Technical approach to the OSCAR project and software demonstration

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Brussels, Thursday 22 November 2012

Workshop

Climate Action in post-2013 Rural Development
- Results from the OSCAR study

Aims

- The principal aim of the project is to produce a manual and checklist on "optimal design of climate change policies within Rural Development Policy" for Member States

- This will contribute towards meeting EU targets on emission reduction and adaptation to climate change impacts

Objectives

- To enable the identification of optimal strategies to address climate change objectives in RDPs post-2013, including the identification of regional variations and hotspots
- To enable the assessment of the cost and effect of each RDP operation in relation to the expected climate benefits, including the production of Marginal Abatement Cost (MAC) curves for mitigation and adaptation
- To provide guidance to Member States on the design of RDPs at regional level in order to achieve optimal climate change benefits, including the production of a manual and checklist

Rural areas

Land use activities








Nutrient use

Water use

Energy/fuel

Pesticide use

Waste management

Livestock

Soil management

Crops

Ecosystem services







Climate regulation

Nutrient cycling

Water regulation

Aesthetic

Pest regulation

Water provision

Biomass

Cultural heritage

Pollination

Soil formation

Food

Recreation

Environmental issues






Air quality

GHG emissions

Biodiversity

Landscape

Wildlife

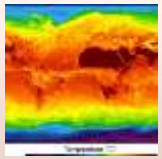
Water quality

Use of non-renewable/scarce resources

Soil quality

Carbon sequestration

Climate change



Sea level change

Precipitation change

Drought

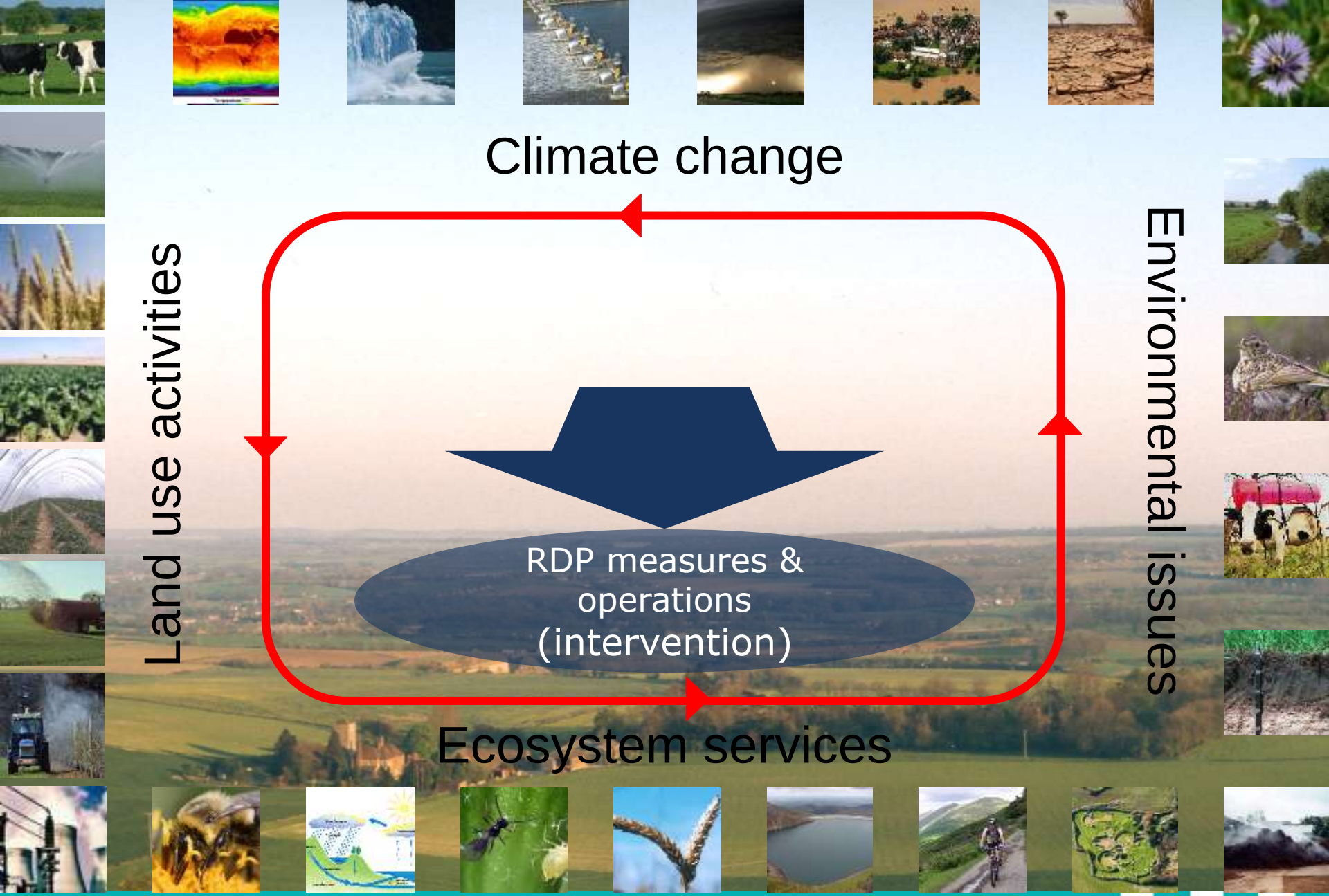
Extreme weather events

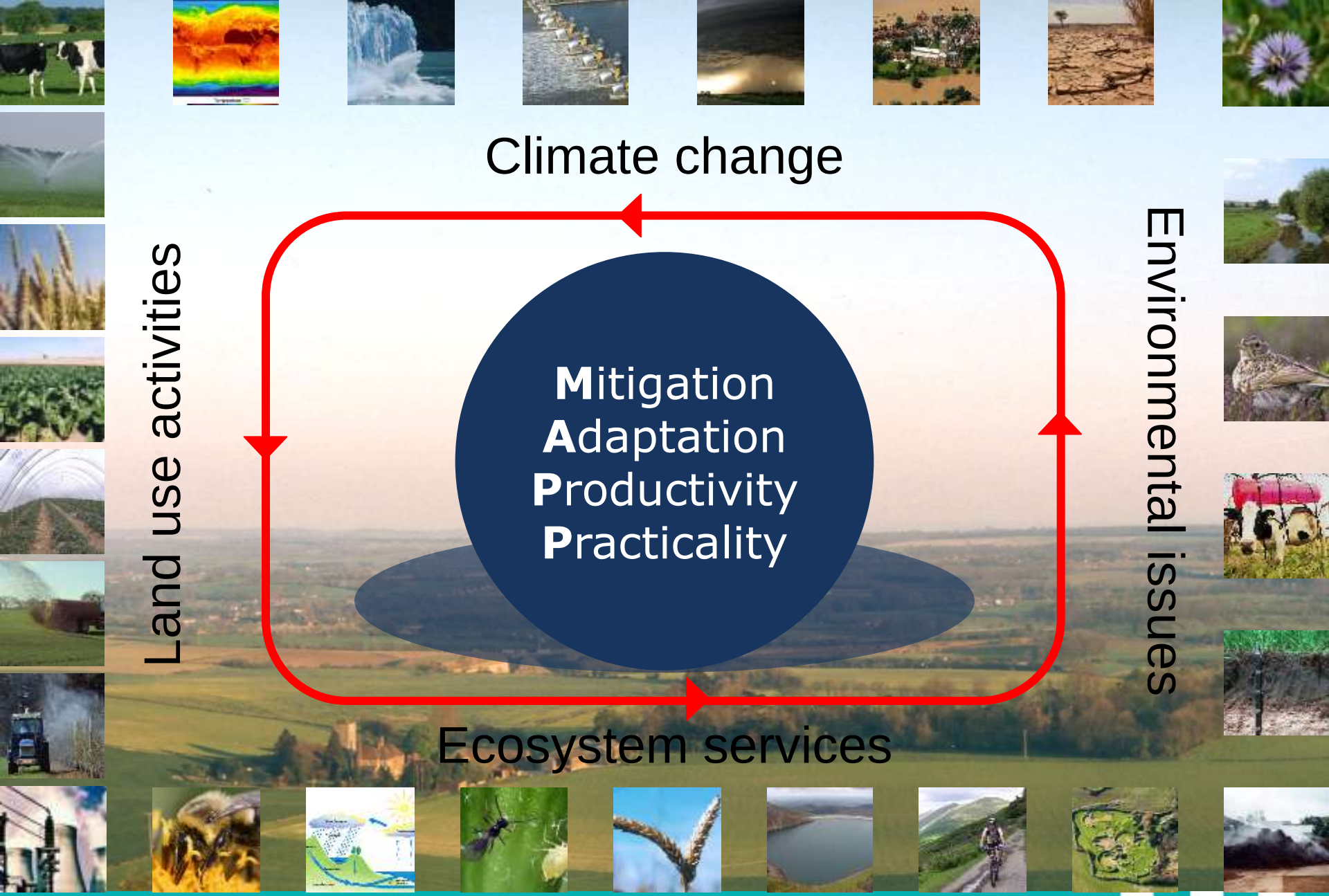
Temperature increase

Flooding

Crop pests

Crop yields

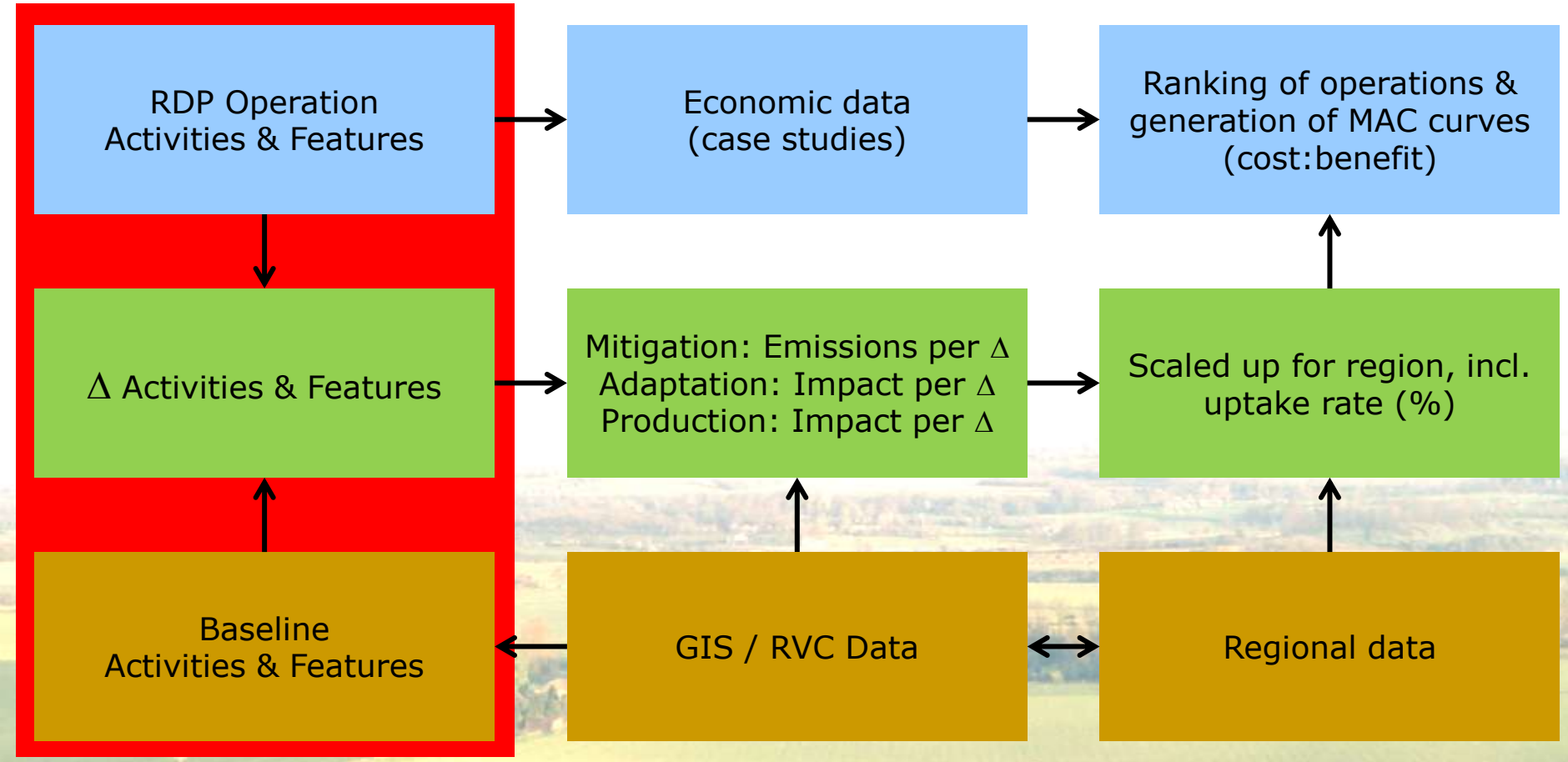

Climate change
Land use activities
Environmental issues
RDP measures & operations (intervention)
Ecosystem services


Climate change
Land use activities
Environmental issues
Ecosystem services
Mitigation
Adaptation
Productivity
Practicality

Techniques

- A number of techniques have been employed to assess the impact of RDP operations on climate change objectives, including:
  - Life Cycle Assessment (LCA)
  - Adaptive Capacity Impact Assessment (ACIA)
  - Production Impact Assessment (PIA)
  - Geographical Information Systems (GIS) to produce Regional Variation Categories (RVCs)
  - Regional case studies
  - Software and database development

Assessment flow chart



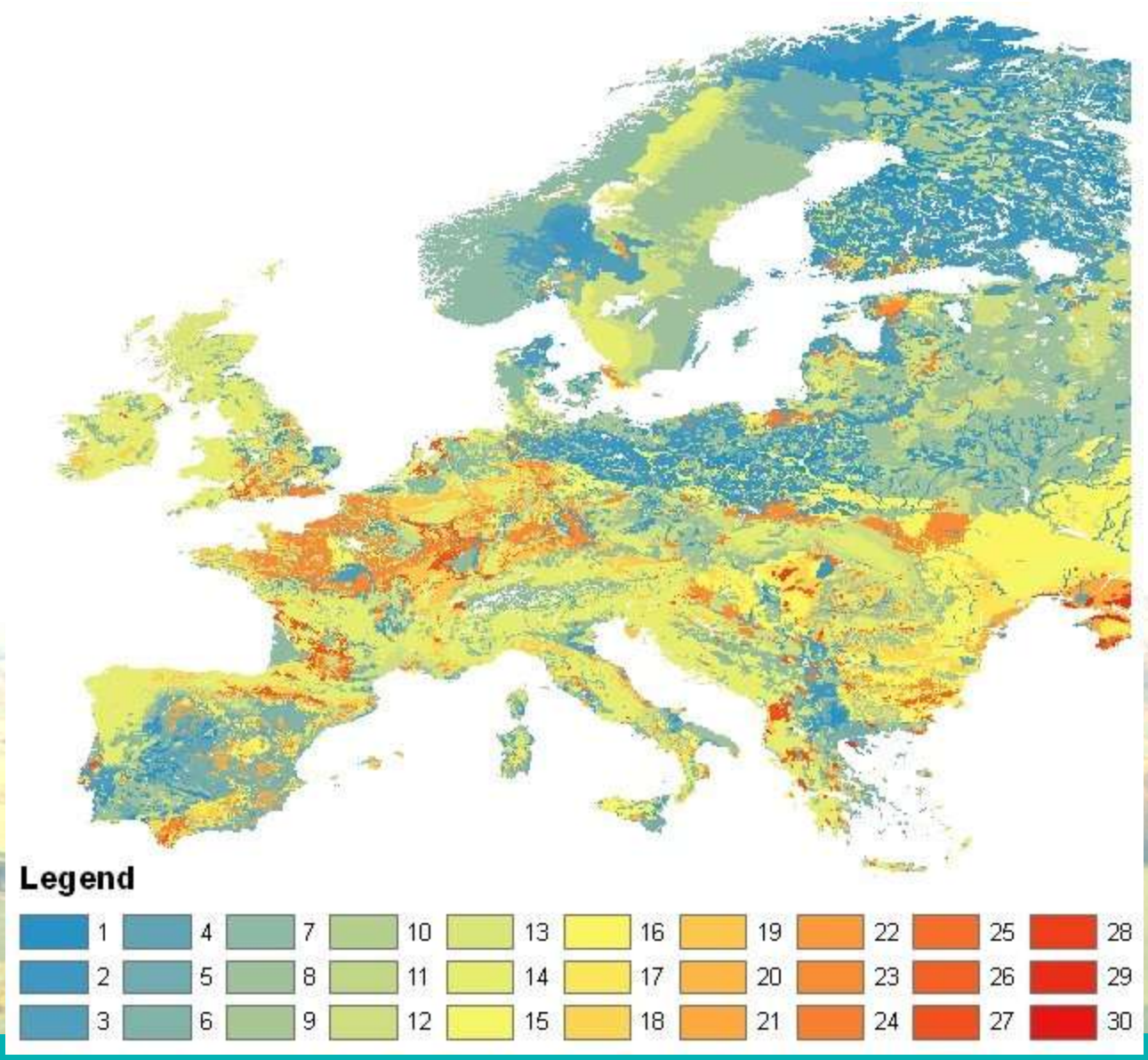
RDP Operations

- Firstly, we need to define an RDP operation
- An RDP operation is a change (delta Δ) from a baseline situation and can include changes in practices, inputs, land use, features – collectively termed 'activities and features'
- For example, the introduction of grass buffer strip into a field of winter wheat will change field operations, pesticide and fertiliser use, soil organic matter, biomass and land cover – all of which has potential to impact upon GHG emissions, carbon sequestration and ecosystem services

RDP Operations

- In some instances we can have variable baselines, e.g. the reduction in fertiliser applied (e.g. from introducing grass buffer strips) will vary depending on how much is being applied to the crop

- Therefore we have used GIS to map potential fertiliser application rates for different crops – this is our first type of RVC – a 'baseline' RVC


Legend
1 4 7 10 13 16 19 22 25 28
2 5 8 11 14 17 20 23 26 29
3 6 9 12 15 18 21 24 27 30

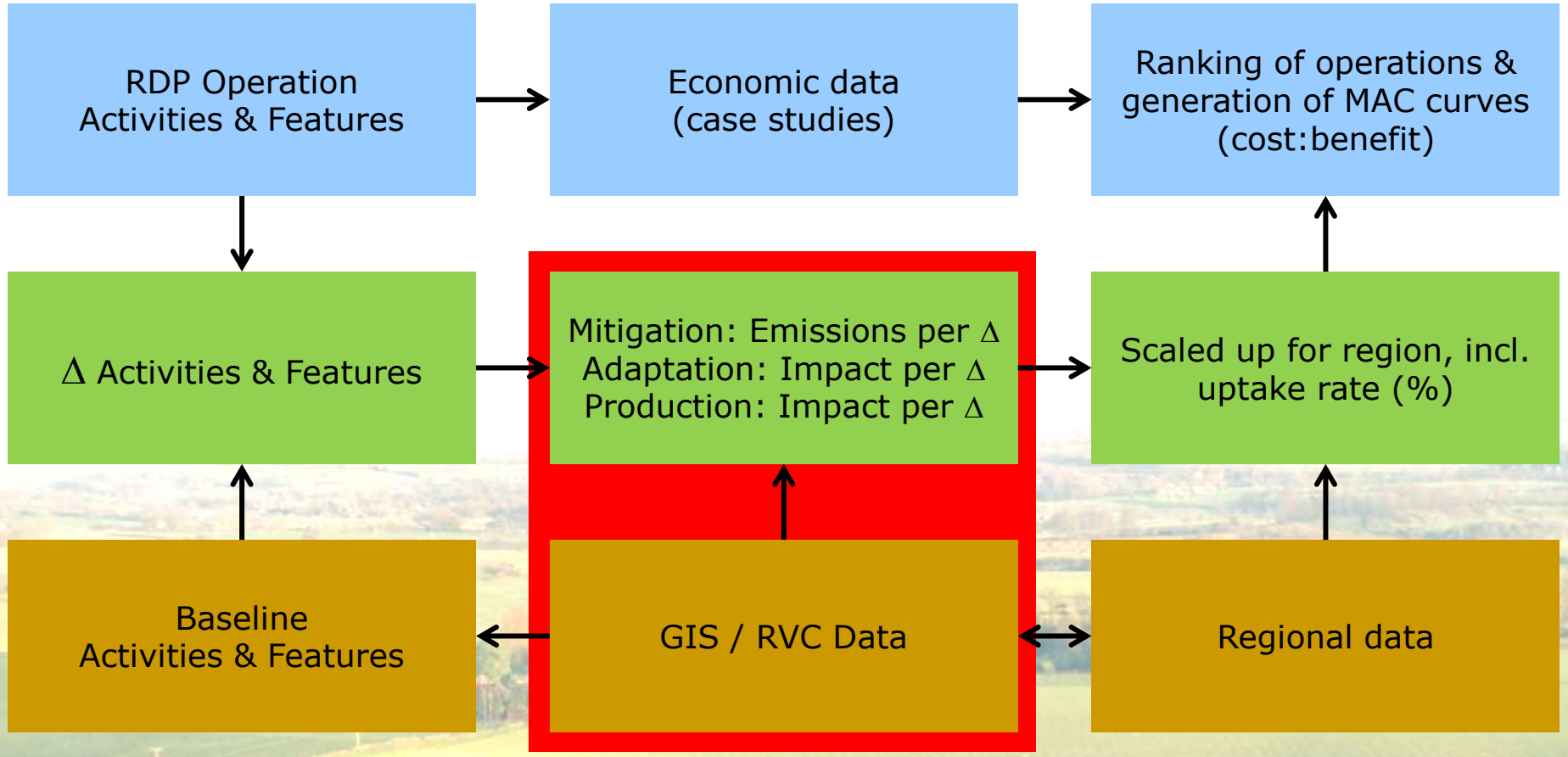
Class	Rainfall (mm)	Soil texture	kg N
1	451-533	Coarse	160
2	533-646	Coarse	160
3	646-765	Coarse	160
4	0-451	Coarse	160
5	451-533	Medium	220
6	0-451	Medium	220
7	765-2958	Coarse	160
8	533-646	Medium	220
9	451-533	Histosols: Organic/organo-mineral	60
10	0-451	Histosols: Organic/organo-mineral	60
11	533-646	Histosols: Organic/organo-mineral	60
12	646-765	Medium	220
13	765-2958	Histosols: Organic/organo-mineral	60
14	765-2958	Medium	220
15	451-533	Medium fine	220
16	533-646	Medium fine	220
17	451-533	Fine	160
18	533-646	Fine	190
19	765-2958	Medium fine	220
20	0-451	Medium fine	220
21	0-451	Fine	160
22	646-765	Histosols: Organic/organo-mineral	60
23	646-765	Medium fine	220
24	646-765	Fine	190
25	646-765	Very fine	190
26	533-646	Very fine	190
27	765-2958	Fine	190
28	451-533	Very fine	190
29	0-451	Very fine	190
30	765-2958	Very fine	190

RDP Operations

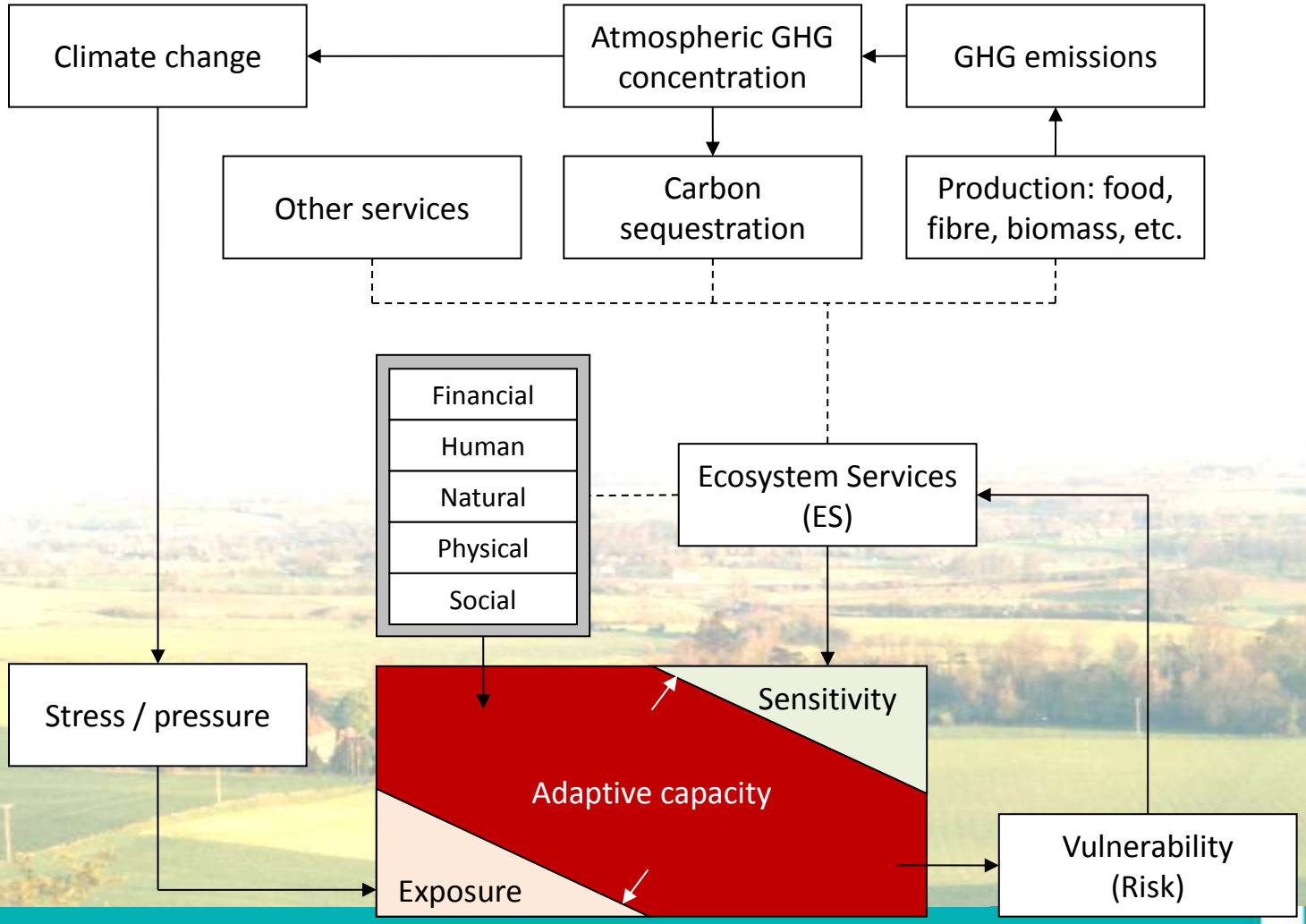
- Currently got impact data for just over 100 operations, and expect ~180 by the end of the project

- All the operations are classified by the old and new RDP measures, plus our own taxonomy

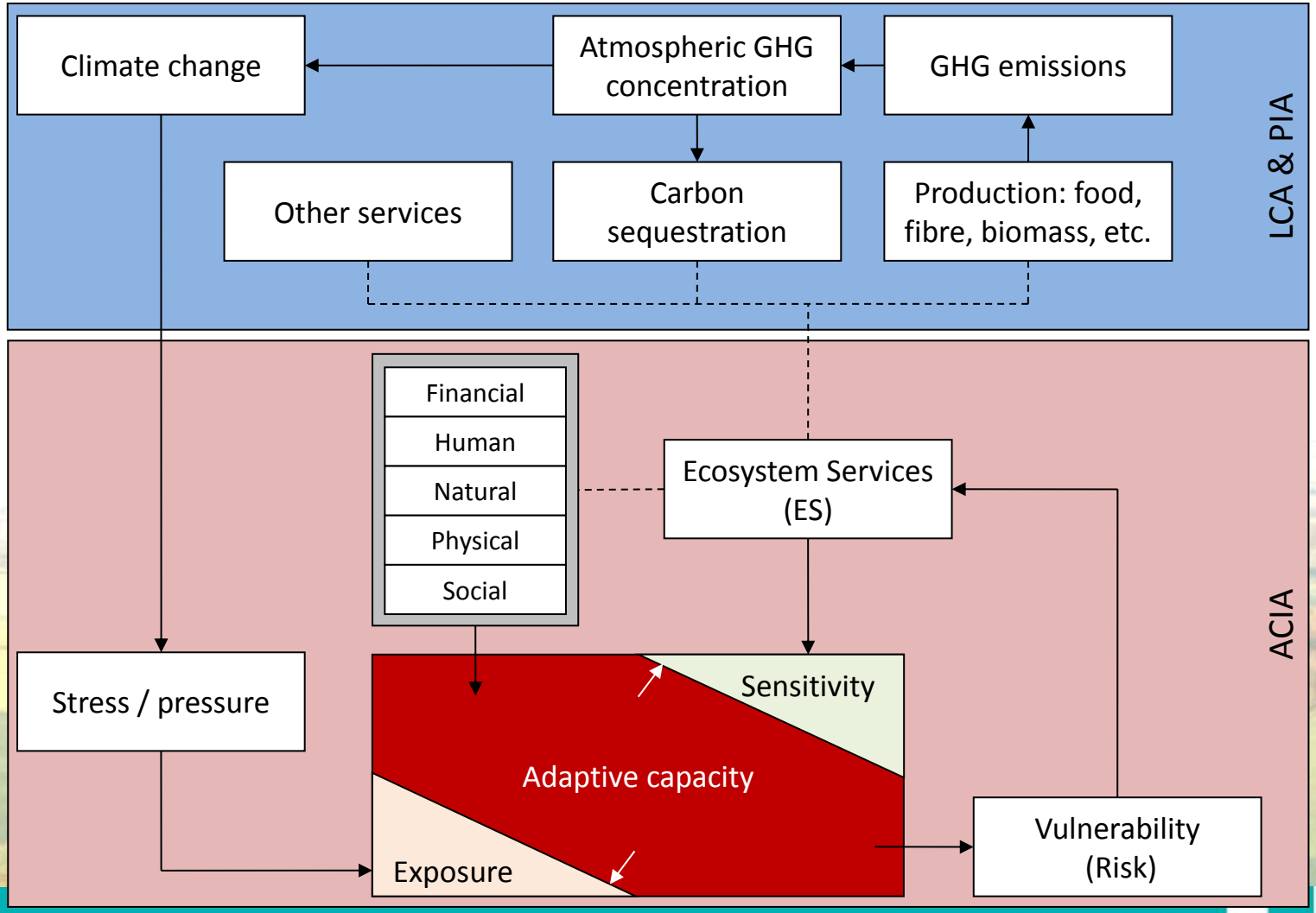
Assessment flow chart



Assessment framework



Assessment framework



Mitigation

- The purpose of the Mitigation criterion is quantify the net change in GHG emissions that arise from the implementation of RDP operations.

- This includes:
  - Direct and indirect emissions (Scopes 1-3) from:
    - Machinery operation
    - Use of inputs (e.g. pesticides and fertilisers)
  - Soil N_2O emission
  - Soil CO_2 emission and soil carbon equilibrium
  - CH_4 emissions from livestock
  - Carbon sequestered in soil
  - Carbon sequestered in plant biomass

Example

- Grass strip on an arable field:
  - Reduced field operations, reduced GHG emissions from fossil fuel combustion
  - Reduced inputs of pesticide, and GHG emissions from manufacture
  - Reduced inputs of N fertiliser, and GHG emissions from manufacture and denitrification
  - Change in soil organic matter – soil carbon sequestration
  - Change in vegetative land cover – biomass carbon sequestration

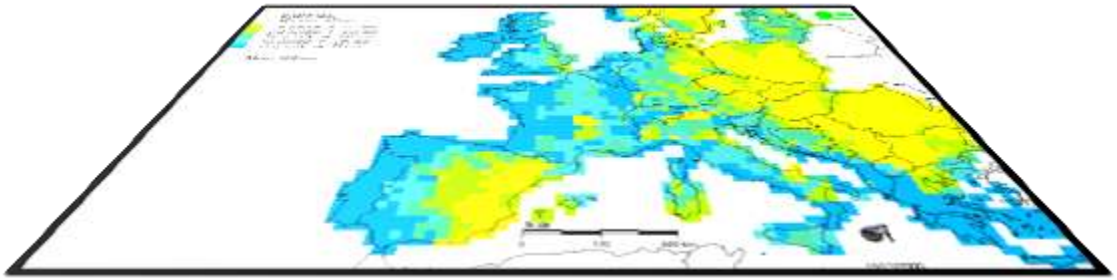
Regional variation

- Emissions and carbon sequestration will vary spatially based on numerous geographical factors
- To take this into account we have developed Regional Variation Categories (RVCs)
- GIS has been used to overlay and combine relevant spatial data, to derive RVCs and RVC classes
- Each RVC class, then has different emissions (and sequestration) factors attached to it for different activities and features

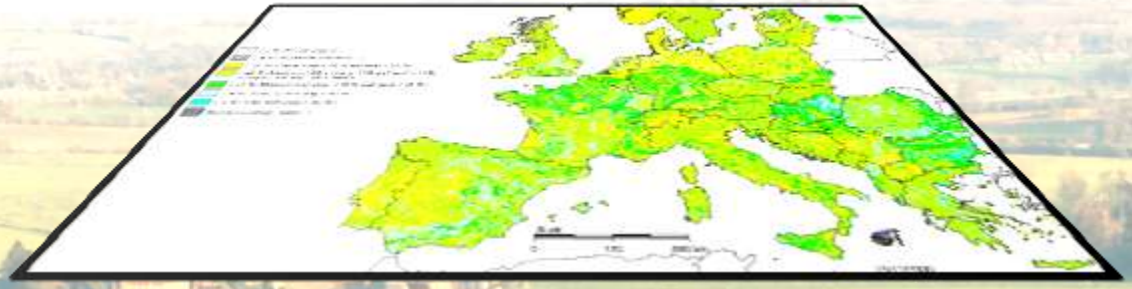
Leaching risk

High rainfall and permeable soil = high leaching risk

Winter rainfall

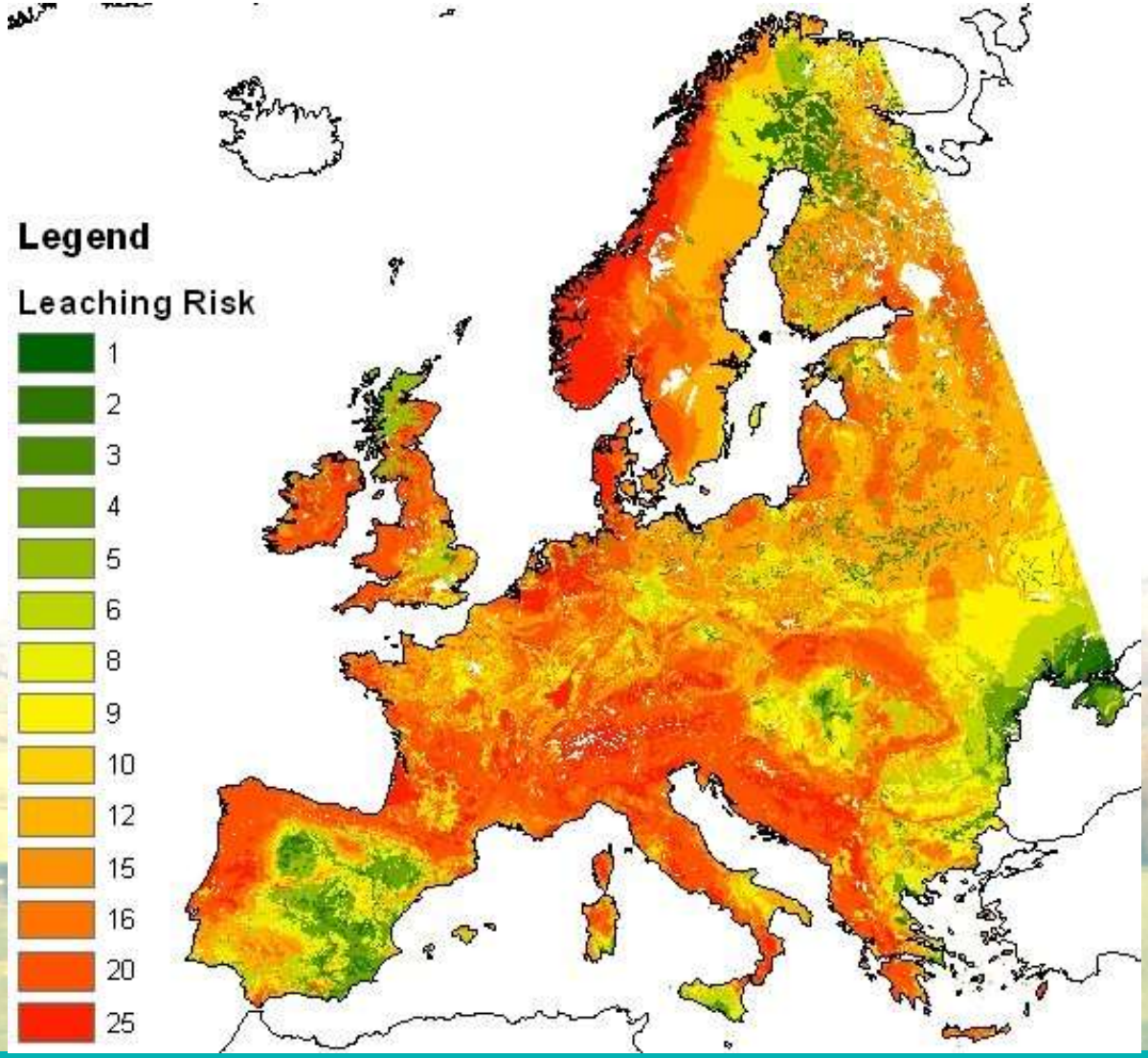


Soil type



Low rainfall and non-permeable soil = low leaching risk

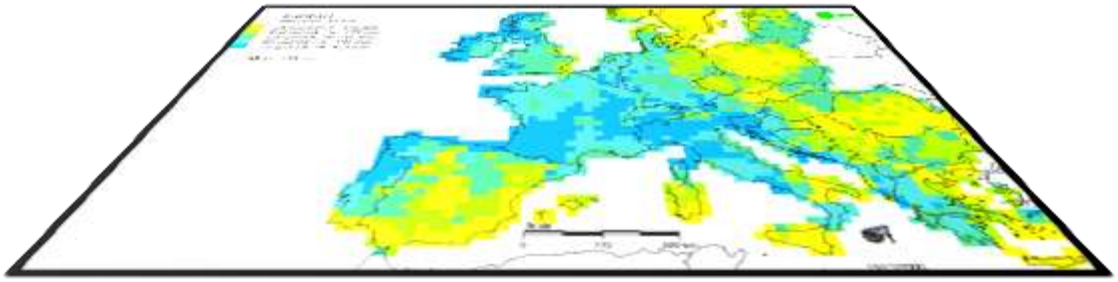
Leaching risk



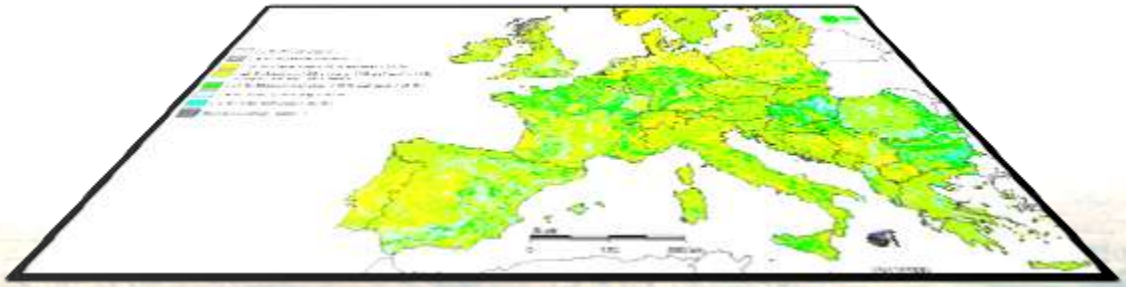
Denitrification risk

High rainfall, heavy clay soil & high compaction = high denitrification risk

Spring rainfall



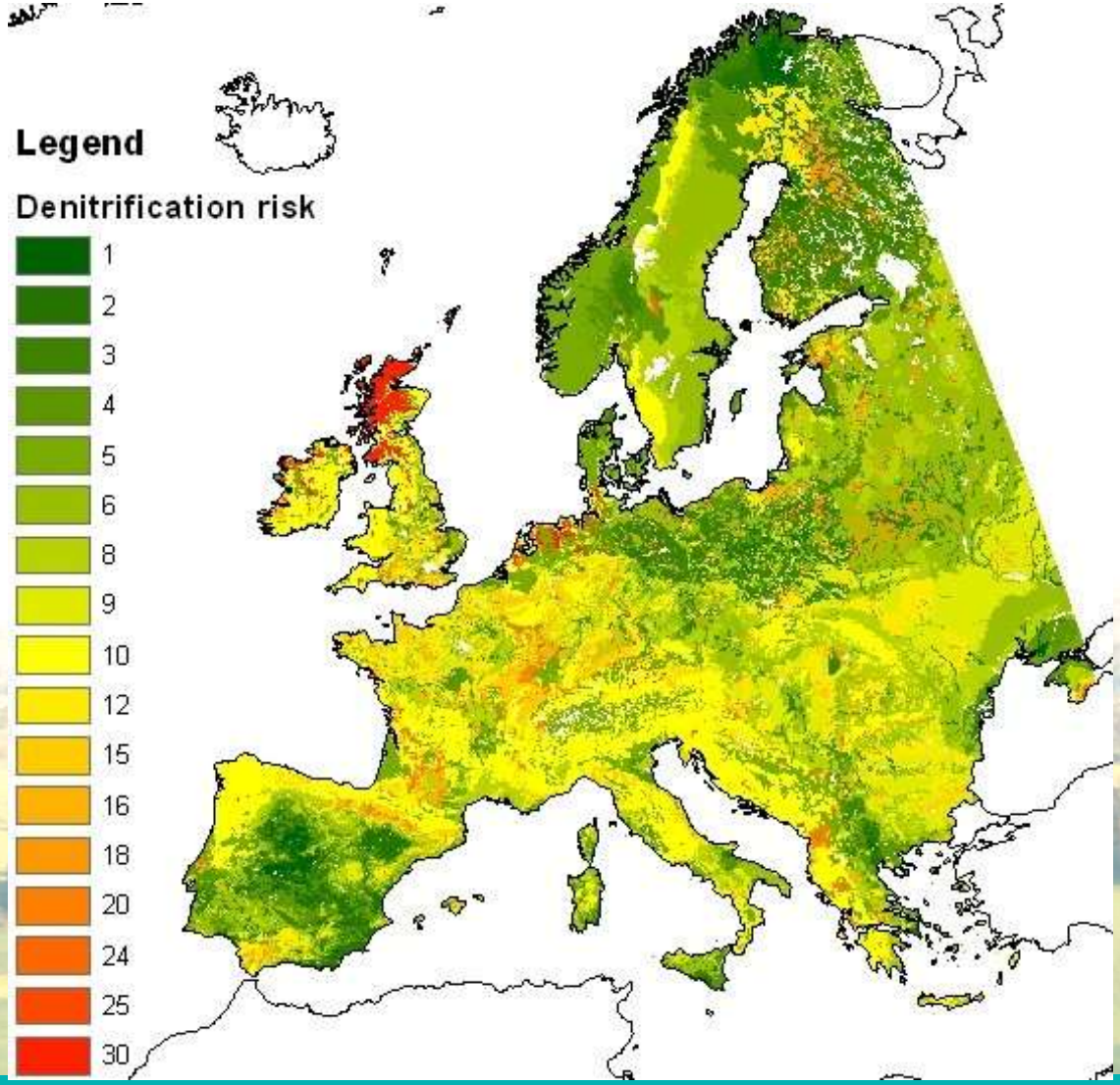
Soil type



Soil compaction susceptibility

Low rainfall, coarse soil and low compaction = low denitrification risk

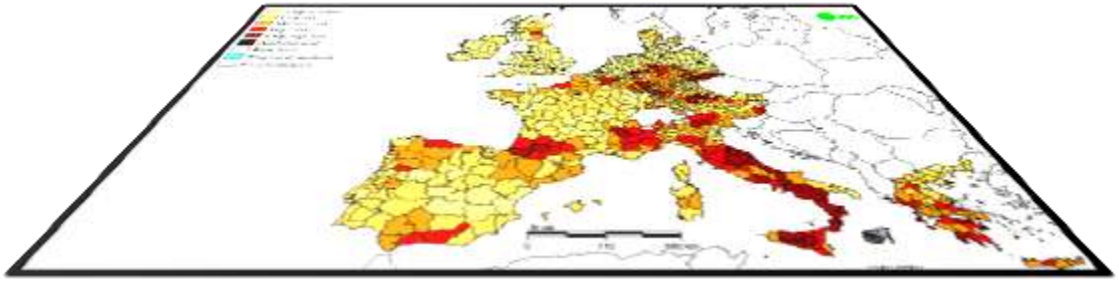
Denitrification risk



Loss of soil organic carbon from soil erosion

High erosion vulnerability and high soil organic carbon = high risk of loss of soil organic carbon

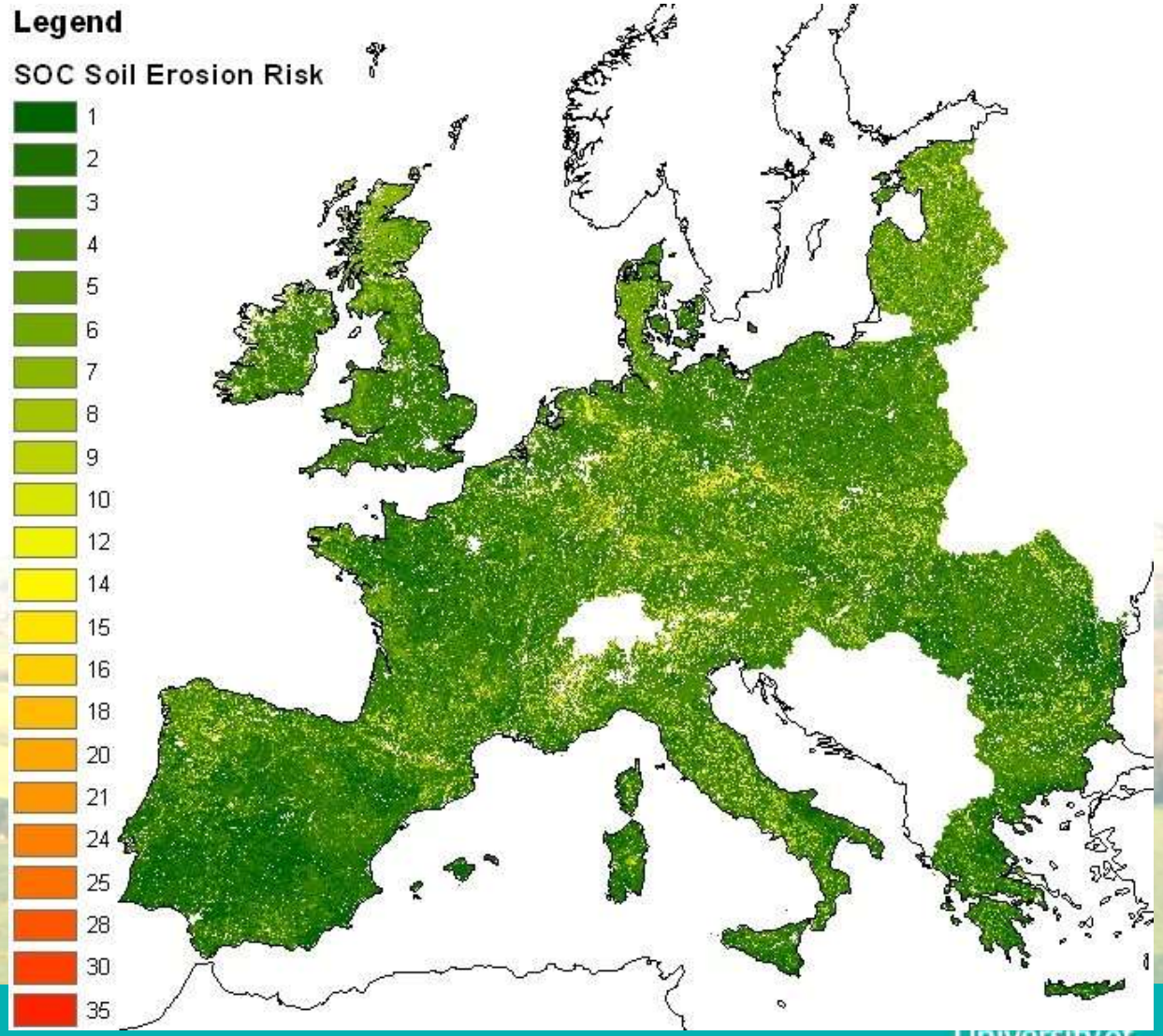
Soil erosion vulnerability



Soil organic carbon

Low erosion vulnerability and low soil organic carbon = low risk of loss of soil organic carbon

Loss of soil organic carbon from soil erosion

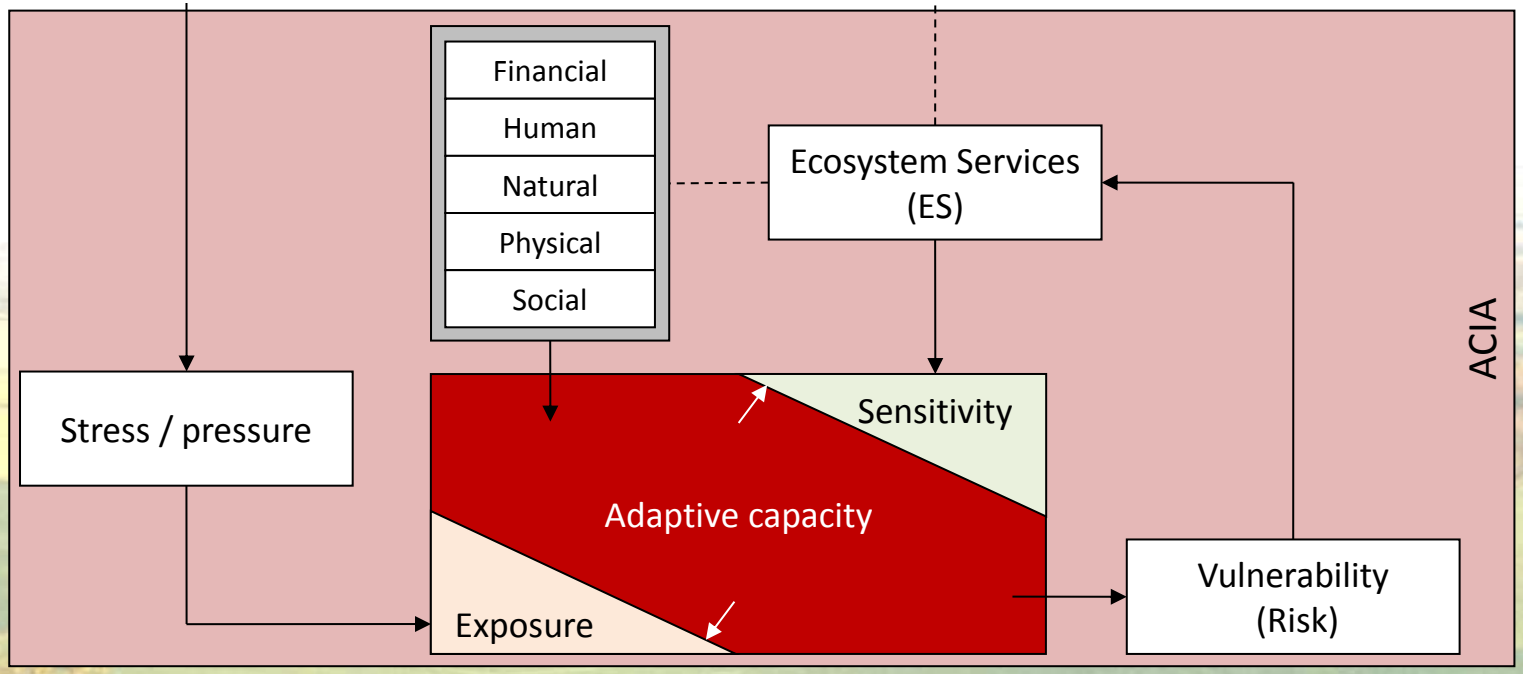


Adaptation

- Quantifying adaptive capacity is inherently difficult as it is an emergent property of a complex system
- We have taken an ecosystem services perspective, however we are NOT attempting to quantify the impact that an RDP operation has with respect to an amount of an ecosystem service
- The ACIA is essentially a risk assessment, i.e. the risk of a lack of adaptive capacity to maintain ecosystem services in the light of projected climate change

Adaptation

- If we return to the assessment framework, we can see that adaptive capacity serves as a 'buffer' between sensitivity and exposure…



Adaptation

- The RVC work involved combining data on sensitivity with exposure to (projected) climate change

- Here's a simple example for forest fires…

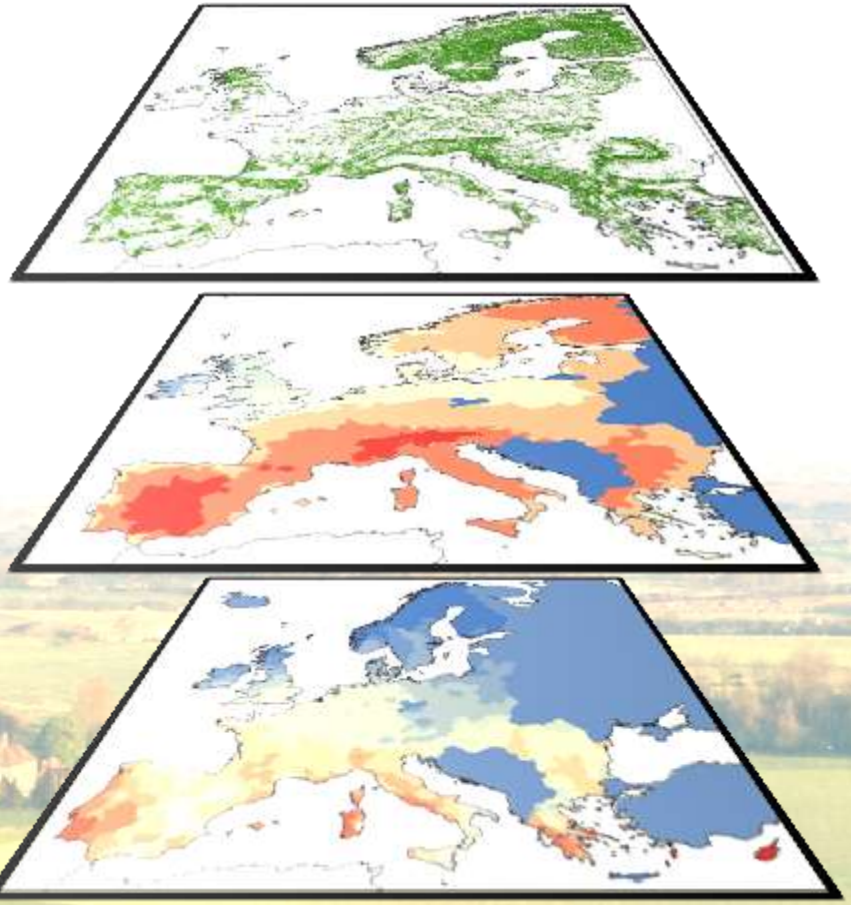
Forest fires

Highly forested area, lower summer rainfall, increased temperature = high risk of forest fires

CORINE forest cover

Projected temperature increase

Projected summer rainfall decrease

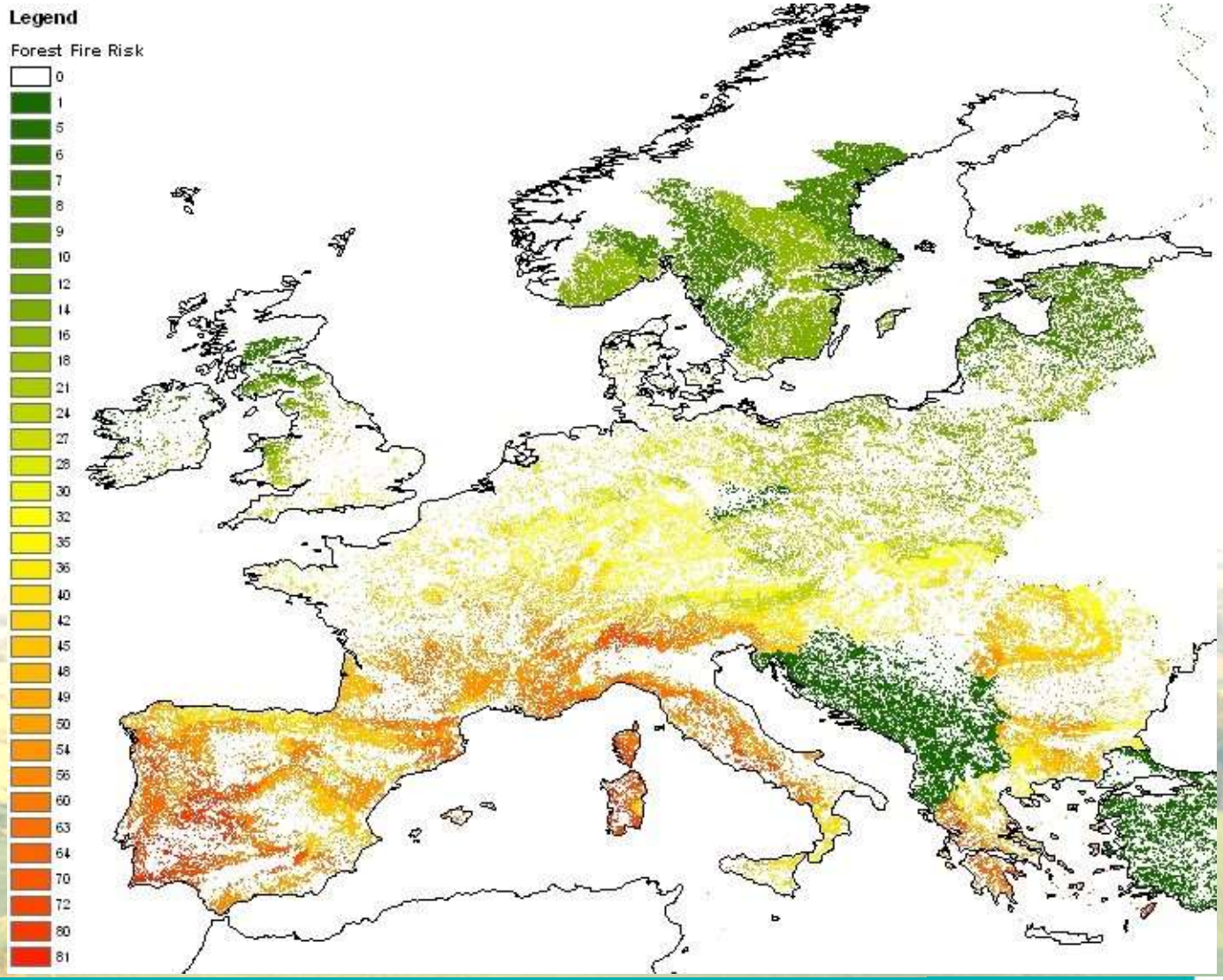


Sensitivity

Exposure

Low forested area, summer rainfall maintained, no increase in temperature = low risk of forest fires

Forest fires



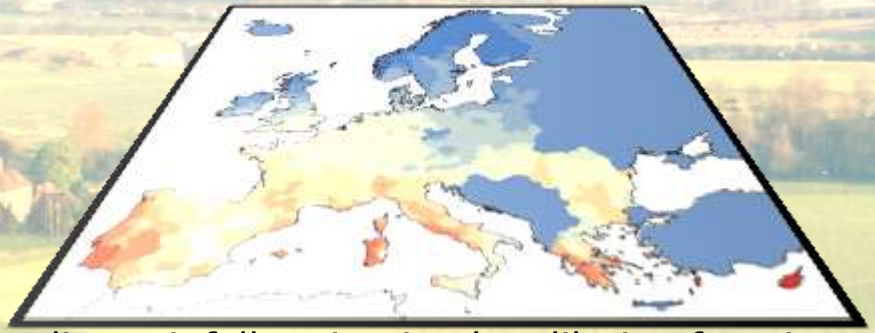
Water quality dilution

Poor water quality, lower rainfall = reduced dilution function

Current WFD surface water quality

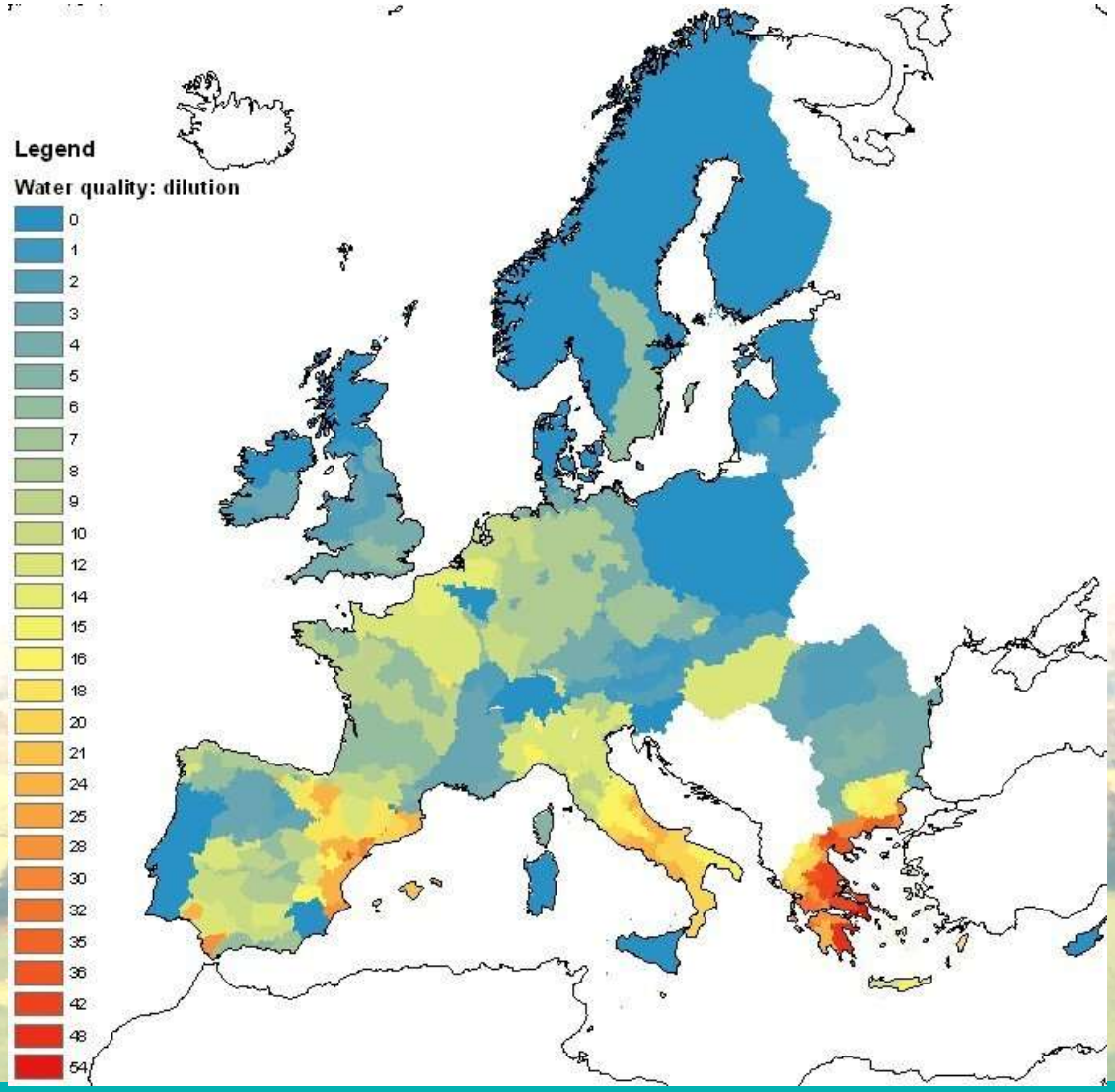
Projected winter rainfall decrease

Projected summer rainfall decrease



Good water quality, rainfall maintained = dilution function maintained

Water quality dilution



ACIA: Risk reduction

Risk reduction = (RDP value / Impact max) x 100

Where:

Impact max = all possible interventions implemented x highest RVC class in Europe x the relevant area in a region

RDP value = ∑(RDP activity impact value[1] x RVC class x area of RVC class in region) for each RVC/ecosystem service

[1] Each RDP operation can change a number of activities and features, some of which will have impact factors for ecosystem services

Productivity

- The third criterion in the MAPP criteria was Productivity, which ideally should be based on a function of Output / Input

- The case studies revealed that input costs (and to a lesser extent outputs) are highly variable, even within a region, let alone across the whole of the EU-27, consequently putting economic values on RDP operations is very problematic, to the extent it has not been possible

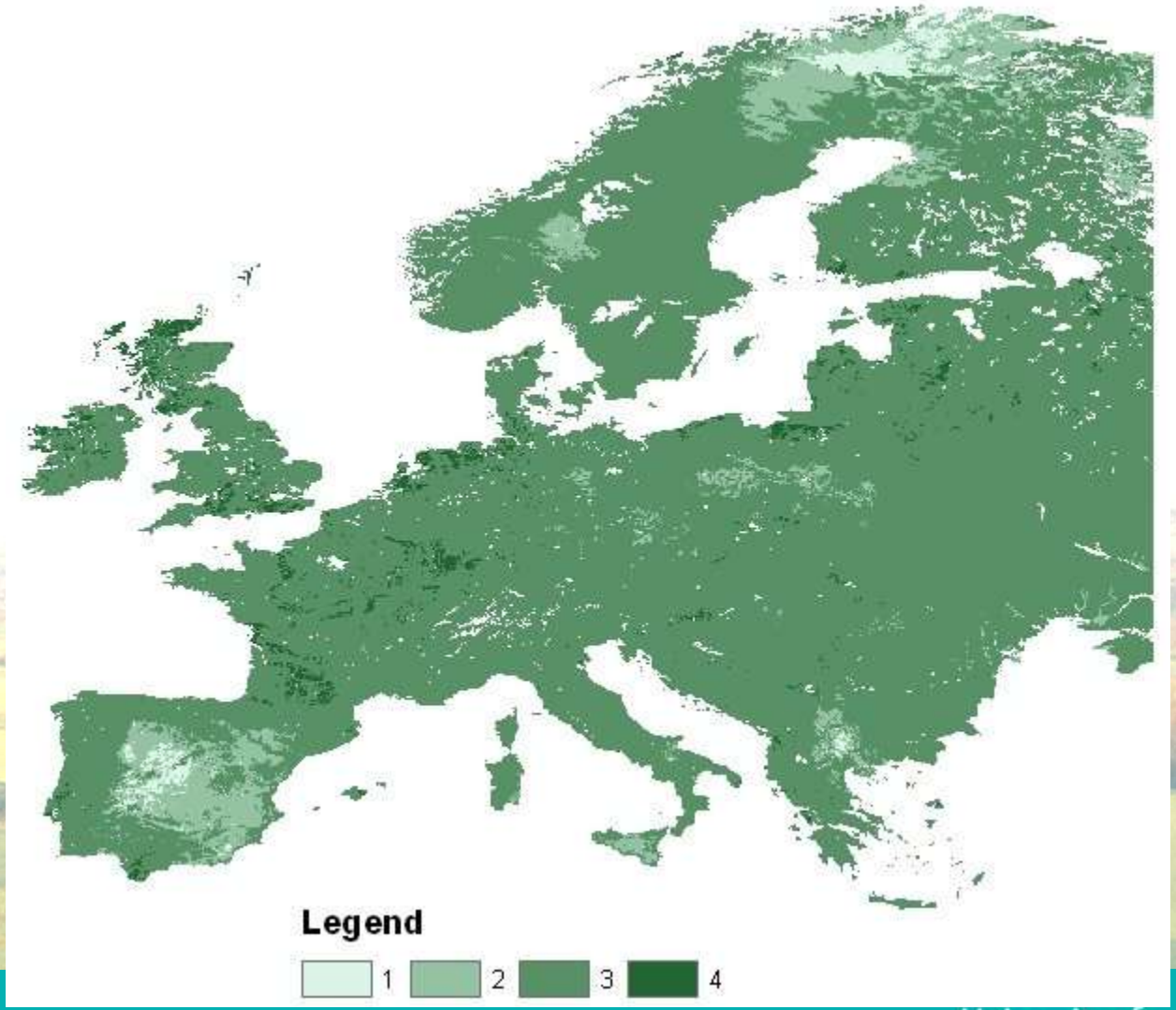
- To overcome this problem we have adopted an alternative approach, focusing on Production..

Production

- We have created RVCs for typical yields for a range of crops/enterprises across Europe. These are based on soil type, elevation, rainfall and solar radiation. This gives us different yield classes for different outputs (tonnes/ha for crops, LSU for livestock)

- Thus when calculating RDP impacts we can also calculate potential changes in yield/output, e.g. if land is taken out of production this has a greater impact on highly productive land, than on land which has a lower productive capability

Example yield class map for semi-improved grassland (cattle)



Production - normalisation

- In order to be able to compare RDP operations, we need to be able to compare their impact on production. Similarly, when an RDP operation changes the cropping (e.g. arable to livestock) we need to be able to assess the impact on a common basis – so normalisation is required.

- We explored a few approaches including nominal indices, typical revenues and typical gross margins.

- Typical gross margins is the one have opted to use

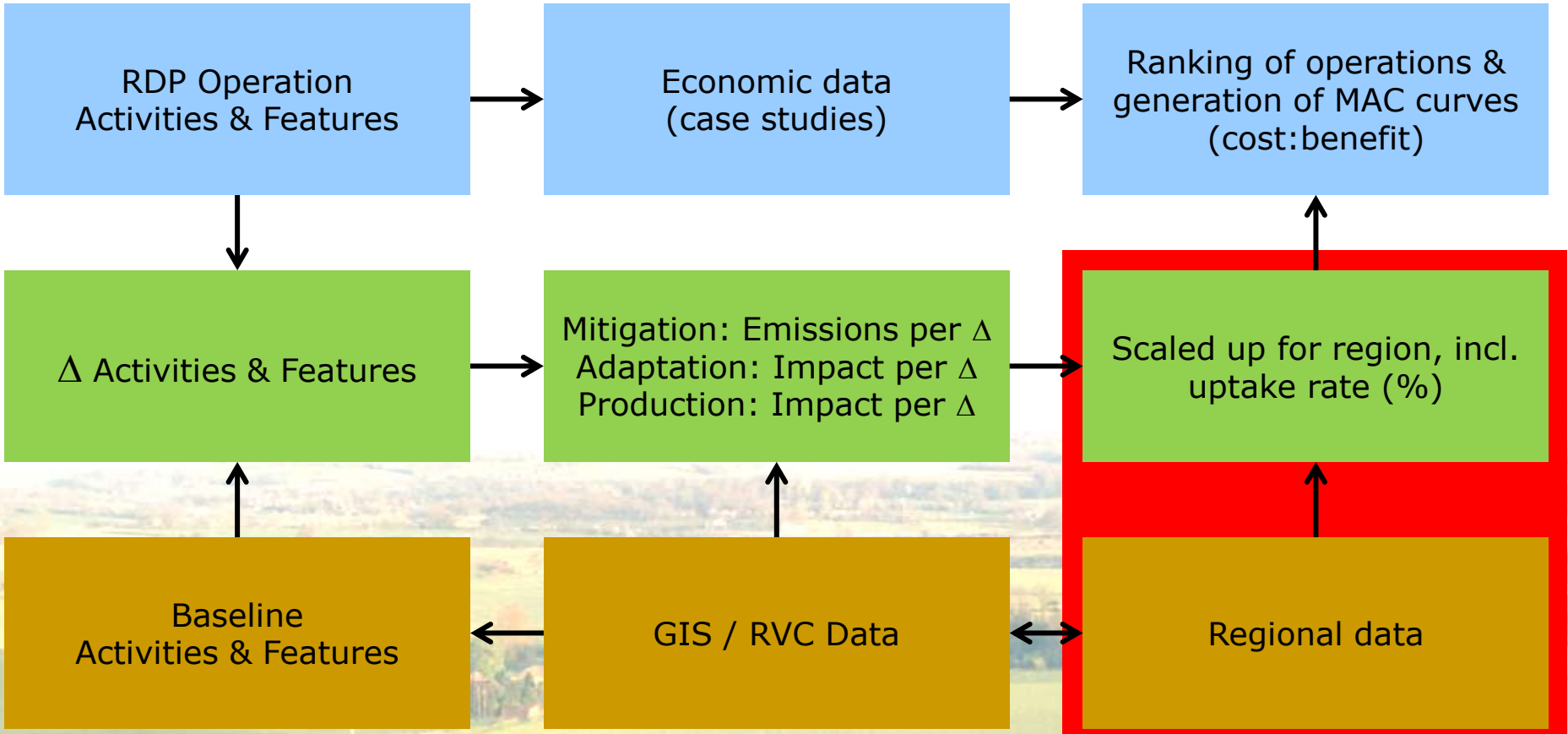
Production - normalisation

- Gross margin accounts for cost, but as described previously these can be highly variable (and not easily mapped to an RVC). Plus standard gross margins are for a specific set of inputs and specific yield.

- Typical gross margins are calculated per tonne (or per LSU) and used for normalising as follows:
  - Typical gross margin = gross margin for an average yield divided by the yield
  - Typical gross margin is then multiplied by the Yield impact (from the Yield RVC)

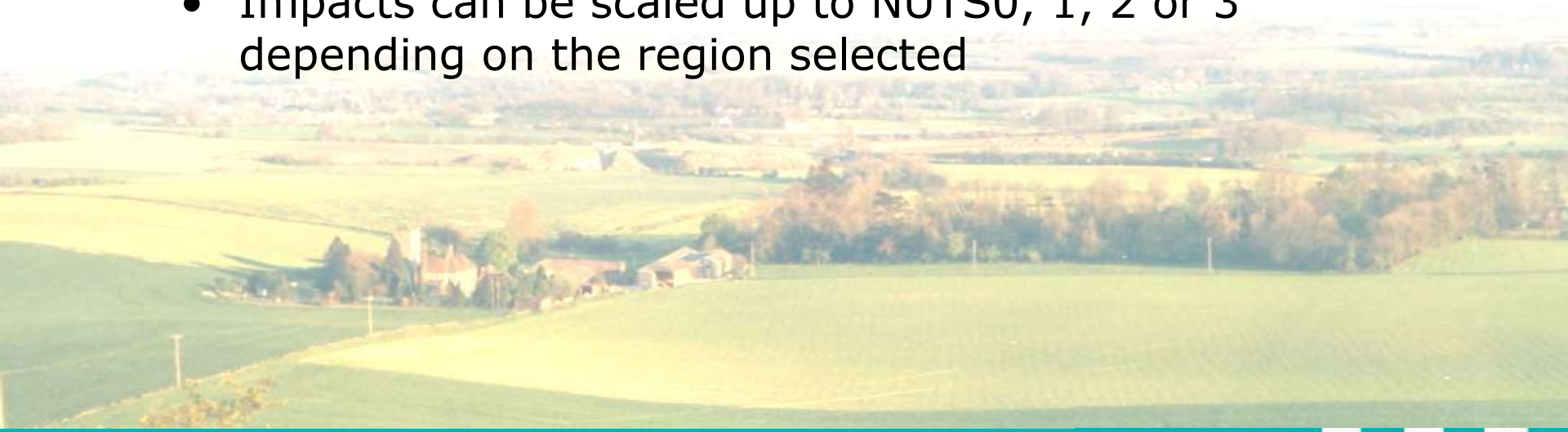
- Not ideal, but seems to be working ok so far as a means of assessing relative impact.

Assessment flow chart



Scaling up

- Each RDP operation impact is calculated on a per hectare basis
- In order to determine the potential impact within a defined region, these impacts need to be scaled up
- Impacts can be scaled up to NUTS0, 1, 2 or 3 depending on the region selected



Scaling up

- There are several processes involved in scaling up:

1. Applicable land – using the CORINE data set

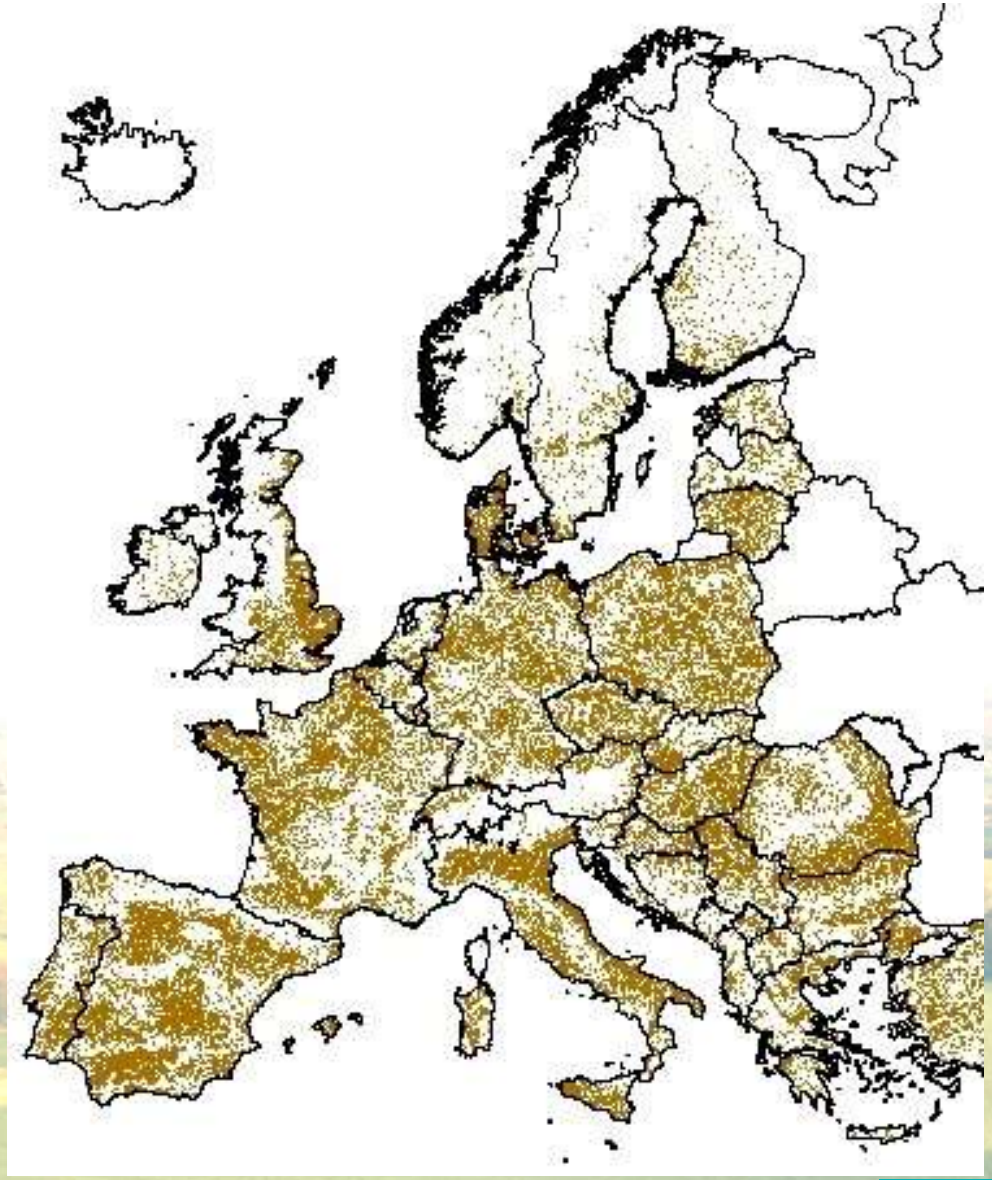
2. RVC Distribution

3. Scaling up technique
   - Whole area
   - Field boundary

4. Uptake rates

Scaling up: Applicable land

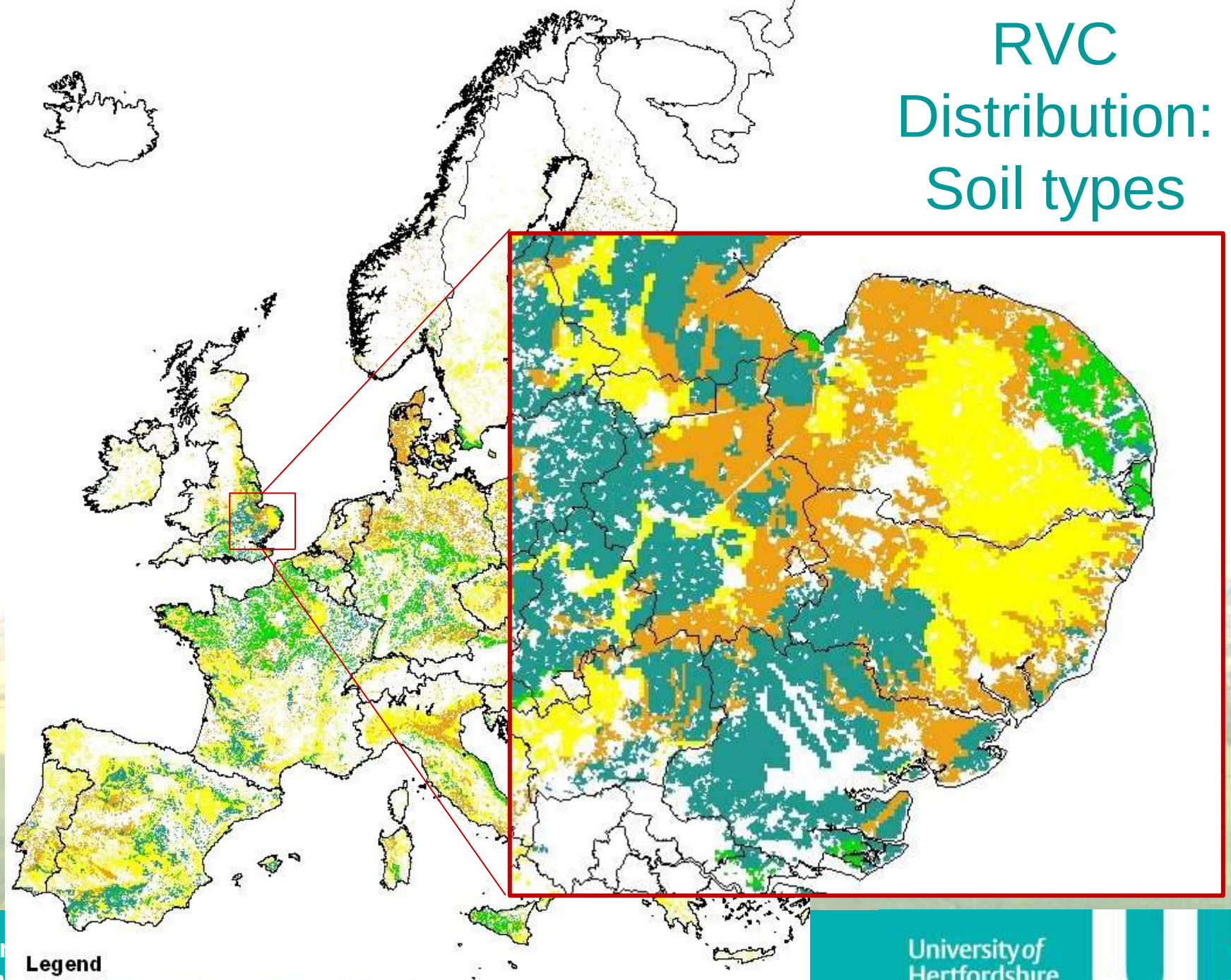
- Each RDP operation is defined for specific land uses, using the CORINE data set, e.g. some operations are for cropland only, while others are for upland grassland
- Thus within any NUTSx region we know the proportion of different land uses
- This data can be overlaid with RVC data (using GIS) so we know the proportion of RVC classes within a given area



Scaling up: RVC Distribution

- Within the applicable land area, we can then view the distribution of RVC classes for each RVC
- In some instances we have some complex data overlays and combinations, e.g. baseline RVC data, overlaid with impact RVC data and then CORINE data
- Here is a simple example using CORINE cropland with the RVC for soil texture (used to work out CO_2 emissions from field operations)…

RVC Distribution: Soil types



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Scaling up: Technique

- We have two scaling up techniques:

1. Firstly, simple percentage area (e.g. 100% of applicable land)

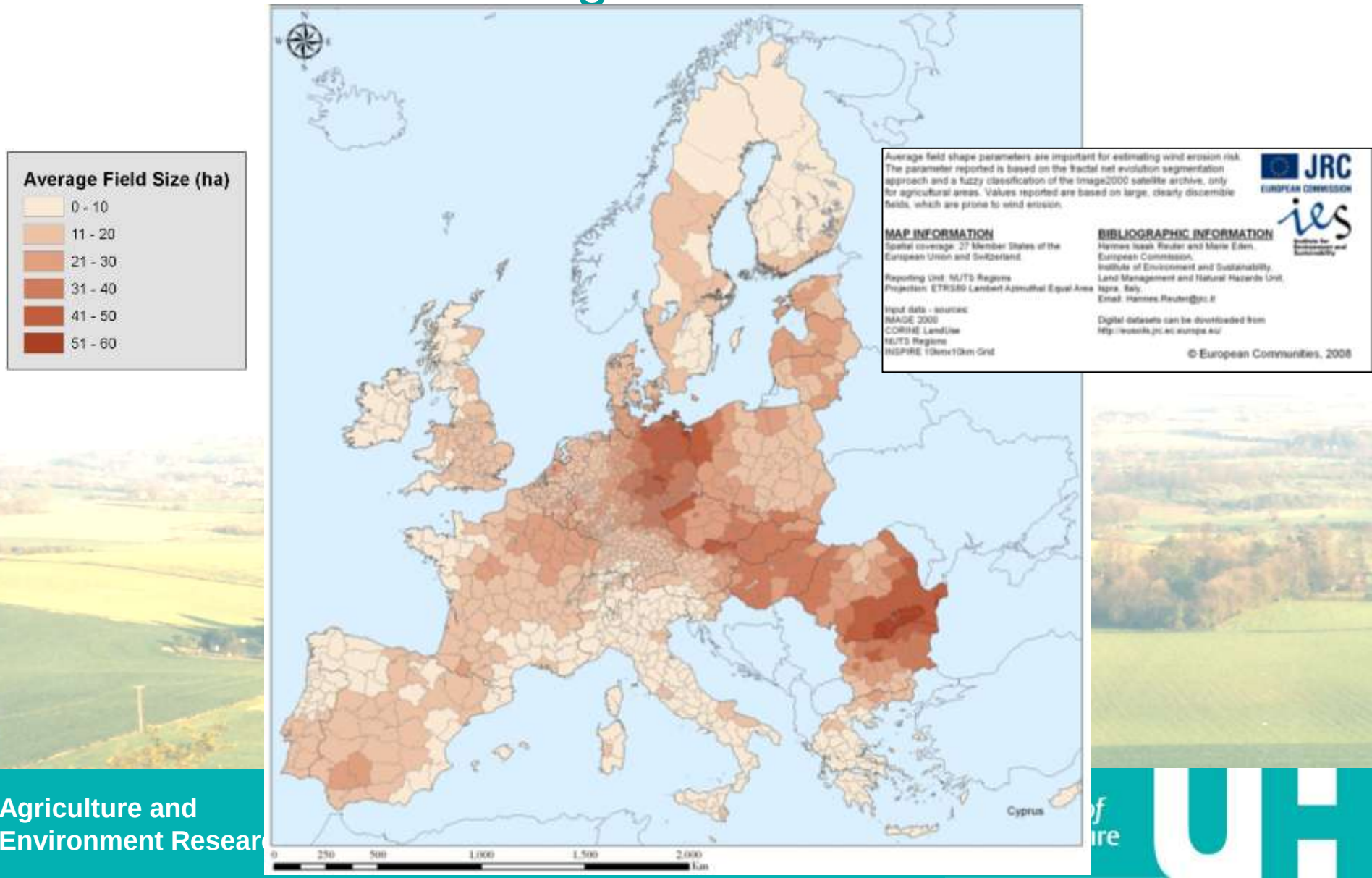
2. Secondly, based on field margins using average field sizes..

Scaling up technique: average field sizes

- Where an operation is applicable to a field boundary we can use average field sizes - per field the operation is applicable only to a proportion of a field, and that proportion depends on the size of the field.
  (If we assume all small field sizes then we risk over-estimating the potential length of buffer strips that could be implemented in a region and likewise, under-estimate if large field sizes are used)

- E.g. UK mean field size is ~12 ha (400m x 300m):
  - 400 + 400 + 300 + 300 = 1400m of boundary/12 ha
  - If a region is 12000 ha then roughly 1400000m (1400*(12000/12)) is available to which the buffer strip could be applied for that region

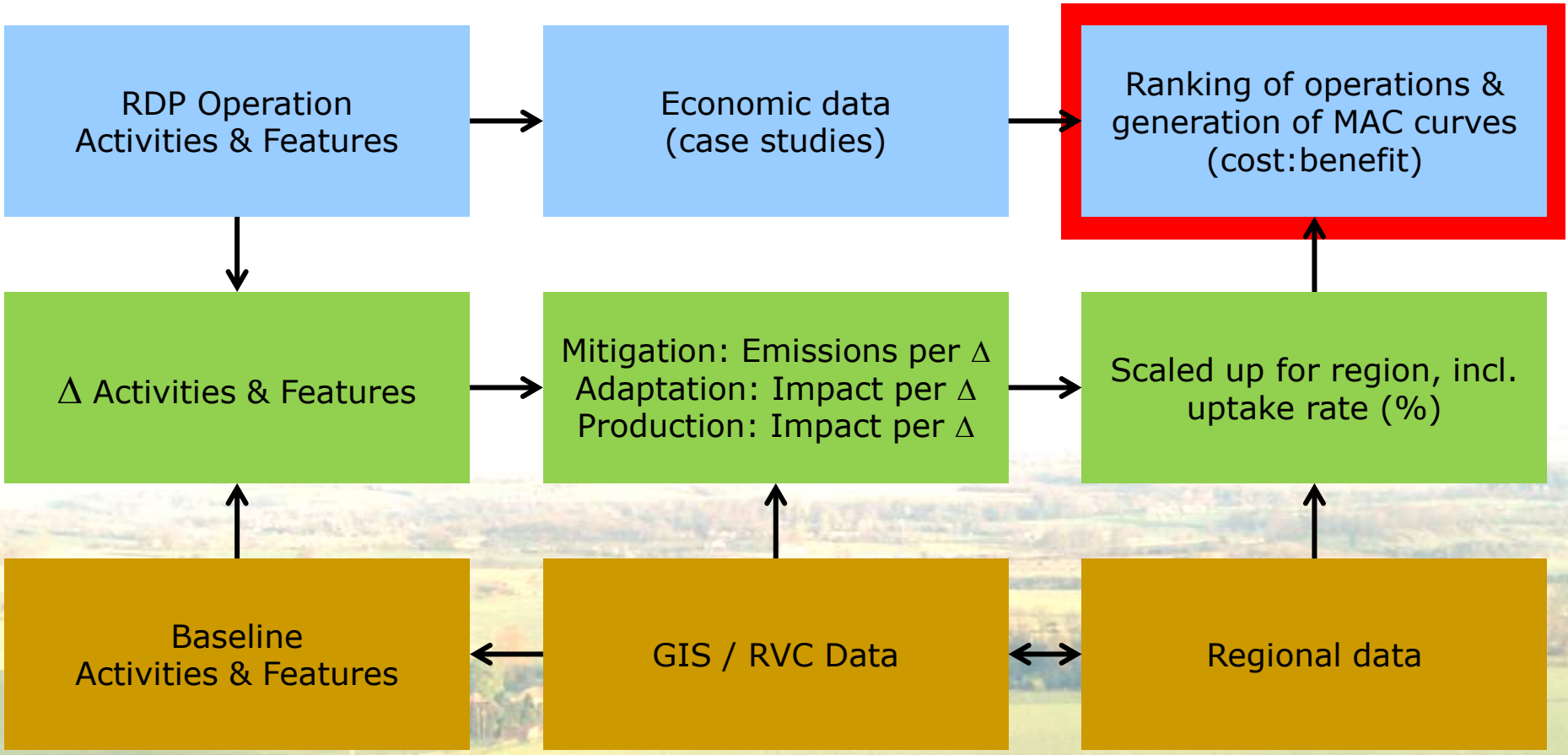
Scaling up technique: average field sizes



Scaling up: Uptake rates

- Finally, having taken account of applicable land, RVC distribution and scaling up techniques, an uptake rate can be applied
- This is the anticipated uptake or adoption of the operation within the region on an area basis
- By default is set to 100% in the software, but could be a lot lower, so is a parameter that the user can set for each operation themselves

Assessment flow chart



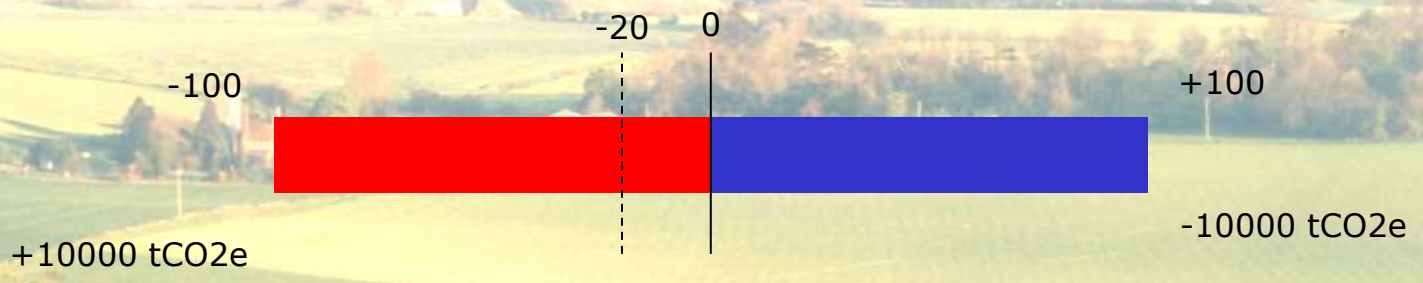
Ranking

- Once the potential impact of an operation has been scaled up, and two or more operations have been selected, their performance can be ranked
- Ranking allows RDP operations to be compared using the MAP criteria
- Each MAP criteria has a -100 to +100 scale (negative impact to positive impact)

Ranking

- The -100 to +100 scale is set by using the largest impact (positive or negative) of all the operations selected, to set the boundaries of the scale.

- For example, if for all the operations selected the GHG emissions ranged from -10000 to +2000 tCO_2e, then the -100 to +100 scale would equate to +10000 to -10000. Thus the lowest potential index in this instance would be -20
  (note: for mitigation a negative number is a positive impact)



Ranking

- Then each RDP operation is scored based on it performance on this scale, resulting in 3 indices for the MAP criteria, and 4th combined 'optimal' index

- The user can adjust the weight of each of the MAP criteria, so if they wish the combined 'optimal' index to be more focused on mitigation, they can increase its weight

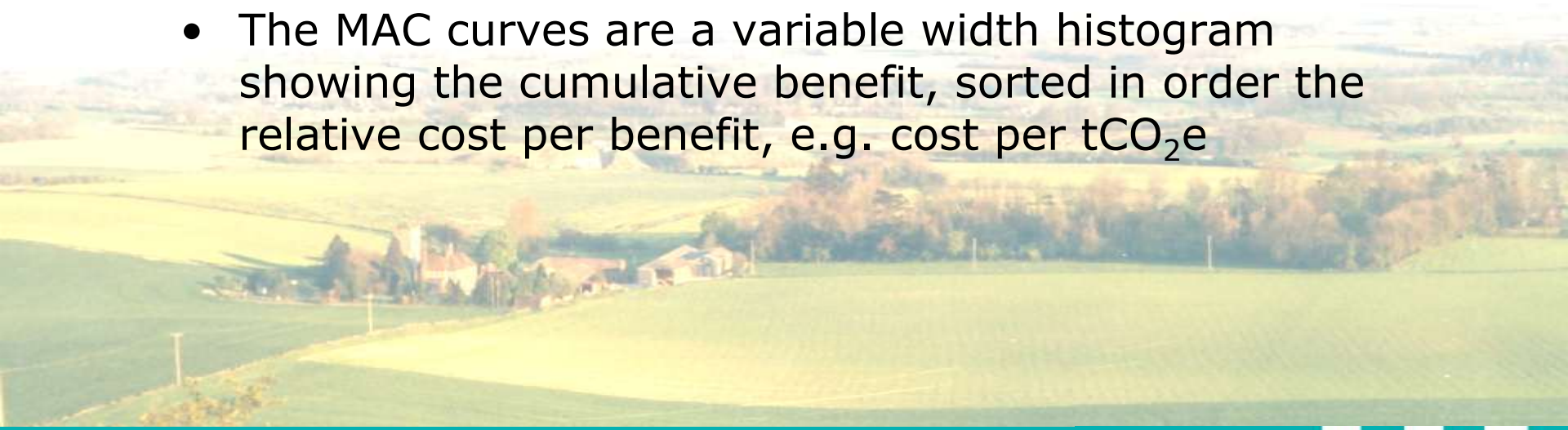
Cost-benefit

- Many RDP operations have a cost attached to them
- This cost can vary depending on the perspective being taken, for example it can include:
  - The cost to farms, in terms of impact on enterprises (input costs or impacts on yield or revenue)
  - The cost to the 'public purse', in the form of payments for operations, as part of RDP schemes
- Both approaches can be taken in OSCAR

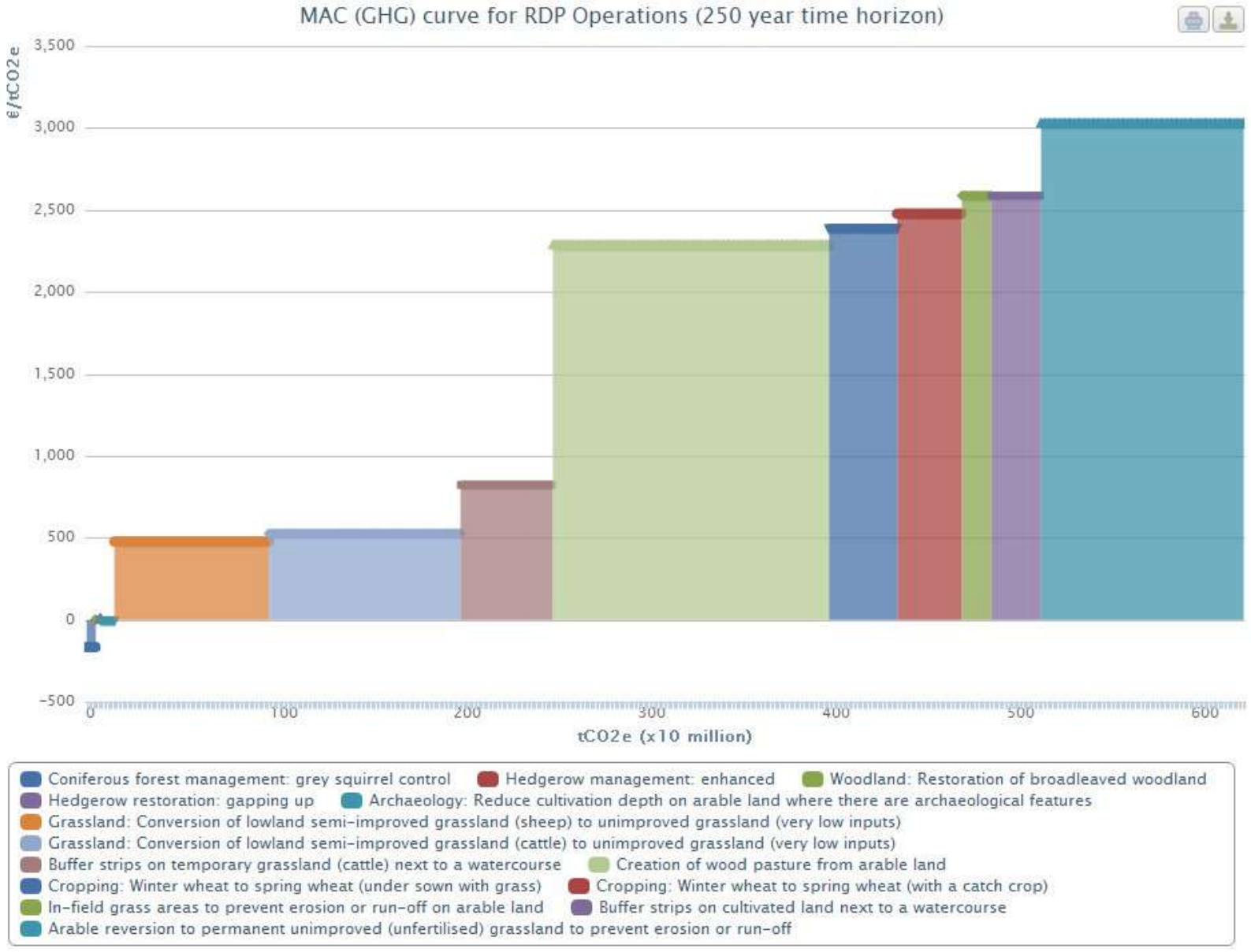
Cost-benefit

- Cost-benefit analysis in OSCAR is done using MAC curves:
  - Marginal Abatement Cost curves for GHG emissions reductions (MAC_{GHG})
  - Marginal Adaptation Cost curves of adaptive risk reduction (MAC_{ADAPT})

- The MAC curves are a variable width histogram showing the cumulative benefit, sorted in order the relative cost per benefit, e.g. cost per tCO_2e



Example MAC_{GHG} curve



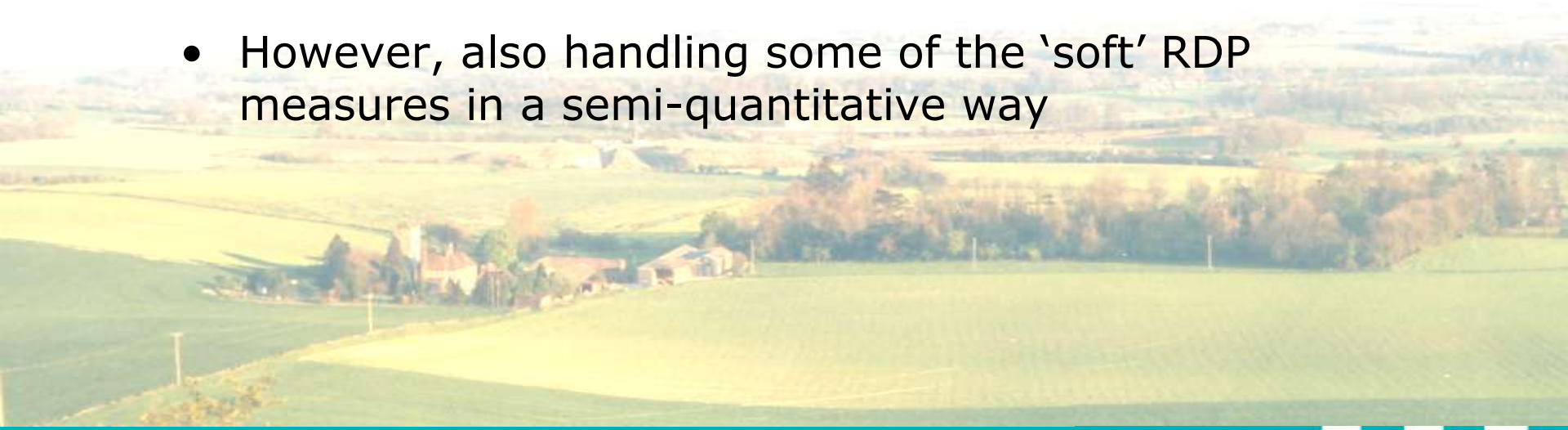
Agricult
Environ

Cost-benefit

- MAC curves can be generated using:
  - Economic data entered by the user for:
    - Annual area-based costs to the farm
    - Single one-off capital costs
    - Annual area payments
    - Single investments
  - Production impact data/costs
- MAC curves can be generated for RDP operations or aggregated for RDP measures

Practicality

- Practicality assessment is largely about qualitative data being provided alongside the operation impact assessment
- Information that relates to the efficacy of the operation
- However, also handling some of the 'soft' RDP measures in a semi-quantitative way



Practicality: Qualitative data

- Presented in a bullet point style, alongside the MAP criteria impact data
- For example, grass buffer strips can help filter pollutants that run-off from fields.
  - In the OSCAR database we have given them an 80% efficacy/impact factor
  - However, this can vary depending on a number of site-specific factors, including:
    - Slope/topography (5-10% slope ideal)
    - Position of the strip
    - Infiltration rate
    - Pollutant type and properties (e.g. sediment size, Koc, chemical characteristics, dissolved or particulate)
  - This information is presented alongside the MAP impact data

Practicality: Training, Education and Advice (TEA)

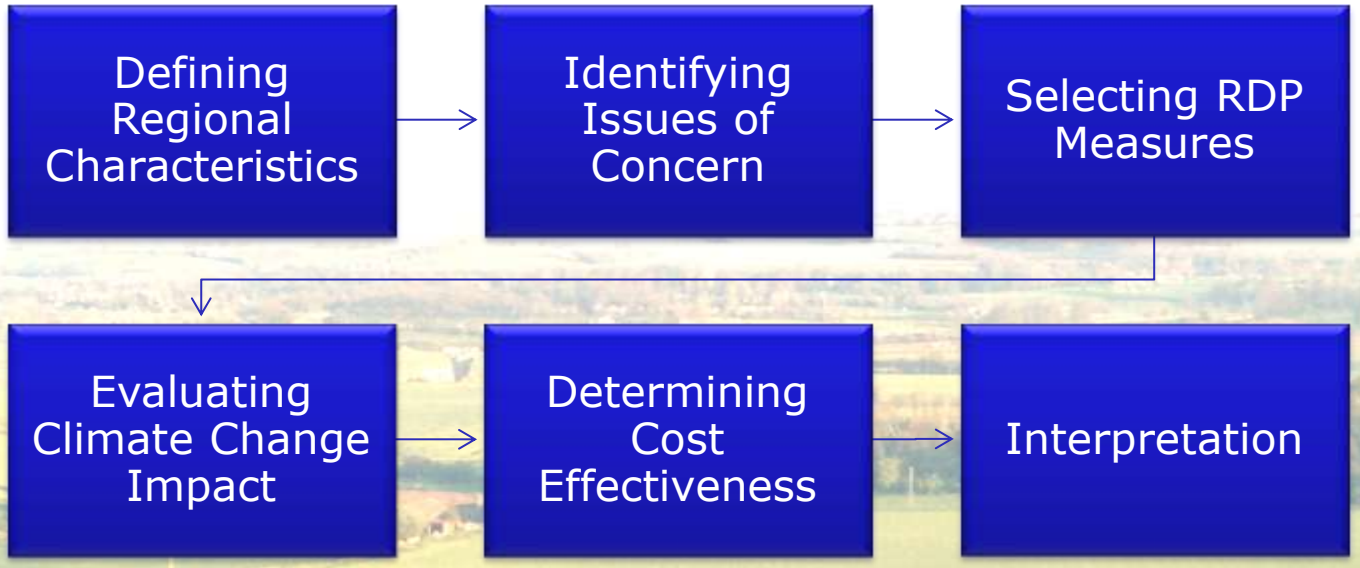
- As part of the RDP operation properties, users can set whether TEA is provided, and if it is not provided what impact is this likely to have on the efficacy (impact) that the operation

- Thus, if it considered essential to provide training to ensure benefits are realised, then the reduction factor can be set high (e.g. 50-100%)

- This data is also used to allocate potential benefits to soft RDP measures, when aggregating data for RDP measures

OSCAR Manual

- The manual is a guide to assessing impact of RDP operations on climate change objectives
- It covers several key steps:



- Design to used in a flexible way, to meet the needs of different end users

OSCAR Manual

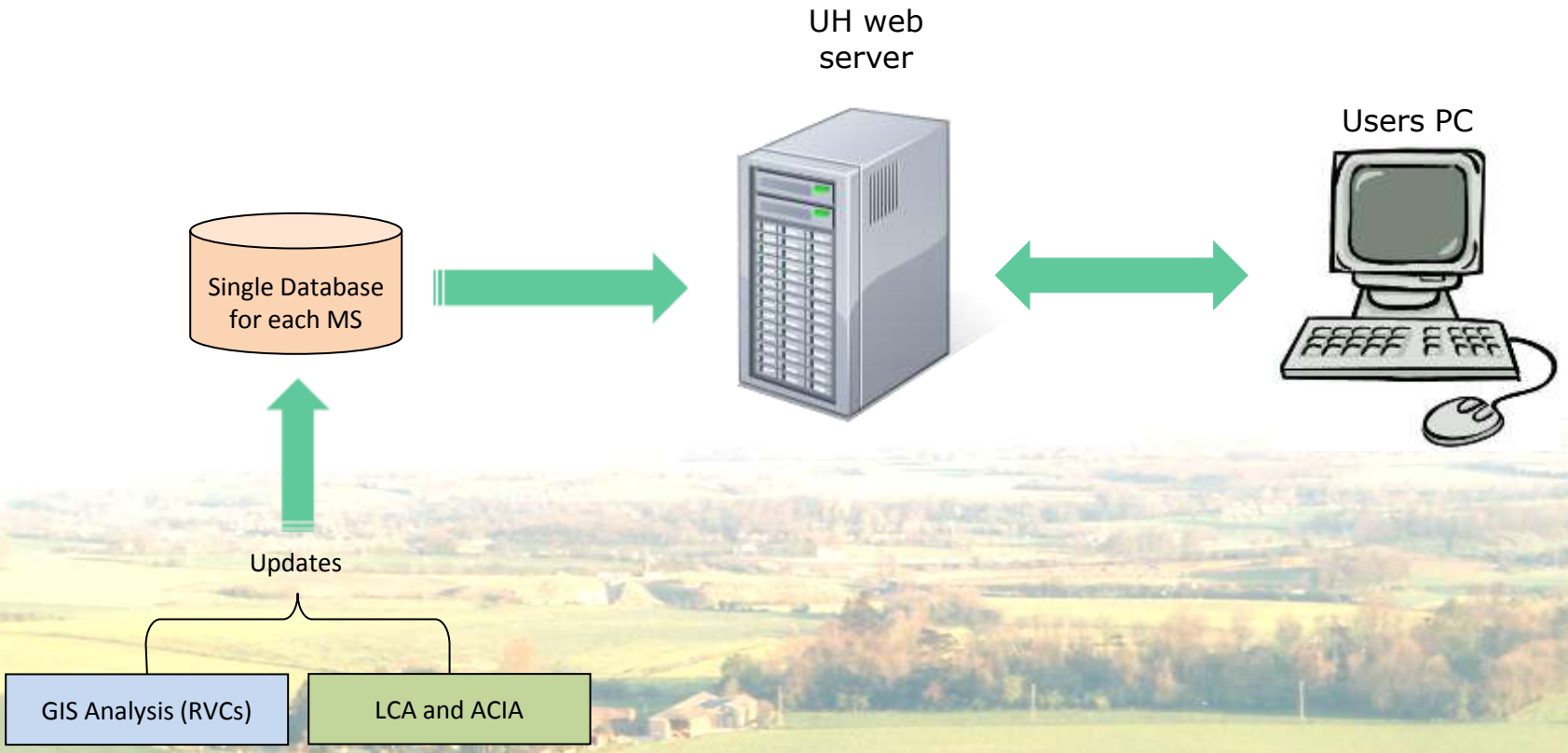
- It was apparent early in the project that any manual would need to be supported by interactive software tools and databases (because of the amount and type of data involved).

- The manual operates in conjunction with the software and aims to provide a bridge between existing RDP development processes and optimisation for climate change objectives.

OSCAR Software

- The software is the delivery vehicle for RDP climate change impact assessment process
- The OSCAR software stores all the RDP and RVC data, and supports the process of determining the climate change benefits of RDP measures and operations.
- Data are pre-processed for all NUTSx regions, making calculations within the software faster
  (e.g. to pre-process/calculate data for 100 operations for all NUTS regions in Germany takes 4 days computer run-time)
- Updates are made available via the internet

OSCAR Software: updates



Task list

OSCAR Software

Software demonstration

Any questions?

Software and manual can be downloaded from the project website:

http://www.herts.ac.uk/aeru/oscar/