the magnitude of the highest impact or indicator, of the selected Operations in terms of their mitigation potential (impact based), adaptive capacity potential (indicator based), impact on production (financial) or a combined rank (the mean of the mitigation, adaptive and production rank values). This data can be ordered according to the values in any column using the and . icons.

ii. **Mitigation:** This tab summarises the regional impact values for the Operations selected, which can be re-ordered alphabetically, by the per hectare values or by the total regional impact values by clicking on the and . icons.

iii. **Adaptation:** This tab summarises the regional impact indices for each of the Operations selected, which again can be re-ordered alphabetically, by the per hectare indices or by the total regional impact indices.

iv. **Production:** This tab summarises the regional impact that the selected Operations have on t (based on an estimate of impact on typical gross margin in Pounds Sterling).

v. **Operations:** This tab allows individual selected options to be viewed in much the same way as described above (Section 3.3.1.1), the main difference being that 'Operation Properties' are added to the report. These detail some of the assumptions made in the OSCAR model, and which can be amended in light of region specific experience by clicking on the link or the 'Edit Operation Properties' icon ( ).

vi. **Aggregated:** This tab apportions the impacts detailed on the other tabs according to the RDP Measures which result in them.

The ranking process allows users to assess which operations are the most optimal at addressing mitigation, adaptation and production objectives. Ideal operations have benefits for all these objectives, i.e. an operation that reduces GHG emissions, increases adaptive capacity and increases production. However, in many instances this is not the case and there are trade-offs rather than synergies between the objectives. In such instances it is then down to the user to evaluate which trade-offs may or may not be acceptable. This may be based on understanding the hotspots in the region or based on other local knowledge and objectives.

Figure K.16 shows an example ranking report where there is a mix of synergies and trade-offs. The data shown are for RDP operations applied to north-east England in the UK, with a 15% uptake. Note: the ranking report in this instance is based on the 250 year time horizon data. The choice of time horizon to be used in the ranking can be set by the user in the settings section of the software (the default value is 50 years).

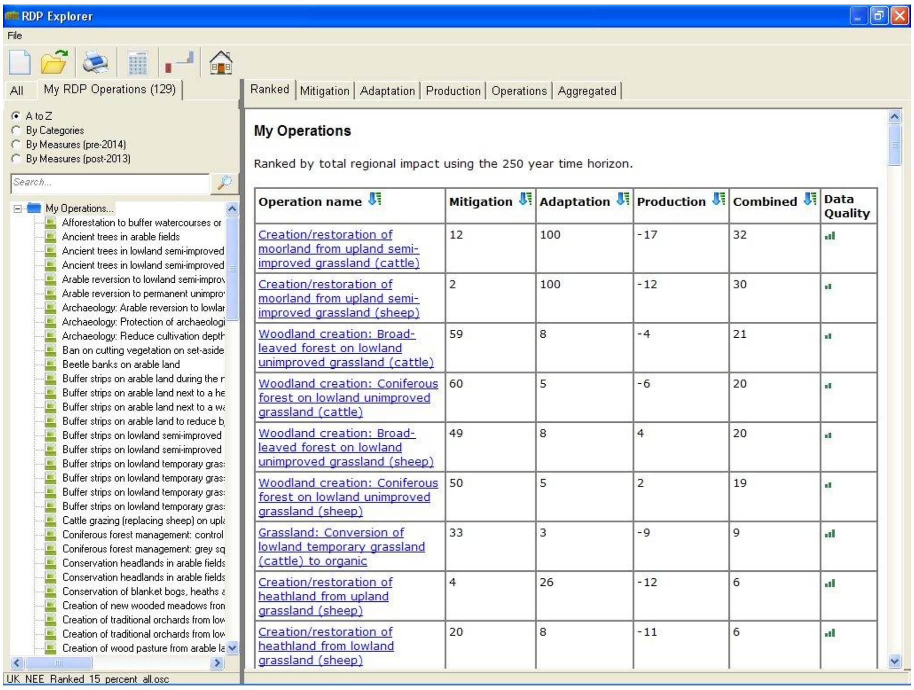


Figure 16: Example Ranking Report

3.5 Step 5: Determining cost effectiveness

As mentioned above (Section 3.4) it is essential to obtain the maximum possible benefit (in this case climate change benefit) for the resources (finances) applied to the various elements of a Rural Development Programme, particularly in times of financial constraint. A number of methodologies may exist for doing this, but one of the most commonly adopted in terms of climate change policy, is the use of marginal abatement cost curves (MAC curves). These are defined as graphs that indicate the cost associated with the last unit (the marginal cost) of emission abatement for varying amounts of emission reduction. Therefore, the first step is to define a baseline with no CO_2 constraint in order to establish a basis against which to assess the marginal abatement cost. They have been applied in a number of sectors, including fuel resource provision[47], air pollution abatement[48,49], water resources[50], but more recently have been successfully applied to cost-benefits assessments for climate change mitigation[51]. It is therefore recommended that such an approach is used when adopting the OSCAR mechanism, to assess the cost and benefits associated with both climate change mitigation and adaptation. Although alternative methods for doing this in terms of mitigation have been published, no such pre-existing methodologies exist for adaptation; however, one has been developed for use with the OSCAR Manual and is embedded within the associated decision support software (see Section 3.5.1).

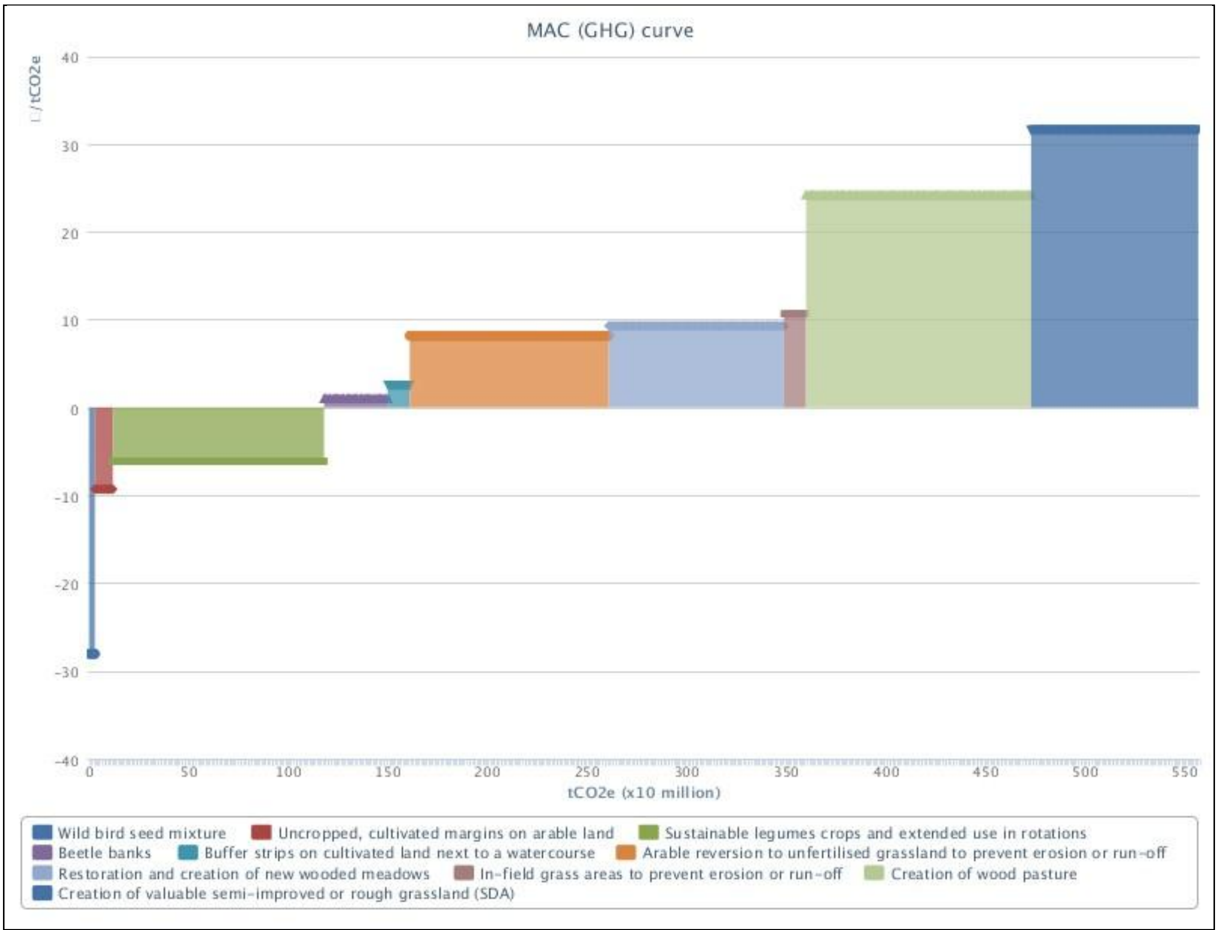


Figure 17: Example MAC curve for GHG mitigation

3.5.1 Determining cost effectiveness in the OSCAR software

The OSCAR decision support tool allows the preparation of MAC curves for both GHG mitigation and adaptation, where costs (in terms of direct costs or income foregone) are available for the selected Operations. This is done through the 'Measures & Operations' section (click on the 'Edit RDP operations' icon ( ) on the front page of the software or the 'Explore & Select Rural Development Operations' under 'Measures & Operations'. Where users have cost data available to them, this can be entered in the 'Edit Operation Properties' section ( ) of each selected Operation (this allows cost figures to accurately reflect costs in different areas of Europe); however, where such data is not available, standard production impact (gross margin) data can be used as a surrogate. Click on the MAC curve button ( ) at the top of the screen, when the 'My RDP Operations' tab has been selected, to access the MAC curve production system.

This reveals the Options screen for MAC curve production, on which the user may select whether to use entered cost data (on an area cost or one-off cost basis or both – most users will wish to use both) or the standard production data. In addition, it is possible to produce MAC curves for the Operations selected or the Measures to which those Operations relate, and this should be changed on this page if necessary. Having done so either GHG emission mitigation MAC curves ( ) can be produced or climate change adaptation MAC curves ( ). In either case, the graph displayed will (if sufficient data is available) permit those Operations which produce the most benefit (in terms of mitigation or adaptation) at the minimum cost, to be identified.

3.6 Step 6: Interpretation of results

There a number of ways in which Managing Authorities could use the outputs from the OSCAR RDP evaluation system (whether supported by the decision support software accompanying this manual or not); however, the OSCAR team envisage that maximum benefit will be gained in the following way. Firstly, the mitigation and adaptation MAC curves should be used to identify those options (and therefore the RDP Measures they relate to) which are likely to result in the maximum possible benefit for the minimum financial cost. It should be remembered that unless the user has entered specific cost related data, then these costs will be in terms of lost production, and as such do not necessarily translate to RDP funding costs. Nevertheless, they provide a valuable insight into the level of funding which might be needed in order to compensate producers for making changes which may benefit climate change objectives.

These curves should then be compared with the ranked tables of Operation performance discussed in Section 3.4 of this manual. This data, along with those pages estimating the GHG emission and adaptive capacity changes estimated to be possible, gives a clear indication of those Operations which are most likely to allow the industry to make the contribution needed towards meeting climate change objectives. Therefore, it is envisaged that this data will be of value to Managing Authorities in determining where to focus available funding, albeit that this will have to take place within any constraints on the balance of RDP funding which result from relevant EU legislation, and an evaluation of other Rural Development priorities.

In addition, the RVC data produce in Section 3.2 of this manual should be revisited at this stage. In doing so, the user should consider whether the options being highlighted as being of most climate change benefit, address the range of environmental concerns highlighted as being of concern in the RDP region under study. This provides assurance that any Measures, and the Operations associated with them, selected for inclusion in post-2013 RDPs are compatible with the environmental priorities within the Region.

Finally, any Operations going forward for inclusion in an RDP, must be evaluated in light of the wider rural development priorities set by the Managing Authority. Although climate change reduction and adaptation are key drivers for policy at many levels, it cannot be ignored that RDPs have a much broader remit. It is essential then that climate options are chosen with this in mind, such that climate change objectives are not met at the expense of other, equally valid, objectives. These may for example include (but not be restricted to) the need to provide jobs and economic security, particularly given the economic pressures being faced in Europe at the present time (at the time of writing).

4 The OSCAR RDP evaluation checklist

Step 1
Define spatial boundaries

- Define the geographical area over which the planned RDP will operate.

Step 2
Identify issues & areas of concern

- Identify ecosystem services at particular risk in the relevant RDP area.
- Identify spatial areas ('hotspots') in which ecosystem services may be at particular risk.

Step 3
Select RDP measures

- Identify a prelimnary set of Measures & Operations for inclusion in the planned RDP.
- Formulate a draft RDP.

Step 4
Evaluate climate change impact

- Rank and compare the climate change characteristics of Operations which meet the programmes rural develpment objectives.

Step 5
Determine cost effectiveness

- Prepare MAC curve for GHG mitigation.
- Prepare MAC curve for GHG adaptation.

Step 6
Interpretation of results

- Assess the results produced in following the various stages of this manual.
- Consider recommendations in light of broader rural development needs.
- make recommendations for RDP inclusion.

Appendix 1: The OSCAR development team

Funding body: DG CLIMA

The Directorate-General for Climate Action (DG CLIMA) of the European Commission was established in February 2010, climate change having previously been included in the remit of DG Environment. It leads international negotiations on climate, helps the EU to deal with the consequences of climate change and to meet its targets for 2020, as well as developing and implementing the EU Emissions Trading System (EU ETS).

Combating climate change within and outside the EU

Given the necessity to keep global average temperature increase below 2 degrees Celsius compared to pre-industrial levels, DG CLIMA develops and implements cost effective international and domestic climate change policies and strategies in order for the EU to meet its targets for 2020 and beyond, especially with regard to reducing its greenhouse gas emissions. Its policies also aim to protect the ozone layer and ensure that the climate dimension is appropriately represented in all Community policies and that adaptation measures will reduce the European Union's vulnerability to the impacts of climate change.

The Directorate-General for Climate Action is at the forefront of international efforts to combat climate change. It leads the respective Commission task forces on the international negotiations in the areas of climate change and ozone depleting substances and coordinates bi-lateral and multi-lateral partnerships on climate change and energy with other nations.

Building an international carbon trading market

DG CLIMA develops and implements the EU Emissions Trading System and promotes its links with other carbon trading systems with the ultimate aim of building an international carbon trading market. Furthermore, it monitors the implementation of Member States' emission reduction targets in the sectors outside the EU ETS (Effort Sharing Decision).

It also promotes the development and demonstration of low carbon and adaptation technologies, especially through the development and implementation of cost effective regulatory frameworks for their deployment (e.g. carbon capture and storage, fluorinated gases, ozone depleting substances, vehicle efficiency standards, and fuel quality standards) as well as through the development of appropriate financial support schemes.

DG CLIMA currently employs around 160 EC officials and external staff.

The project team:

The University of Hertfordshire (UH) in the UK was the main contractor for this project (the OSCAR project) but worked closely with two sub-contracting organisations; namely, the Wroclaw University of Environmental and Life Sciences (WUELS) in Poland and Solagro in France. Particularly in relation to case-studies carried out in the Lower Silesia Province of Poland, and the Midi-Pyrénées region of France (a third having been carried out by AERU in Northumberland in the north of England).

University of Hertfordshire

The University of Hertfordshire's history goes back to 1952, when Hertfordshire County Council built Hatfield Technical College on land donated by the de Havilland aircraft company for educational use. The college rapidly became a centre of excellence in mechanical and aeronautical engineering and the natural sciences, training engineers for Hatfield's then dominant aerospace industry. In 1992, the College was given University status and is now at the vanguard of a new type of emerging university in the UK, those that are business-like and business-facing. As such the University of Hertfordshire is focused on developing new and creative approaches to learning, teaching and research, with a commitment to adding value to employers, enterprise and regional, national and international economies. The University of Hertfordshire is one of the region's largest employers, with over 2,500 staff, a turnover of more than £209 million and a student community of over 25,000, including more than 2,000 international students from over 85 countries.

Research is at the core of the University's strategy to facilitate far-reaching engagement with business, communities and national and international partners, with the University's research groups being based within academic faculties and schools. With respect to this particular tender the project was led by the Agriculture and Environment Research Unit (AERU) within the University's School of Life Sciences, supported by the University's Business School.

AERU carries out research and consultancy related to understanding the sustainability of agriculture, food and rural land use, with much of its work focused towards developing and evaluating national and European policy. AERU has been operating for over 17 years, during which time it has successfully completed over 40 research projects for a wide range of organisations including UK government and the European Union/European Commission.

Wrocław University of Environmental and Life Sciences

Wrocław University of Environmental and Life Sciences focuses its wide-ranging activities on education and research covering agriculture and related sciences. The University's profile and its mission are directly related to transformation programmes dealing with rural development, food quality and management, with full respect paid to social support and interaction. The knowledge acquired and the research projects undertaken at WUELS help to ensure that the future development of the Polish agricultural and land use industries is sustainable, and supports both human and animal welfare.

WUELS is a well-recognised scientific and educational centre, and is the only agricultural university in the south-west of Poland. The University employs around 1,500 people including 160 full and associate professors. There are around 11,000 full and part-time students, who are offered a wide range of degree courses in agriculture and related disciplines.

Research projects carried out at WUELS are financially supported by the Polish Committee for Scientific Research (KBN), industry, local government and international foundations. The results obtained in these projects are published in scientific journals in both Poland and abroad. A number of international conferences are held at WUELS every year, and many of its researchers are members of prestigious international organisations. The University prides itself in its international activities, has signed bilateral agreements (including Wroclaw University of Economics) with 52 universities in different parts of the world, and participates in the Socrates/Erasmus, CEEPUS, Leonardo da Vinci, COST and EU Framework programmes. In February 2010 Wroclaw University of Environmental and Life Sciences, were awarded an International Certificate ISO 9001:2000 in didactic management, education, science and research activities.

With respect to this particular project, the work for which WUELS were responsible was undertaken within the Faculty of Environmental Engineering and Geodesy (FEEG).

Solagro

Solagro is a Non-Governmental Organisation based in Toulouse, south-west France, and was established in 1981. It consists of a team of 17 permanent staff comprised of agronomists, environmental engineers and economists. Its mission is to promote sustainable energy and agriculture, and respect for the natural environment. By working at the intersection of project development and general studies, Solagro ensures that its expertise is closely connected to farmers and the rural community, adopting a practical and pragmatic approach. With over 30 years of experience, the organisation has established a network of contacts in France and Europe, including local authorities, businesses, farmers and other professional organisations, institutions, research establishments and other NGOs.

Solagro is a leader in France on topics related to agriculture, energy and GHG emissions, and the organisation has been involved both in project development and research. They have worked extensively with the French Agriculture Ministry and with ADEME (French Environment and Energy Management Agency) on reducing energy use in agriculture and consequent climate impacts. Solagro notably developed Dia'terre and Climagri, which are official evaluation tools which measure greenhouse gases from farming and forestry, respectively at farm and territorial scales. At European level, Solagro has worked with the Joint Research Centre (JRC) of the European Commission, the European Environment Agency and the Institute for European Environmental Policy on various policy evaluation assignments.

Appendix 2: NUTS classification national structures

Country		NUTS1		NUTS2		NUTS3	
BE	Koninkrijk België, Royaume de Belgique, Königreich Belgien	Gewesten / Régions	3	Provincies / Provinces	11	Arrondisse-menten / Arrondissements	44
BG	Република България	Райони (Rajoni)	2	Райони за планиране (Rajoni za planirane)	6	Области (Oblasti)	28
CZ	Česká Republika	Území	1	Oblasti	8	Kraje	14
DK	Kongeriget Danmark	-	1	Regioner	5	Landsdeler	11
DE	Bundesrepublik Deutschland	Länder	16	Regierungs-bezirke	38	Kreise	412
EE	Eesti Vabariik	-	1	-	1	Groups of Maakond	5
IE	Republic of Ireland, Éire	-	1	Regions	2	Regional Authority Regions	8
GR	Ελληνική Δημοκρατία	Γεωγραφική Ομάδα (Groups of development regions)	4	Περιφέρειες (Periferies)	13	Νομοί (Nomoi)	51
ES	Reino de España	Agrupacion de comunidades Autonomas	7	Comunidades y ciudades Autonomas	19	Provincias + islas + Ceuta, Melilla	59
FR	République française	Z.E.A.T + DOM	9	Régions + DOM	26	Départements + DOM	100
IT	Repubblica italiana	Gruppi di regioni	5	Regioni	21	Provincie	110
CY	Κυπριακή Δημοκρατία, Kıbrıs Cumhuriyeti	-	1	-	1	-	1
LV	Latvijas Republika	-	1	-	1	Statistiskie reģioni	6
LT	Lietuvos Respublika	-	1	-	1	Apskritys	10
LU	Groussherzogtum Lëtzebuerg, Grand-Duché de Luxembourg, Großherzogtum Luxemburg	-	1	-	1	-	1
HU	Magyarország	Statisztikai nagyrégiók	3	Tervezési-statisztikai régiók	7	Megyék + Budapest	20
MT	Repubblika ta' Malta	-	1	-	1	Gzejjer	2
NL	Nederland	Landsdelen	4	Provincies	12	COROP regio's	20

Country		NUTS1		NUTS2		NUTS3	
AT	Republik Österreich	Gruppen von Bundesländern	3	Bundesländer	9	Gruppen von politischen Bezirken	35
PL	Rzeczpospolita Polska	Regiony	6	Województwa	16	Podregiony	66
PT	República Portuguesa	Continente + Regioes autonomas	3	Comissaoes de Coordenaçao regional + Regioes autonomas	7	Grupos de Con- celhos	30
RO	România	Macroregiuni	4	Regiuni	8	Judet + Bucuresti	42
SI	Republika Slovenija	-	1	Kohezijske regije	2	Statistične regije	12
SK	Slovenská Republika	-	1	Oblasti	4	Kraje	8
FI	Suomen tasavalta	Manner-Suomi, Ahvenananmaa / Fasta Finland, Åland	2	Suuralueet / Storområden	5	Maakunnat / Landskap	19
SE	Konungariket Sverige	Grupper av riksområden	3	Riksområden	8	Län	21
UK	United Kingdom	Government OHce Regions; Country	12	Counties (some grouped); Inner and Outer London; Groups of unitary authorities	37	Upper tier authorities or groups of lower tier authorities (unitary authorities or districts)	139

Appendix 3: Glossary

Activities & Features: Describe and RDP Operation such that it can be compared to a baseline state (described using the same set of Activities & Features) and temporal changes (delta) can be identified.

Adaptive capacity: The capacity of a system to adapt if the environment within which it exists changes.

AERU: Agriculture & Environment Research Unit. A specialised research and consultancy unit based within the School of Life & Medical Sciences at the University of Hertfordshire, UK (see Appendix 1).

Carbon sequestration: The process of carbon capture in which it is transferred from the atmosphere to (in the main) soil and vegetative stores.

Common Strategic Framework (CSF): Investment priorities Member States and their regions established set at the EU level in order to enable better combining of various funding streams to maximise the impact of EU investments.

DG CLIMA: Directorate-General for Climate Action of the European Commission (see Appendix 1).

Ecosystem services: The benefits (goods and services), both tangible and intangible, we derive from the ecosystems around us.

European Climate Change Programme (ECCP/ECCPII): A series of programmes with the aim of identifying cost-effective options for reducing greenhouse gas emissions.

Features: See 'Activities & Features'.

Geographical information system (GIS): A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.

Global warming potential (GWP): The warming impact of a gas over a given period (often 100 years – GWP_{100}) compared to that of CO_2 (CO_2 equivalents - CO_2e).

Greenhouse gasses (GHGs): Atmospheric gasses which although they permit solar radiation to pass through the atmosphere, absorb reradiated infrared radiation trapping heat. A change in the level of GHGs in the atmosphere causes a change in the equilibrium between incoming and outgoing radiation.

Gross domestic product (GDP): Total value of all goods and services produced over a specific time period.

Hotspots: Spatial areas and/or processes within rural enterprises, in which there is significant scope for GHG mitigation and/or significant issues with respect to adapting to projected climate change.

Impact: Effects on the ability of ecosystems to provide the services we require from them.

Impact Factors: The relative impact on adaptive capacity that may arise due to a change in an Activity or Feature.

Intergovernmental Panel on Climate Change (IPCC): An intergovernmental scientific body set up established the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP).

Marginal Abatement Cost (MAC) curve: Graphs that indicate the cost associated with the last unit (the marginal cost) of emission abatement for varying amounts of emission reduction.

Measures: Broad areas established under EU legislation, for which funding may be provided under the umbrella of Rural Development (i.e. EAFRD funding). The EU funds differing proportions towards different measures.

National Strategy Plan (NSP): A plan prepared at the national level based on EU Strategic Guidelines, and which takes into account the specific circumstances and needs of a country. This plane is intended to provide a reference tool for preparing rural development programmes.

Nomenclature of Units for Territorial Statistics (NUTS): Subdivisions of countries (and country level areas) used for statistical purposes within the European Union.

Operations: More detailed elements comprising a Rural Development programme, each of which contributes to meeting the objectives of one or more Measure.

OSCAR: Optimising Strategies for Climate change Action in Rural areas, the DG CLIMA funded project resulting in this manual and associated decision support software.

Partnership Contract: Drafted by Member States to establish their own strategies for implementing the EU's ' Common Strategic Framework (see above).

Regional Variation Categories (RVCs): Categories based on the combination of geophysical characteristics (e.g. soil, climate, land use, etc.) and potential climate change impacts which describe the potential impact of climate change on a series of ecosystem services (see above) mapped across the EU.

WUELS: Wrocław University of Environmental and Life Sciences, Poland.

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