ENVIEVAL

Development and application of new methodological frameworks for the evaluation of environmental impacts of rural development programmes in the EU

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Executive summary of case study results (Deliverable D6.3)

Authors: Katalin Balázs (SZIE), Péter Tóth (SZIE), Csaba Centeri (SZIE), László Podmaniczky (SZIE), Gerald Schwarz (TI), Anne Wolff (TI), Angela Bergschmidt (TI), Frank Offermann (TI), Bernhard Osterburg (TI), Inge Aalders (JHI), David Miller (JHI), Jane Morrice (JHI), Alessandro Gimona (JHI), George Vlahos (AUA), Alexandra Smyrniotopoulou (AUA), Janne Artell (LUKE), Jyrki Aakkula (LUKE), Heini Toikkanen (LUKE), Andrea Povellato (CREA), Davide Longhitano (CREA), Valentina Lasorella (CREA), Zymantas Morkvenas (BEF), Kestutis Navickas (BEF), Justas Gulbinas (BEF), Aivaras Jefanovas (BEF)

Approved by Work Package Manager of WP6: Katalin Balázs

Approved by Project Coordinator: Gerald Schwarz

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SEVENTH FRAMEWORK PROGRAMME

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Abbreviations

AEM	Agri-Environment Measure
AEP	Agri-Environmental Programme
BW	Biodiversity Wildlife
CF	CounterFactual
CMEF	Common Monitoring and Evaluation Framework
CMES	Common Monitoring and Evaluation System
DiD	Difference-in-Difference
DREMFIA	Dynamic multi-REgional sector Model for FInnish Agriculture
EEA	European Environment Agency
ENRD	European Network for Rural Development
FADN	Farm Accountancy Data Network
FAEP	Finnish Agri-Environmental Programme
FBI	Farmland Bird Index
FSS	Farm Structure Survey
FU	Functional Unit
GHG	GreenHouse Gas
GNB	Gross Nutrient Balance
GWP	Global Warming Potential
HFC	HydroFluoroCarbons
HNV	High Nature Value
IACS	Integrated Administration and Control System
IPCC	Intergovernmental Panel on Climate Change
ISPRA	Institute for Environmental Protection and Research
LCA	Life Cycle Assessment
LFA	Less Favoured Area

LFASS	Less Favoured Area Support Scheme
LPIS	Land Parcel Identification System
LSU	LiveStock Unit
LULUCF	Land Use, Land Use Change and Forestry
NBS	Number of farmland Bird Individuals
NIR	National Inventory Report
RDP	Rural Development Programme
SAC	Special Area of Conservation
SAPM	Survey on Agricultural Production Methods
SOC	Soil Organic Carbon
SWOT	Strengths Weaknesses Opportunities Threats
UAA	Utilized Agricultural Area
UNFCCC	United Nations Framework – Convention on Climate Change
USLE	Universal Soil Loss Equation

Introduction

The main aim of the report is to provide an overview of the results of the case studies testing a range of indicators and methods for the evaluation of rural development measures and Rural Development Programme (RDP) impacts on environmental public goods, and to derive recommendations for adjustments to the methodological framework in WP3 to WP5 as a basis for the methodological handbook.

The case studies are the central tool to validate the developed logic models (methodological framework) for the counterfactual-based evaluation of environmental impacts of RDPs at micro and macro level (WP3 – WP5) and to test the contributions of indicators and methods identified in previous reviews and theoretical analyses (e.g. D3.1, D3.2, D4.1, D4.2, D5.1 and D5.2) to address the main challenges in evaluations of environmental impacts of RDPs. Of the main environmental public goods identified in ENRD (2011), the case studies focus on climate stability, biodiversity, water quality, soil functionality and cultural landscapes. These environmental public goods reflect the key environmental objectives of the CAP and are at the core of the needs of evaluations of environmental impacts of the rural development programmes in the Member States. In addition to the testing of indicators and methods in the context of environmental public goods, a review of the integration of animal-based (result-based) indicators into a multi-criteria evaluation framework of animal welfare has been carried out in a final case study deriving guidelines for the selection of animal welfare indicators.

The selection of case study areas and the description of database infrastructure are provided in D6.1 and D6.2. Table 1 provides an overview of the public good case studies summarising the main evaluation challenges addressed in the case studies, the case study context, the indicators and methods tested and their expected outcome.

Table 1 Summary table of public goods case studies

Case study	Public good	Main evaluation challenges addressed	Case study context		Indicators tested		Methods tested		Expected outcome
			Case study area	Policy measures	Micro level	Macro level	Micro level	Macro level	
BW-HU	Biodiversity wildlife	Establishing robust causal linkages between implemented policy measures and changes in biodiversity indicators at micro level	Heves-plain	214	Number of farmland bird species (NBS) and Number of farmland bird individuals	Farmland Bird Index	Spatial analyses of survey spots (with and without comparison groups)	Spatial analyses of quadrats (with and without comparison groups)	• Assessment of additional biodiversity indicator (NBS) at micro level • Set up feasible hierarchical sampling strategies which allow consistent biodiversity impact assessment at micro and macro levels based on accessible data
BW-LT	Biodiversity wildlife	Indicator gaps at micro level - missing robust indicators to evaluate net-effects of specific agri-environmental measures on biodiversity wildlife at micro level; Lack of coordination and integration of available data between agriculture and environmental sectors	Micro level assessment: Šilutė and Vilnius regions	214	Singing males of corncrake (corncrake density) , white stork breeding density and breeding success		Multiple regression analysis	Hierarchical sampling and spatially explicit up-scaling	• Assessment of additional biodiversity indicator at micro level •Assessment of appropriateness of biodiversity monitoring data for the AEM evaluation • Recommendations for improving integration of data systems at public administration in order to enable cross-sectoral linkages and impact assessments of causal linkages between agricultural and environmental sectors.
CC-FI	Climate stability	Area-wide implementation of policy measures and lack of a non-participant control group.	Finland: whole country	211, 212 and 214	CO_2 equivalent measures both with and without land cover changes		Not applicable	Partial equilibrium model	• Application for macro level evaluation in particular in cases with limited or lacking non-participants • Regionally differentiated sectoral modelling framework to consider indirect effects at macro level
CC-IT	Climate stability	Complexity and data requirements of existing and additional impact indicators and public good assessments	Emilia Romagna	214, 216, 221	GHG balance at farm level/at crop level		IPCC and LCA approaches (Carbon footprint)	Up-scaling from hierarchical sampling (consistency check)	• Assessment of the suitability and robustness of the footprint method to evaluate net-effects of RDPs • To infer regional result (macro level) to evaluate RDP environmental impact in terms of carbon emissions • Assessment of carbon emissions (CO_2) in different agricultural contexts and processes (farm type)

Case study	Public good	Main evaluation challenges addressed	Case study context		Indicators tested		Methods tested		Expected outcome
			Case study area	Policy measures	Micro level	Macro level	Micro level	Macro level	
HNV-IT	High Nature Value farmland	Establishing consistent micro-macro linkages to inform the net-impact assessment at micro and macro level Lack of control groups to establish advanced and robust counterfactuals to assess the environmental impact of RD measures.	Veneto Region	211, 214, 216, 221	% of HNV farmland, HNV score		Multicriteria analysis	Up-scaling of micro level results (consistency check)	• Quantification of HNV farmland under different data availability • Quantitative assessment of the contribution of RDP measures to improve the diffusion of HNV farmland
HNV-LT	High Nature Value farmland	Indicator gaps - Testing additional result indicators for HNV assessments covering forestry	Lithuania: Panevezys plain area	214, 221, 223	Landscape heterogeneity (changes in diversity of ecotones)		Spatial statistics	Spatial statistics	• Quantitative assessment of the contribution of RDP measures to improve the diffusion of HNV farmland and forestry. • Assessment of additional HNV indicator to improve integration of forestry
L-GR	Landscape	Indicator gaps - lack of suitable result and impact indicators for counterfactual-based micro and macro level assessment Establishing robust causal linkages between implemented policy measures and landscape changes in a specific traditional and local context	Island of Santorini	214 and the special measures in favour of the Small Aegean Islands	Land cover change (conversion at different points in time), Visual amenity		Spatial analysis (DiD)	Spatial analysis upscaled	• Assessment of suitability and robustness of additional result indicators for landscape changes in a specific local context • Assessment of synergies of two different policy measures, including a multiple objective RD measure, not directly focusing on landscape protection but rather on maintaining the rural society.
L-SCO	Landscape	Indicator gaps - lack of suitable result and impact indicators for counterfactual-based micro and macro level assessment Consistent micro-macro linkages to contribute to net-impact assessment.	Aberdeen-shire	212, 214	Coherence (shape and edge metrics), disturbance (Patch metrics) visual scale (openness/ closed-ness)	Complexity (Shannon index), historicity (presence of historic features), naturalness (% UAA Natura2000)	Landscape metrics (patch/field metrics for holdings), spatial analysis (visibility)	Spatial analysis and landscape metrics (shape metrics)	• Identification of LCA indicators that can measure impact of RDP on landscape at micro and macro level, • Robustness of landscape metrics, in particular the indicators for landscape character assessment, under different data availabilities • Systematic approach to identify causal links between implementation at micro level and impact at macro level.

Case study	Public good	Main evaluation challenges addressed	Case study context		Indicators tested		Methods tested		Expected outcome
			Case study area	Policy measures	Micro level	Macro level	Micro level	Macro level	
SQ-HU	Soil quality	Explicit consideration of other intervening factors and the establishment of robust causal relationships Consistent micro-macro linkages to contribute to net-impact assessment	Hungary: whole country	214	Soil quality: Soil organic carbon (SOC) content; decrease in soil organic matter (SOM) Soil erosion: annual average soil loss per ha		Biophysical modelling approach: CLUE model USLE prediction model	Biophysical model results scientific sampling and spatially explicit up-scaling	• Modelling based consideration of other intervening factors at macro level. • Comparative assessment of model-based and sampling-based approaches • Establishment micro-macro linkages through aggregation of spatially explicit GIS data
SQ-SCO	Soil quality	Consideration of other intervening factors and local environmental characteristics Establishment of robust causal relationships	Grampian region	212, 214, 221, 223, 225	Soil organic carbon content; soil carbon in arable land; soil erosion: annual average soil loss and sediment retention		USLE prediction model and InVest model	USLE model: calculation of the soil indicators	• Robustness of the tested indicators and methods with limited data availability • Modelling based consideration of other intervening factors at macro level. • Establishment of robust micro-macro linkages through aggregation of spatially explicit GIS data
WQ-DE	Water quality	Lack of control groups to establish advanced and robust counterfactuals	Lower Saxony	214 and 114	GNB and Nmin		Biophysicial models, PSM and regression analysis	biophysical model results, spatially explicit up-scaling	• Testing of an alternative impact indicator (non-CMEF) • Integration of data from different sources to construct robust counterfactuals and use advanced statistical methods to assess net-effects
WQ-FI	Water quality	Area-wide implementation of policy measures and lack of a non-participant control group.	Southern Finland	214	Nitrogen reduction (calculated GNB, nitrogen)		Biophysical and structural modelling	Biophysical and structural model results up-scaled	• Existing structural models provide solutions for counterfactual analysis without comparison groups. • Needs and capabilities to accommodate structural models with new data • Quantitative assessment of environmental impacts of nitrogen reduction on the level of Southern Finland (possibly)
WQ-GR	Water quality	Establishment of robust causal relationships and counterfactuals Lack of sufficient data	Karditsa Plain of Thessaly	214	GNB & Water use/ha		Biophysical model	Biophysical model up-scaled	• Assessment of causal relationships and solutions for counterfactuals with limited data availability • The case study testing is expected to

Case study	Public good	Main evaluation challenges addressed	Case study context		Indicators tested		Methods tested		Expected outcome
			Case study area	Policy measures	Micro level	Macro level	Micro level	Macro level	
		measured at the required spatial level with appropriate frequency in time							address the lack of sufficient data measured at the required spatial level with appropriate frequency in time.
AW-DE	Animal welfare	Indicator gaps - lack of robust and quantifiable animal welfare indicators in RDP evaluations	North-Rhine Westphalia	215	Management and animal based indicator combination		Not applicable		Development of guidelines for the selection of robust animal welfare indicator combinations

This executive summary discusses and synthesises the extent to which the tested indicators and methods were able to address the main evaluation challenges identified at the beginning of the project. In addition, data issues were of particular importance through all case studies. The synthesis highlights the solutions applied to data gaps, remaining data gaps and problems, monitoring and sampling issues and the need for improved data integration. Due to the complexity and number of different case studies, the synthesis highlights examples of the case study results which facilitate and underline the derivation of key issues. The second part of the synthesis summarises suggestions for revisions to the logic models (methodological framework) are summarised which will feed into the development of the final methodological framework and handbook and indicator and method fact sheets.

Synthesis and discussion of results

The main purpose of the public good case studies was to test the potential contributions of the selected indicators and methods to address the main challenges in the evaluation of environmental impacts of RDPs. In addition, the case studies were used to test the practical applicability of the logic models, i.e. the methodological framework, developed for environmental RDP evaluations. The main challenges for the evaluations of environmental impacts of RDPs were identified at the beginning of the project and validated through a stakeholder consultation. Table 1 in the Introduction of this report provides an overview of the challenges addressed by the case studies. The discussion of the case study results in addressing these challenges focuses on and differentiates between:

- Contributions of additional (non-CMES) indicators tested to address indicator gaps
- Contributions of advanced modelling approaches tested at micro and macro level for dealing with the complexity of public goods, considering other intervening factors and providing solutions for situations without (or very limited) non-participants
- Contributions to the integration of counterfactuals and sample selection issues in environmental evaluations of RDPs.

In addition, data issues were of particular importance through all case studies. The discussion highlights the solutions applied to data gaps, remaining data gaps and problems, monitoring and sampling issues and the need for improved data integration. Due to the complexity and number of different case studies, the discussion will highlight examples of the case study results which facilitate and underline the derivation of key issues.

Part 2 of the discussion section briefly synthesises the experiences from the application of the logic models in the public good case studies and highlights the requirements identified for revisions of the methodological framework for environmental evaluations of RDPs.

Review of the contributions of the case studies to the evaluation challenges

Contribution of tested additional (non-CMES) indicators

The CMES does not provide common impact indicators for the landscape and animal welfare public goods. Evaluators and managing authorities are also required to define additional environmental result indicators to bridge the gap between evaluating effects at focus-area level and the use of impact indicators at programme level. In particular, the case studies for the public goods biodiversity wildlife, HNV and landscape, and animal welfare focussed on testing alternative and additional result and impact indicators, based on the findings of the indicator review in Deliverable D2.1. Additional indicators were also explored for water quality.

The specific biodiversity wildlife indicators - corncrake density and white stork breeding success - have been tested in Lithuania as additional result indicators being applied in addition to the FBI. Corncrake density is a suitable indicator for the evaluation of specific grassland-related agri-environmental measures at a local level and has a good responsiveness to management changes of grassland habitats. The results of the case study in Lithuania indicate that the indicator of white stork breeding success can be applied at regional and national levels for a wider range of measures. Spatial aspects of the indicator species and the use of existing monitoring programmes are key factors determining the counterfactual assessment of the effects of relevant measures under the focus area 4a Biodiversity. The example of the white stork also highlights that the consideration of socio-cultural aspects (positive image of the species and official national species of Lithuania) in the selection of the indicator facilitates good acceptance amongst farmers and other stakeholders, and consequently the availability of monitoring data through volunteers and farmers.

In the Hungarian biodiversity wildlife case study, the indicators of the number of farmland bird species and number of farmland bird individuals were developed for assessing the micro-level effects of measures under focus area 4a. The indicators are more sensitive to micro-level effects than the FBI, as the unit of analysis is linked to distinct parcels of contracted or not contracted areas. The results of the case study indicate a good responsiveness to land-management changes defined in the prescriptions of relevant measures. However, the assessment of net effects is more data intensive than for the other two indicators, and requires substantial monitoring data with survey points at a suitable spatial distribution for participants and non-participants. Overall, the indicator has good potential to be applied in other member states and programme areas where sufficient baseline data of the FBI indicator are available.

Biodiversity wildlife

Corncrake density

+ Application for specific grassland agri-environmental measures at local level
+ Good responsiveness to management changes of grassland habitats
– Narrow indicator not suitable to capture complexity of biodiversity at macro level

White stork breeding success

+ Application to assess effects of relevant measures under focus area 4a, if sufficient data for the number of farmland bird species are not available.
+ Indicator for national key species for biodiversity assessments - integration of socio-cultural aspects (positive image of the species and official national species of Lithuania) in the selection of the indicator
– Narrow indicator with limited suitability to capture complexity of biodiversity at macro level

Number of farmland bird individuals

+ Application for micro-level effects of measures under focus area 4a
+ Good responsiveness to land management changes defined in the prescriptions of relevant measures
– Assessment of net-effects requires substantial monitoring data with survey points at a suitable spatial distribution for participants and non-participants

The landscape case studies tested a range of different indicators for the counterfactual assessment of the effects of relevant measures under the focus area 4a including Landscape structural and visibility indicators and the method Landscape metrics (in Scotland) and Land cover change and Visual amenity (in Greece). A land cover change indicator based on Google Earth images was tested, which provided a reasonable database for detecting landscape change. However, specific landscape features such as terraces and boundary walls are not represented and it requires a ground-level familiarity with the study area to assess changes in these features. The indicator needs to be adapted to relevant land cover for the specific evaluation case by constructing a site-specific land-cover classification. Adoption of other commonly-used land-cover and/or landscape classifications (CORINE, EEA) might not be possible for smaller areas with rather specific landscape elements, such as traditional vineyards in Greece or traditional olive orchards in Spain.

Many scientific studies have explored the assessment of the visual quality of landscapes. In the case-study testing, the indicator visual amenity also had to be adapted by the team to reflect the particular visual features of the specific landscape of the case study area. The adaptation consisted of the arbitrary assignment of values to land-cover types, which entails the risk of non-comparability across different applications.

Landscape

Land cover change

+ Application using Google Earth data for specific measures in well-defined areas
– The indicator needs to be adapted to relevant land cover for the specific evaluation case by constructing a site specific land-cover classification

Visual amenity

+ Application for specific landscape features in the context of particular traditional agricultural systems
– The measurement of visual quality is based on a subjective method and the categorisation of indicator into three levels is based on arbitrary criteria, which needs to be further established in a robust theoretical context

The use of data from IACS for uptake of RDP measures, and spatial analysis of their content and change enabled a multi-dimensional assessment of impacts on the character of landscapes in the case study in Scotland. The approach used a theoretically-grounded approach which relates to landscape concepts and character and enabled causal relationships to be identified. Changes in the visibility of land cover and uses associated with selected measures, in the context of landscape character, enables temporal assessments. The use of changes in landscape spatial metrics of land cover and use associated with RDP measures provides a second dimension for interpretation with respect to landscape character. Combinations of the three approaches enable the assessment of a broader set of net effects and better capture the complexity of environmental relationships with respect to the character of the landscape and thus the public good.

Landscape (continued): Multi-dimensional assessment of impacts on the character of landscapes

Landscape metrics

+ Local environmental characteristics are included; explicit analysis of micro and macro levels are included
– The application of the approach needs further scrutiny regarding the analytical soundness (i.e. the approach needs more rigorous testing)

Visibility of change

+ Direct link to widely used definition of landscape areas (LCA), with easily understood interpretation (visibility of features), using an indicator which represents a clear impact on, or contribution to, the landscape public good, and a theoretical basis which provides causal links.
– Interpretation required with respect to landscape character to assess the net effects on landscape, thus requiring qualitative judgement required by expert or relevant training

Natura 2000

– Local environmental characteristics are included, specifically those of ecological quality and naturalness
– The indicator of the extent and number of Natura 2000 sites does not change significantly over a RDP period

The German water quality case study explored the application of the indicator Mineral N content in the soil in autumn (Nmin). The Nmin indicator is based on well-documented, theoretically-sound models and methods. The autumn Nmin values have a strong relation to the potential nitrate that is leached into the groundwater in winter. The indicator and its characteristics are well known and used for monitoring purposes related to drinking water protection by the managing authorities. The indicator can be used as a result indicator contributing to statistical evidence of the effects of rural development measures under focus area 4b (water management) on water pollution by agricultural land use. The suitability of the indicator for statistics-based approaches (e.g. such as propensity score matching) to consider sample selection issues depends on the availability of, and access to, sufficient annual monitoring data. It is recommended to use the indicator in combination with the CMES impact indicator GNB which is well-known and widely used for monitoring water quality.

Water quality

Mineral nitrogen indicator (Nmin)

+ Application as a result indicator contributing to statistical evidence of the effects of rural development measures under focus area 4b
+ Strong relationship to nitrate leaching into groundwater and well known and high acceptability by stakeholders
– Suitability to consider sample selection issues depends on the availability of, and access to, sufficient annual monitoring data.

The animal welfare case study focussed on the review of suitable animal welfare indicators. The CMES does not provide guidance on animal welfare indicators. The evaluation of animal welfare impacts under the focus area 3a requires appropriate concepts to cover different animal welfare criteria targeted by relevant policy measures such as animal welfare payments and farm investment support. The case study tested the integration of a result-based approach with animal-based indicators into the evaluation of animal welfare impacts. The integration of specific animal-based indicators provides a practical solution to add a direct assessment of health criteria to the assessment of housing and feeding criteria through the use of resource or management-based indicators. Indicators such as lameness and body conditions have a high acceptability of both stakeholders (including farmers and monitoring organisations and managing authorities) and scientists. Practitioners and farmers viewed had concerns about the use of the indicator mortality rates, as they felt that on small farms the occurrence of one accident or disease could already affect their eligibility for payment. This problem can however be solved by using average mortality rates over several (e.g. three) years.

Animal welfare

Animal-based indicators

+ Application in a multi-criteria framework in combination with resource and management based indicators to assess animal welfare effects of measures under focus area 3a.
+ Robust causal relationships between policy measures and animal-based indicators which have a high acceptance by stakeholders and scientists.
– The cost-effective application depends on inclusion of indicators in available livestock databases such as the HIT database in Germany.

The results of the case study indicate robust causal relationships between policy measures and animal-based indicators. Application of the indicators is recommended in a multi-criteria assessment in combination with resource- and management-based indicators. The cost-effective application depends on available monitoring data in livestock databases such as the HIT database in Germany. Few cases exist where livestock monitoring data are collected as part of animal welfare payments. High monitoring requirements and costs might prohibit the application if no data sources exist.

Contributions of tested advanced modelling approaches at micro and macro level

A number of advanced modelling approaches were tested for the suitability to contribute to net impact assessment at micro and macro level. Generally, the case studies tested environmental modelling approaches which require a combination with statistical methods to assess the net effects of RDP measures and approaches which deal with the construction of counterfactuals internally (i.e. cases without comparison groups). Advanced modelling approaches can contribute to net-impact assessment through an improved consideration of the complexity of public goods and environmental assessments, and explicit consideration of other intervening factors and theoretically-sound counterfactual assessment in situations without available comparison groups (non-participants).

In this section we focus on a few examples of environmental methods tested in climate stability and soil quality case studies which, based on our reviews, have not been used in previous RDP evaluations. These case studies provide examples for advanced environmental methods dealing with the complexity of public goods and environmental assessments and the explicit consideration of other intervening factors. In addition, we identify examples of economic-based models which were tested in climate stability and water quality case studies for their suitability in dealing with situations without comparison groups (e.g. in situations of area-wide uptakes of measures).

Complexity of public goods and consideration of other intervening factors

The Carbon Footprint (CF) method, tested in the Climate Stability case study in Italy, allows for a robust estimation of the emission based on a well consolidated procedure now also available under ISO rules. CF includes greenhouse gas (GHG) absorption and emission during the life cycle of a product or service, from the extraction of raw materials to its final use. In this way, CF can be considered as a sub-set of data derived from Life Cycle

Assessment (LCA). CF can be applied at process level and at farm level with no particular difficulties to estimate the emissions of RDP participants and of the control groups. With sufficiently representative data of the process/farm samples, micro-level results can be aggregated to provide a robust estimation of macro-level effects. The existence of a well-established farm sample, such as FADN, is a good starting point for the creation of a database for participants and non-participants. But a satisfying estimation of carbon emissions and sequestrations requires the collection of additional data on farming practices, generally not available in the existing databases, and a significant amount of time for calculating the final carbon footprint. Besides, the application of the method for elaborate statistics-based evaluations of the comparison groups relies on a sufficient number of observations which may increase the whole monitoring and evaluation costs.

Climate stability [Complexity of public goods and environmental assessments]

Carbon Footprint

+ Application primarily for micro-level evaluations although, with sufficiently representative data, results can be aggregated to robust macro-level effects.
+ Captures the complexity of GHG absorption and emission during the life cycle of a product or service, from the extraction of raw materials to its final use.
– Application of the method for elaborate statistics-based evaluations of comparison groups relies on a sufficient number of observations, increasing the monitoring costs.
– Estimation of carbon footprint requires the collection of additional data on farming practices through ad-hoc surveys.

The soil quality case study in Hungary tested the application of the Universal Soil Loss Equation (USLE) for modelling soil erosion in combination with the CLUE model (Conversion of Land Use and its Effects) (Verburg et al., 2002). The modelling approach enabled the explicit consideration of other intervening factors influencing soil erosion (sample selection issues) such as rainfall intensity, slope length, slope steepness and land use, which informed the comparison of areas with and without the policy measures. The CLUE model simulates land-use transitions over time and can thus provide a solution for the creation of 'before and after' data in the absence of monitoring data. The method requires substantial modelling effort, which might not be feasible for short-term evaluation contracts, in particular as indicator values for different years need to be modelled and analysed separately.

The Scottish soil case study applied the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) model for the modelling of change in ecosystem services, which is more commonly used for ex-ante assessment, but has proven useful for an ex-post evaluation in data-poor conditions. The USLE equation used for the soil erosion approach is well established as the most effective way to assess rates of soil erosion. It takes account of the importance of the spatial distribution of RDP measures with respect to their impacts on soil erosion, and of the extent of retention of the soil eroded within water sub-catchments. Particular strengths of the modelling approach are the consideration of local environmental characteristics and the establishment of theoretically robust causal relationships. However, the accuracy of the results from the model is dependent upon the level of spatial detail of the input data for the model. Dedicated processes for monitoring soils in relation to different RDP measures would further improve the capability of the modelling approach to contribute to the assessment of net impacts.

Soil quality [consideration of other intervening factors]

Universal Soil Loss Equation (USLE) in combination with the CLUE model

+ Application for micro and macro-level evaluations
+ Explicit consideration of other intervening factors and simulations of land-use transitions over time as solution for the creation of ‘before and after’ data in the absence of monitoring data.
– Requires a substantial modelling effort, which might be unfeasible for short-term evaluation contracts.

Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) model

+ Application for macro-level evaluation, both in ex-ante and ex-post evaluations
+ Explicitly considers local environmental characteristics and the spatial distribution of RDP measures and establishes theoretically robust causal relationships.
– Accuracy of the results depend on the level of spatial detail of the input data for the model and further targeted RDP soil monitoring would enable a stronger contribution to the assessment of net impacts.

Lack of comparison groups (non-participants)

The DREMFIA model is an economic modelling approach which was tested in the Finnish climate stability case study for its suitability in dealing with situations without comparison groups, and for its capabilities for taking into account indirect effects such as displacement effects at a macro level. Temporal dimensions of environmental impacts are directly incorporated in the dynamic modelling framework and policy impacts are quantified based on before and after simulations. The modelling framework provides the flexibility to simulate different counterfactual scenarios and the regional differentiation enables the interpretation of indirect effects at a macro level, such as displacement effects. Care must be taken with respect to the assumptions applied to implementation of the policy measures in the modelling framework to ensure that the causal relationships of the policy measures and related land-management changes are theoretically sound. The complexity of the modelling framework limits its suitability for RDP evaluations to long-term evaluation contracts or the use of already existing models, and requires particular modelling expertise. The application of such a modelling approach for other public good impacts, for example biodiversity wildlife, would rely on the use of proxy indicators directly linked to agricultural land management.

Climate stability [Measures with area-wide implementation – lack of sufficient non-participants]

DREMFIA sector model

+ Application for macro-level evaluation in particular in cases with limited or lacking non-participants
+ Regional differentiation of sectoral modelling frameworks enables interpretation of indirect effects at macro level.
– Results are dependent on assumptions applied to the measure implementation in the modelling framework – consistency checks of the causal relationships required.

The Finnish water quality case study addressed the control group formation through structural economic modelling. The structural model is used as the counterfactual of non-participation to the agri-environmental programme which is not possible to construct due to the lack of a non-participant control group (90% of farmers participate, covering approximately 95% of Finnish UAA). A biophysical model is used to convert simple pressure indicators (fertiliser use) into more advanced figures of pressure (run-off) using transfer functions from run-off to environmental damage (also in monetary terms). The results are based on a theoretically sound economic model of a representative farm which is calibrated with real-world data. Furthermore, the approach using an environmental impact transfer function provides a robust assessment of environmental impacts. The structural model approach enables counterfactual analysis with missing comparison groups, and is theoretically sound and more robust in comparison to other methods that would rely on naïve approaches to baseline farmer behaviour. However, the results of the case study highlight a few limitations and potential problems in the application. Animal farms are not included in the tested model, as it is under development and a single econometric model may not be able to capture the differences between crop and animal farms. Despite the intuitively clear adaptability of the structural models to impact analysis, problems related to acquiring new FADN data and recalibrating the model to pass consistency checks in the analysis proved surprisingly difficult.

Water quality [Measures with area-wide implementation – lack of sufficient non-participants]

Structural model combined with biophysical model (transfer function)

- \+ Theoretically sound and more robust approach to deal with counterfactual analysis with missing comparison groups in comparison to naïve approaches.
- – Required recalibration of existing models can be problematic and time-consuming.

1.1.1 Contributions to the integration of counterfactuals and sample selection issues

Having counterfactuals is essential for assessing change. The classic way of comparing programme/measure participants vs. non participants is not always applicable or is very difficult (e.g. in the case of assessing climate stability). In other cases, temporal or spatial scarcity of data – especially of non-participants – hinders counterfactual evaluations of environmental impacts of RDPs. It is inherent in each counterfactual evaluation to clarify who are considered to be non-participants and what sample selection issues are important to be considered in the design of comparison groups. The results of the case studies clearly show that, even in situations with data gaps, at least some sample selection issues can be considered through an ad-hoc approach, e.g. selecting participants and non-participants in close proximity. However, as discussed in the previous sub-section, in cases where, due to the area-wide implementation of measures, there are non non-participants or in cases of aggregated macro-level evaluations of programme effects, advanced modelling approaches such as dynamic partial and general equilibrium models provide a theoretically sound alternative for robust before-and-after counterfactual assessments for climate and water quality impacts of RDPs.

The case study results confirmed the suitability of the conceptual methodological framework for counterfactual approaches developed in WP3. The three options (Statistics-based Evaluation Options – Explicit Approach to Sample Selection, Evaluation options without comparison groups, Qualitative and naïve quantitative evaluation options – Ad-hoc approach to sample selection) provided suitable solutions across all case studies.

Only a few case studies were able to use statistics-based evaluation options to tackle self-selection issues in constructing the counterfactual and to assess net effects. As the statistical methods hinge on data quality and quantity, the problems reported are less surprisingly related to data issues. However, the results of the case study highlight possible solutions for the application of elaborate counterfactual evaluation in situations with limited availability of, and access to, data. For example, the water quality case study in Germany highlights the possibility of using propensity score matching despite data gaps for non-participants and lacking panel data. The application of propensity score matching with a smaller sample still enabled the consideration of some sample selection issues and has thus improved the robustness of results of the analysis in comparison to naïve approaches.

The Finnish climate stability and water quality case studies tested solutions for the situations without comparison groups. The advanced modelling approaches tested provide a theoretically sound and more robust approach to deal with counterfactual analysis with missing comparison groups than do naïve approaches. However, in the case of the water quality case study, the calibration of the model proved more time intensive than initially thought. Learning from this experience suggests a requirement for allowing sufficient time for the recalibration of existing modelling approaches which otherwise could be a time-saving option especially when no comparison groups can be constructed. The complexity of the modelling approaches limits its suitability for RDP evaluations to long-term evaluation contracts and requires particular modelling expertise.

Naïve quantitative approaches were frequently used to construct a counterfactual in the case studies mainly due to a lack of environmental monitoring data or difficulties in using existing environmental monitoring data for RDP evaluations. Yet, the results of the case studies show a number of solutions to still consider sample selection issues through an ad-hoc design of comparison groups. For example:

- Climate stability case study in Italy: participants and non-participants were selected in close proximity to ensure similar structural and bio-physical characteristics.
- Soil quality case study in Hungary: the comparison groups of participants and non-participants were designed taking into account rainfall intensity, slope length, slope steepness and land use.

- Biodiversity wildlife case study in Lithuania: hydrological aspects such as groundwater level were considered.

In addition, several case studies (e.g. Biodiversity wildlife case study in Lithuania, HNV case study in Italy and the landscape case studies in Greece and Scotland) used multiple comparison groups to improve the robustness of the results of naïve approaches.

Counterfactual integration

Statistics-based options to deal with sample selection issues

+ Application with smaller samples and data gaps can still improve the robustness of results compared to using ad-hoc approaches to deal with sample selection issues.
– Additional and / or specifically targeted environmental monitoring programmes are needed to fully utilise the potential advanced statistics-based approaches.

Evaluation options without comparison groups

+ Theoretically sound and more robust approach to deal with area-wide implemented policy measures or counterfactuals at macro level.
– Time and resource constraints and required modelling expertise might limit the practical application.

Naïve counterfactual assessments – ad-hoc approaches for sample selection issues

+ Sample selection issues can, and have, to be considered in naïve approaches through ad-hoc consideration in the design of comparison groups.
– Contribution to the quantification of net-effects are very limited.

General key issue

☞ Choice of indicator, data availability and the possibilities to construct counterfactual - poor indicator with good counterfactual may not be preferable to a good indicator with a naive counterfactual approach and comparison group design

The choice of indicator relates to data availability and the possibilities to construct a counterfactual. Essentially this means that the evaluator may need to prioritise the impact indicators available and see the level of counterfactual analysis possible in each case before choosing the method of constructing the counterfactual (unless more than one approach is used). A poor indicator with a good counterfactual may be preferable to a good indicator with more circumstantial evidence on impact. A more detailed summary of the reported problems and applied solutions to counterfactuals can be found in Deliverable D3.3.

1.1.2 Data issues

The results of the case studies highlight the importance of the availability of, and access to, environmental monitoring data in combination with key secondary databases. At an EU level, a number of relevant data bases are available such as CORINE and FADN, which provide the baseline for CMES context and impact indicators. This section discusses the use of existing EU databases, provides examples for solutions applied to existing data gaps and highlights remaining problems. Emerging monitoring and sampling issues are also reviewed.

The following table provides an overview of the EU database used in the case studies.

Table 2 European databases used in the ENVIEVAL case studies

	European databases used				
Case studies	Corine Land Cover (CLC)	FADN	IACS/ LPIS	Farm structure survey (FSS)	Pan-European Common Bird Monitoring Scheme (PECBMS)
BW HU FBI and NBS	X		X		X
BW-LT: Corncrake and White Stork	X		X		
CC-FI: DREMFIA		X	X	X	
CC-IT: GHG at farm level		X	X	X	
HNV-IT		X	X		
HNV-LT			X		
L-GR: Land cover change			X		
L-GR: Visual amenity			X		
LSCO: Natura2000			X		
L-SCO: Landscape metrics	X		X		
L-SCO: Landscape visibility			X		
SQ HU: USLE and SENSOR	X		X		
SQ-SCO: Soil carbon and soil erosion	X		X		
WQ-DE: Nmin and GNB			X		
WQ-FI		X	X		
WQ-GR: GNB and water use			X		
AW-DE			X		

The IACS database is the central database for the evaluation of rural development measures and programmes and all case studies used this database. However, in the practical application of these EU databases for environmental evaluations of RDPs at micro and macro level, a number of problems have emerged in addition to substantial gaps in environmental monitoring data suitable for designing robust comparison groups of participants and non-participants. The representativeness of existing EU databases and the spatial and temporal resolution of data did not fit with the unit of analysis applied in the evaluations or the temporal scale of the evaluation period. National and regional databases and environmental monitoring programmes play a crucial role in providing the required data for environmental evaluations of RDPs.

For example, the resolution of the CORINE data was not sufficient for all types of land cover, and consequently the Land Cover Map created by the technical service of Regione Veneto was used in the HNV case study in Italy instead of CORINE data. In the context of the Greek landscape case study, the CORINE data do not enable the identification of vineyards pruned by traditional techniques to be distinguished from linear vineyards. Therefore, Google Earth images were digitised to create the specific land-cover maps that enabled the differentiation. In the Scottish landscape case study no EU land cover were used, with Scottish national and IACS data providing the required information. The number of survey points in the Common Farmland Bird Monitoring and their spatial distribution was inadequate for using the FBI indicator at a micro level in Lithuania. Instead, single species included in the Farmland Bird Monitoring Scheme were used as a basis for specific micro-level indicators for which detailed regional and local monitoring data were available.

The representativeness of existing databases such as FADN has a major impact on the consistency of evaluation results across different levels. The consistency between micro and macro-level results would be improved if the representativeness of FADN samples was also established at territorial level. The HNV case study in Italy highlighted that a better statistical representativeness should allow for more robust extrapolation from the FADN sample to regional estimations. This would require a larger number of observations to achieve a sufficient statistical significance of the estimated parameters and, consequently, increase the cost of the analysis. Alternatively, better integration or linking of FADN, FSS and IACS-LPIS databases could lead to a more appropriate georeferencing, and spatial representativeness of, the farm samples. In this case special attention has to be given to data access.

In addition to data gaps, e.g. gaps in environmental monitoring covering a sufficient number of participants and non-participants, data access remains a major obstacle for better use of existing databases from statistics institutes, monitoring agencies and administrative bodies. Therefore, this is a potential key constraint for the application of advanced evaluation approaches. Time-consuming processes to negotiate access to databases and strict interpretation of data protection laws have impacted on the timetables of a number of public good case studies and ultimately also on the design of the tested evaluation approaches. While in most cases access to IACS data for evaluators can be assumed, access to aggregated IACS is not good enough to apply elaborate statistics-based methods to quantify net effects of RD measures and RDPs.

In some cases only aggregated environmental monitoring data were available, which are not suitable for robust assessments of net effects using comparison groups. The water quality case study in Germany explored the combination and integration of different data sources (e.g. monitoring data, farm accounting data or control data of the fertiliser ordinance) to create a sufficient number of samples for sound statistical analysis of comparison groups. As nutrient balances from different data sources are calculated by different organisations and stakeholders, particular care must be taken in ensuring the comparability and reliability of different data sets.

Applied practical solutions to existing data gaps:

+ Application of national and specific regional and local monitoring programmes from different organisations
+ Application of freely-available spatial data such as via Google Earth and remote-sensing data e.g. Copernicus Programme
+ Combination of different data sources to enable bigger samples, but comparability and reliability of different data sets can become a critical issue
+ Early start of negotiating data access to account for time-consuming processes to obtain data access

Data gaps constrain the effectiveness of direct environmental indicators and advanced methods. The performance assessment of the evaluation approaches carried out in the case studies highlights data issues as the single most important factor influencing the effectiveness of the evaluation approaches. However, the impacts of data gaps on the effectiveness of indicators and methods need to be compared with the additional cost of improved environmental monitoring programmes. This requires the consideration of different scenarios for future environmental monitoring programmes. Based on the results of the case study testing, three key types of scenarios can be derived:

- Additional efforts to increase the sample size and to improve the spatial coverage of the monitoring programme
- Strategic sampling design of monitoring programmes exploring options to reduce monitoring efforts while, at the same time, improving the spatial targeting of participants and non-participants

- Better integration of existing monitoring data from different sources or / and better integration of environmental monitoring data with farm structural data

These types of scenarios will be further analysed in a few selected case studies and the results as well as the results of the performance assessment will be further analysed in the cost-effectiveness assessment in Deliverable D7.2.

Strengthening the policy loop – especially between programme planning and monitoring and evaluation – in terms of data gathering and data gaps is one key for successful evaluation. Setting data pre-requisites at the beginning of each programming period to enable sound statistical analyses for evaluation at a later stage is imperative. Planning evaluations already at the stage of scheme design, adjustments to sampling and monitoring methods to be targeted at RDP evaluation, and embedding additional data collections into a multipurpose monitoring system has clear advantages. The case studies examined several aspects relating to sampling and monitoring methods, for example:

- Good coordination and, especially for time-series data, long-term cooperation between monitoring and evaluation can increase the quality and efficiency of evaluations, as is shown in the water quality case study in Lower Saxony.
- Improved strategic sampling can increase the coverage of sub-measures with poor coverage (e.g. restoration of extensive grassland) but also utilise the potential to reduce the sample size for some measures with very large sample sizes and secure effects. The revisions to sampling design can also result in reduced monitoring cost (e.g. despite an overall large sample size not all sub-measures could be analysed due to small sample sizes for some sub-measures in the water quality case study in Germany.)
- The biodiversity case study in Hungary shows the important role of volunteers during data collection: without their efforts, the appropriate data for the assessment of net effects would be insufficient for evaluation purposes. Long-term cooperation between monitoring organisations and managing authorities is required to ensure strategic sampling with sufficient survey squares for the FBI for ‘participating’ and ‘non-participating’ farms / parcels to enable sound statistical analysis.

- The options for mutual and multipurpose monitoring and use of databases across the agricultural and nature conservation sectors, as explored in the biodiversity wildlife case study in Lithuania, can reduce transaction costs.

Sampling design needs to take into account farmers' economic rational behaviour (e.g. less productive areas are enrolled into agri-environment schemes where wildlife/habitat status is already acceptable, farm or land management changes prescribed by the policy measure would have been implemented without the policy measure). Sufficiently large samples of participants and non-participants in environmental monitoring programmes enable the application of advanced statistics-based methods such as propensity score matching to consider sample selection issues and the quantification of deadweight effects at a micro level.

Key benefits of additional or more targeted strategic environmental monitoring programmes:

+ Cost-effectiveness of monitoring programmes can be improved through strategic sampling: evidence for cost-savings potential needs to be further explored
+ Increased effectiveness of evaluation approaches and environmental evaluations
+ Robust quantification of deadweight effects and causal relationships
+ Facilitates separation of effects of RDP measures from effects of direct payments and greening, as well as other intervening factors
✋ Close cooperation and good coordination between monitoring organisations, managing authorities and different ministries needs to be further strengthened.

Suggested revisions of the methodological framework (logic model) for environmental RDP evaluations

One of the main objectives of the public good case studies was the validation of the structure of the methodological framework, represented through the logic models, for environmental evaluations of RDPs. The case studies tested the practical applicability of the logic models and identified a set of revisions and additions to be implemented in the final version of the logic model. The application of the logic models in the case studies highlighted the need for a few general adjustments such as the terminology to the legal framework of the new programming period 2014 – 2020 (e.g. CMES instead of CMEF) and a revision of the term functional unit to unit of analysis or unit of observation. In addition, the outcome of the case study application highlighted a few specific suggestions for revisions to different logic model steps which are summarised in Table 3.

Table 3 Overview of the suggested revisions to the logic model steps

Logic model step	Suggested revision	Evidence
Step 1.2 – selecting additional environmental indicators	Adding a specific layer for the indicator selection or more tasks (boxes) in particular for those case where no CMES indicator exists. More detailed justification of interventionl logic and causal relationships of indicators with the measures	The selection of additional indicators for case study testing required a review of the intervention logic of the policy measures and the development of a conceptual framework of the causal relationships between policy measures and required management changes, different aspects and criteria of the public good affected and candidate indicators (e.g. animal welfare and wildlife case studies)
Step 2.3 – Selecting counterfactual-based evaluation options	Using DiD as a concept for comparing differences between two groups at different points in time requires the inclusion of DiD also under naive counterfactual options	A naive application of the DiD concept with ad-hoc consideration of sample selection issues in the group design proved to be the best possible solution in a number of case studies (e.g. landscape case studies)
Step 3.3 (Step 4.3) Application of counterfactual options at micro level	Statistics-based counterfactual methods[1] need to be included in the counterfactual processing box of step 3.3. The statistics-based counterfactual methods need to included after the specific environmental methods.	Statistics-based counterfactual methods are the core element of the counterfactual processing (box) and, as for example shown in the water quality case study in Germany, can be the only method used in an evaluation approach (see below).
Step 3.3 (Step 4.3) Application of counterfactual options at micro level	The logic model needs to include a direct arrow from step 3.2 (or 4.2) to the counterfactual methods without going through specific micro or macro-level environmental methods. Basically, the logic model needs to highlight both options, the direct application of indicators with 'statistics-based counterfactual methods' and the combination of specific environmental micro / macro level methods with 'statistics-based counterfactual methods'.	Several case studies could directly apply the monitoring data of the selected indicators with advanced or standard statistics-based methods to quantifiy changes for the different comparison groups. Examples include the biodiversity wildlife case study in Lithuania and the water quality case study in Germany. Other case studies (e.g. the climate case study in Italy) have used specific environmental methods such the carbon footprint to quantify the indicators which then were used in the statistical assessment of comparison groups.
Step 3.3 (Step 4.3) Application of counterfactual options at micro level	The content of the boxes describing the contributions of the methods to net-impact assessments need to be reviewed and adjusted based on the experiences of the case studies.	In each case study a particular evaluation approach was tested for a specific contribution to net-impact assessments. These specific contributions now need to replace the generic contributions initially indicated.
Step 3.4 and 4.4 Micro-Macro aggregation / disaggregation and consistency checks	The logic model needs to consider disaggregation from macro to micro level.	The macro-level evaluation approaches tested highlighted the plausibility of disaggregating results from macro to micro level.

[1] Statistics-based counterfactual methods refer to statistical assessments of comparison groups

3 Summary

The main aim of the report is to provide an overview of the results of the case studies testing a range of indicators and methods for the evaluation of rural development measures and Rural Development Programme (RDP) impacts on environmental public goods, and to derive recommendations for adjustments to the methodological framework in WP3 to WP5 as a basis for the methodological handbook.

The case studies are the central tool to validate the developed logic models (methodological framework) for counterfactual-based evaluation of environmental impacts of RDPs at micro and macro level (WP3 – WP5) and to test the contributions of indicators and methods identified in previous reviews and theoretical analyses (e.g. D3.1, D3.2, D4.1, D4.2, D5.1 and D5.2) to address the main challenges in evaluations of environmental impacts of RDPs.

The main challenges for the evaluations of environmental impacts of RDPs were identified at the beginning of the project and validated through a stakeholder consultation. The case studies have in particular highlighted contributions of tested additional (non-CMES) indicators to address indicator gaps, contributions of tested advanced modelling approaches at micro and macro level in dealing with the complexity of public goods, considering other intervening factors and providing solutions for situations without (or very limited) non-participants, and contributions to the integration of counterfactuals and sample selection issues in environmental evaluations of RDPs.

The results of the case studies clearly show that, even in situations with data gaps, at least some sample selection issues can be considered through an ad-hoc approach, e.g. selecting participants and non-participants in close proximity. However, in cases where, due to the area-wide implementation of measures, non-participants do not exist or, in cases of aggregated macro-level evaluations of programme effects, advanced modelling approaches such as dynamic partial and general equilibrium models provide a theoretically sound alternative for robust before-and-after counterfactual assessments for climate and water quality impacts of RDPs.

The results of the case study highlight possible solutions for the application of elaborate counterfactual evaluation in situations with limited availability of, and access to, data. Applications of advanced statistics-based approaches, such as propensity score matching, with smaller samples and data gaps can still improve the robustness of the results compared to using ad-hoc approaches to deal with sample selection issues. But additional and / or specifically targeted environmental monitoring programmes are needed to fully utilise the potential advanced statistics-based approaches.

The choice of indicator relates to data availability and the possibilities to construct a counterfactual. Essentially this means that the evaluator may need to prioritise the impact indicators available and see the level of counterfactual analysis possible in each case before choosing the method of constructing the counterfactual (unless more than one approach is used). A poor indicator with a good counterfactual may be preferable to a good indicator with more circumstantial evidence on impact.

In addition, the results of the case studies highlight the importance of the availability of, and access to, environmental monitoring data in combination with key secondary databases. The case studies applied practical solutions to existing data gaps such as the application of national and specific regional and local monitoring programmes from different organisations, the application of freely-available spatial data such as Google Earth and remote-sensing data e.g. Copernicus Programme and a combination of different data sources to enable bigger samples. Negotiations to obtain data access should start as early as possible in the evaluation process to account for time-consuming processes in the context of different data protection laws.

Data gaps constrain the effectiveness of direct environmental indicators and advanced methods. The performance assessment of the evaluation approaches carried out in the case studies highlights data issues as the single most important factor influencing the effectiveness of the evaluation approaches. The results of the case studies indicate that the cost-effectiveness of monitoring programmes and environmental evaluations can be improved through strategic sampling. More targeted environmental monitoring programmes would facilitate a more robust quantification of deadweight effects and causal relationships and other intervening factors. However, the cooperation and good coordination between monitoring organisations, managing authorities and different ministries needs to be further strengthened.

The findings from this report will inform the development of the final methodological framework and handbook. The report also informs the project synthesis and serves as a source for producing fact sheets in the project synthesis workpackage (WP8, D 8.1).