POLICY OPTIONS FOR AN EU NO NET LOSS INITIATIVE

Final Report – Annexes

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Disclaimer

The authors have full responsibility for the content of this report, and the conclusions, recommendations and opinions presented in this report reflect those of the consultants, and do not necessarily reflect the opinion of the Commission.

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1 ANNEX 1: TRENDS IN EU AGRICULTURE AND THEIR IMPACTS ON BIODIVERSITY

Source: Poláková, J, Tucker, G M, Hart, K, Dwyer, J and Rayment, M (2011) *Addressing biodiversity and habitat preservation through Measures applied under the Common Agricultural Policy*. Report prepared for DG Agriculture and Rural Development, Contract No. 30-CE-0388497/00-44, Institute for European Environmental Policy, London.

Change	Description	Drivers	Trends at EU level	Effects on different areas	Likely scale and future trends	Consequences for biodiversity
Specialisation	Increasing farm level and regional focus on particular systems and products, loss of mixed farming systems	Profit maximisation by exploiting comparative advantage and economies of scale, trade liberalisation	Significant trend across most parts of EU in recent decades, though relatively little change recorded in 2003 to 2007 period	Marked differences between Member States, with mixed farming still prominent in many of the new MS, reflecting less modernised agricultural systems	Trend is expected to continue to 2020, especially in more productive areas	Specialisation impacts negatively on habitat diversity
Mechanisation	Use of machinery to undertake tasks previously completed by hand	Labour costs and need to enhance farm incomes, finance for investment	Advanced trend across much of the EU, less advanced in some eastern and southern MS	Rates of change highest in least agriculturally developed areas; use of hand tools and horses widespread in some MS	Ongoing trend especially in parts of new Member States where agriculture is less capital intensive	Often results in intensification with negative consequences for biodiversity
Consolidation	Continuing concentration of agriculture into smaller numbers of larger units	Economies of scale and drive to increase farm incomes	Continuing trend across the EU in recent decades; number of holdings declined by 9% 2003 to 2007 in EU27.	Widespread trend but rates of consolidation most rapid in less developed areas. Very large variations in absolute farm sizes, with tendency for large farms in most productive, specialised areas and smallest in least developed areas	Major ongoing trend; number of holdings has been forecast to decline by one third 2003 to 2020, with more rapid decline in new MS	Increasing farm size does not necessarily harm biodiversity but may be accompanied by other structural changes
Diversification	Growth in other enterprises to supplement farm income	Need to enhance farm incomes, consumer demands (eg recreation, food)	Survey evidence indicates only a minority (12%) of EU farms are diversified – based on narrow	Wide variations in rates of diversification across the EU, with highest rates in western and northern MS.	Ongoing trend	Other farm enterprises (eg tourism, local food) may be complementary to biodiversity conservation and may encourage measures to protect/enhance biodiversity;

Change	Description	Drivers	Trends at EU level	Effects on different areas	Likely scale and future trends	Consequences for biodiversity
			definition – but that proportion is increasing.			alternatively could encourage developments and land use changes less sympathetic to biodiversity
Intensification/ extensification	Changes in input use, stocking densities, area of land on holding devoted to production	Product and input prices, consumer demands (eg organic food)	Major intensification of agriculture occurred in most parts of EU in latter half of 20th century. Recent trends indicate slight extensification in EU15 but intensification in NMS10 2004-2007.	Variations in intensity of production – 31% of farms in EU15 and 16% of those in NMS10 classed as high intensity in 2007. Evidence of convergence, with some extensification in the former and intensification in the latter. These overall trends likely to mask regional and sub-regional variations.	Lower prices will encourage extensification in some areas; however crop yields are expected to increase, driven by ongoing technological development. Intensive livestock systems expected to increase relative to extensive ones.	Pesticide use, fertiliser use, grazing pressure, maintenance of farmland features, balance between extensive and intensive livestock systems all have important impacts on biodiversity
New market/ product development	Development of new products, markets and farming systems – eg energy crops	Policy (eg climate policy) and market drivers	Growth in area of energy crops to 1.315mha in 2008.	Variations depending on regional growing conditions and national policies; highest production in most productive arable areas, especially DE, FR	Significant growth in energy crops expected to continue	May have positive or negative effects on habitat quality and diversity
Cost-cutting and labour saving	Adoption of more simplified approaches to management which require lower inputs and/or enable shedding of labour	Cost-price squeeze – combination of policy and sustained market price effects	EU27 agricultural labour force declined by 25% from 14.95 million annual work units in 2000, to 11.22 million in 2009	Wide variations in labour intensity of production, but decline in employment is occurring across the EU.	Ongoing trend especially in EU-15	Labour-saving usually has negative effects upon habitat quality and diversity, while reduction in other inputs may have positive or negative effects

Change	Description	Drivers	Trends at EU level	Effects on different areas	Likely scale and future trends	Consequences for biodiversity
Adoption of new management systems (ICM, organic, min-till)	Changing some fundamental elements of regular management practice in order to benefit environment, save costs and/or gain market advantage	Changing attitudes and technologies, research and development, consumer preferences	Area of organic land certified or in conversion increased from 4.9 million hectares in the EU27 in 2001 to 8.6 million hectares in 2009	Very wide variations in rates of uptake between MS. Organic area greatest in EU15, especially Austria and Sweden. ICM most prominent in UK.	Ongoing trend across EU-27, although still affecting only a minority of farmland	Generally positive impacts upon biodiversity (although some mixed impacts for min-till due to increased use of agro-chemical treatments)
Fragmentation of holdings and reversion to semi-subsistence farming	Farms splitting up as a result of landownership and institutional changes and the need to accommodate ex-urban unemployed returning to the family farm	Major economic restructuring in EU-12 and new Lander in Germany, following collapse of planned economies	Major trend in new MS in 1990s; consolidation now means that number of farms is declining in new MS, but there was an increase in Poland between 2003 and 2007.	Variations between new MS depending on previous institutional structures; average farm sizes typically less than 10 ha but 89 ha in Czech Republic.	Largely a feature of the 20 years from 1990 onwards, but its impacts are still very evident and the resulting structures persist due to lack of alternative opportunities for employment, in some areas	Mixed impacts upon biodiversity
Abandonment	Cessation of farming activity	Negative or low profitability of marginal farmland, difficulty of competing in competitive markets	Significant trend in some areas, on a small and local scale, not captured by official statistics.	Affects especially more marginal agricultural areas. Widespread abandonment occurred in new MS in 1990s but much has returned to production.	Significant levels of abandonment could occur in coming years, especially in marginal farming areas in southern, eastern and northern Europe	Negative effects from loss of high nature value farming, benefits for habitat re-creation in other areas
Land use change	Loss of farmland to urbanisation/	Demand for land for development	Gradual and continuing trend;	Greatest net loss of agriculture occurring in EU15. Pressure on	Ongoing small scale loss of	Negative consequences of loss of habitat to built

Change	Description	Drivers	Trends at EU level	Effects on different areas	Likely scale and future trends	Consequences for biodiversity
	development pressure		0.5% of agricultural land lost between 2000 and 2006.	biodiversity from development is particularly prevalent in more prosperous rural and urban fringe areas and less so in more remote areas.	farmland to other forms of development	development
Restructuring of rural economy	Declining share of agriculture relative to services, differences in level of performance, including decline and depopulation in some areas	Combination of above trends and drivers in wider economy	Growth in most rural economies. Varying population trends with growth in some areas and declines in others.	Wide variations in rural incomes; highest in rural Sweden, Denmark, Finland parts of Ireland (>125% of EU average) and lowest in Bulgaria and Romania (10% of average). Highest growth rates in new Member States, some localised economic declines. Relative dependence on primary sector varies (>20% employed in agriculture in some eastern and southern MS). Variable population trends (steady growth in most of EU15 but decline in some new MS).	Continuing decline in agriculture's relative significance.	Implications for society's needs from agricultural policy, including relative significance of demand for biodiversity and other public goods. Pressures on biodiversity from development or abandonment of economic activity. Pressures from population growth and associated development, but also possible opportunities from diversification and hobby farming.

2 ANNEX 2: TECHNICAL SPECIFICATION OF MODEL SETTINGS

This annex describes the different categories of model settings for the scenarios simulated in this contract.

The data frame used for the presentation of maps is the WGS1972 Albers Conical Equal Area projection.

Margins:

- Left -2,780,930.731015359 m
- Top 2,125,553.266887691 m
- Bottom -1,964,677.615319867 m
- Right 1,134,828.998966719 m

2.1 Land use change modelling

2.1.1 Land use classification

Table 2-1: Land use classification of CLUE-scanner simulations

Land use coding	Land use description
0	Built-up area
1	Arable land (non-irrigated)
2	Pasture
3**	(semi-) natural vegetation (including natural grasslands, scrublands, regenerating forest below 2 m, and small forest patches within agricultural landscapes)
4*	Inland wetlands
5*	Glaciers and snow
6	Irrigated arable land
7***	Recently abandoned arable land (i.e. “long fallow”; includes very extensive farmland not reported in agricultural statistics, herbaceous vegetation, grasses and shrubs below 30 cm)
8	Permanent crops
9**	Arable land devoted to the cultivation of (annual) biofuel crops
10	Forest
11*	Sparsely vegetated areas
12*	Beaches, dunes and sands
13*	Salines
14*	Water and coastal flats
15*	Heathland and moorlands
16***	Recently abandoned pasture land (includes very extensive pasture land not reported in agricultural statistics, grasses and shrubs below 30cm)
17**	Perennial biofuel crop cultivation

* These land use types are assumed to be constant during simulations with CLUE. These areas are assumed to be unsuitable for agriculture or urban expansion. This assumption is based on the adverse environmental conditions at these locations. Natural succession is also assumed to be hampered by adverse environmental conditions.

** In most cases, biofuel crops are part of (non-irrigated) arable land and therefore not shown on the map. Biofuel crops are explicitly mapped only in specific projects.

*** These classes are considered to be an intermediate stage in the natural succession from recently abandoned farmland to (semi-) natural vegetation. Under certain conditions succession will be so slow that the vegetation will remain in the abandoned farmland class for a long period.

Table 2-2: Detailed description of CLUE land use types

Land use coding	Land use name	Detailed description of land use type
0	Built-up area  Picture: http://terrestrial.eionet.europa.eu/CLC2000	This land cover class contains all built-up areas (and other human fabric). It includes continuous urban fabric, discontinuous urban fabric, industrial areas, commercial areas, road and rail networks, (air)ports, mineral extraction sites, dump sites, construction sites, green urban areas, sports facilities, and leisure facilities.
1	Arable land (non-irrigated)  Picture: http://en.wikipedia.org/wiki/Arable_land	This land cover class contains all agricultural land that is not pasture or permanent crops. If biofuels are separately shown on the map they are excluded from this class. In addition, this class does not include irrigated agricultural land uses (i.e. irrigated arable land) and permanent crops.
2	Pasture  Picture: http://www.birdlifecapcampaign.org/frameset.htm	This class contains all types of "pasture", including pastures used for the production of fodder. Included are also pastures with a lot of hedges (bocage). In principle it excludes grassland in rotation (< 5 years) which is part of arable land.

3	<u>(semi-) Natural vegetation</u>  Picture: http://www.corse-sud.net/maquis/maquis.html	This class includes all (semi-) natural vegetation types that are non-forest with the exception of small forest patches as occur in agricultural landscapes. This class includes natural grasslands, scrublands and regenerating forest (below 2 metres in height). Inland wetlands and heather/moorland are not included in this class as they are a separate class in the CLUE-map. This class includes rangeland.
4	<u>Inland wetlands</u>  Picture: http://www.natuurmonumenten.nl	This class covers all inland wetlands and peat bogs. Only standing waters are included in this land cover class. Flowing rivers and other water courses are included in a separate class.
5	<u>Glaciers and snow</u>  Picture: http://alps.virtualave.net/	This class covers all glaciers and permanent snow.

6	Irrigated arable land  Picture: http://www.parc-camargue.fr	This class contains all irrigated agriculture/arable land. It includes rice fields, but not greenhouses or spray/rotary sprinklers.
7	Recently abandoned arable land 	This class contains recently abandoned arable land that is no longer used in a crop rotation. It consists of herbaceous vegetation, grasses and shrubs below 30 cm. This class naturally transgresses into the class "(semi-) natural vegetation". Most of this land cover type is still classified as arable land or permanent crops in the input data for the CLUE-map. Therefore, this class will only evolve during the simulations.
8	Permanent crops  Picture: http://www.lodestarfarms.com/	This class contains all land cover classes that are associated with permanent crops. This class includes all kinds of agro-forestry classes, such as dehesas and montanas.

9	Arable land devoted to the cultivation of (annual) biofuel crops  Picture: http://www.actionrenewables.org/RenewableImages/Bio/bf06.jpg	All (annual) crops that are grown with the aim to produce biofuel are included in this class. This land cover type is classified as (non-irrigated) arable land in the base map for 2000. Therefore, this class will only be indicated as a reclassification of arable land in simulations where biofuels are explicitly considered. This class does not consider perennial crops cultivated for biofuel production.
10	Forest  Picture: http://www.naturbilder.de/NBenglisch/html/bavarian%20forest.html	The forest class contains production forest, protected forest, and forest not currently harvested for other reasons. It does not include other types of natural vegetation, nor does it contain agro-forestry land cover types.
11	Sparsely vegetated areas 	This class contains all land cover types that are extremely sparsely vegetated. It includes bare rock, badlands, etc.

12	Beaches, dunes and sands  Picture: http://www.natuurmonumenten.nl	This class includes land cover types such as beaches, dunes and sands in general.
13	Salines  Picture: http://www.parc-camargue.fr	This class contains salt pans, but excludes salt marshes.
14	Water and coastal flats  Picture: http://www.werkgroep-vlieland.nl/tesNatura/index.html.	All water surfaces and coastal flats.

15	Heathland and moorlands 	Vegetation with low and closed cover, dominated by bushes, shrub and herbaceous plants (heather, briars, broom, gorse, laburnum). Succession into forest vegetation is often constrained by climate or soil conditions.
16	Recently abandoned pasture land 	This class contains recently abandoned pasture land. It consists of herbaceous vegetation, grasses and shrubs below 30 cm. This land cover class contains vegetation that is no longer production grassland but cannot yet be considered natural grassland. It may be under a very extensive grazing regime not being respected in agricultural statistics. This may include horse keeping. This class naturally transgresses into the land cover class "(semi-) natural vegetation". Most of this land cover type is still classified as pasture land in the land use map of the year 2000. Therefore, this class will only evolve during the simulations.
17	Perennial biofuel crop cultivation 	All perennial crops that are grown with the aim to produce biofuel are included in this class, e.g., willows, Miscanthus, switch-grass etc. This land cover type is classified as (non-irrigated) arable land in the base map for 2000. Therefore, this class will only be indicated as a reclassification of arable land in simulations where biofuels are explicitly considered. This class does not consider annual crops cultivated for biofuel production.

2.1.2 Land use requirements

Land use requirements (demands) are based on the VOLANTE A2 scenario (Lotze-Campen et al, 2013a) and are described in Annex 3. In the policy scenarios, the demands deviate from the Business as Usual (BaU) as described in

Table 2-1. The deviations of built-up area in the B, C and D scenarios are based on the VOLANTE Compact Cities scenario that assumes a strict spatial planning regime to avoid urban sprawl (Verburg et al, 2013). The land use types not described in Table 2-3 are either static, or the demand is calculated from the remaining land area and a dynamic allocation of the land use types, as specified in

Table 2-1.

Table 2-3. Demand adaptations in policy scenarios (% deviation from BaU demand).

Land use	**Policy scenario**			
	A	**B**	**C**	**D**
Built-up area	As BaU	-4%	-4%	-4%
Arable land	As BaU	As BaU	As BaU	As BaU
Pasture	As BaU	As BaU	As BaU	As BaU
Permanent crops	As BaU	As BaU	As BaU	As BaU

2.1.3 Specification of location specific preference additions

For the scenarios simulated in this project, the implementation of the policy themes is to some extent done by location specific modification of the suitability of the land for a specific land use type. The suitability values reflect an index of the potential land prices that can be attained at a specific location for a specific land use type. Scenario settings (subsidies and taxes) influence these suitability values. These modifications are reflected in the location-specific addition factors. These location-specific addition factors for different policies are combined in one map for each land use type. Table 2-4 shows which spatial zonings are included in the different scenarios. Table 2-5 and Table 2-6 describe the location-specific preference addition maps for each scenario and land use type, and the maps are shown in Figure **2-1** to Figure **2-8**.

Table 2-4. The use of location specific preference additions for the different scenarios. "X" indicates that spatial zoning is included in the location-specific preference additions.

	Policy scenario				
Spatial zoning	**BaU**	**A**	**B**	**C**	**D**
Natura 2000 areas	X	X	X	X	X
Areas that are cropped in the year 2000*	X	X	X	X	X
National protected areas			X	X	X
LFA areas cropped in the year 2000	X	X	X	X	X
Areas with a high provision of regulating and cultural ecosystem services			X	X	X
Areas with a high erosion risk	X	X	X	X	X
(Semi)natural areas in the year 2000			X	X	X
Forest in the year 2000			X	X	X

**currently cropped areas include land cover types: arable land, permanent grassland and permanent crops*

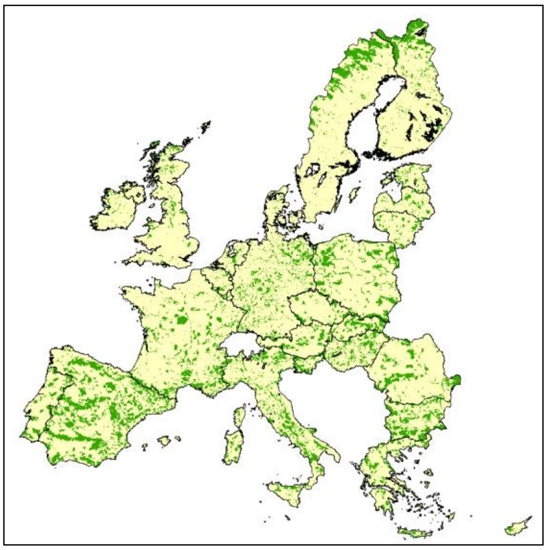


Figure 2-1: Natura 2000 areas

A definite GIS map for Natura 2000 is not available to date, therefore a preliminary version was used for this project. The European Natura 2000 database holds information about sites designated by EU Member States under the Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC). These are referred to as Specially Protected Areas (SPAs) for birds and adopted Sites of Community Importance (SCIs) for habitats and other species.

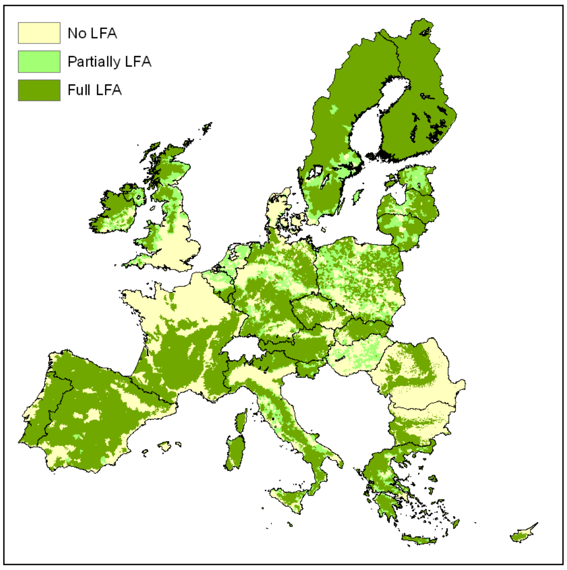


Figure 2-2: LFAs

The LFA map is derived from the spatial dataset Less-Favoured Areas 2000-2006 based on GISCO Communes version 2.3. Areas that are fully eligible under one of the LFA articles are classified as 1. The non-LFA areas are classified as 0.

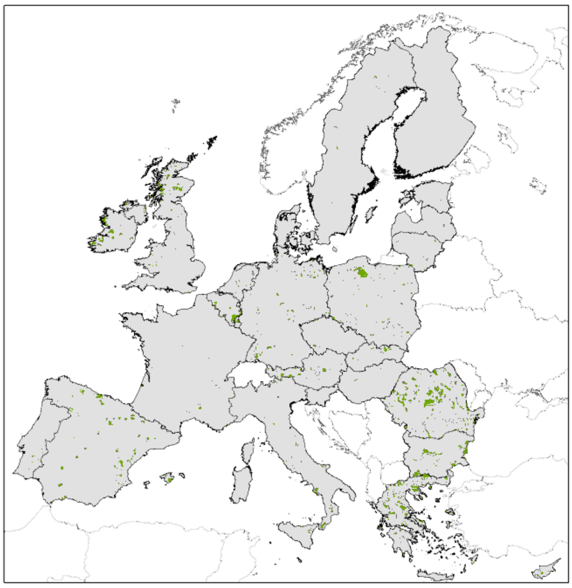


Figure 2-3: National protected areas

Map of WDPA areas up to IUCN category IV (IUCN and WDPA, 2013).

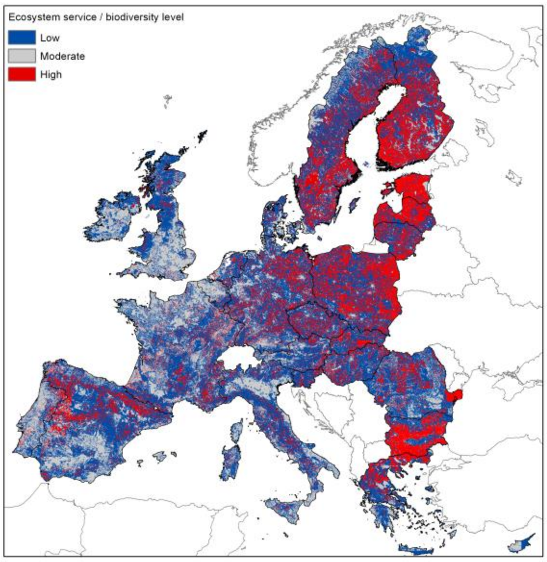


Figure 2-4: Ecosystem services and biodiversity areas

This map classifies ecosystem quality / service bundle data into areas with a low, moderate or high potential for ecosystem services supply or biodiversity. For this, a map of the bundle of regulating services was used. The ES bundle map is the sum of the normalized services. A map of bird species richness in 2000 was normalized and added. The map was reclassified to distinguish the hotspots (areas with values in the upper quartile of the values distribution) and coldspots (areas with values in the lower quartile of the values distribution).

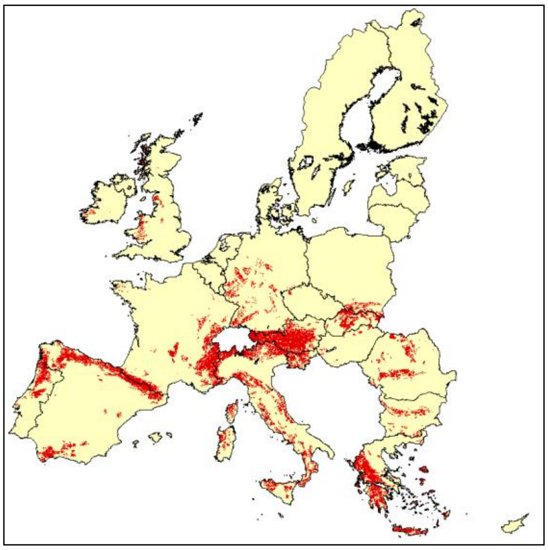


Figure 2-5: Erosion sensitive areas

Delineation of areas with a high potential for soil erosion. Derived from a potential soil erosion map that was computed as the product of slope, soil erodibility and rain erosivity. A threshold was identified by making an overlay with current arable land, with the aim that approximately 8% of current arable land would be eligible for receiving subsidies to prevent soil erosion.

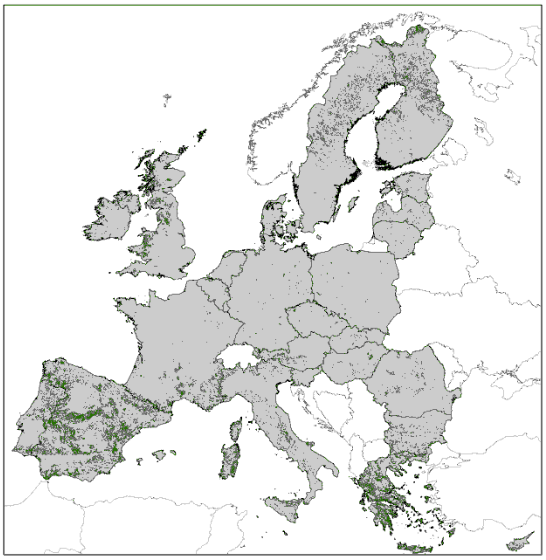


Figure 2-6: (Semi)natural areas

Delineation of (semi-)natural vegetation in the year 2000.

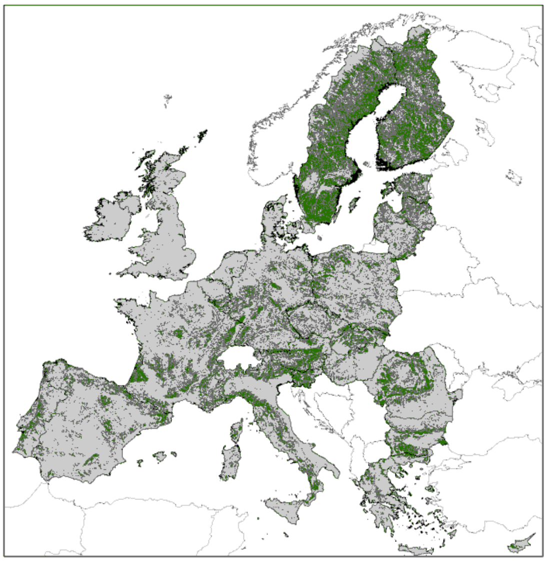


Figure 2-7: Forest areas

Delineation of forested areas in the year 2000.

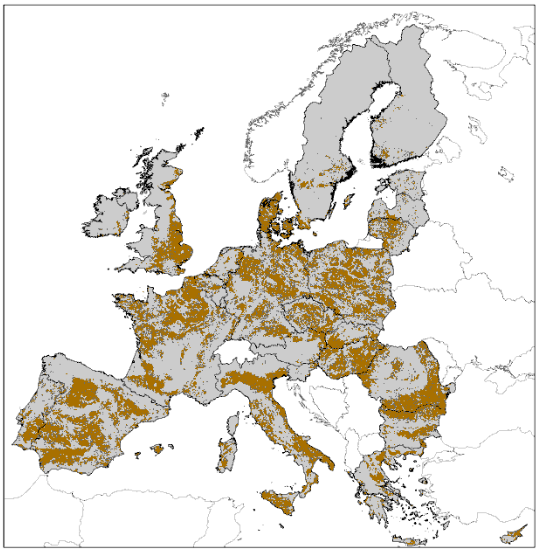


Figure 2-8: Cropped areas

Delineation of cropped areas in the year 2000.

The change in suitability for a certain land use and a certain location varies depending on the spatial policy considered and the possible interaction with other policies. Many of these location-specific drivers can coincide, e.g. Natura 2000 areas within LFA areas. The values for the changes in suitability due to the location-specific preference additions (representing the spatial policies) have been defined for each scenario. Table 2-5 and Table 2-6 describe the location-specific preference addition maps and the weight assigned to them in the land use change modelling.

Table 2-5: Description of location-specific preference addition maps in the BaU and policy scenarios.

Land use code and name		Scenario				
		BaU	A	B	C	D
0	Urban	1 in Natura2000 areas, 0 outside	As BaU	1 in Natura2000 areas, 0.5 in areas with a high provision of ES, 0.5 in national protected areas, 0.5 on all current semi-natural and forest, 0.5 in areas with a high provision of ES.	As B	As B
1	Rainfed Arable	1 in currently cropped areas in LFA and Natura2000; -0.5 on all current grassland; -1 in erosion sensitive areas.	As BaU	1 in currently cropped areas in LFA and Natura2000; -0.5 on all current grassland; -1 in erosion sensitive areas, -0.5 on all current semi-natural and forest, -0.5 0.5 in areas with a high provision of ES.	As BaU	As BaU
2	Pasture	1 in currently cropped areas in LFAs.	As BaU	As BaU	As BaU	As BaU
3	(Semi)natural	n/a	As BaU	0.5 in Natura2000 or national protected areas that were (semi)natural in the year 2000.	As B	As B
4	Irrigated arable	n/a	As BaU	As BaU	As BaU	As BaU
5	Recently abandoned arable	n/a	As BaU	As BaU	As BaU	As BaU
6	Permanent crops	1 in currently cropped areas in LFAs.	As BaU	As BaU	As BaU	As BaU
7	Forest	n/a	As BaU	As BaU	As BaU	As BaU
8	Recently abandoned pasture	n/a	As BaU	As BaU	As BaU	As BaU
9	Static land use types	n/a	As BaU	As BaU	As BaU	As BaU

Table 2-6: Fraction of the suitability defined by location-specific preference addition

Land use code, name		BaU	A	B	C	D
0	Urban	-0.3	-0.3	-0.3	-0.3	-0.3
1	Rain fed arable	0.2	0.2	0.2	0.2	0.2
2	Pasture	0.2	0.2	0.2	0.2	0.2
3	(Semi)natural	0	0	0.2	0.2	0.2
4	Irrigated arable	0	0	0	0	0
5	Recently abandoned arable	0	0	0	0	0
6	Permanent crops	0.2	0.2	0.2	0.2	0.2
7	Forest	0	0	0	0	0
8	Recently abandoned pasture	0	0	0	0	0
9	Static land use types	0	0	0	0	0

2.1.4 Land use conversions

2.1.4.1 Allow drivers

'Allow drivers' are maps that define locations where specific land use conversions are (not) allowed, or where there are temporal constraints on specific conversions. These allow driver maps contain the spatially explicit settings as used in the conversion matrices. Table 2-7 gives a description of these drivers. The model codes indicated by 'X..' refer to the specific allow driver maps in the CLUE-scanner framework and the driver codes are used in the conversion matrices. Drivers specifying temporal constraints indicate the maximum or minimum years after which a conversion can or should take place.

2.1.4.2 Conversion matrices

Table 2-8 and Table **2-9** present the conversion matrices for the BaU and policy scenarios. These tables indicate what land use conversions are allowed. Values of 1 indicate that the conversion is allowed, values of 0 indicate that the conversion is not allowed. Other numbers refer to the spatial restrictions maps listed in Table 2-7. For example, a conversion from semi-natural to arable land is allowed unless a Natura 2000 protection regime is in force at that location (code 52).

Table 2-7: Description of spatial restrictions maps

Model Code	Driver code	Driver description
X1	52	Natura2000 (0, outside 1)
X2	53	Natura2000 with a 2km buffer (0, outside 1)
X3	54	Areas with a high provision of ecosystem services of Natura2000 (0, outside 1)
X4	55	Succession rate (years) from semi-natural to forest
X5	56	Succession rate (years) from abandoned arable to semi-natural
X6	57	Succession rate (years) from abandoned pasture to semi-natural
X7	58	Areas with a high provision of ecosystem services of Natura2000 with a 2km buffer (0, outside 1)

Table 2-8: Conversion matrix BaU scenario. Values of 1 indicate that the conversion is allowed, values of 0 indicate that the conversion is not allowed. Other numbers refer to the spatial restrictions maps listed in Table 4.1.

		Conversion to									
		Built-up	Arable	Pasture	Semi-natural	Irrigated arable land	Abandoned arable	Permanent crops	Forest	Abandoned pasture	Other
Current land use	Built-up	1	0	0	0	0	0	0	0	0	0
	Arable	1	1	1	0	0	1	1	0	0	0
	Pasture	1	1	1	0	0	0	1	0	1	0
	Semi-natural	52	52	52	1	0	0	52	55	0	0
	Irrigated arable land	0	0	0	0	1	0	0	0	0	0
	Abandoned arable	1	52	52	56	0	1	52	0	0	0
	Permanent crops	1	1	1	0	0	1	1	0	0	0
	Forest	52	52	52	0	0	0	52	1	0	0
	Abandoned pasture	1	52	52	57	0	0	52	0	1	0
	Other	0	0	0	0	0	0	0	0	0	1

Table 2-9: Conversion matrix scenarios A-D. Values of 1 indicate that the conversion is allowed, values of 0 indicate that the conversion is not allowed. Other numbers refer to the spatial restrictions maps listed in Table 2-7.

		Conversion to									
		Built-up	Arable	Pasture	Semi-natural	Irrigated arable land	Abandoned arable	Permanent crops	Forest	Abandoned pasture	Other
Current land use	Built-up	1	0	0	0	0	0	0	0	0	0
	Arable	53	1	1	0	0	1	52	0	0	0
	Pasture	53	52	1	0	0	0	52	0	1	0
	Semi-natural	53	52	52	1	0	0	52	55	0	0
	Irrigated arable land	0	0	0	0	1	0	0	0	0	0
	Abandoned arable	53	52	52	56	0	1	52	0	0	0
	Permanent crops	53	1	1	0	0	1	1	0	0	0
	Forest	53	52	52	0	0	0	52	1	0	0
	Abandoned pasture	53	52	52	57	0	0	52	0	1	0
	Other	0	0	0	0	0	0	0	0	0	1

2.1.5 Conversion elasticity

The conversion elasticity (Table 2-10) determines how easy or difficult it is to convert a certain land use into another land use, and is therefore a proxy for the conversion costs (0 = very easy to convert and 1 is very difficult to convert). As the scenarios have different incentives / protection regimes for the various land use types, the conversion elasticity differs between the scenarios. These values are based on expert knowledge and calibration of earlier applications of this modelling framework (Verburg and Overmars, 2009).

Table 2-10: Conversion elasticity in the BaU and other policy scenarios. Values of 1 indicate the conversion is difficult (no elasticity), values of 0 indicate the conversion is easy (good elasticity).

Land use type	Scenario				
	BaU	**A**	**B**	**C**	**D**
Built-up	1	1	1	1	1
Arable	0.4	0.4	0.4	0.4	0.4
Pasture	0.5	0.7	0.9	0.9	0.9
Semi-natural	0.7	0.7	0.7	0.7	0.7
Irrigated arable land	1	1	1	1	1
Abandoned arable	0.3	0.3	0.3	0.3	0.3
Permanent crops	0.8	0.8	0.8	0.8	0.8
Forest	0.7	0.7	0.7	0.7	0.7
Abandoned pasture	0.3	0.3	0.3	0.3	0.3
Other	1	1	1	1	1

2.1.6 Neighbourhood settings

Neighbourhood settings determine how the land use allocation depends on the land use in the vicinity, and therefore determine the fragmentation patterns. For each land use type, a fraction of the suitability that is defined by neighbourhood settings is specified (Table 2-11). This varies between zero (no impact of land use in vicinity) to 1 (allocation fully based on land use in vicinity). Second, a neighbourhood size is specified for each land use type (Table 2-12). The values are chosen based on the scenario specifications and calibrated based on earlier model application (Verburg and Overmars, 2009).

Table 2-11: The fraction of the location suitability that is determined by land use in the neighbourhood. Values of 0 indicate there is no influence from the neighbourhood, values of 1 indicate that the neighbourhood fully determines the land use allocation.

	Scenario				
Land use	**BaU**	**A**	**B**	**C**	**D**
Built-up	0.3	0.4	0.5	0.5	0.5
Arable	0	0	0	0	0
Pasture	0	0	0	0	0
(Semi-)natural	0	0.3	0.5	0.5	0.5
Irrigated arable land	0	0	0	0	0
Abandoned arable	0	0	0	0	0
Permanent crops	0	0	0	0	0
Forest	0	0.3	0.5	0.5	0.5
Abandoned pasture	0	0	0	0	0
Other	0	0	0	0	0

Table 2-12: Neighbourhood size for the relevant land use types. The values indicate which cells are considered in the neighbourhood calculations.

Land use type(s) \ scenarios	**BaU**	A	B, C, D
Built-up	1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 0 1 1 1 1	1 1 1 1 0 1 1 1 1
(semi-)natural, forest	1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1

2.1.7 Allocating offsets

One of the measures possible to achieve no net loss of ecosystem services and biodiversity is to compensate losses of ecosystems and biodiversity on one location by creating new habitat at another location (offsetting). There are several ways in which offsetting can be done. Firstly, impacts on species or ecosystem services could be offset by facilitating the same species or ecosystem service elsewhere. Secondly, a general decrease in ecosystem services could be offset by increasing the general level of ecosystem service supply elsewhere. Thirdly, offsetting can be targeted at habitats or other nature areas (in-kind or out-of-kind area compensation). In-kind or out-of-kind area compensation restores a certain amount of habitat elsewhere for each km^2 of habitat lost.

The amount and location of offsets is dependent on the scenario results in terms of land use change. Therefore, offsets are allocated in a post-processing procedure. For the sake of simplicity, we simulate area compensation. This is the best match for the scale of the land use change simulations, as the changes of biodiversity and ecosystem services are a direct function of the land use changes.

2.1.7.1 Offsetting procedure

1. The grid cells where a land take takes place that requires an offset (according to Table 2-13) are identified by comparing the land use maps of 2000 and 2020.
2. A buffer of 7 km is drawn around the grid cells requiring an offset (step 4a). Smaller buffer sizes would result in settings that are too strict, and failure of the offsetting procedure due to a lack of available land. With larger buffer sizes, buffers of neighbouring land takes would merge, resulting in offsetting at large distance from the land take[1].
3. A region group function is applied, assigning a number (1 to n) to each separate region in which offsetting is needed.
4. Land to realise offsets is allocated in each region (Step 3):
    - **a.** Land where offsetting can take place is identified: offsetting is allowed on agricultural land use.
    - **b.** The demand for offsetting per region (Step 3) is calculated. The required compensation for the loss of one km^2 land is:
        - **i.** 1 km^2 for forest and (semi)natural land use;
        - **ii.** 0.5 km^2 for pasture;
        - **iii.** 0.3 km^2 for arable land.
    - c. The land required to offset impacts (Step 4b) is allocated on the grid cells with the highest suitability for offsetting. The allocation is done based on a suitability map (described in Table 2-14).

Table 2-13 and Table 2-14 summarize the model settings and input maps for the offsetting procedure. Figure 2-9 gives an example of the result of the offsetting procedure.

[1] In areas with a large offsetting demand, this effect still occurs with a 7km buffer. In these cases, the buffer size is decreased sufficiently to ensure offsetting closer to the land take.

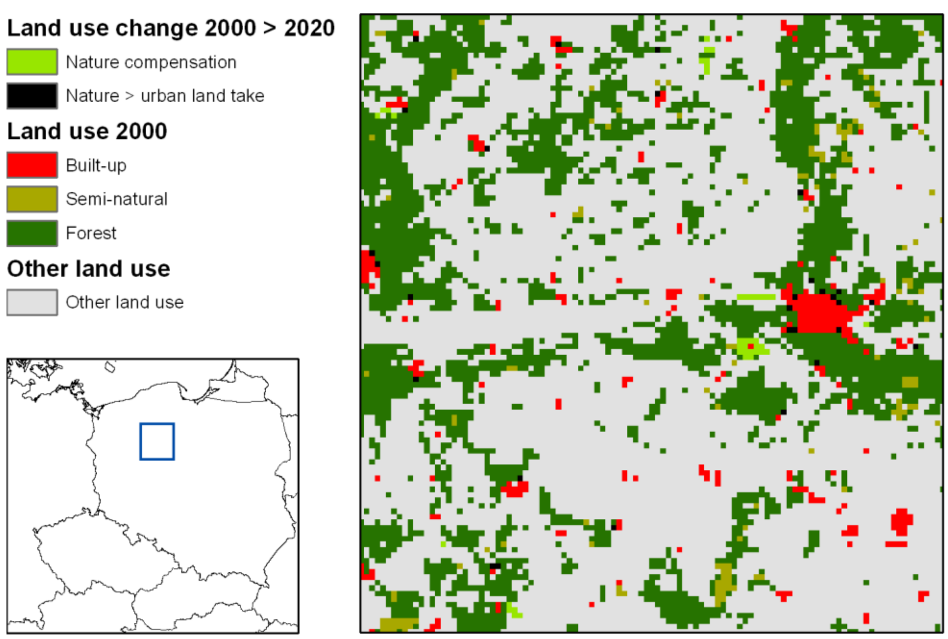
Table 2-13: Land take for which offsetting is required and the percentage offsetting. The maps referred to are explained in Table 2-14. No offsetting is required in scenarios BaU and A and for land takes not listed in this table.

Land take	Scenario		
	B	C	D
Forest > Built-up area	20% offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take outside areas with a low ES or BD supply[1].
Forest > arable	20% offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take in areas with important natural habitat, ecosystem services or biodiversity[2].	Full offsetting of land take outside areas with a low ES or BD supply[1].
(semi-) natural > built-up area	20% offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take outside areas with a low ES or BD supply[1].
(semi-) natural > arable	20% offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take in areas with important natural habitat, ecosystem services or biodiversity[2].	Full offsetting of land take outside areas with a low ES or BD supply[1].
Pasture > built-up area	-	Full offsetting of land take outside areas with a low ES or BD supply[1].	Full offsetting of land take outside areas with a low ES or BD supply[1].
Pasture > arable	-	Full offsetting of land take in areas with important natural habitat, ecosystem services or biodiversity[2].	Full offsetting of land take outside areas with a low ES or BD supply[1].
Arable > built-up area	-	Full offsetting of land take in areas with important natural habitat, ecosystem services or biodiversity[2].	Full offsetting of land take outside areas with a low ES or BD supply[1].

Table 2-14: Description of the maps used to allocate offsetting of land take.

Map ID (Table 2-13)	Map name	Description
1.	Areas with a low ES or BD supply	A map of the ecosystem service bundle in the year 2000 was normalized. A map of the Annex I bird species richness was normalized. These two maps were added up. The areas in the lower quartile were selected.
2.	Areas with important natural habitat, ecosystem services or biodiversity	A map of the ecosystem service bundle in the year 2000 was normalized. A map of the Annex I bird species richness was normalized. These two maps were added up. The areas in the upper quartile were selected. Also, national protected areas were selected.
3.	Suitability map	The suitability map ranges between zero (not suitable) to 100 000 (highly suitable). As a basis, a map of agricultural production is used. This map is scaled from 0 (high production, preferentially no offsetting) to 100000 (low production, preferential areas for offsetting). The suitability is modified in PEEN areas (+20000), Areas with >90% High Nature Value farmland (-10000), and Natura2000 areas (-10000). Finally, random noise is added to ensure sufficient variation. This is achieved by adding random values ranging from -250 to +250.

Figure 2-9: Example of offsetting impacts from land take in Poland. Cells where habitat was lost to urban area are indicated in black, and cells where nature is restored to offset these impacts are indicated in light green.



2.1.8 Allocating Ecological Focus Areas

The CAP foresees Ecological Focus Area (EFA) measures. Under this measure, it is proposed that 7% of the eligible area must be managed as ecological focus areas. EFAs will include land with a high density of land use features such as buffer strips, hedges and fallow land. These features will not be visible at the 1km^2 resolution used in the CLUE modelling. However, there will be specific areas where EFA land can be predicted to comprise existing natural and environmental features (hedgerows, river banks). In such locations, these areas will most probably become part of the EFAs. Where such features do not exist, farmers will most likely use the least productive areas to manage them as EFAs. Consequently, a landscape that currently has a high density of EFA features such as hedgerows, HNV farmland, river banks or forest edges will most probably register a high density of EFA in the future. Also, areas with a low density of such features and a low suitability for agriculture will be likely to register a high density of EFA features in the future.

These areas are identified in a post-processing step, after the allocation of biodiversity / ES offsets. The procedure is as follows:

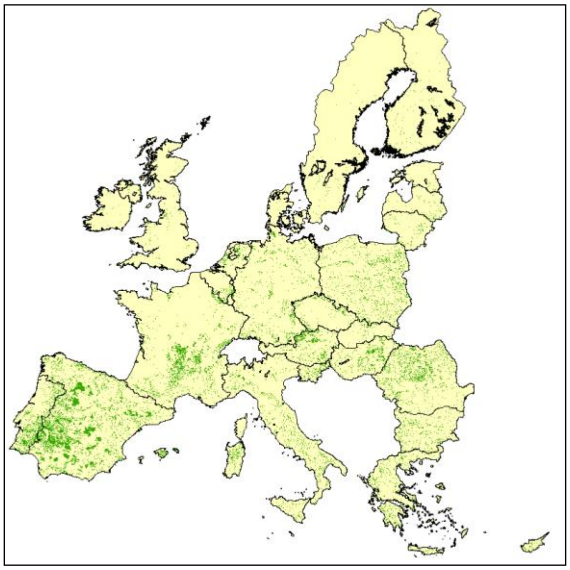
- A map is created that indicates the areas with a very high and a very low density of EFA features. A description of the map is given below.
- The land use maps of 2015 and 2020 are combined with the EFA map following the following decision rules:
    - If land use in 2020 is arable land and EFA features = yes: the final map will be “arable land with a high density of EFA features”
    - If land use 2020 is recently abandoned arable land and land use 2015 is arable land and EFA features = “yes”: the final map will be “arable land with a high density of EFA features”

2.1.8.1 Documentation of the EFA map

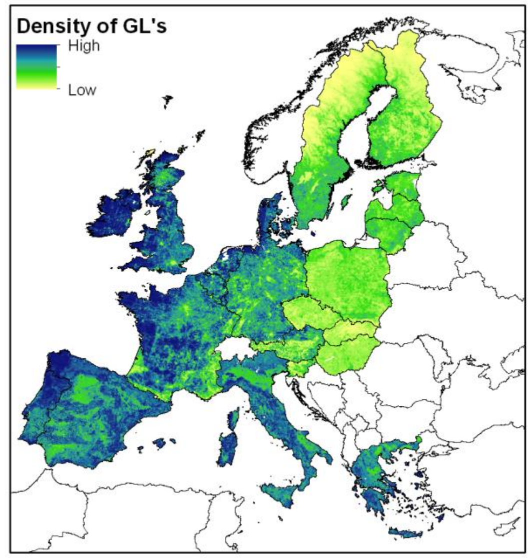
- Maps of HNV density (Paracchini et al, 2008) (Figure 2-10a) and the density of green linear elements (GL map, Van der Zanden et al, 2013) (Figure 2-10b) were normalized from 1 to 100.
- Areas along rivers were selected:
    - The GISCO river map (Eurostat, 2013) was used to identify grid cells within 2 km of rivers.
    - This map was multiplied with a zero/one cropland mask and then classified into 50 (TRUE) and 0 (other) (Figure 2-10c).
- Forest edges were selected (Figure 2-10d):
    - The land use map was reclassified into forest (1) and other land use (zero). A focal sum within a radius of 1km was calculated, thereby including the grid cell considered and the 8 surrounding cells.
    - Grid cells with a value of 0 are not adjacent to a forest, grid cells with a value of 9 are forest and completely surrounded with other forest grid cells, grid cells with values of 1-8 are forest edges. These were reclassified into 50; other areas into 0. This map was multiplied with a zero/one cropland mask.
- The GL map, HNV map, forest edge map and river edge map were added up.
- In each country, 10% areas with the highest value and the 5% area with the lower value were selected as likely areas for EFA’s.

Figure 2-11 shows the final EFA map.

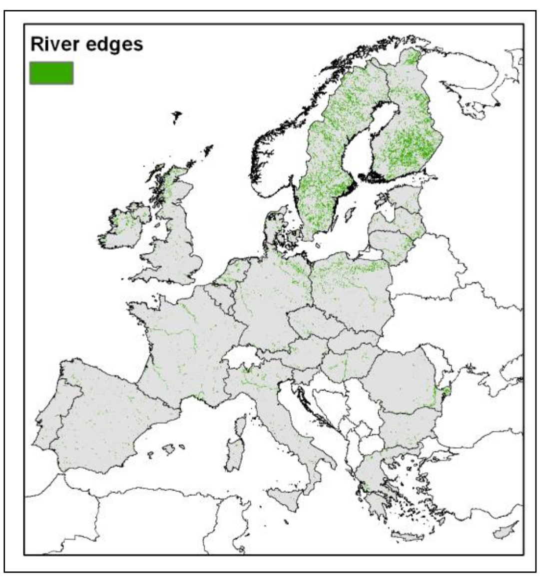
Figure 2-10 Inputs for the EFA features map.



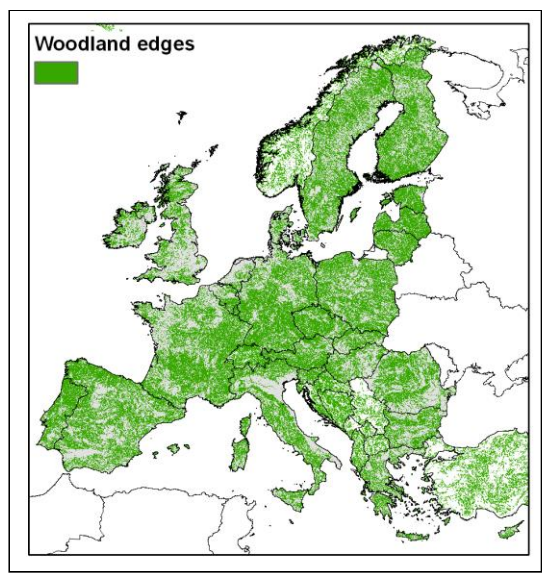
a. High Nature Value farmland. Derived from the HNV map with a threshold of 50% and filtered for the agricultural areas of the land use map of 2000.



b. Density of green linear elements. Based on regression-based upscaling of observations throughout Europe.



c. River edges. Described in section 8.



c. Woodland edges. Described in section 8.

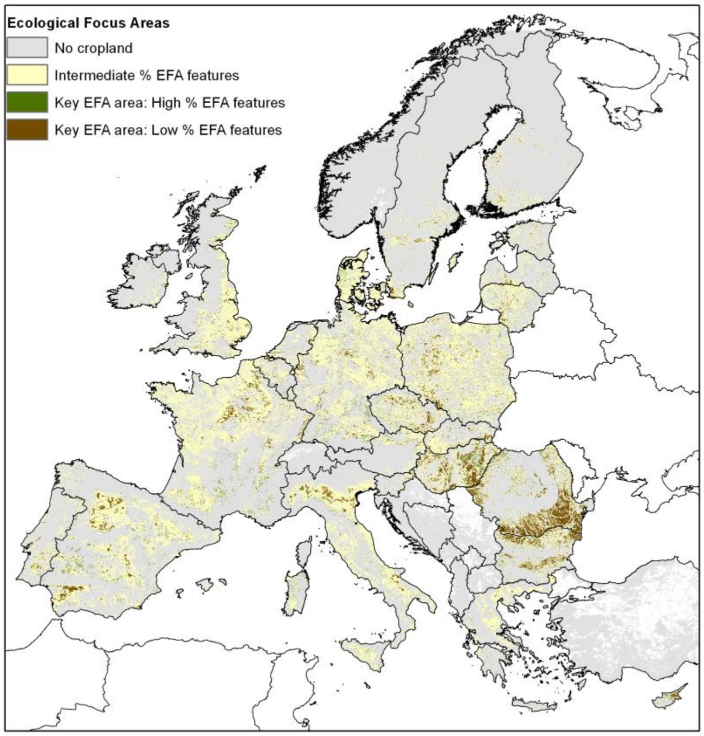


Figure 2-11: EFA key areas

Delineation of areas with a high density of green linear elements, HNV farmland, river banks or forest edges.

2.2 Habitat / Biodiversity indicators

2.2.1 Ecosystem coverage

Indicator name	Ecosystem coverage
Short description	Extent of selected number ecosystem types at NUTS2 and country level
Units	Area percentage
Spatial resolution	Country, NUTS2
Temporal resolution	Start and end year

2.2.1.1 Description of causality in calculation method

Consistent with the SEBI indicator 'Ecosystem Coverage' (EEA, 2009) we calculate the area percentage ecosystem coverage and changes therein at NUTS2 level. We are able to project changes to three ecosystem types (forests, (semi-) natural habitat and abandoned farmland. A number of other ecosystem types (wetlands, heath and moorland) are also included as land cover classes in the CLUE model, but these land use types are not subject to change in the scenario employed and are therefore not presented here. The methodology is well established (e.g. SEBI 004 and analogous versions in SCI and BIP indicator schemes). A change in each of the ecosystem types indicates a change in habitat availability for species depending on this habitat. Abandoned farmland is a land use class not available in CORINE, but available in CLUE. We consider it relevant to include it here, as abandoned farmland can develop into valuable habitat for species, for which it is an indicator for potential future habitat.

2.2.1.2 Input parameters

Name	Quantity	Source	Description
Land cover	CLUE classes (18)	CLUE modelling	CLUE Grid 1x1 km.

2.2.1.3 Calculation rules

1. The land use maps are reclassified into habitat (1) and other land use (zero). This is done separately for the land use types (in parentheses: land use class in CLUE output):
    - forest (10)
    - (semi-) natural vegetation (3)
    - recently abandoned farmland (by combining maps of recently abandoned arable land (7) and recently abandoned pastures (16)
2. A zonal mean of the map resulting from step (1) within NUTS2 regions and countries is calculated.
3. A zonal sum of the map resulting from step (1) within countries is calculated.

2.2.2 Land take

Indicator name	**Land take**
Short description	Measure of land use transitions between habitat and more intensive land use types (agriculture and built up area) per NUTS2 region
Units	Area %
Spatial resolution	EU, country, NUTS2
Temporal resolution	Start and end year

2.2.2.1 Description of causality in calculation method

The land take indicator is analogous to the CSI014 "Land take" indicator and also related to SEBI 004. Natural succession or nature management can cause a change between more natural land cover types which are not as dramatic to the environment as a change from more natural cover types to agriculture, or artificial land use types such as build up area (although specific species can be affected). This indicator can help to identify causes of land use change and habitat loss, and thus assist in defining appropriate No Net Loss policy instruments.

2.2.2.2 Input parameters

Name	Quantity	Source	Description
Land cover	CLUE classes (18)	CLUE modelling	CLUE Grid 1x1 km

2.2.2.3 Calculation rules

1. The maps of the start and end year are combined in ArcGIS using the COBINE function.
2. In the map resulting from step (1) those cells where land use did not change between the start and end year are set to 0, through a CON operation.
3. The following land conversion types are next classified per scenario:

		Land use in end year		
		Forest & (semi-) natural vegetation	(abandoned) farmland	Built-up area
Land use in start year	Forest & (semi-)natural vegetation		Yellow conversion	Red conversion
	(abandoned) farmland	Light green conversion		Orange conversion
	Built-up area	Dark green conversion	Light green conversion	

Green shaded conversions are considered as 'land gain conversions, yellow/orange/red conversions are considered 'land take' conversions.

4. For each of the conversion types, the map from step (2) is reclassified into converted (1) and not converted (zero).
5. A zonal sum of the map resulting from step (4) within countries and the EU is calculated.

2.2.3 *Land cover connectivity potential*

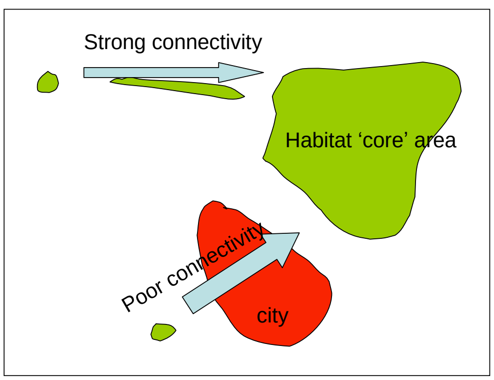
Indicator name	Land cover connectivity potential
Short description (max. 3 lines)	This indicator measures to what extent habitat patches are connected to larger habitats within the landscape
Developer:	Peter Verburg, VU University, the Netherlands: Peter.Verburg@vu.nl in cooperation with Maarten Hilferink from Object Vision, the Netherlands
Source:	EU-ClueScanner project

Indicator data type: quantitative

Indicator	Units
Habitat connectivity	5 classes

Description of causality in calculation method (max. 10 lines)

This indicator assesses the difficulty to reach the nearest larger sized habitat from smaller habitats based on output of the EU-ClueScanner land-use allocation results. This is an approximation of the connectivity potential of the landscape for species and the viability of smaller habitats within the landscape matrix. The difficulty to reach other habitats is differentiated between land use types, assuming, for example, a high resistance for urban and arable areas to allow migration of species, a medium to low resistance of permanent grassland areas and a low resistance of other small patches of (semi-) natural area. As the indicator is not including information on the quality of different land-use types, it only offers an initial indication of the potential coherence of possibly valuable natural areas.



The indicator has been defined in such a way as to be as much as possible independent of the area of natural land use types in the region. Therefore, also areas with limited natural area may still have, in theory, a good connectivity potential. This way the indicator has added value to the biodiversity indicator that is included as well. This indicator has been developed to best identify differences in landscape connectivity potential (here: permeability) at the relatively coarse scale of analysis. Other indicators such as the frequently used proximity indicator (Gustafson and Parker, 1994) are not sufficiently sensitive to the data used at the spatial and thematic resolution of analysis.

Calculation input parameters:

Name	Quantity	Source	Description
LU18	18 classes	Primary EU-ClueScanner output	Land use resulting from simulation. This is initially based on Corine Land Cover 2000.

Technical implementation of calculation method (Incl aggregation method)

The following steps are performed to calculate the indicator:

1. Reclassify the land use map to the following classes.

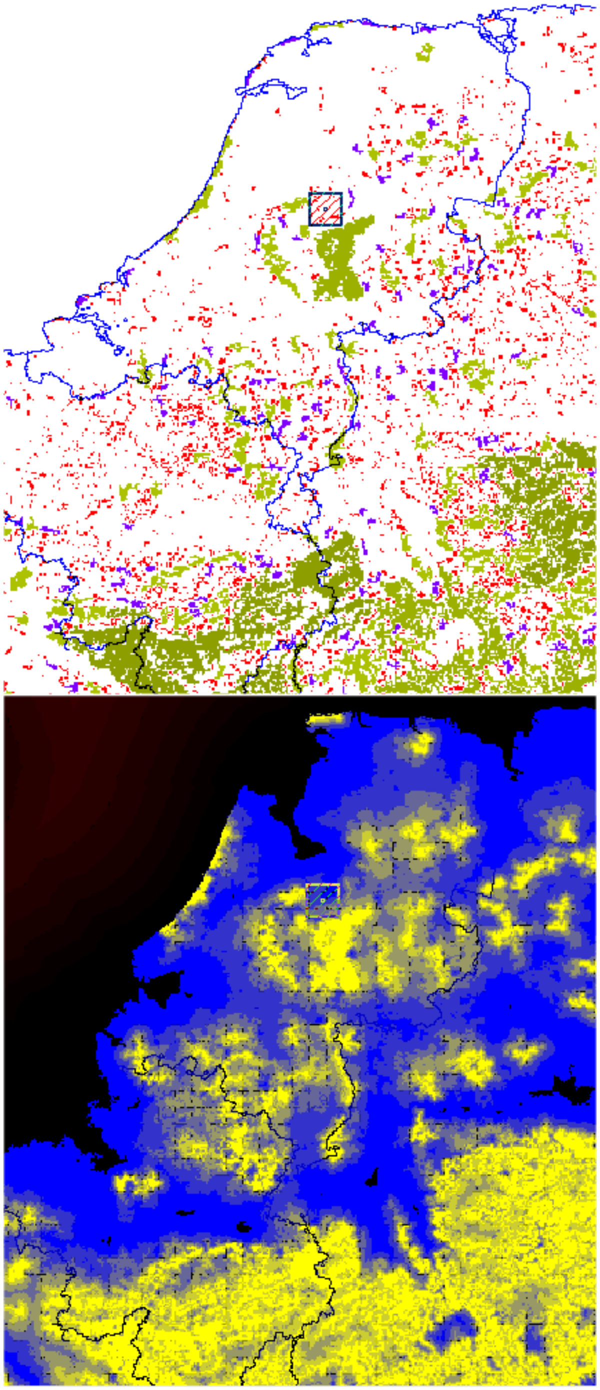
New class	Friction	Nr.:	Land cover class:
0	10	0	Built-up area
1	4	1	Arable land (non-irrigated)
2	1	2	Pasture
3	0	3	(semi-) natural vegetation
3	0	4	Inland wetlands
4	2	5	Glaciers and snow
2	4	6	Irrigated arable land
2	1	7	Recently abandoned arable land
1	4	8	Permanent crops
1	4	9	Arable land devoted to the cultivation of (annual) biofuel crops
3	0	10	Forest
4	2	11	Sparsely vegetated areas
4	2	12	Beaches, dunes and sands
4	2	13	Salines
5	4	14	Water and coastal flats
3	0	15	Heather and moorlands
2	1	16	Recently abandoned pasture land
1	1	17	Perennial biofuel crop cultivation
4	2	18	Ecological Focus Areas
1	4	-9999	No data. Most no data values relate to marine waters and have therefore been given the friction value of water. This prevents islands to be complete cut off from mainland Europe.

2. identify continuous patches of New class 3 (natural areas) and calculate patch size.
3. classify all patches > 25 km^2 as 'destinations'.
4. classify the remaining landscape following the friction indicated in the table above.
5. calculate the 'cost' (= friction * distance) from each location to the nearest 'destination' (= larger patch, see example below).
6. retain the 'cost' for each patch (note that all cells in a patch have the same value since the travel cost within a patch is 0). Cost for 'destination' patches = 0.
7. search all patches within a 15 km radius (diameter 30 km) for presentation on 1 km grid and calculate the average cost for these patches. This is the value of the grid cell. Note that each patch counts one time irrespective of its size. Patches that fall partly within the 15km radius only count for the share they fall within the radius.
8. for presentation on NUTS2: calculate average of all patches in NUTS2, each patch counts 1 time, irrespective of size.

The images on the next page represent the main steps in this process.

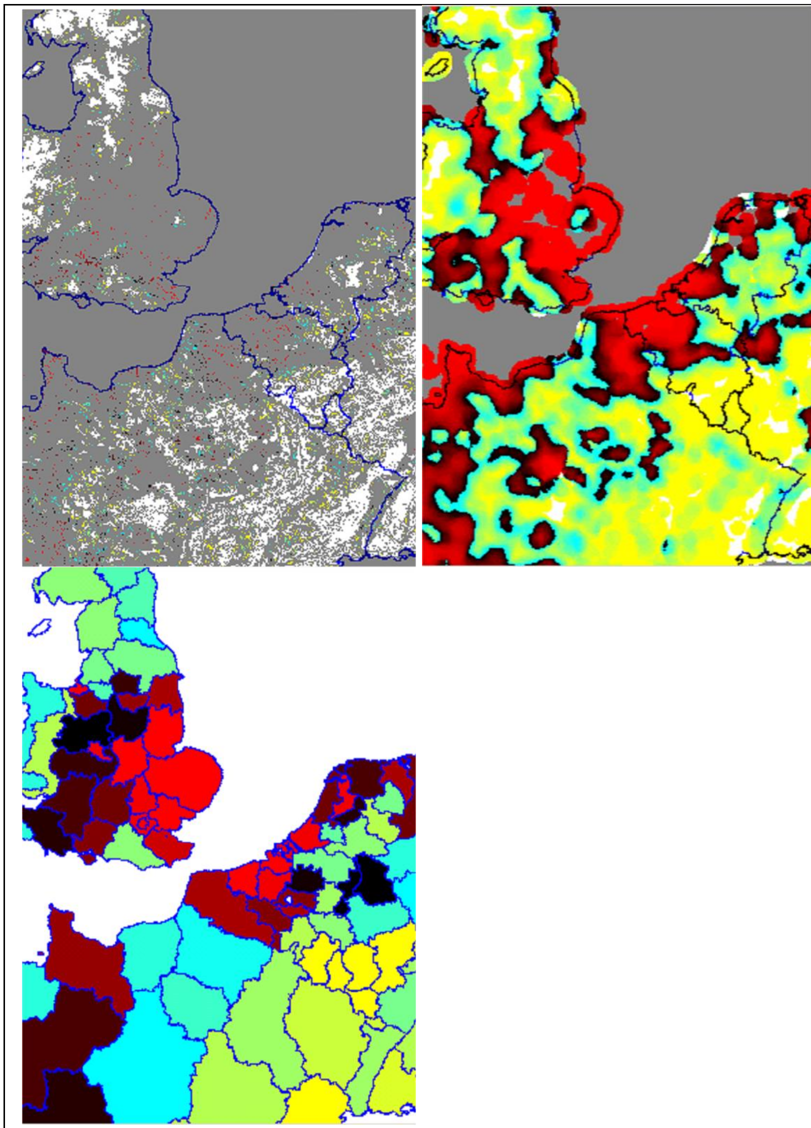
The land cover connectivity potential indicator is newly developed for the EU-ClueScanner project. It aims to capture the difficulty species have to move from a nature area to the nearest larger habitat. As such it describes potential connectivity (or rather the lack thereof: fragmentation) based on a straightforward assessment of land-use types. More detailed analyses can be performed when quality differences of habitats (e.g. forest age) can also be included. This is a topic for further research.

Steps 2 and 5:



Part of Europe showing patches of natural areas (at left, with patch size ranging from red=small to green=large) and the cost to travel to nearest patch of more than 25km2 (at right, with costs ranging from yellow=low to blue/black = high).

Steps 6, 7 and 8:



Part of Europe showing cost per patch (left, ranging from red = high cost to white = destination patch), average cost within 15 km radius (middle, ranging from red = high to white = low), average cost per NUTS2 region (right, red = high to yellow = low).

2.2.4 Mean Species Abundance

Indicator name	MSA
Short description (max. 3 lines)	This indicator is constructed to show the potential impact of land-use change on biodiversity. Biodiversity is described by the Mean Species Abundance (MSA) and the approach used is derived from the GLOBIO3 concept. The biodiversity indicator responds to land-use change and is affected by fragmentation, N deposition, infrastructure development and land-use intensity. These factors are driven by the (global) driving forces but also by specific nature policies which are spatially explicit.
Developer:	Jana Verboom, Alterra the Netherlands: jana.verboom@wur.nl Rob Alkemade, Netherlands Environmental Assessment Agency: rob.alkemade@mnp.nl Willem Rienks Alterra the Netherlands: willem.rienks@wur.nl Igor Staritsky, Wageningen University: igor.staritsky@wur.nl
Source:	CLUE-scanner; Verboom et al. (2007)

Indicator data type: quantitative

Indicator	Units
Biodiversity index (MSA)	0 (none)-100 (maximum)

Description of causality in calculation method (max. 10 lines)
The biodiversity index or MSA is derived from land-use, land use intensity (agriculture and forestry), the N-deposition, fragmentation, infrastructure developments and policy assumptions on high nature value (HNV) farmland protection and organic agriculture. The methodology used is the GLOBIO3 approach initially developed for biodiversity assessments at a global scale (Alkemade et al., 2009), but also applied to level of Europe (Verboom et al., 2007). The indicator provides an approximation of the land-use related changes in biodiversity. As it is not able to discern actual habitats, applies a 1x1 km resolution that is too coarse to capture detailed ecological processes and only uses a limited range of factors that influence biodiversity, the results do not provide a precise, local account of biodiversity. It does, however, allow for the comparison between the current and different future situations. It shows potential changes in biodiversity at a generalised level.

Calculation input parameters

Name	Quantity	Source	Description
LU18	18 classes	Primary EU-ClueScanner output	Land use resulting from simulation. This is initially based on Corine Land Cover 2000.
Dairy density	0-9999 Large Stock Units (LSU)	Result of EURURALIS dairy density metamodel	Scenario specific 1x1 km map showing dairy density for 2000. 1 LSU is equivalent to one bovid weighing 420 kg.
Forest age	Years	EU-ClueScanner	This is a dynamic file that is updated for each year of simulation.
MSA land-use conversion table	0-100	Expert judgement table created by Rob Alkemade / Jana Verboom	The table describing the relation between land-use type and MSA is provided below
Forest use intensity factor	1 or 1.1	Scenario-based assumption by experts (Jana Verboom, Rob Alkemade, Willem Rienks)	For the B1 scenario, the values 1 (for the years 2000 & 2010) and 1.1 (2020, 2030) are used as a decrease in forest use (thus 10% increase in MSA) is expected because more wood will be imported from outside Europe
High Nature Value (HNV) farmland	Yes/no	EC-JRC	1x1 km map showing approximate extent of potential HNV areas
Organic agriculture table	0-300	Expert judgement table created by Pytrik Reidsma and others	The tables showing the increase in % organic agriculture over time and its land-use specific impact on MSA are provided below
Road map 2000	Yes/no	TEN-Stack project through NEA company	1x1 km road map of 2000
Road map 2010	Yes/no	TEN-Stack project through NEA company	1x1 km road map of 2000
Road map 2020	Yes/no	TEN-Stack project through NEA company	1x1 km road map of 2020
Road map 2030	Yes/no	TEN-Stack project through NEA company	1x1 km road map of 2020
Road disturbance table	0-0.39	Expert judgement table (Jana Verboom and Rien Reijnen of Alterra Wageningen)	Based on type of road and distance to road a disturbance factor is calculated that ranges from 0 (no disturbance) to 0.39 (maximum disturbance). See table below.
Natura 2000	Yes/no	EC-JRC	1x1 km showing areas under Nature2000 designation. Please note that many Natura2000 areas are too small to be adequately captured at this scale

Nature fragmentation table	0-0.45	Expert judgement table (Fleur Smout and Rob Alkemade of Netherlands Environmental Assessment Agency).	The degree of fragmentation of natural areas depends on their size. The impact of fragmentation on MSA ranges from 0 to a 0.45 decrease. See table below.
N-deposition	Kg N/ha	IMAGE model	Scenario specific Nitrogen deposition maps for 2000, 2010, 2020, 2030. Initial resolution approximately 50x50km.
Critical Nitrogen load	Kg N/ha	Netherlands Environmental Assessment Agency (Rob Alkemade)	Map showing critical Nitrogen load at approximately 50x50 km resolution
Critical load formulas	-	Expert judgement (Netherlands Environmental Assessment Agency).	The relation between Nitrogen load and MSA is described in three different formulas that apply to different groups of land-use types. The approach applies critical load exceedence for N as does the Streamlining European 2010 Biodiversity Indicators project (EEA, 2007).

Technical implementation of calculation method (including aggregation method)

The main approach is the following (example 2000):

MSA_{2000} = MSA-landuse$_{2000}$ * MSA-infrabuffer$_{2000}$ * MSA-fragmentation$_{2000}$* MSA-Ndeposition$_{2000}$ * 100

The main components (*MSA-landuse, MSA-infrabuffer, MSA-fragmentation and MSA-Ndeposition*) in this formula are calculated as follows:

MSA-landuse

1. Select land-use map;
2. Split up land-use class Pasture into Intensive pasture and Extensive pasture with the Livestock density map (Extensive pasture is pasture with less than 50 LSU/km2);
3. Split up land-use category Forest into Forest plantation and natural forest with the Forest age map. Age classes are younger than 10, 20, 30, 40 50-80 years, and older than 80 years;
4. Join the land-use map with the land-use conversion table that specifies a MSA value per land-use class (see below);
5. Multiply all agricultural classes with 1.25 when within boundaries of HNV map;
6. Multiply all agricultural classes with Organic correction factor (e.g. times 2 for intensive agriculture, see table below);
7. Multiply all forest with the scenario-specific and year-dependent Forest use intensity factor.

Land-use class[1]	MSA-value[2]	Organic correction[3]	Type[4]	Crit.load formula[5]	Description
0	5	1	Other	0	Built-up area
1	10	2	Agriculture	0	Arable land (non-irrigated)
2	10	1	Agriculture	0	Pasture intensive (>60 LSU/km2)
3	70	1	Nature	F1	(semi-) natural vegetation
4	100	1	Nature	F1	Inland wetlands

5	100	1	Nature	F2	Glaciers and snow
6	5	3	Agriculture	0	Irrigated arable land
7	30	1	Agriculture	0	Recently abandoned arable land
8	20	1.4	Agriculture	0	Permanent crops
9	10	2	Agriculture	0	Biofuel crops (Intensive)
10	70	1	Nature	F3	Forest (natural/plantation – average forest age in region between 50 and 80 years)
11	100	1	Nature	F2	Sparsely vegetated areas
12	100	1	Nature	F2	Beaches, dunes and sands
13	100	1	Nature	F2	Salines
14	100	1	Nature	F2	Water and coastal flats
15	100	1	Nature	F2	Heather and moorlands
16	30	1	Nature	0	Recently abandoned pasture land
17	30	1.4	Agriculture	0	Woody biofuel crops
18	40	1.4	Agriculture	0	Pasture extensive(<60 LSU/km2)
19	60	1	Nature	F3	Forest (plantation with average forest age in region below 50 yrs)
20	45	1	Nature	F3	Forest (plantation with average forest age in region below 40 yrs)
21	35	1	Nature	F3	Forest (plantation with average forest age in region below 30 yrs)
22	25	1	Nature	F3	Forest (plantation with average forest age in region below 20 yrs)
23	15	1	Nature	F3	Forest (plantation with average forest age in region below 10 yrs)
24	100	1	Nature	F3	Forest (natural – average forest age in region older than 80 years)
25	20	1.4	Agriculture	0	Ecological Focus Areas

Notes:

[1]The original 18 EU-ClueScanner classes have been subdivided for pastures (based on livestock density) and forests (based on forest age map). Please note that the latter subdivision is done again for every year the indicator is calculated as the forest age map is dynamically updated during simulation.

[2]The MSA values are based on the expert judgment of Rob Alkemade (Netherlands Environmental Assessment Agency) and Jana Verboom (Alterra).

[3]The correction factor for organic farming is based on Reidsma et al (2006) and was elaborated for the EURURALIS project. In addition this factor is multiplied with a scenario and year-specific conversion factor that represents the increased attention for organic farming over time. The B1 scenario has a relatively strong increase of organic farming of 1, 1.05, 1.10 and 1.15 for the years 2000, 2010, 2020 and 2030 respectively.

[4]Type is used in various calculations to distinguish between areas with a predominant agricultural, natural or other character.

[5]Per group of land-use types one of three available formulas (F1-F3) is applied to link local nitrogen exceedence to MSA (see below at MSA-Ndeposition).

MSA-infrabuffer

1. Select the road map
2. Buffer road map with Table road buffer. Depending on road type (0 = smallest, 4 = largest) and distance to these roads (in number of grid cells) this produces a map with disturbance factors ranging from 0 to 0.39 (39% decrease). See the table below for all disturbance factor values. The MSA is then multiplied by (1-disturbace factor).

Road type	Distance to road (nr. of cells)	Disturbance factor
0	0	0.1344
0	1	0.0000
0	2	0.0000
0	3	0.0000
1	0	0.2878
1	1	0.0115
1	2	0.0000
1	3	0.0000
2	0	0.3641
2	1	0.0401
2	2	0.0000
2	3	0.0000
3	0	0.3903
3	1	0.0776
3	2	0.0229
3	3	0.0115
4	0	0.3903
4	1	0.1081
4	2	0.0229
4	3	0.0115

Source: Jana Verboom and Rien Reijnen of Alterra Wageningen

MSA-fragmentation

1. Select the land-use map;
2. Select all the nature categories and make map Yes/no nature;
3. Select the Road map and the Natura 2000 map; in case of the B1 scenario, grid cells referring to a road within Natura 2000 boundaries in the years 2020 or 2030 are considered as nature cells as it is assumed that their fragmenting effect will be compensated in this scenario that stresses the importance of ecological values;
4. Subtract the Road map from the Yes-nature map resulting in smaller patch sizes;
5. Calculate patch sizes;
6. Join the patch size with the Fragmentation table (see below) to calculate the MSA-fragmentation factor. The amount of fragmentation depends on the size of the nature areas and ranges from 0 to 45%, see below. The MSA-fragmentation is then calculated as 1-fragmentation degree. When land use is agriculture or other, the MSA-fragmentation factor (showing the impact of fragmentation on MSA of agricultural or other areas) equals 1. This implies that the (limited) species richness of these areas is not affected by their size.

Nature area (km^2)	Fragmentation degree
0-1	0.45
1-10	0.25
10-100	0.15
100-1000	0.05
> 1000	0.0

Source: Fleur Smout and Rob Alkemade of Netherlands Environmental Assessment Agency

MSA-Ndeposition

1. Select the N-deposition map and the Critical load map;
2. Calculate the N-exceedence by subtracting both maps: Nexc = N-dep - CL;
3. When Nexceedence > 0 calculate MSA N-deposition for each location based on the step

described below;

4. The MSA-Ndepostion factor is then calculated based on N-exceedance (NE) according to one of the following three land-use specific formulas (F1-F3, see first table in this section):
   - F1 0.8-0.08 * ln(NE)
   - F2 0.9-0.05 * ln(NE)
   - F3 0.8-0.14 * ln(NE)

   These formulas express empirically observed relations between critical-load level and the relative local species richness (considered as a proxy for MSA) in different land-use environments (Alkemade et al., 2009). These relations have been adjusted for the European context. As can be seen in one of the tables above (under the MSA-land use heading), formula 1 (F1) is applied to locations that are classified as being with (semi-) Natural vegetation or Inland wetlands, formula 2 (F2) is applied to locations that are classified as being sparsely vegetated areas, beaches, dunes etc.

   When no N exceedance occurs, or the impact of exceedence according to the above formulas is higher than 1, or when land-use class is not sensitive to N-deposition, the MSA N-deposition equals 1.

Present aggregated results:
The results are aggregated to various NUTS levels by taking the mean value for the region. In addition a smoothed 1x1 km resolution representation is created by taking the mean value for that location based on the surrounding 10x10 grid cells. The indicator thus shows the mean MSA value in a 100km^2 neighbourhood.

2.2.5 Bird species richness

Based on methods described by (Overmars et al., 2013; Eggers et al., 2009; Louette et al, 2010) an indicator for bird species richness and changes therein is developed. The indicator is based on data on species occurrence and their sensitivity to environmental pressures (Delbaere et al., 2009). In this indicator, we focus on the impact of land use changes on bird species richness. Bird species richness is a commonly used indicator for biodiversity. Also, bird species richness is correlated with the species richness of other species groups (Thuiller et al., 2012). The impact of land use change is expected to be an important driver for biodiversity changes in the coming decades and is therefore chosen as the environmental pressure of interest. The indicator shows the percentage of a set of bird species potentially present at a certain location, based on coarse-scale distribution data and high-resolution land use data. This percentage is calculated based on data of a set of species of which the management and conservation potentially could be effective for most of the other species occurring in the same landscape (Overmars et al., 2013).

The indicator is calculated as follows.

1. For 168 bird species, presence/absence maps (Hagemeijer and Blair, 1997) with a 50 * 50 km resolution are used. These are combined with two data sources, explained in steps 2 and 3.
2. For each species, a 1km resolution habitat suitability map was made. The habitat suitability map indicates if the land use type is suitable for the bird species (1) or not (0). This was done by reclassifying the land use map resulting from the CLUE-scanner following the habitat suitability values of each land use type for each species from the BIOSCORE database (Delbaere et al, 2009). The BIOSCORE database summarizes data on the impact of a wide

range of environmental pressures on a set of approximately 1000 species from different species groups.

3. For each species, a map of the land use intensity (Potter et al, 2010; Temme and Verburg, 2011) was reclassified into a habitat suitability map indicating if the land use intensity is suitable for the bird species (1) or not (0).
4. The habitat suitability maps based on land cover and intensity and the 50 * 50 km resolution presence (1) / absence (0) map are multiplied, resulting in a 1km resolution map of potential presence / absence of each bird species.
5. Three Species richness maps were calculated by adding up the maps from step 4.
    a) Species richness: All 168 bird species are included;
    b) Annex 1 bird species richness: only the Annex 1 bird species (Table 2-15) are included (91 species);
    c) Farmland bird species richness: only farmland bird species (Table 2-15) were included (45 species).

Table 2-15: Bird species used in the bird species richness indicators

Name	Annex I	Farmland	Name	Annex I	Farmland
Accipiter brevipes	x		*Caprimulgus europaeus*	x	
Acrocephalus paludicola	x	x	*Carduelis cannabina*		
Actitis hypoleucos			*Carduelis chloris*		
Aegypius monachus	x		*Charadrius alexandrinus*	x	
Alauda arvensis	x	x	*Chlidonias hybridus*	x	
Alcedo atthis	x		*Chlidonias niger*	x	
Alectoris barbara	x		*Ciconia ciconia*	x	x
Alectoris chukar			*Ciconia nigra*	x	
Alectoris graeca	x		*Circaetus gallicus*	x	
Alectoris rufa		x	*Circus cyaneus*	x	
Anas acuta			*Circus macrourus*	x	x
Anas clypeata			*Columba palumbus*	x	x
Anas penelope			*Coracias garrulus*	x	x
Anas platyrhynchos			*Corvus monedula*		
Anas querquedula			*Coturnix coturnix*		x
Anas strepera			*Crex crex*		x
Anser erythropus	x		*Cygnus cygnus*	x	
Anthus campestris	x		*Cygnus olor*		
Aquila chrysaetos	x		*Elanus caeruleus*	x	x
Aquila clanga	x		*Emberiza cia*		x
Aquila heliaca	x		*Emberiza hortulana*	x	
Aquila pomarina	x		*Emberiza melanocephala*		
Ardea purpurea	x		*Emberiza schoeniclus*		
Ardeola ralloides	x		*Erithacus rubecula*		
Arenaria interpres			*Falco biarmicus*	x	x
Asio flammeus	x	x	*Falco cherrug*	x	x
Athene noctua		x	*Falco eleonorae*	x	
Aythya ferina			*Falco naumanni*	x	x
Aythya fuligula			*Falco rusticolus*	x	
Aythya marila			*Falco tinnunculus*		x
Aythya nyroca	x		*Falco vespertinus*	x	x
Botaurus stellaris	x		*Ficedula semitorquata*	x	
Branta bernicla			*Fringilla coelebs*	x	
Bubo bubo	x		*Fulica atra*		
Bucephala clangula			*Galerida cristata*		x
Burhinus oedicnemus	x	x	*Galerida theklae*	x	
Buteo rufinus	x	x	*Gallinago media*	x	
Calandrella brachydactyla	x	x	*Gavia arctica*	x	
Calandrella rufescens		x	*Gavia stellata*	x	
Calidris alpina	x		*Gelochelidon nilotica*	x	
Calidris maritima			*Glareola nordmanni*		x
Calidris minuta			*Glareola pratincola*	x	

Name	Annex I	Farmland	Name	Annex I	Farmland
Grus grus	x		*Passer montanus*		x
Gypaetus barbatus	x		*Perdix perdix*	x	x
Haliaeetus albicilla	x		*Perisoreus infaustus*		
Hippolais pallida			*Phoenicurus phoenicurus*		
Hirundo rustica		x	*Phylloscopus bonelli*		
Ixobrychus minutus	x		*Phylloscopus sibilatrix*		
Jynx torquilla			*Picoides tridactylus*	x	
Lanius collurio	x	x	*Picus canus*	x	
Lanius excubitor			*Picus viridis*		
Lanius minor	x	x	*Platalea leucorodia*	x	
Lanius nubicus	x		*Plegadis falcinellus*	x	
Lanius senator		x	*Pluvialis apricaria*	x	
Larus canus			*Podiceps auritus*	x	
Larus minutus	x		*Podiceps cristatus*		
Larus ridibundus			*Porzana pusilla*	x	
Limosa lapponica	x		*Prunella modularis*		
Limosa limosa		x	*Pterocles alchata*	x	x
Lullula arborea	x		*Pterocles orientalis*	x	x
Lymnocryptes minimus			*Pyrrhocorax pyrrhocorax*	x	
Melanitta fusca			*Recurvirostra avosetta*	x	
Melanocorypha calandra	x	x	*Regulus regulus*		
Mergus albellus	x		*Saxicola rubetra*		x
Mergus merganser			*Scolopax rusticola*		
Merops apiaster		x	*Sterna caspia*	x	
Miliaria calandra		x	*Sterna dougallii*	x	
Milvus migrans	x		*Sterna sandvicensis*	x	
Milvus milvus	x		*Streptopelia turtur*		x
Monticola saxatilis			*Sturnus vulgaris*		x
Monticola solitarius			*Sylvia atricapilla*		
Muscicapa striata			*Sylvia borin*		
Neophron percnopterus	x		*Sylvia communis*		x
Netta rufina			*Sylvia undata*	x	
Numenius arquata			*Tadorna ferruginea*	x	
Nyctea scandiaca	x		*Tetrao tetrix*	x	
Nycticorax nycticorax	x	x	*Tringa erythropus*		
Oenanthe leucura	x		*Tringa glareola*	x	
Otis tarda	x	x	*Tringa totanus*		
Otus scops		x	*Turdus merula*		
Oxyura leucocephala	x		*Turdus philomelos*		
Pandion haliaetus	x		*Turdus viscivorus*		
Parus caeruleus			*Tyto alba*		x
Parus cristatus			*Vanellus vanellus*		x

2.3 Ecosystem services

2.3.1 Nutrition – Terrestrial food provision

Indicator name	**Cropland area**
Short description	Cropland percentage
Units	Area %
Spatial resolution	NUTS2, country
Temporal resolution	Start and end year

2.3.1.1 Description of causality in calculation method

Consistent with Maes et al (2011) we calculate the area percentage cropland and changes therein at NUTS2 level. We also summarize the changes in cropland percentage per country.

2.3.1.2 Input parameters

Name	Quantity	Source	Description
Land cover	CLUE classes (18)	CLUE modelling	CLUE Grid 1x1 km.

2.3.1.3 Calculation rules

1. The land use maps for the start year and resulting from the CLUE-scanner simulation are reclassified into cropland (100) and other land (zero). Croplands are defined as non-irrigated arable (land use type 1), irrigated arable (6) and permanent crops (8).
2. A zonal mean of the map resulting from step (1) within NUTS2 regions is calculated.
3. A zonal sum of the map resulting from step (1) within countries is calculated and divided by 100.

2.3.2 Nutrition – potable water

Indicator name	**Water area per demand area**
Short description	Area open water per km^2 water-consuming area
Units	km^2 / km^2
Spatial resolution	Watershed / country combinations
Temporal resolution	Start and end year

2.3.2.1 Description of causality in calculation method

As in many parts of Europe open water is used for water extraction, the area of open water is a useful indicator for the level of supply that enables comparing the supply level of different regions. Therefore, it is a commonly used indicator for the supply of potable water, e.g. in the MAES assessment (Maes et al, 2011). However, this indicator is unlikely to change in the timeframe of the contract while the actual balance between supply and demand for potable water is expected to change due to population changes and changes in water extraction by industry and agriculture. We therefore calculate the ratio between the area of open water and area built-up and arable land per watershed-country region. This gives an indication of the actual service delivery and changes therein.

2.3.2.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
Watershed – country polygons		Eurostat, Vogt et al., 2007	Intersection of country map (Eurostat) and major basins from Vogt et al. (2007)
Global Lakes and Wetlands Database	12 different lake / river / wetland / intermediate classes	Lehner and Doll (2004)	The GLWD Level 3 database combines the best available data sources into a database describing the location and extent of open water bodies with a service area ≥ 0.1 km^2.

2.3.2.3 Calculation rules

1. The area of open water is identified in the Global Lakes and Wetlands Database: Classes 1 (lake), 2 (reservoir), 3 (river) and 9 (intermittent wetland/lake) are included.
2. The land use maps resulting from the CLUE simulations are reclassified into areas that extract water (1) and other areas (zero). Land use types that extract water are built-up (0), arable land (1, 6 and 18).
3. Zonal sums of the area open water and the water using area are calculated within each watershed – country combination.
4. The area of open water per km^2 water using area is calculated by dividing the area open water per watershed – country polygon with the area of land use that extract water per watershed – country polygon.

2.3.3 Materials – Biotic – Forest biomass stock

Indicator name	**Forest biomass carbon stock**
Short description	Forest biomass carbon stock, calculated with the CLUE-SINKS model
Units	Mg C / km^2
Spatial resolution	$1km^2$
Temporal resolution	Start and end year

2.3.3.1 Description of causality in calculation method

Forests sequester carbon in vegetation. The potential amount and sequestration rate depends on the management, including tree species and forest age as a result of the rotation length. Changes in land use can thus result in changes in carbon emission / sequestration.

Emission / sequestration is calculated using an emission factor; this is a region-specific, age group specific, annual carbon sequestration / emission rate per km^2. The emission for a grid cell is equal to the emission factor. When the land use changes, the emission factor changes to the emission factor of the new land use type. Emission factors from resulting from EFISCEN calculations are used. Deforestation causes loss of carbon from biomass.

2.3.3.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km
Age of land use		CLUE modelling, EFISCEN	1x1 km grid with age of gridcells (Nabuurs, 2001; Pussinen et al., 2001)
Emission factors	Ton C/km^2 per year	Own data source, EFISCEN	• Map with emission factor for each land use type as 1x1 km grids (see calculation rules) (Janssens et al., 2005) • Forest emission factors for soil and biomass from EFISCEN simulations
Forest biomass content	Ton C/km^2	EFISCEN	• Map of forest biomass carbon content per EFISCEN region

2.3.3.3 Calculation rules

1. Forest grid cells are identified in the land use maps of the base year resulting from the CLUE-scanner simulations. For each grid cell that is forest, the carbon stock in vegetation from EFISCEN is assigned as the initial carbon stock.

2. Land use maps from the base year and the end years of the simulations are compared. If the land use changes from forest to another land use type (i.e. deforestation), 80% of the biomass is lost.

2.4 Regulation of waste – Dilution and sequestration - Carbon sequestration

Indicator name	Carbon sequestration
Short description	The CLUE-SINKS model is a bookkeeping model to calculate the amount of carbon that is sequestered in or emitted from soils and biomass.
Units	Ton C/km^2 per year
Spatial resolution	1km^2 Aggregation to mean value per NUTS2 region (map) Aggregation to summed value per country (table) Aggregation to summed value for the EU27 (table)
Temporal resolution	Start year (2010) and end year (2020)

2.4.1.1 Description of causality in calculation method

Land use types differ in the amount of carbon they sequester or emit in soil and vegetation. Carbon is sequestered in soils of forests, pasture and natural vegetation, and emitted by croplands and parts of wetlands. Additionally, in forests large amounts of carbon are stored in vegetation as well with the amount being dependent on the management. Changes in land use can thus result in changes in carbon emission / sequestration.

Emission / sequestration is defined by an emission factor; this is a region-specific, land use type specific amount of sequestration / emission per km^2 per year. The emission for a grid cell is equal to the emission factor. When the land use changes, the emission factor changes to the emission factor of the new land use type. Emission factors from Janssens (2005) and EFISCEN are used. Deforestation causes loss of carbon from biomass.

Other factors influencing carbon emission and sequestration are the amount of carbon already present in the soil (Sleutel et al., 2003; Bellamy et al., 2005) and the age and management regime of forests.

2.4.1.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
Soil organic carbon	0-8 (SOC classes); 9 (peat)	Own data source	Combination of JRC soil organic carbon map (Jones et al., 2004) and ESB soil map (European Soil Bureau, 2004)
Age of land use		CLUE modelling, EFISCEN	1x1 km grid with age of grid cells (Nabuurs, 2001; Pussinen et al., 2001)
Emission factors	Ton C/km^2 per year	Own data source, EFISCEN	• Map with emission factor for each land use type as 1x1 km grids (see calculation rules) (Janssens et al., 2005). • Forest emission factors for soil and biomass from EFISCEN simulations.
Forest biomass content	Ton C/km^2	EFISCEN	• Map of forest biomass carbon content per EFISCEN region.

2.4.1.3 Calculation rules

For each grid cell, the sequestration / emission is equal to the emission factor of that land use type. Maps with emission factors for cropland, pasture, forest and peatland are used, and emission factors for other land use types are derived from these.

1. Emission is zero for built-up area; glaciers and snow; sparsely vegetated areas; beaches, dunes and sands; salines; water and coastal flats.
2. The emission factor for inland wetlands is the peatland emission factor.
3. The emission factor of heath and moorlands is the grassland emission factor.
4. The emission factor of natural vegetation other than forest is 25 % of the forest emission factor. This is independent of forest management, and is therefore derived from a baseline scenario with zero management.
5. The emission factor of permanent crops is set at 60 tons carbon per km^2 in soil (Freibauer et al., 2004; Smith, 2004). Additionally, newly established areas of permanent crops sequester 223 ton per km^2 in biomass (average of Palmer, 1990; Sofo et al., 2005; Villalobos et al., 2006).
6. For pastures on peat, the emission factor is the peatland emission factor. For pastures on mineral soils there is a specific emission factor.
7. For arable lands, including non-irrigated and irrigated arable lands and biofuels, the emission factor is differentiated between soil organic carbon content:

SOC %	Diff factor	SOC %	Diff factor
0 %	No emission	12.5-25	2
0.01 – 1 %	0.1	25-35	2.5
1 – 2 %	0.2	>35	3.5
2 – 6 %	0.65	Peat (ESB)	EF of peatland
6 – 12.5 %	1.6		

8. Deforestation: Upon deforestation, 80% of carbon in forest biomass as calculated in EFISCEN is lost.
9. Total: deforestation carbon loss is subtracted from emission/sequestration from other land use changes.

2.4.2 Regulation of waste – Dilution and sequestration – Air quality regulation

Indicator name	Air quality regulation
Short description	Capacity of the land cover to capture air pollutants, specified as the deposition rate in zones with artificial land cover.
Units	Cm/s
Spatial resolution	NUTS2 level
Temporal resolution	Start year and end year

2.4.2.1 Description of causality in calculation method

Consistent with the MAES atlas (Maes et al., 2011), we calculate the capacity of the land cover to capture and remove air pollutants in a 3km radius around artificial land use.

2.4.2.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
Capturing capacity	% / deposition rate (cm)	Pistocchi et al., 2006	Table to reclassify CLUE land use into capture capacity map
Road map	Yes/no	TEN-Stack project through NEA company	1x1 km road map of 2000

2.4.2.3 Calculation rules

1. The land cover maps resulting from CLUE simulations are reclassified using Table 2-16, resulting in a map of the capacity of the vegetation to capture air pollutants.
2. All land cover in CLUE land cover map except built-up is set to NoData. The resulting map is combined with the roads map, resulting in a map indicating artificial areas (built-up and roads, 1) while all other areas are NoData.
3. A buffer of 3km around all artificial areas is calculated.
4. The buffer map (step 3) is multiplied with the capturing capacity map (step 2), resulting in a map of the capture capacity within 3km buffers around artificial areas.

2.4.3 Flow regulation – Water flow regulation – Storm protection

Indicator name	**Storm regulation**
Short description	Area percentage land use that is capable of slowing down waves and as such provides protection against storms in coastal areas
Units	%
Spatial resolution	NUTS2 level
Temporal resolution	Start year and end year

2.4.3.1 Description of causality in calculation method

Consistent with the MAES atlas (Maes et al., 2011) we map the area of land use types that reduce wind speed and wave speed and with that protect against damage from storms. As the thematic resolution of the land use simulations is lower than the CORINE map used by Maes et al. (2011), the parameterization is slightly adapted.

2.4.3.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
Global Lakes and Wetlands Database (GLWD)	12 different lake / river / wetland / intermediate classes	Lehner and Doll (2004)	The GLWD Level 3 database combines the best available data sources into a database describing thelocation and extent of open water bodies with a service area ≥ 0.1 km^2.

2.4.3.3 Calculation rules

1. CLUE land cover map is reclassified into land cover providing storm protection (1) and other land use (zero). Land cover types 4, 12 and 13 provide storm protection.
2. CLUE land cover map is reclassified into land cover types that could provide storm protection if they are natural land cover within wetlands (1) and other land cover (0). This applies for the land covers 3, 7, 10, 11, 16.
3. GLWD is reclassified into GLWD classes that provide storm protection (1) and other classes (0). The classes providing storm protection are 4 (Freshwater marsh), 5 (Swamp forest), 6 (coastal wetland), 7 (pan, brackish / saline wetland), 8 (peatland), 10 (50-100% wetland), 11 (25-50% wetland), 12 (wetland complex).
4. Maps from step 2 and 3 are multiplied.
5. Maps resulting from step 4 are combined using an OR function with map from step 1.
6. NUTS2 regions along the coast with built-up area are identified by reclassifying the CLUE results into built-up and other land. A zonal mean in NUTS2 regions * 100 is calculated, and regions with urban >3% are selected.
7. In the regions identified in step 5, the area % protective land cover (step 4) is calculated.

2.4.4 Flow regulation – Water flow regulation – Flood protection

Indicator name	**Flood regulation**
Short description	Relative water retention (normalized index ranging from 0-100
Units	0-100
Spatial resolution	1km^2
Temporal resolution	Start year and end year

2.4.4.1 Description of causality in calculation method

Natural landscape features as terrain, vegetation and soils can potentially alter the runoff regime in a river catchment, ultimately impacting on the discharge amounts by its different water retention potentials. This indicator represents the landscape's capacity to modify the river discharge after heavy precipitation events potentially causing flood events. Indicator values are available at a scale of 1 km².

2.4.4.2 Input parameters

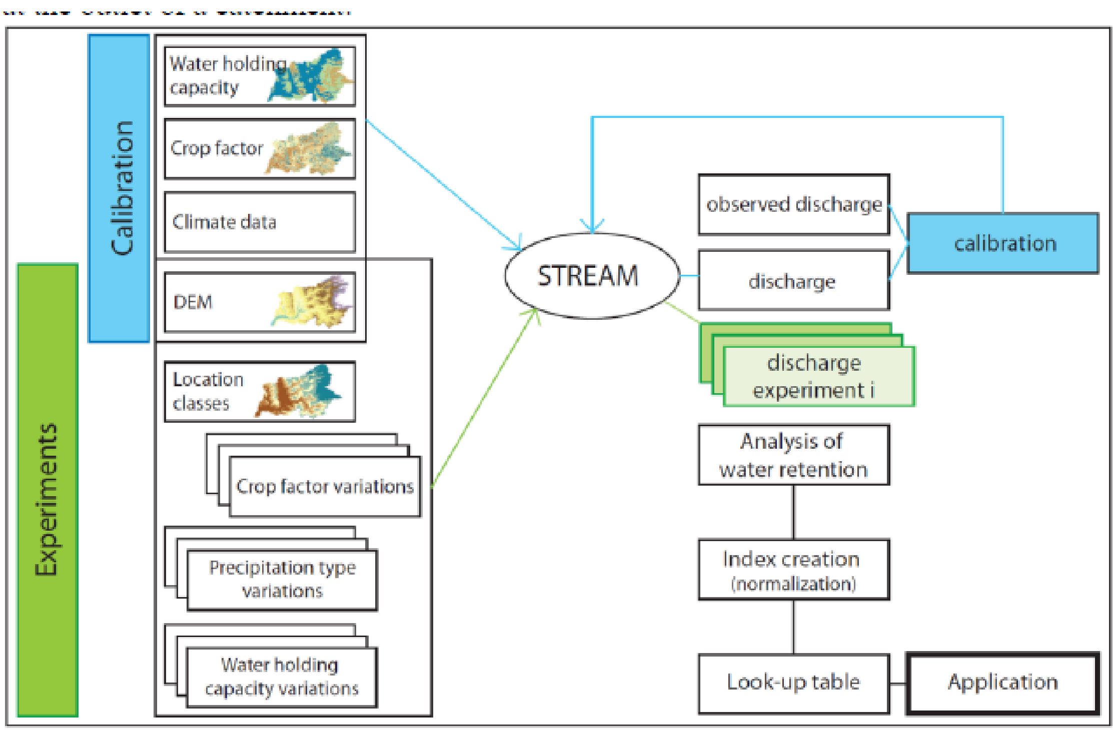
Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
Catchment types	-	EEA, 2008; USGS, 2001	Classification of EU river catchments in hydrology classes
Catchment zones	-	USGS, 2001	Map indicating the relative position within river catchment
Precipitation regime		Haylock et al., 2008	Classification of daily precipitation 1990-2000 into precipitation distribution regimes
Crop factor	-	EEA 2011; Temme and Verburg 2011; Kuemmerle et al 2012; Gallaun et al 2010; Hengeveld et al 2012; Brus et al 2012	Flood regulating capacity of the land, based on land cover, agricultural intensity, agricultural field size, forest growing stock, forest management and tree species.
WHC	-	FAO 2009	Soil water holding capacity classification

2.4.4.3 Flood regulation supply index

The flood regulation supply index is based on catchment experiments within the hydrological model STREAM. For these experiments, a number of catchments are selected to cover the geomorphological variety of catchment forms within the analysed area. Each catchment is calibrated based on observed river discharge data (EWA). Land use and soil are iteratively changed within the selected catchments based on predefined location characteristics of the catchment, and the effects of these land use and soil alterations within the specified zones during different types of events of heavy precipitation are analysed.

The resulting index itself is based on alterations in water retention within a distinct time frame at the outlet of a catchment (Stürck et al, 2014).

Figure 10-2. Overview of the approach of the flood regulation supply index.



2.4.4.4 STREAM model

STREAM (Spatial Tools for River basins and Environment and Analysis of Management options) is a conceptual empirical hydrological model by the Institute for Environmental Studies of the Vrije Universiteit Amsterdam (IVM-VU). Its core compartment is formed by a GIS based spatially distributed rainfall runoff model. The model has been developed to assess the processes which impact water availability within the river basin. Its use is specifically optimized for the analysis of effects of land use and climate changes on freshwater hydrology in large river basins, which facilitates the use of the STREAM instrument for applications as extensive scenario analysis in water resource management. The model is capable of processing input data of any spatial and temporal resolution.

An extreme scenario of soil / land use is designed for each experiment catchment, representing the “worst case” scenario in terms of water retention. 205 soil / land use combinations are tested iteratively per catchment and precipitation type. The land use alterations are based on the spatial extent of the location classes, thus each crop factor is assigned to the whole extent of one location class in a catchment.

2.4.4.5 Flood regulation provision - STREAM model experiments

The discharge outputs retrieved from the model runs are analyzed for the quantities of retained water after a certain time step after a precipitation event occurred (Eq. 1). These values are compared for each run with a 'worst case' scenario, where soil and land use parameters are set to least favourable conditions. The relative difference of each run compared to the worst case scenario for the respective catchment and precipitation type is than normalized to the maximum (Eq. 3).

Relative water retention = (total precipitation – discharge) / total precipitation *(eq. 1)*
R = relative water retention $_{I}$ *– relative water retention*$_{min}$ *(eq. 2)*

Where R = increased water retention of model run *i* compared to worst case scenario

$I = (R_i - R_{min}) / (R_{max} - R_{min})$ *(eq. 3)*

Where
I = normalized increased water retention of model run *i* compared to minimum and maximum increased water retention values.

2.4.5 Regulation of flows –Mass flow – Erosion regulation

Indicator name	**Erosion risk**
Short description	Soil loss through sheet and rill erosion as a function of topography, soil, precipitation intensity and land use
Units	Ton/ha
Spatial resolution	$1km^2$ NUTS2 level
Temporal resolution	Start year and end year

2.4.5.1 Description of causality in calculation method

The currently used model to quantify the regulation of soil particle flow at European scale is the MESALES model. This is a factor scoring model in which data on land use, slope, soil properties and climate are combined to predict the seasonal and averaged soil erosion in five classes ranging from very low to very high (Le Bissonnais et al., 2002). A limitation of this indicator is the limited thematic resolution. Especially the role of pasture and some agricultural systems in erosion protection is underestimated. The erosion risk indicator used in the DG ENV report "*Land use modelling – implementation. Preserving & enhancing the environmental benefits of "land-use services"* (Perez-Soba et al., 2010) overcomes several of these shortcomings and gives a more quantitative output, providing better possibilities to quantify net loss or gain of the ecosystem service. This indicator is builds on the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) and results in a quantitative estimate of erosion risk in ton ha^{-1} at a $1km^2$ resolution.

In the USLE, First, a potential for soil erosion is derived from topography, rainfall regime and soil erodibility, whereby rainfall regime is considered to be variable in time. Second, the land use maps resulting from each scenario are used to derive a measure for the protective vegetation cover, so that an actual soil erosion map can be obtained (Perez-Soba et al., 2010).

2.4.5.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
R map	-	Perez-Soba et al (2010)	Rainfall intensity
KLS map	-	Perez-Soba et al (2010)	Product of soil erodibility (K), slope length (L) and slope steepness (S) factors.
C data	0-1	Perez-Soba et al (2010)	Map of the MESALES C factor. Reclassification of the CLUE land use map into protection the land cover provides against erosion (Table 3).
Stones	0.5, 1	Perez-Soba et al (2010)	0.5 for very stony areas, i.e. soil mapping units with an agricultural limitation due to stones and gravel according to the ESDB, to 1 for areas with few or no stones.

2.4.5.3 Calculation rules

1. Soil erosion is calculated based on the USLE, using the following empirical equation:

   $$A = R * K * L * S *C$$

   in which:

   - A = mean (annual) soil loss (ton ha^{-1} yr^{-1}),
   - R = rainfall erosivity factor (MJ mm ha^{-1} h^{-1} yr^{-1}),
   - K = soil erodibility factor (ton h MJ^{-1} mm^{-1}),
   - L = Slope factor (-),
   - S = Slope length factor (-),
   - C = cover management factor (-).
2. An R map was developed in Perez-Soba et al (2010).
3. A map combining the K, L and S factors (KLS map) was developed in Perez-Soba et al (2010).
4. A C map was calculated by reclassifying the CLUE land use maps according to Table 2-16.
5. Furthermore, stone cover was considered to protect sediment from being washed away, which was implemented by multiplying the reclassification by the stone protection map.
6. The maps resulting from steps 2, 3 and 5 were multiplied.

2.4.6 Regulation of flows – Mass flow – Pollination

Indicator name	**Pollination**
Short description	Habitat for pollinators in the vicinity of croplands
Units	Area %
Spatial resolution	Km2 Aggregated to NUTS2 for visualization purposes
Temporal resolution	Start year and end year

2.4.6.1 Description of causality in calculation method

A common indicator to map the regulation of pollen flow is the visitation probability (Ricketts et al., 2008). This indicator describes the probability that a crop gets visited by a pollinator as a function of the distance to pollinator habitat. The current status of pollen flow is best indicated by mapping the visitation probability based on high-resolution land cover data (Maes et al., 2012). However, a realistic map of visitation probability depends on high-resolution land use / land cover data while realistic future land use change projections at a resolution higher than 1 km^2 are not available at a European scale. Consequently, realistic mapping of future changes of the visitation probability is not possible using the land use change projections foreseen in this study and therefore we use an alternative approach as developed by Serna-Chavez et al. (2013).

In this method, an empirical relation is established between the percentage natural habitat and the percentage cropland that is accessible for pollinators. The relation applies in areas with land cover consisting of a mix of croplands and natural habitats, as these are the areas where there is an actual flow of pollination. The relation is based on analysis of 10x10km windows in aerial photographs.

To map the flow of pollen using this indicator, land use maps resulting from the CLUE-scanner simulations are classified into natural habitat and other land cover. The percentage natural land cover in a 5km radius is calculated. With the equation given by Serna-Chavez et al., (2013) the percentage cropland that can be accessed by pollinators from this natural habitat is calculated. This is mapped at 1km^2 resolution for croplands.

2.4.6.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.

2.4.6.3 Calculation rules

1. The CLUE land cover map is reclassified resulting in a map showing the habitat percentage for wild pollinators. These are the natural land use types and agricultural land use types with a low level of disturbance:

- Land use types 3, 4, 7, 10, 11, 15, 16 (See
- Table 2-1 in this annex) are reclassified to 100 (100% of this land cover provides habitat)
- Land use types 2 and 8 are reclassified to 50 (these land cover types can provide habitat. As a rough estimate, we assume that half of it indeed provides habitat while in the other half the disturbances due to cattle, management and pesticides are too frequent to enable wild pollinators nesting).
- Other land use types are reclassified to zero (no habitat for wild pollinators).

2. The average habitat percentage is calculated as the focal mean of step (1) in a 5km radius.
3. The % cropland that is accessible from the pollinator habitat is calculated as:
   $(3E\text{-}4 * HabPerc^3) – (0.0332 * HabPerc^2) + (4.1044 * HabPerc) – 19.5$
4. This equation only applies in areas with a mix of croplands and nature. To identify these areas, the land use maps is reclassified:
   - Croplands (Land use types 1, 6 and 9) to 1; other land to NoData.
5. The results from step 3 and 4 are multiplied, resulting in a map of the percentage cropland in the vicinity of pollinator habitat.
6. The map of step 5 is reclassified into:
   - No cropland;
   - Cropland accessible by wild pollinators (Values ≥ 95%)
   - Cropland inaccessible by wild pollinators (Values<95%).

2.4.7 Regulation of the physical environment - Soil Quality

Indicator name	Soil Quality
Short description	Topsoil (0-30 cm) Soil Organic Matter stock
Units	Gg/km^2
Spatial resolution	1km^2 Aggregated to NUTS2 for visualization purposes
Temporal resolution	Start year, end year

2.4.7.1 Description of causality in calculation method

Soil organic matter (SOM) is often seen as an indicator for soil quality because it is closely linked to other aspects of soil quality. SOM improves the soil water holding capacity and increases the resistance against erosion. It is often found in higher concentrations in nutrient rich soils. SOM stocks change as a response to land use. Generally, forests accumulate carbon in soils and forest floors while carbon is emitted from soils in arable lands.

Sequestration / emission of soil carbon is calculated with the CLUE-Sinks model. The total over the period assessed is used to calculate the change in soil organic matter.

2.4.7.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
SOM	Fraction	Gardi et al (2011)	Soil organic matter content (g/g), $1km^2$ resolution.
Rho	g/cm3	Gardi et al (2011)	Soil bulk density (g/cm3), $1km^2$ resolution
SoilSink	Mg/km2	Carbon modelling	Carbon sequestration in / emission from soil between the start and end year

2.4.7.3 Calculation rules

1. The soil quality indicator for the start year is calculated as:

$$SOMStock_{0\text{-}30} = SOMcontent * Rho * 30 * 10000$$

2. Changes in soil organic carbon stock are calculated with the CLUE-Sinks model (Section “Regulation of waste – Dilution and sequestration: Carbon”).
3. The result of step 2 is converted into SOM stock change by multiplying by 1.72 (equal to assuming a C content of SOM of 58%).
4. The results of step 3 and 1 are added.

2.4.8 Cultural services – recreation

Indicator name	**Nature based tourism**
Short description	Capacity of the ecosystem to provide recreational services
Units	Dimensionless (0-100)
Spatial resolution	$1km^2$
Temporal resolution	Start year, end year

2.4.8.1 Description of causality in calculation method

The capacity of the ecosystem to support recreation and tourism is mapped based on the degree of naturalness; the presence of protected areas, the presence of coasts, lakes and rivers; the presence of High Nature Value farmlands.

2.4.8.2 Input parameters

Name	Quantity	Source	Description
Land cover	Clue classes (18)	CLUE modelling	Clue Grid 1x1 km.
Lakes and rivers	Yes (1) / No (0)	Lehner and Doll (2004)	Areas within 5km of lakes or 2km of rivers
Relief	Classes: Flat – rolling – hilly – mountainous – very mountainous	Perez-Soba et al (2010)	Classification of the relief within a 10km radius: Flat: 0-20m elevation difference; Rolling: 20-80m elevation difference; Hilly: 80-200m elevation difference; Mountainous: 200-500m elevation difference; Very mountainous: >500m elevation difference.
Protected areas	Yes (1) / No (0)	EC (2009)	Natural 2000 areas
Natural monuments	UNESCO sites	WDPA (2009)	
HNV farmlands	Area % of 1km^2 grid cell that is of High Natural Value (HNV)	Paracchini et al., 2008)	

2.4.8.3 Calculation rules

1. *Land use variety:* The land use map resulting from CLUE simulations is subdivided into four landscape types. These are assigned a capacity to provide recreational services based on the landscape type:
    a) Forest: More than two-third of the land use in a 5km radius is forest (land use type 10) – Capacity 100;
    b) Peri-urban: more than one quarter of the land use in a 5km radius is built-up (land use type zero) – Capacity zero;
    c) Open or agriculture: more than 80 percent of land use in a 5km radius is agriculture (land use types 1, 2, 6, 8, 9, 18) – Capacity 30;
    d) Mosaic landscapes: more than 80 percent of natural land use types (Land use types 3, 4, 5, 7, 11, 12, 13, 14, 16, 17; Table 1-1 of this annex) in a 5km radius – Capacity 70.
2. *Lakes and rivers*: areas close to lakes and rivers get a capacity of 100.
3. *Relief*: the relief classes are assigned capacities to provide recreational services. Flat landscapes: 30; Rolling landscapes: 50; Hilly landscapes: 70; mountainous landscapes: 100; very mountainous landscapes: zero (because of low accessibility).
4. *Protected areas*: Natura protection sites and national parks are assigned a capacity to provide recreational services of 100.
5. *Tourist attractions*: Areas within 5km of natural and UN designated regions of special natural significance are assigned a capacity of 100.

6. *HNV farmlands*: HNV farmlands farther than 1 hour but within 3 hours from large urban centres (>600000 people) are assigned a capacity of 100. Steps (1-6) each result in a capacity map ranging from zero to 100.
7. An average value of maps resulting from step 1-6 was calculated.

2.4.9 Bundles of ecosystem services

Indicator name	**Bundles of ecosystem services**
Short description	Normalized summary of the provision of ecosystem services
Units	Dimensionless (0-100)
Spatial resolution	$1km^2$
Temporal resolution	Start and end year

2.4.9.1 Description of causality in calculation method

The loss or gain of ecosystem services is quantified for each ecosystem service separately as described. Bundles of services and changes therein are quantified. This is done for a bundle that summarizes all regulating services into one indicator.

2.4.9.2 Input parameters

Name	Quantity	Source	Description
All ecosystem services maps as explained in this document.			

2.4.9.3 Calculation rules

1. Each ecosystem service map is normalized from zero to one:
    - The minimum and maximum value of the map are looked up;
    - A normalized map is calculated:
      (MapValue – minimum) / (maximum – minimum)

2. Bundle maps are calculated by adding up all relevant ecosystem services maps resulting from step 1:
    - A map for all services;
    - A map for the regulation services, so Air quality regulation, Carbon sequestration, Erosion protection, Flood regulation, Storm protection, Pollination, Soil quality regulation.
3. Bundle maps are normalized again from zero to one.

2.4.10 Number of changing ecosystem services

Indicator name	**Ecosystem service change**
Short description	Number of ecosystem services that decrease and increase between the start and end year
Units	Number of services that changes (0-11)
Spatial resolution	1km^2
Temporal resolution	Start-end year difference

2.4.10.1 Description of causality in calculation method

For each ecosystem service, the input and output map are compared to identify areas where the service increases, remains stable and decreases. This is summarized into two maps: the number of services that decrease and the number of services that increase.

2.4.10.2 Input parameters

Name	Quantity	Source	Description
All ecosystem services maps as explained in this document.			

2.4.10.3 Calculation rules

1. For each ecosystem service, the start and end year maps are compared. Based on this comparison, two maps are made for each service:
    a) Areas where the service increases (1) and other areas (zero);
    b) Areas where the service decreases (1) and other areas (zero);
2. Maps of the number of increasing / decreasing services are made by adding up all maps from step 1a and step 1b respectively.

Table 2-16: Land use related model inputs for the ecosystem service models

Nr.:	Description	Air quality regulation – dry deposition velocity (cm/s)	Erosion protection – cover factor (-) Mediterranean	Erosion protection – cover factor (-) Boreal	Erosion protection – cover factor (-) Temperate
0	Built-up area	0	0	0	0
1	Arable land (non-irrigated)	1.8	0.32	0.32	0.24
2	Pasture	1.05	0.1	0.05	0.03
3	(semi-) natural vegetation	1.8	0.1	0.03	0.03
4	Inland wetlands	1.7	0	0	0
5	Glaciers and snow	1.7	0	0	0
6	Irrigated arable land	1.8	0.32	0.32	0.24
7	Recently abandoned arable land	1.8	0.2	0.2	0.15
8	Permanent crops	1.8	0.25	0.15	0.15
9	Arable land devoted to the cultivation of (annual) biofuel crops	1.8	0.32	0.32	0.24
10	Forest	14.000	0.005	0.001	0.001
11	Sparsely vegetated areas	1.425	0.25	0.15	0.15
12	Beaches, dunes and sands	1.050	0	0	0
13	Salines	1.7	0	0	0
14	Water and coastal flats	1.7	0	0	0
15	Heather and moorlands	1.8	0.005	0.001	0.001
16	Recently abandoned pasture land	1.45	0.1	0.05	0.05
17	Perennial biofuel crop cultivation	7.9	0.25	0.15	0.15

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3 ANNEX 3: PROJECTED MODELLED IMPACTS OF THE BUSINESS AS USUAL AND POLICY PACKAGE SCENARIOS ON BIODIVERSITY AND ECOSYSTEM SERVICES

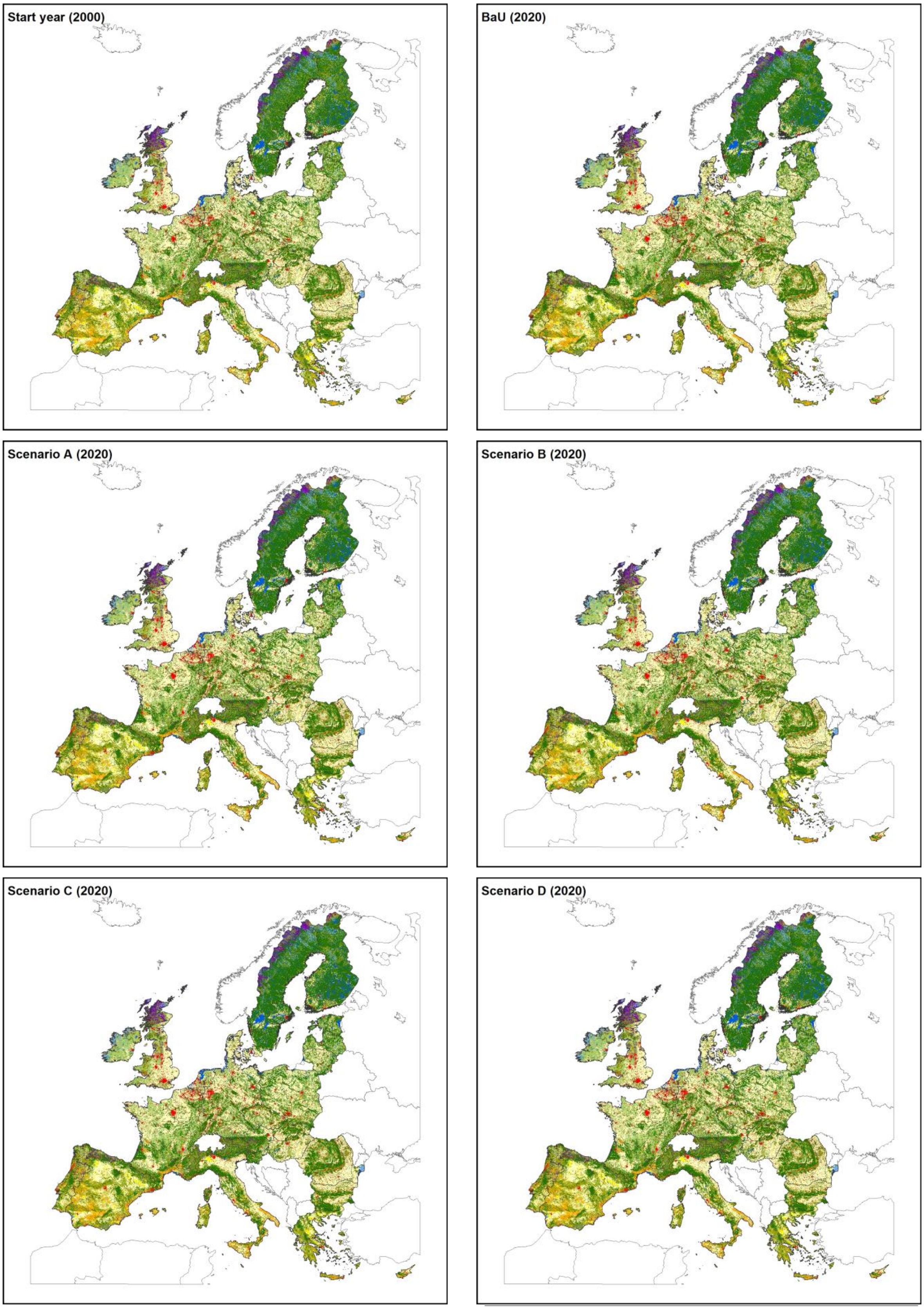
3.1 Land use change

This section 3.1 covers key changes with respect to the built-up area and agricultural land. Changes with respect to other major land cover types such as forest and semi-natural vegetation are covered in the next section (3.2.1 Ecosystem coverage).

The BaU scenario indicates a continuous increase of built-up areas, with a modelled increase over 2000-2020 of 16%. Agricultural land is projected to decrease by 2% (see Figure 3 - 2 to Figure 3 - 5, and see Figure 3 - 1 for maps). The decrease of agricultural land is due to ongoing technological improvements and intensification, leading to higher yields and a lower demand for land. The decrease of agricultural land is relatively modest compared to other scenarios as e.g. simulated in the VOLANTE FP7 project (Lotze-Campen et al, 2013). This is because a relatively high demand for agricultural products from within Europe is assumed compared with scenarios with a higher level of globalization. Despite the general decreases of agricultural land area, countries such as Ireland, UK, Netherlands, and to a lesser degree Belgium, Germany, Denmark and Austria, are expected to face an increase of agricultural land due to favourable conditions for agricultural production. Additionally, a large expansion of built-up area is expected in these countries due to expected population and GDP increases, resulting in a higher pressure on land. On the contrary, a number of countries are projected to face widespread abandonment of arable land.

As no farmland was indicated as recently abandoned in the base map of the year 2000, there were only increases in recently abandoned farmland (Table 3 - 3). In the majority of countries the area of recently abandoned farmland increased up to 5% of the country's area (Figure 3 - 2 to Figure 3 - 5). This level of abandonment is likely to have significant detrimental nature conservation impacts in many areas (e.g. through the loss of semi-natural grasslands), although in the longer term it may provide opportunities for the restoration of other semi-natural or natural vegetation types and the enhancement of associated ecosystem services.

In the policy scenarios, the land demand in scenario A is similar to the BaU scenario. In scenarios B through D, the overall increase of built-up area is 4% smaller than in the BaU (Figure 3 - 2 to Figure 3 - 5). In Ireland, Belgium, the UK, Austria, France and Sweden the built-up expansion is decreased by more than 5% compared to the BaU, while in the Czech Republic, Romania and Bulgaria the same built-up expansion is expected in all scenarios. In the latter countries, population increases are expected that cannot be counteracted by the stricter spatial planning assumed in scenarios B through D.



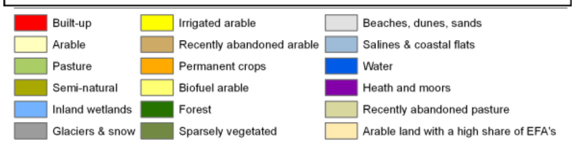


Figure 3 - 1 Land use in the start year (2000) and land use change under the Business as Usual scenario (BaU) and the four policy scenarios

Figure 3 - 2 Land use change in BaU and policy scenarios in central EU countries

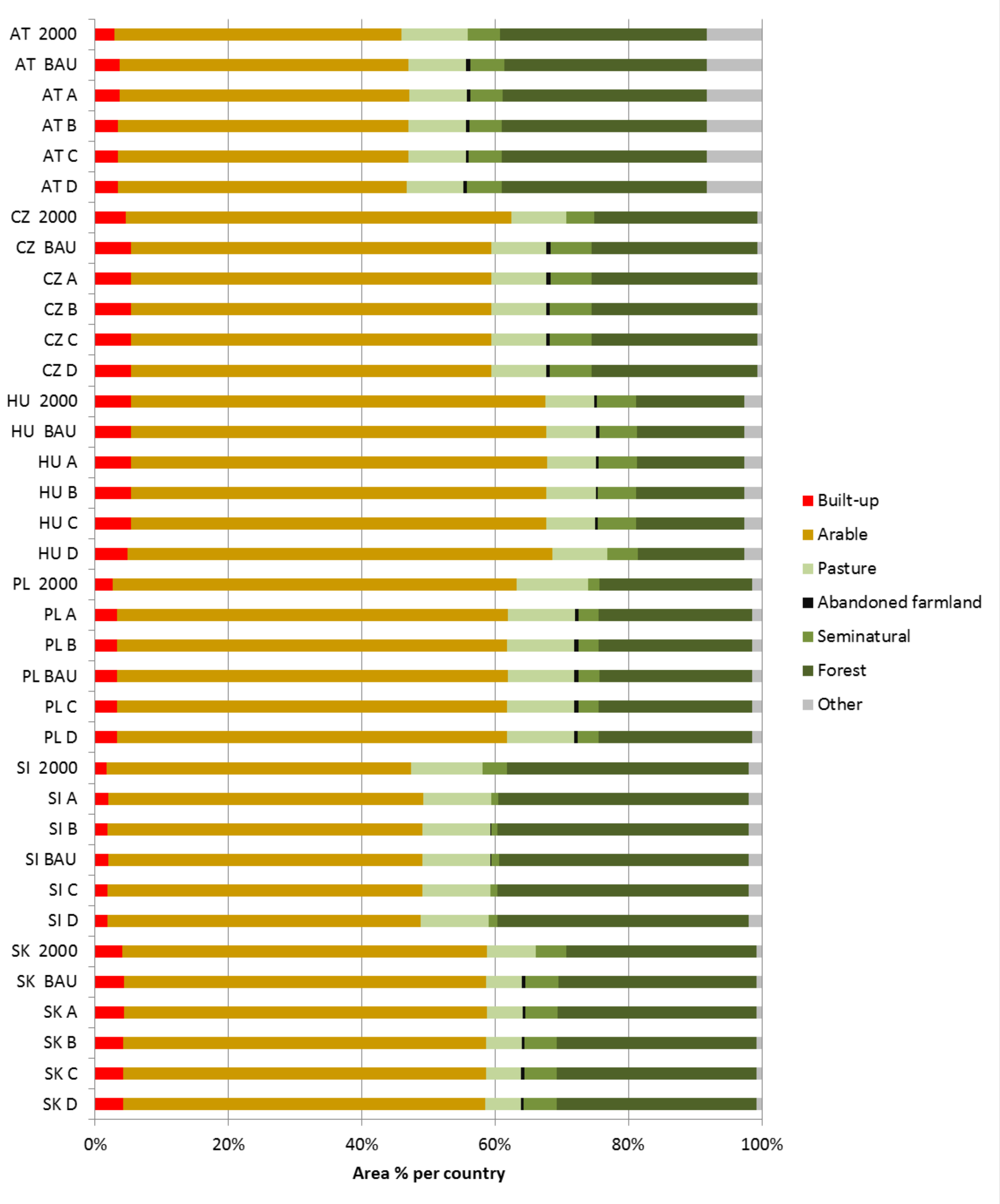


Figure 3 - 3 Land use change in BaU and policy scenarios in southern EU countries

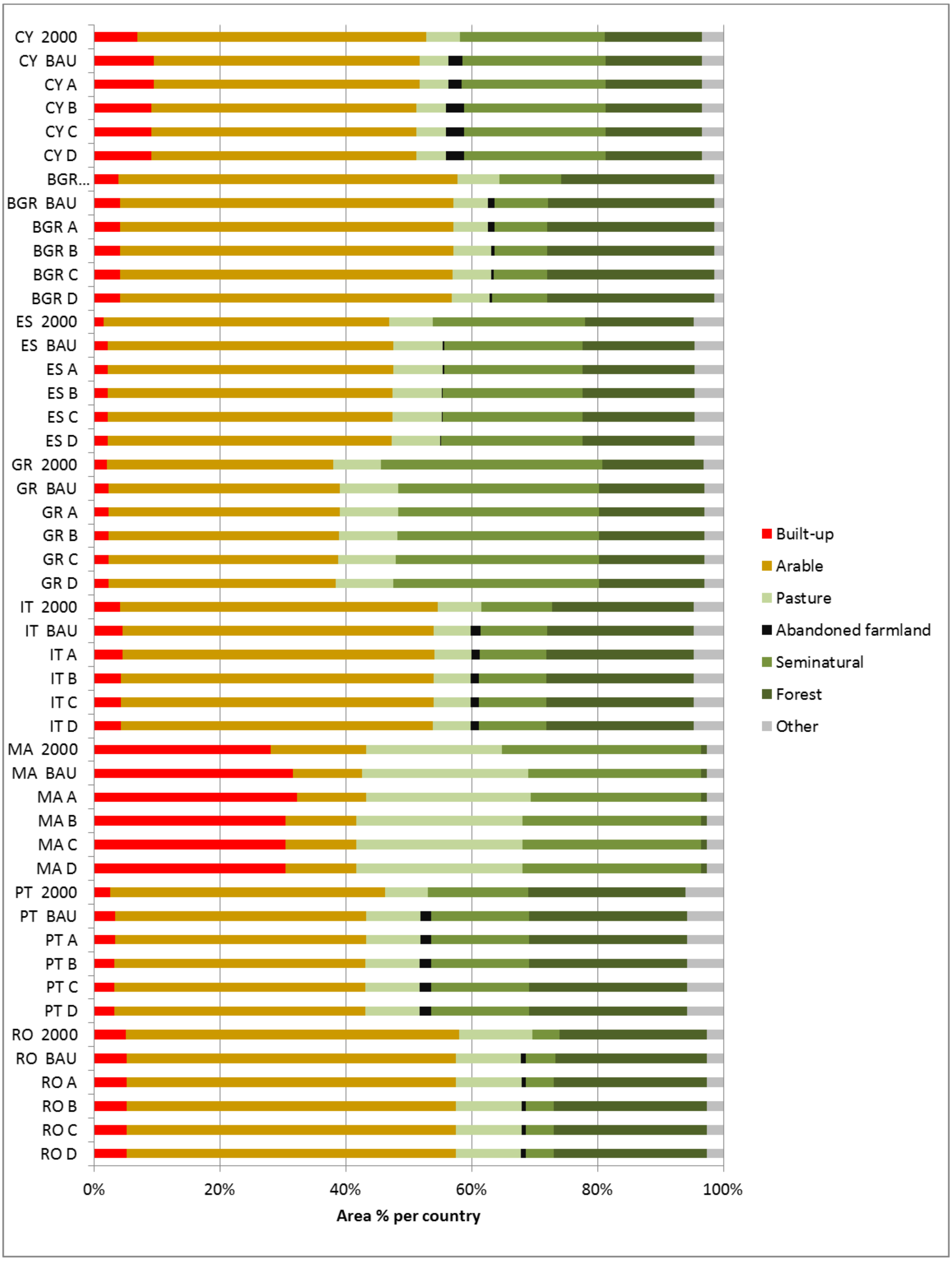


Figure 3 - 4 Land use change in BaU and policy scenarios in northern EU countries

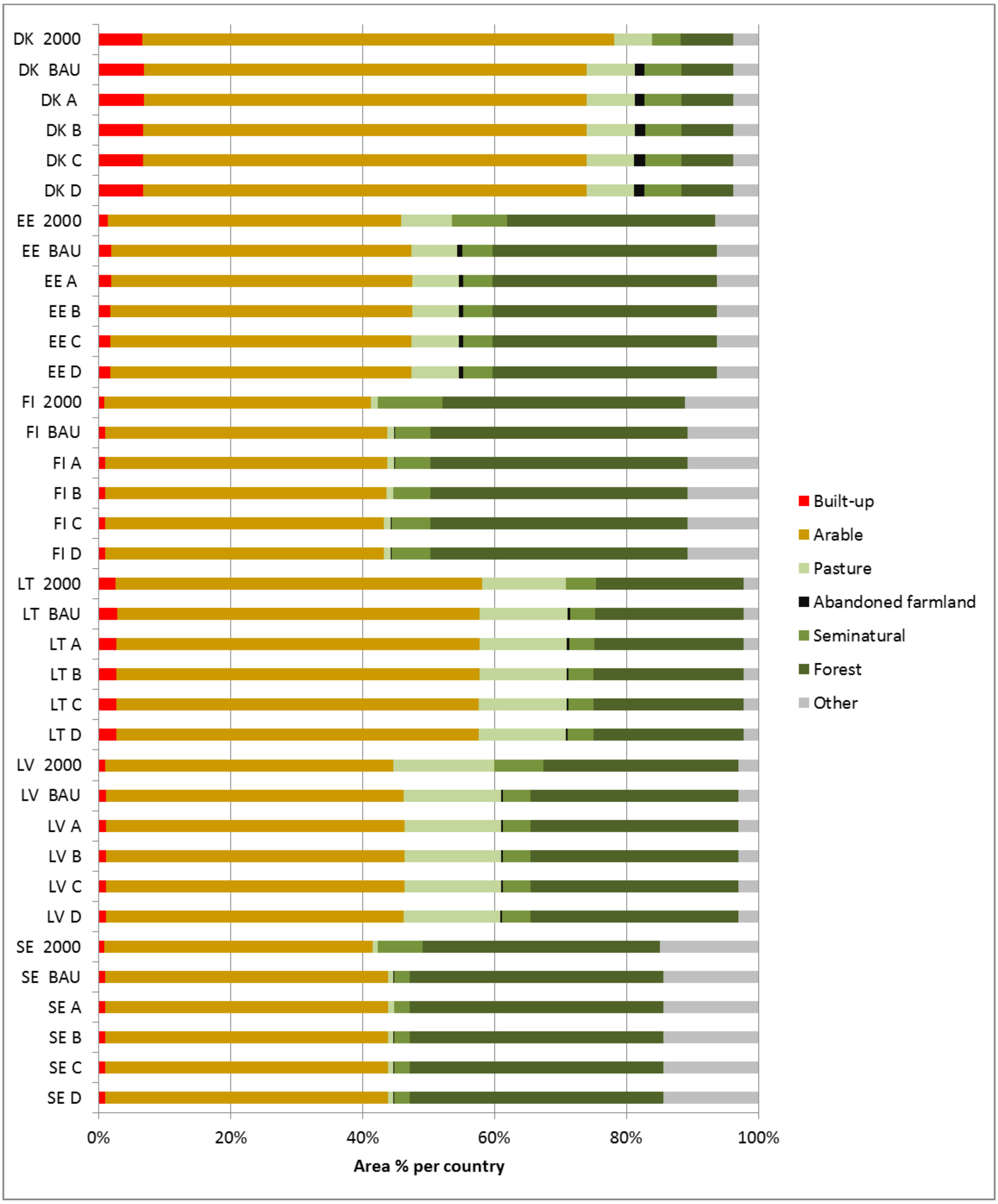
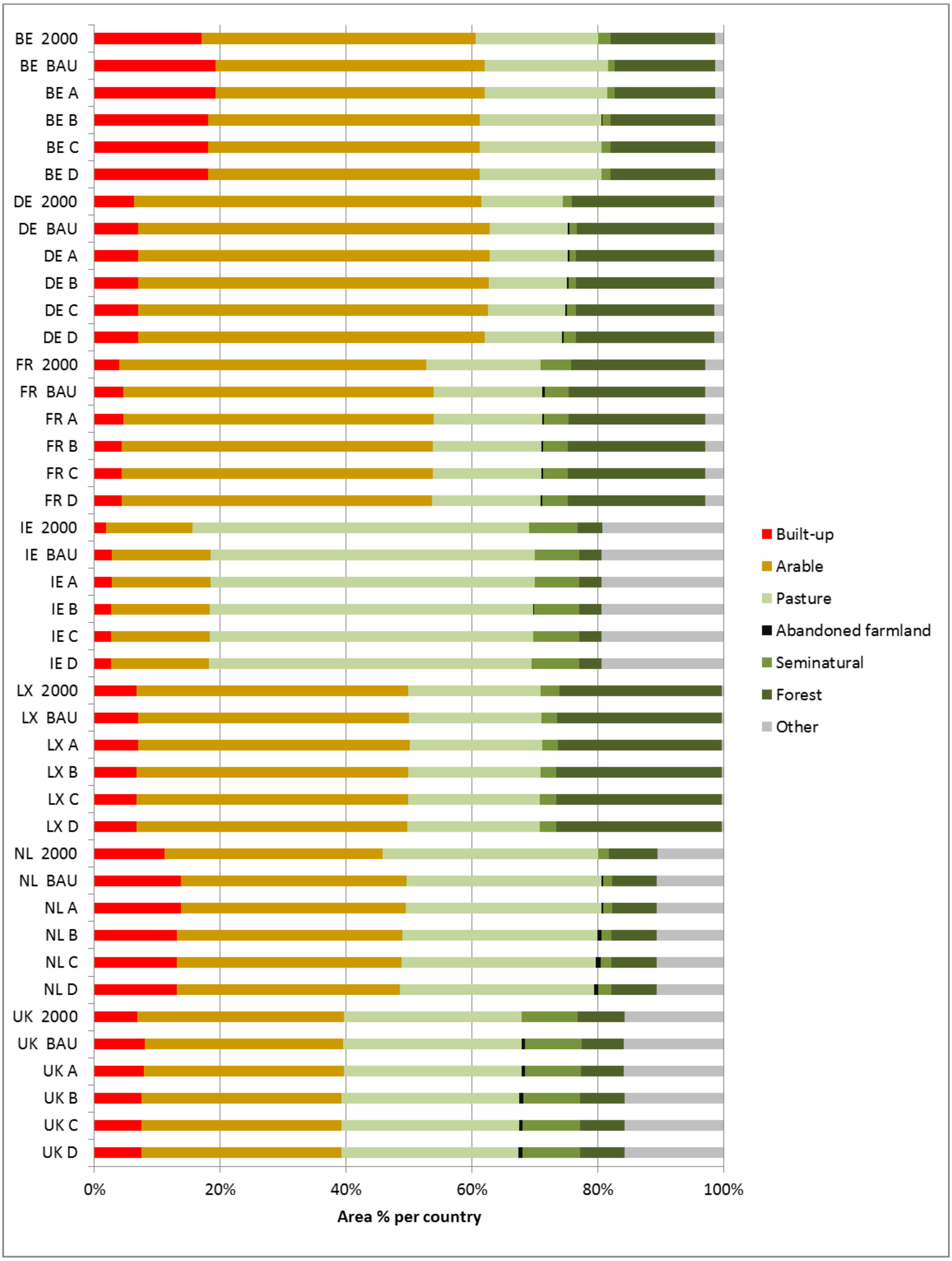


Figure 3 - 5 Land use change in BaU and policy scenarios in western EU countries

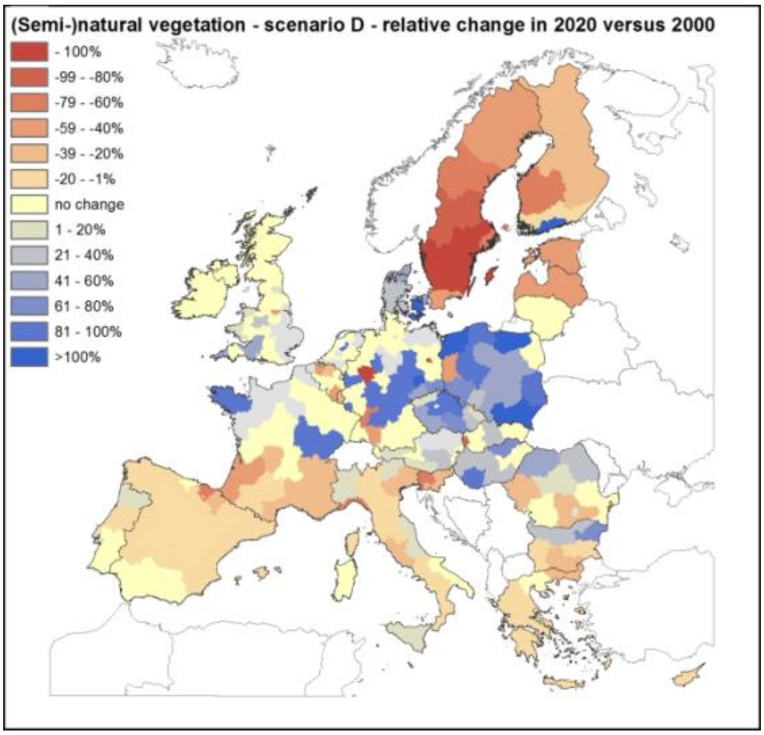


3.2 Ecosystem coverage and quality indicators

3.2.1 Ecosystem coverage

Under the BaU scenario, the area of forest is projected to remain stable or increase for nearly all countries compared to the start year (0-13% increase; Table 3 - 1), as a result of the lower pressure on land. Decreases in forest cover do occur however, mainly for Ireland (-12%), the UK (-12%), the Netherlands (-9%) and slight decreases for Belgium, Germany, Denmark and Austria. The area of (semi-) natural vegetation is, however, projected to decrease in most countries, with losses of up to 68% (Table 3 - 2). Note however, that in many cases these losses are caused by succession to forest (see indicator 'land take' for net loss of (semi-) natural vegetation and forest to agriculture and built up area). In contrast, in a few countries the area of semi-natural vegetation will increase by 1% to 68%, including Poland (68%), Czech Republic (50%), Denmark (29%), Hungary (23%) and Slovakia (11%). These countries are projected to face extensive abandonment of arable land, resulting in large percentage changes (the model converts abandoned agricultural land to (semi-) natural vegetation under the assumption of natural succession).

Generally, the area of (semi-) natural vegetation increases in the policy scenarios B (+0.7%), C (+1.8%) and D (+3.7%) relative to the BaU (Table 3 - 2). Largest effects of the scenarios on the area of (semi-) natural vegetation are seen in Germany, Belgium and the Netherlands (Table 3 - 2). Also the forest area increases slightly (by approximately 0.6%) relative to the BaU. These changes are due to the lower demand for built-up area and to the offsetting of land take in the scenarios B-D. The offsetting of land take in scenarios B-D goes at the cost of agricultural land. Arable land and pasture consequently decrease in most countries relative to the BaU.



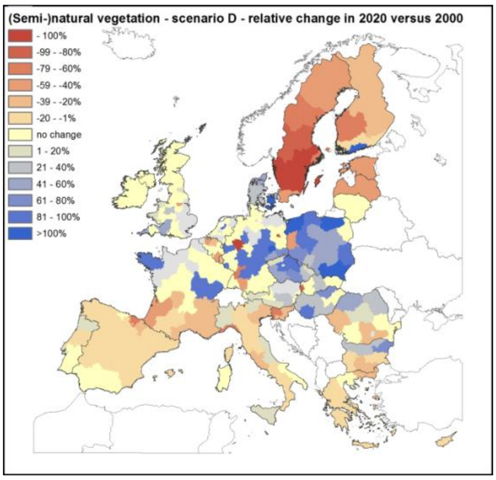
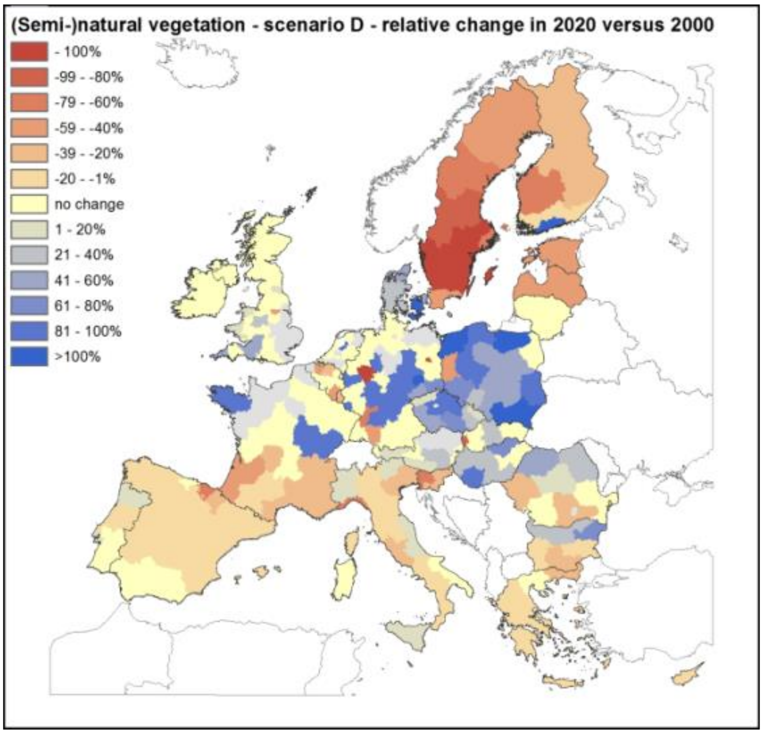
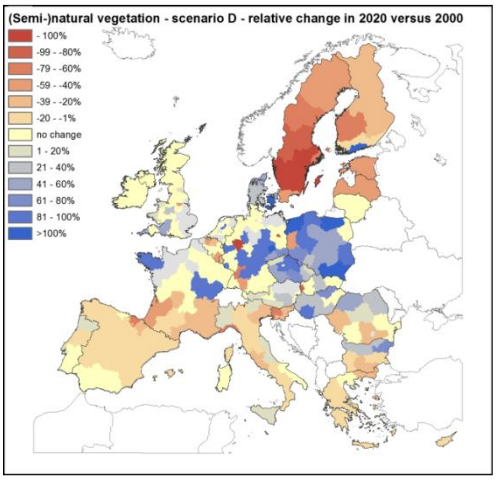


Figure 3 - 6 and provides a spatial representation of the changes in forest cover and (semi-) natural vegetation respectively, averaged per Nuts2 level. Note that the representation by NUTS2 level may differ from the changes at the country level: Ireland for example experiences 11.5% forest loss in total, but the total forest area is relatively low, and the loss is evenly spread, resulting in less than 1% of the area losing forest, as depicted in Figure 3 - 6. In contrast, in countries where the changes are more spatially heterogeneous, this clearly flags up in these maps, such as the red areas in the UK and the Netherlands, which lose relatively large areas of forests under the BaU scenario.

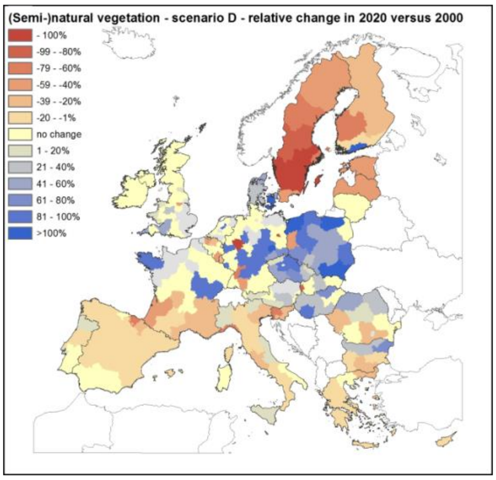
More pronounced changes are visible for (semi-)natural vegetation





where strong increases exist in Poland and the Czech Republic in particular.

Even though France and Germany are not projected to lose large fractions of (semi-natural) vegetation overall (Table 3 - 2), large differences exist between the NUTS2 regions within these countries



. The policy scenarios B-D reduce the loss of semi-natural vegetation across Europe, with the exception of Sweden, due to the regeneration of recently harvested forest areas (classified as semi-natural in 2000).

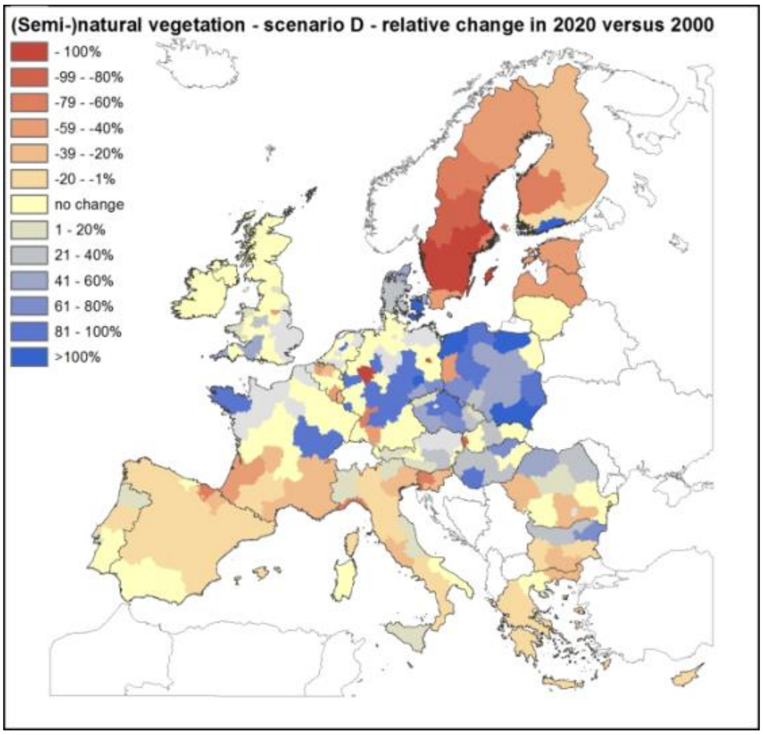

(Semi-)natural vegetation - scenario D - relative change in 2020 versus 2000
- 100%
-99 - -80%
-79 - -60%
-59 - -40%
-39 - -20%
-20 - -1%
no change
1 - 20%
21 - 40%
41 - 60%
61 - 80%
81 - 100%
>100%

Table 3 - 1 The relative change in forest cover per country, compared to the start year (2000), for the five scenarios.

Forest			Relative change in 2020 compared to the start year, per scenario				
Country name	Country code	Start year (km^2)	BaU	A	B	C	D
Belgium	BE	6126	-4.2%	-4.7%	-0.1%	-0.1%	-0.1%
Bulgaria	BG	34994	12.3%	13.0%	13.2%	13.2%	13.1%
Czech Republic	CZ	25435	2.1%	2.2%	2.3%	2.3%	2.3%
Denmark	DK	3747	-1.9%	-1.6%	-1.6%	-1.6%	-1.6%
Germany	DE	103898	-4.6%	-4.5%	-4.2%	-4.3%	-4.3%
Estonia	EE	20854	12.0%	12.1%	12.2%	12.2%	12.2%
Ireland	IE	2880	-11.5%	-11.2%	-9.9%	-9.9%	-9.9%
Greece	EL	23638	4.1%	4.3%	4.4%	4.4%	4.4%
Spain	ES	91963	2.4%	2.8%	3.0%	3.0%	3.0%
France	FR	145039	2.3%	2.6%	3.5%	3.5%	3.5%
Italy	IT	78869	5.7%	6.5%	6.8%	6.8%	6.8%
Cyprus	CY	1563	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Latvia	LV	27058	9.9%	10.1%	10.2%	10.2%	10.2%
Lithuania	LT	18640	0.6%	1.5%	1.9%	1.9%	1.8%
Luxembourg	LU	884	1.6%	0.9%	1.7%	1.7%	1.7%
Hungary	HU	17344	0.8%	1.3%	1.7%	1.7%	1.7%
Malta	MT	0	-	-	-	-	-
Netherlands	NL	3159	-9.3%	-9.8%	-7.6%	-7.6%	-7.6%
Austria	AT	37558	-3.5%	-2.4%	-1.8%	-1.8%	-1.8%
Poland	PL	91932	0.4%	0.8%	1.1%	1.1%	1.1%
Portugal	PT	24357	4.6%	4.7%	4.7%	4.7%	4.7%
Romania	RO	69665	4.6%	5.5%	5.5%	5.5%	5.5%
Slovenia	SI	11212	5.2%	5.9%	6.3%	6.3%	6.2%
Slovakia	SK	19394	5.7%	6.7%	7.1%	7.1%	7.1%
Finland	FI	194663	9.5%	9.6%	9.6%	9.6%	9.5%
Sweden	SE	252481	11.2%	11.3%	11.4%	11.4%	11.4%
United Kingdom	UK	19873	-11.7%	-9.9%	-6.9%	-6.9%	-6.9%
Total	EU	**1327226**	4.9%	5.3%	5.6%	5.6%	5.6%

Table 3 - 2 The relative change in the area of (semi-) natural vegetation per country, compared to the start year (2000), for the five scenarios.

(Semi-)natural vegetation			Relative change in 2020 compared to the start year, per scenario				
Country name	Country code	Start year (km^2)	BaU	A	B	C	D
Belgium	BE	738	-48.9%	-44.9%	-31.4%	-28.7%	-26.7%
Bulgaria	BG	14322	-12.0%	-12.1%	-12.1%	-11.1%	-8.3%
Czech Republic	CZ	4274	50.4%	50.2%	50.3%	50.5%	50.8%
Denmark	DK	2012	28.6%	28.6%	26.8%	27.0%	27.5%
Germany	DE	6478	-20.5%	-21.8%	-12.7%	0.9%	38.9%
Estonia	EE	5519	-43.0%	-45.4%	-46.0%	-45.6%	-45.1%
Ireland	IE	5585	-8.1%	-7.7%	-5.7%	-5.1%	-1.3%
Greece	EL	51816	-9.2%	-9.1%	-8.6%	-8.0%	-6.8%
Spain	ES	128437	-8.7%	-8.5%	-8.0%	-7.6%	-6.7%
France	FR	33245	-21.3%	-21.5%	-20.6%	-20.0%	-17.8%
Italy	IT	39778	-4.1%	-4.2%	-3.8%	-3.7%	-3.4%
Cyprus	CY	2322	0.0%	0.5%	-1.5%	-1.5%	-1.5%
Latvia	LV	6845	-41.1%	-42.1%	-42.2%	-41.7%	-40.7%
Lithuania	LT	3747	-15.2%	-15.2%	-14.9%	-14.2%	-11.6%
Luxembourg	LU	103	-18.4%	-17.5%	-14.6%	-13.6%	-12.6%
Hungary	HU	4946	23.6%	23.7%	25.2%	26.1%	28.9%
Malta	MT	0	-	-	-	-	-
Netherlands	NL	673	-12.8%	-11.4%	-5.3%	8.0%	24.5%
Austria	AT	5865	2.9%	0.1%	0.3%	1.8%	7.9%
Poland	PL	7365	68.4%	65.6%	67.3%	68.3%	69.6%
Portugal	PT	15517	2.2%	2.2%	2.3%	2.3%	2.3%
Romania	RO	13049	7.9%	4.0%	4.4%	5.0%	6.0%
Slovenia	SI	1140	-68.2%	-72.4%	-72.6%	-71.0%	-64.0%
Slovakia	SK	3166	10.5%	5.7%	7.0%	7.4%	9.1%
Finland	FI	51602	-42.5%	-42.5%	-40.3%	-36.9%	-36.4%
Sweden	SE	47765	-63.6%	-64.0%	-63.9%	-63.6%	-63.1%
United Kingdom	UK	23445	0.1%	0.0%	1.1%	1.6%	2.6%
Total	EU	**479754**	-16.0%	-16.2%	-15.4%	-14.5%	-12.9%

Table 3 - 3 The absolute change in the area of recently abandoned farmland per country, compared to the start year (2000), for the five scenarios.

Recently abandoned farmland		Area (km2)					
Country name	Country code	Start year	BaU	A	B	C	D
Belgium	BE	0	1	2	17	17	17
Bulgaria	BG	0	1,656	1,459	644	642	637
Czech Republic	CZ	0	699	655	638	636	636
Denmark	DK	0	680	673	741	741	740
Germany	DE	0	1,161	1,148	1,156	1,155	1,153
Estonia	EE	0	488	470	477	477	477
Ireland	IE	0	44	13	16	16	16
Greece	EL	0	123	39	17	17	17
Spain	ES	0	1,436	746	749	749	747
France	FR	0	2,403	1,968	2,209	2,204	2,203
Italy	IT	0	5,302	4,659	4,854	4,854	4,854
Cyprus	CY	0	224	212	302	302	302
Latvia	LV	0	222	200	224	223	222
Lithuania	LT	0	270	267	259	259	259
Luxembourg	LU	0	0	0	0	0	0
Hungary	HU	0	613	528	413	412	412
Malta	MT	0	0	0	0	0	0
Netherlands	NL	0	118	124	292	291	291
Austria	AT	0	749	488	547	546	546
Poland	PL	0	2,670	2,523	2,501	2,494	2,492
Portugal	PT	0	1,686	1,667	1,784	1,784	1,784
Romania	RO	0	2,250	2,061	2,035	2,035	2,035
Slovenia	SI	0	47	13	23	23	23
Slovakia	SK	0	324	297	325	325	325
Finland	FI	0	645	515	657	657	656
Sweden	SE	0	578	464	553	553	553
United Kingdom	UK	0	1,674	1,373	1,640	1,639	1,637
Total	EU	**0**	**26,063**	**22,564**	**23,073**	**23,051**	**23,034**

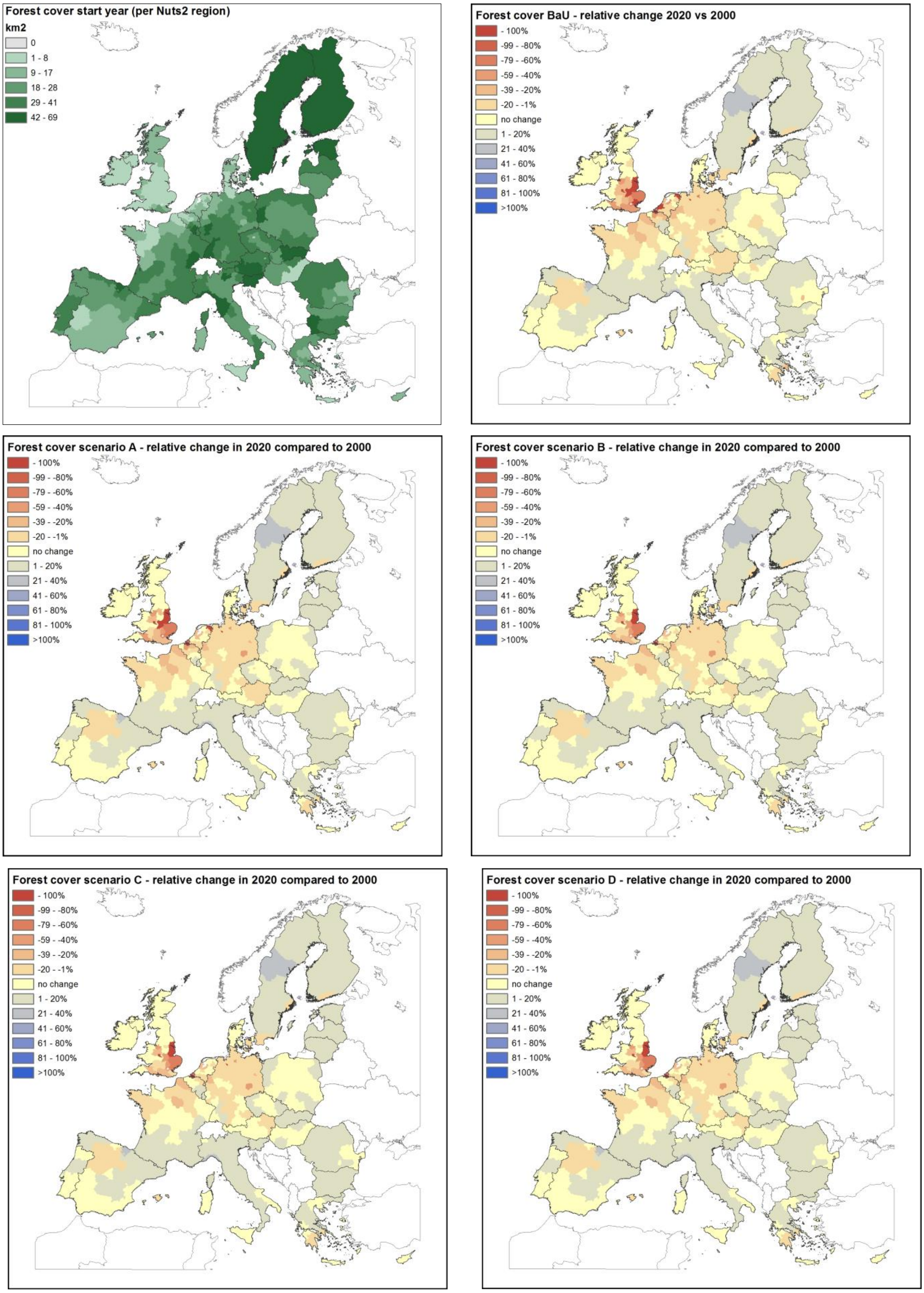


Figure 3 - 6 Changes in forest cover. Top left panel: Original forest cover in the start year (2000) in km^2 per nuts2 region; Other panels: relative change of the forest cover per nuts2 region, for each of the 5 scenarios, compared to the start year. Areas in red shading have decreasing forest cover, areas in blue shading have increasing forest cover, areas in yellow shading have stable forest cover, on average.

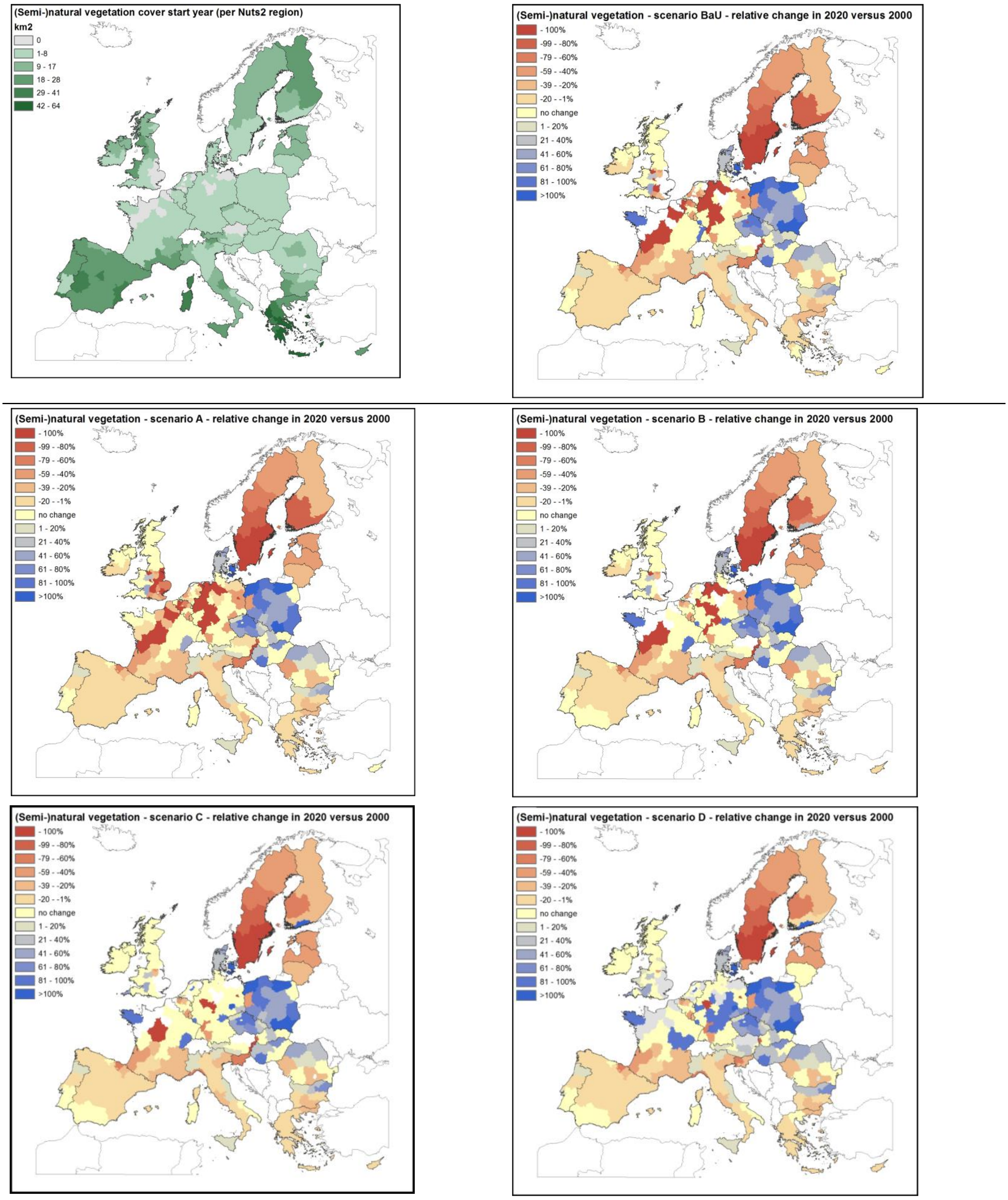


Figure 3 - 7 Changes in cover with (semi-)natural vegetation. Top left panel: Original area of (semi-) natural vegetation in the start year (2000) in km^2 per nuts2 region; Other panels: relative change in area of (semi-) natural vegetation per nuts2 region, for each of the 5 scenarios, compared to the start year. Areas in red shading have a lower area of (semi-)natural vegetation in 2020, areas in blue shading have more (semi-)natural vegetation in 2020, areas in yellow shading have remained stable.

3.2.2 Land take

The policy scenarios show a strong decrease, from 7% (scenario A) to 22% (scenario D), in the total amount of land take compared to the BaU (Table 3-5). All types of land take are reduced under the scenarios (Table 3 - 4). Comparing levels of land take versus levels of land gain, the loss:gain ratio changes from about 1:0.5 to 1:0.87 (Table 3-6), thus approaching no net loss in terms of more natural land cover compared to the BaU. Note however that this indicator is summed over all EU27 countries, and does not account for effects of the spatial configurations of ecosystem networks, habitat regeneration time or habitat quality. Land gain first decreases compared to the BaU, after which it increases again for scenarios B-D (Table 3-5 and Figure 3 - 8). The initial slight decrease under scenario A can be explained by the stricter regulations to maintain pastures, thus reducing succession towards semi-natural vegetation and forest. The subsequent increase in land gain in scenarios B-D is a consequence of the increasing offset requirements in policy scenarios B-D. For the Natura 2000 areas, land take that occurred still under the BaU scenario is now halted (Table 3-6), with considerable amounts of land gain in Natura 2000 areas. Land gain is higher under the BaU scenario, because under the policy scenarios farmland in Natura 2000 areas is assumed to be High Nature Value farmland, conversion of which to semi-natural vegetation or forest is restricted.

Table 3 - 4 Land take and land gain specified by type in EU27 (in km^2)

Land use types as indicated in Table 3-4, with "Agricultural land" referring to the combined area of the land use types non-irrigated arable land, irrigated arable land, permanent crops, pasture, and recently abandoned arable land and pasture following Table 3 4.

			Land use in 2020		
			Forest & (semi-) natural vegetation	agricultural land	Built-up area
Land use in start year	Forest & (semi-) natural vegetation	Scenario BaU		36,194	9,732
		Scenario A		31,583	7,481
		Scenario B		29,284	4,050
		Scenario C		29,101	4,050
		Scenario D		28,794	4,050
	agricultural land	Scenario BaU	33,975		19,029
		Scenario A	30,630		21,278
		Scenario B	33,016		17,928
		Scenario C	37,243		17,928
		Scenario D	44,410		17,928
	Built-up area	Scenario BaU	0	0	
		Scenario A	0	0	
		Scenario B	0	0	
		Scenario C	0	0	
		Scenario D	0	0	

Table 3 - 5 Total land take and land gain for EU27

The total amount (in km^2) of land take versus land gain projected under each of the scenarios for the EU27.

Scenario	Land take (km^2)	Change in land take relative to BaU	Land gain (km^2)	Change in land gain relative to BaU	Ratio lost : gained
BaU	64,955		33,975		1 : 0.52
A	60,342	-7%	30,630	-10%	1 : 0.51
B	51,262	-21%	33,016	-3%	1 : 0.64
C	51,079	-21%	37,243	10%	1 : 0.73
D	50,772	-22%	44,410	31%	1 : 0.87

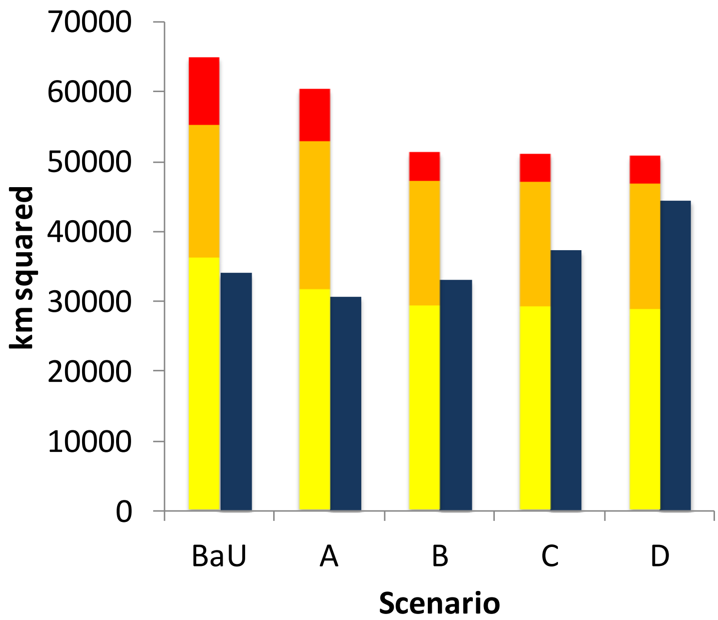
Table 3 - 6 Total land take and land gain for Natura 2000 areas.

The total amount (in km^2) of land take and land gain that is projected under each of the scenarios within the Natura2000 areas, summed over the EU27. The 1 km^2 land gain in scenarios A-D is due to rounding effects in the calculations).

Scenario	Land Take (km^2)	Land gain (km^2)
BaU	54	3,930
A	1	3,800
B	1	3,557
C	1	3,604
D	1	3,754

Figure 3 - 8 Total amount of land take and land gain in EU27, in km^2

Bars in dark blue indicate land gain. The various forms of land take that occur are indicated by shades of yellow-orange-red, to match the colours used in Table 3-4: *yellow* refers to a loss of forest and (semi-)natural vegetation due to agricultural expansion. *Orange* refers to a loss of agricultural land due to expansion of built-up areas. *Red* refers to a loss of semi-natural vegetation and forest due to expansion of built-up areas.



On a per country basis, there are 18 countries that experience larger amounts of land take than land gain under the BaU scenario (Figure 3 - 10). In nine countries land gain prevails (Figure 3 - 10). In nearly all countries the net land take is reduced under the policy scenarios B-D, with exceptions for Estonia and Latvia, which do a little worse under a number of these policy scenarios than under the BaU. This is in fact because the amount of land gain (conversion of farmland to (semi-)natural vegetation or forest) is lower, not because the level of land take goes up (land take is slightly reduced) (Figure 3 - 9).

The relative kind of land take that takes place under the various scenarios shifts for almost all countries away from 'red conversions' (built up at the cost of semi-natural vegetation or forest), towards a larger share for built-up on agricultural land or agricultural expansion at the cost of forest or semi-natural vegetation. The only exception is Luxembourg, where the only land take that takes place is built-up at the cost of semi-natural vegetation or forests, but there is very little land take in any case (Figure 3 - 9).

Figure 3 - 9 The relative area per country that is subject to land take (left side of vertical axis) and land gain (right side of vertical axis).

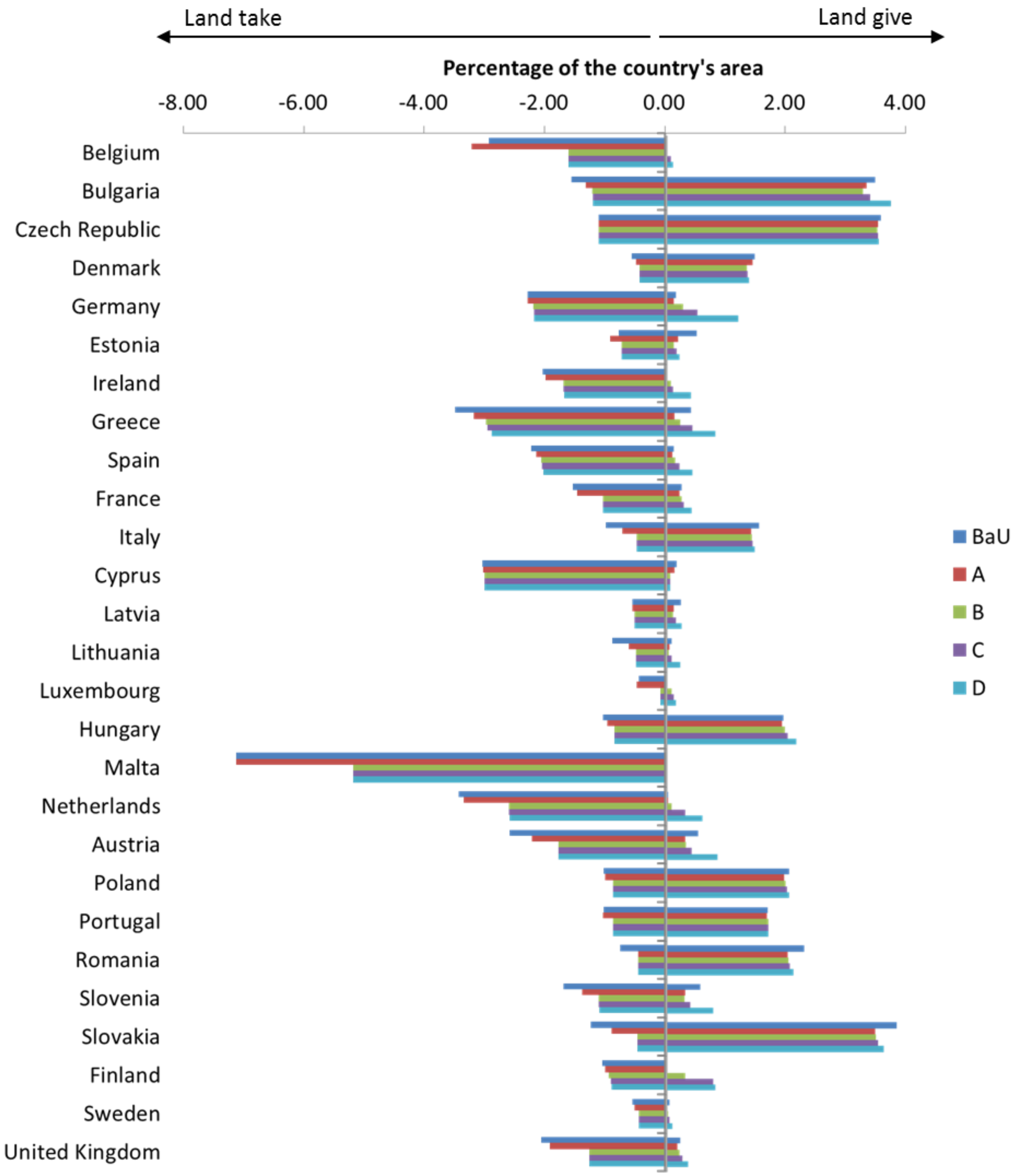


Figure 3 - 10 The net relative area that is subject to and land gain and land take per country, per scenario. Negative values indicate that land take > land gain; Positive values indicate that land take < land gain.

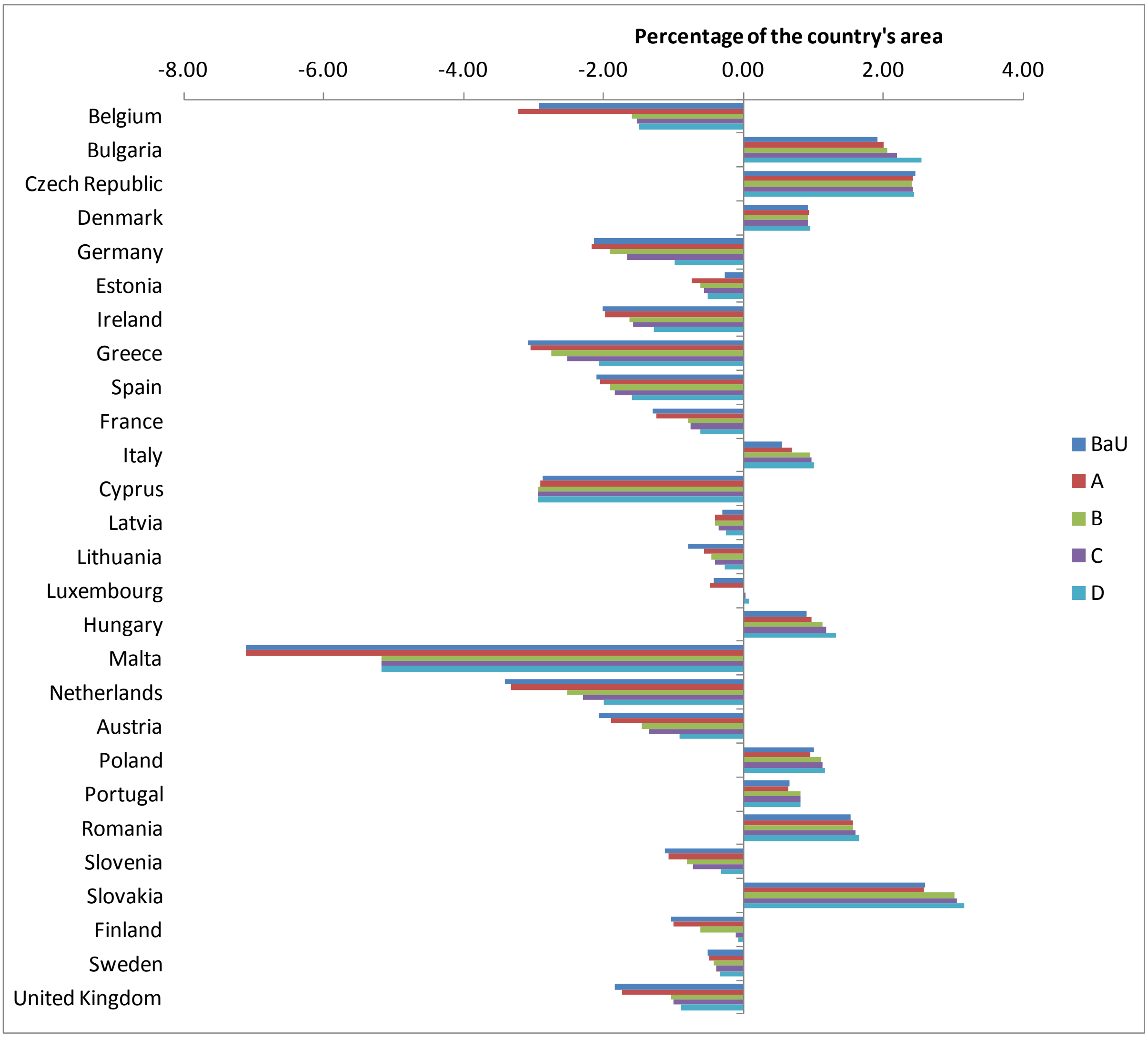
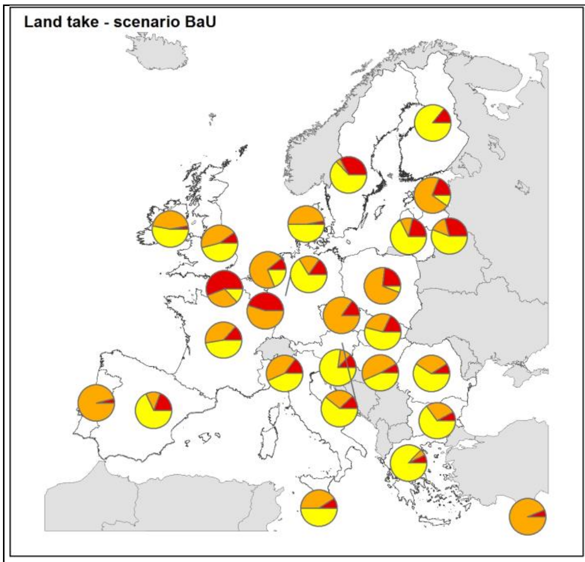
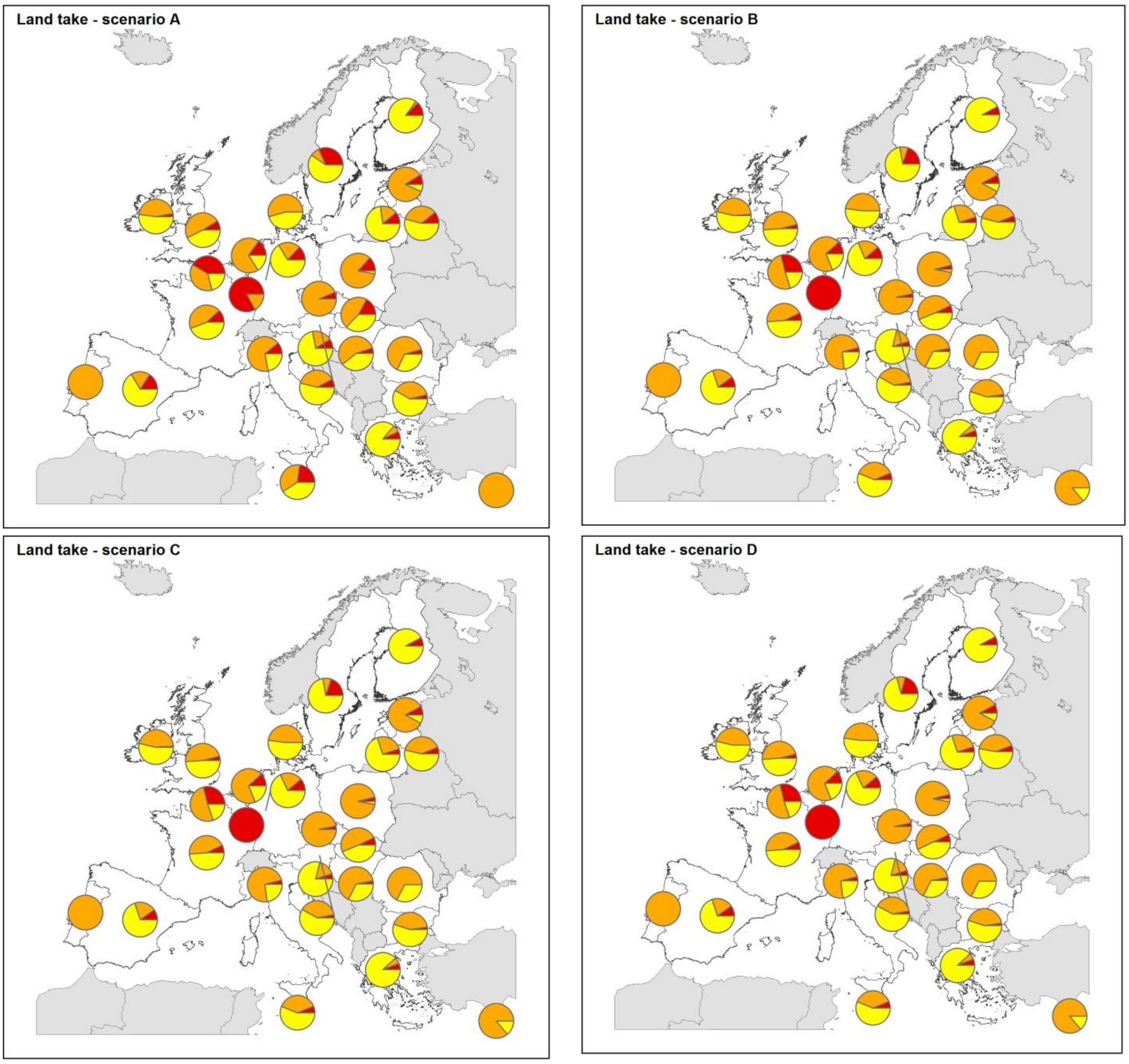


Figure 3 - 11 Type of land take that countries experience under different scenarios.



Colours in the pie diagrams are identical to the colours used in Table 3-4: *yellow* refers to loss of forest and (semi-)natural vegetation due to agricultural expansion. *Orange* refers to loss of agricultural land due to expansion of built-up areas. *Red* refers to loss of semi-natural vegetation and forest due to expansion of built-up areas. Note that pie-charts are not scaled in size.



3.2.3 Land cover connectivity potential

Under all scenarios, the more isolated areas become even more isolated in general, but the policy scenarios A-D are able to reduce fragmentation compared to the BaU scenario (

Figure 3 - 12). Under scenario D there is even some improvement for moderately connected regions. The best connected regions show no change, as connectivity is already very good in these areas. Figure 3 - 13 shows the spatial distribution of changes in connectivity, which reflects that under scenarios A-D isolation is less severe than under the BaU scenario, a pattern that is apparent across the EU. Note that this indicator is a general measure of the permeability of the landscape, to the nearest large nature patch. The indicator takes into account distance and the permeability of the intermediate land use types (e.g. built-up area is assumed to be less permeable than agricultural land). It therefore provides an overall picture, and there can be several processes responsible for an improvement of the indicator. Firstly, the enlargement of nature patches, such that the threshold of what is considered a large patch by the indicator is passed – this reduced the distance to the nearest large patch for areas in its neighbourhood, thus improving their connectivity. Secondly, the friction of the intermediate landscape is reduced; the more natural and the less built up a region becomes, the higher its permeability and the higher the connectivity. Hence also the creation of small nature patches can have a positive effect for this indicator.

Figure 3 - 12 The change in the connectivity measure under the five scenarios.

The regions are classified into 10 quantiles ranging from most connected areas in the year 2000, to the most isolated areas in the year 2000. The graph shows the change in mean connectivity for areas in each quantile. Positive values indicate higher connectivity, negative values indicate more isolation compared to the year 2000.

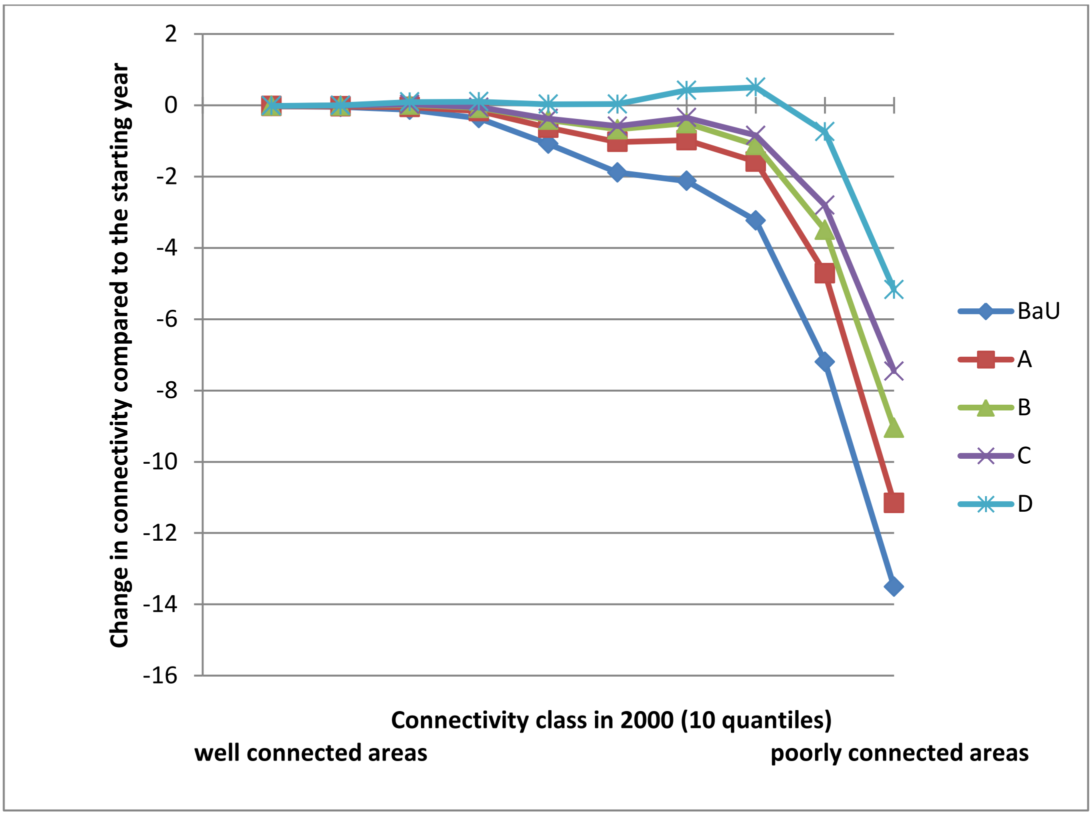
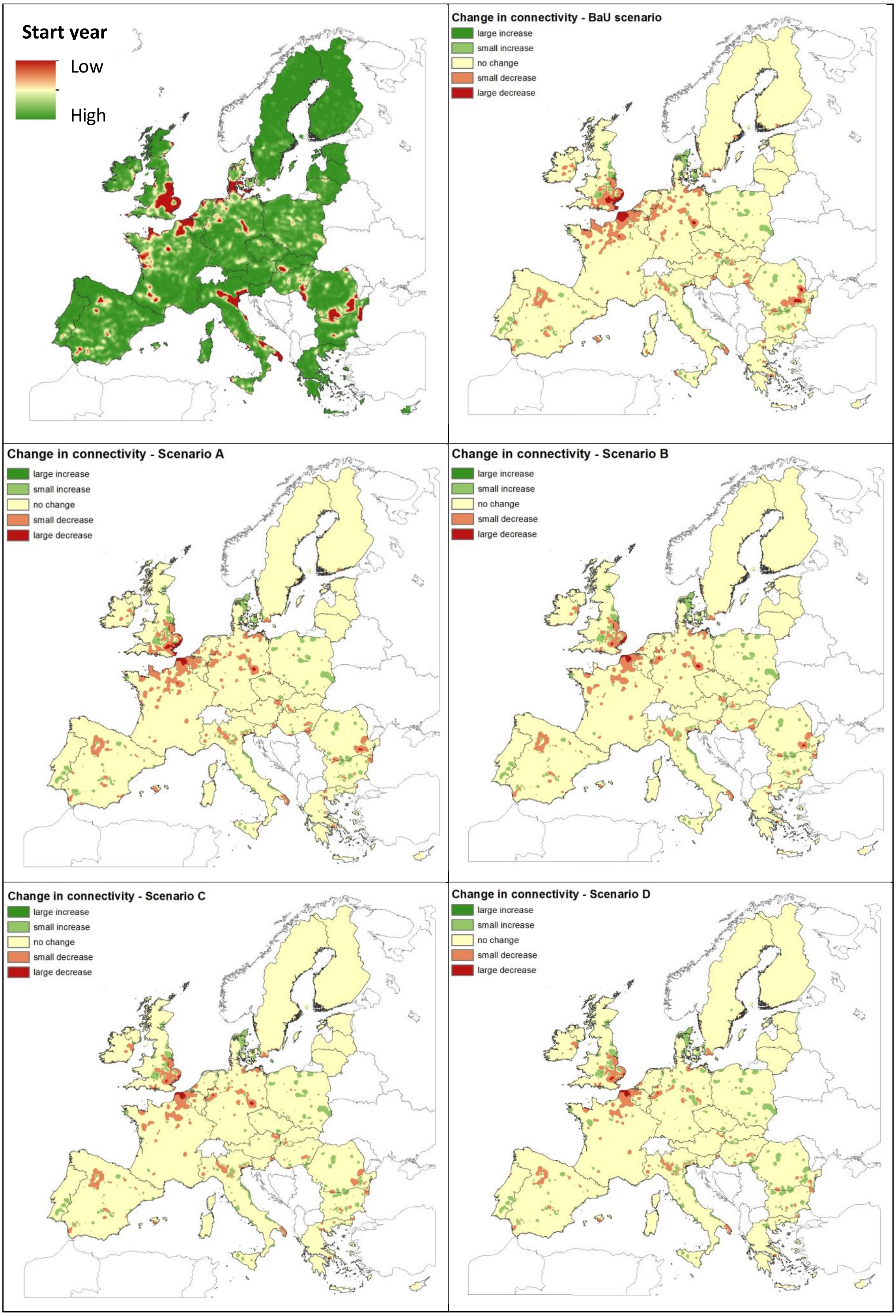


Figure 3 - 13 Change in connectivity to the nearest large area of natural habitat compared to the starting year, for the range of scenarios.



3.2.4 Bird species richness

Although changes in bird species richness appear relatively marginal (Figure 3 - 15,

Figure 3 - 16, Figure 3 - 17), when summing changes in species richness over the EU as a whole, differences between scenarios become substantial (Figure 3-18; Chapters 3 and 6, modelling results).

At an aggregate EU level, overall bird species richness improves considerably for scenarios B, C and D (Figure 3-14), improving species richness compared to the BaU by 55%, 68% and 92% respectively. Scenario A does not yield similar benefits in terms of bird species richness, and the overall reduction is 31% compared to the BaU. Under scenario A there are fewer sites that lose large numbers of species than under the BaU scenario; ie for poor quality areas, scenario A outperforms the BaU scenario. However, scenario A is not able to realise the same yields in species richness for sites with higher species richness – the BaU scenario results in more sites with larger increases in species richness. There are a few possible explanations for this: Under scenario A, small patches of forest are better protected than under BaU. As a consequence, forest loss could 'leak' to larger patches, which possibly have higher species richness. Protected areas are better protected under scenario A, but protection levels are not necessarily directly linked to bird species richness, leaving potentially species rich areas unprotected. Farmland in Natura 2000 areas is maintained under scenario A as HNV Farmland, but this may not reflect in the bird species richness indicator, as it cannot account for ecosystem quality. The offsetting requirements under scenarios B-D clearly show the added value in terms of species richness.

For Annex 1 bird species, the offset policies are projected to be very effective, halting the loss and even projecting a net increase of Annex 1 species under the D scenario (Figure 3-14). Scenario D improves conditions compared to the BaU scenario by 115% due to the increases in land gain and reductions in land take. Also for Annex 1 species the A scenario performs the worst, for reasons outlined above. The area without any Annex 1 bird species increases under all scenarios compared to the base line year, but less so under scenarios B-D. Particularly under scenarios B-D the number of sites that are relatively species rich, increases compared to the starting year (

Figure 3 - 16) due to the increased level of offsetting and resultant increase of (semi-)natural area.

For farmland bird species, the trends are negative under the policy scenarios, with losses of species richness compared to the BaU of up to 30% under scenario D (Figure 3 - 14). This is directly related to the offset requirements for forest and semi-natural vegetation, which go at the cost of agricultural land. Note, however, that measures to improve the environmental quality of agricultural land, such as agri-environment measures, measures for HNV farmland, or EFAs, are not reflected in the bird species richness indicator, as it is based on quantity and not on quality of land use types. The area without any indicator bird species increases under all scenarios compared to the base line year, but less so under scenarios B-D (Figure 3 - 17).

At the local level, changes in bird species richness range from -51 to +51 species out of 168, although at an aggregate level of NUTS2 these substantial changes are averaged out (Figure 3 - 18). These averages do however reveal a spatial pattern in the areas where decreases and increases are strongest. The urbanising regions experience most species declines, while regions in central Europe (northern Italy, northeast France, Czech Republic) and the Iberian Peninsula experience most gains in species richness. Under the policy scenarios, the decreases of the BaU scenario become milder, and more increases are anticipated, for example in the UK.

Figure 3-14 Cumulative change in bird species richness over the EU27, compared to the starting year

Negative values indicate an overall net loss, positive values indicate an overall net gain.

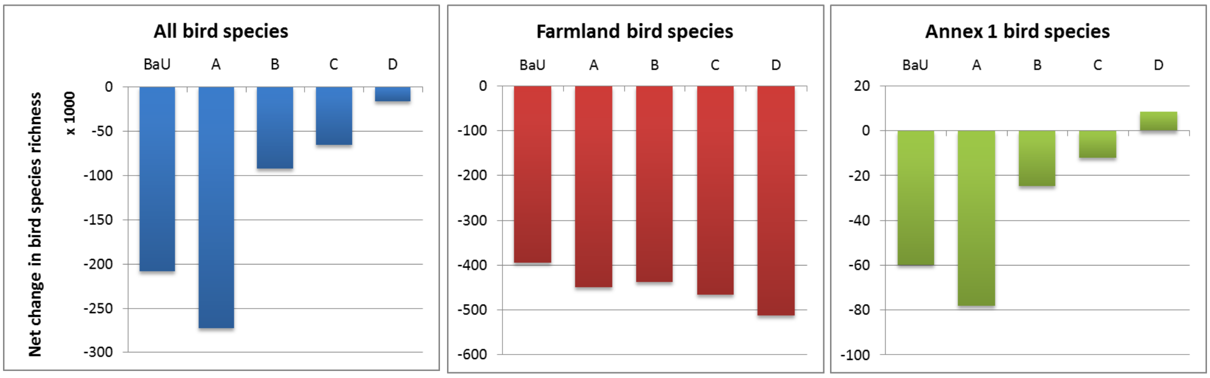


Figure 3 - 15 The total area in the EU27 with a given indicator bird species richness, under each of the scenarios and the starting year

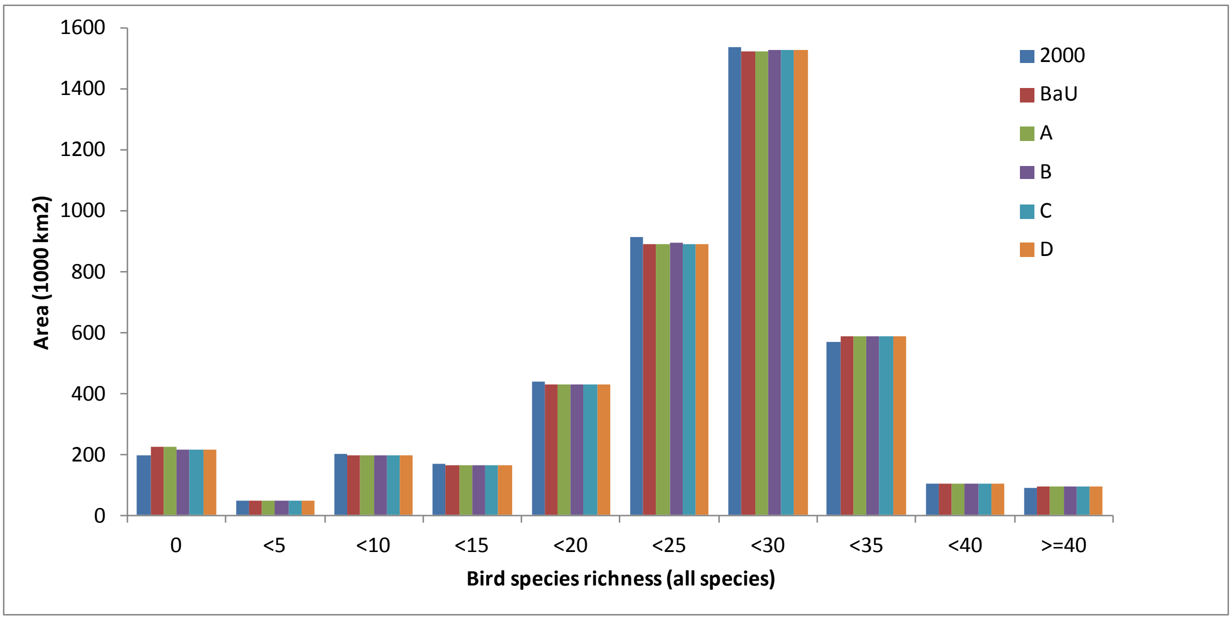

1600
1400
1200
1000
800
600
400
200
0
Area (1000 km2)
2000
BaU
A
B
C
D
0
<5
<10
<15
<20
<25
<30
<35
<40
>=40
Bird species richness (all species)

Figure 3 - 16 The total area in the EU27 with a given indicator Annex 1 (Birds Directive) bird species richness, under each of the scenarios and the starting year

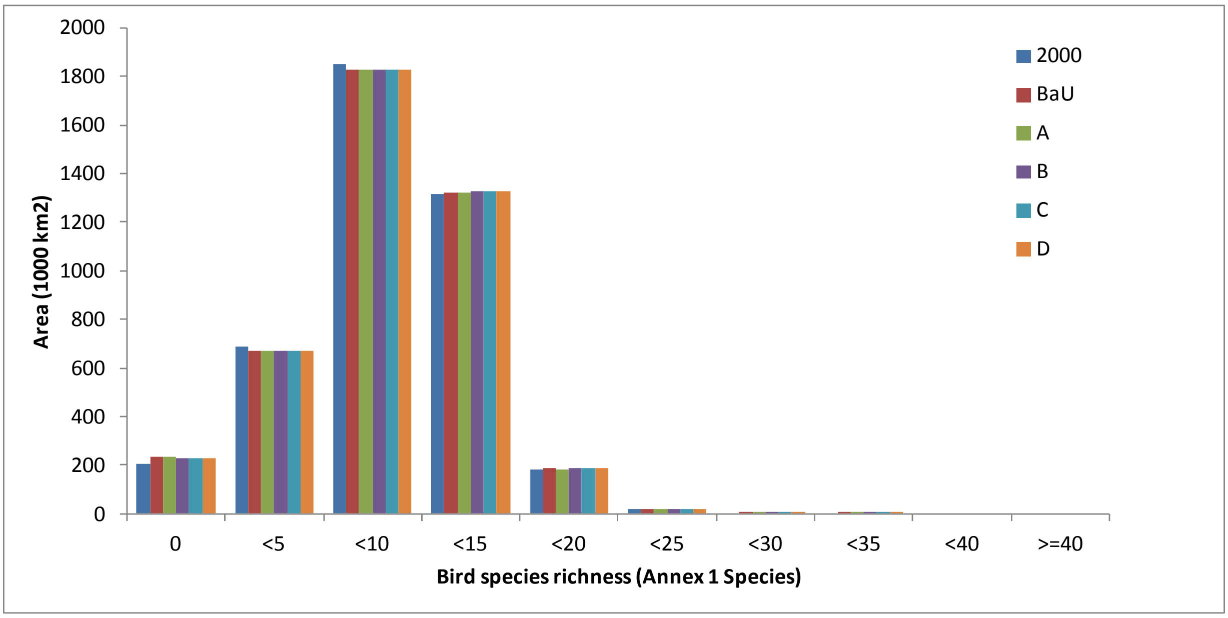


Figure 3 - 17 The total area in the EU27 with a given indicator farmland bird species richness, under each of the scenarios and the starting year

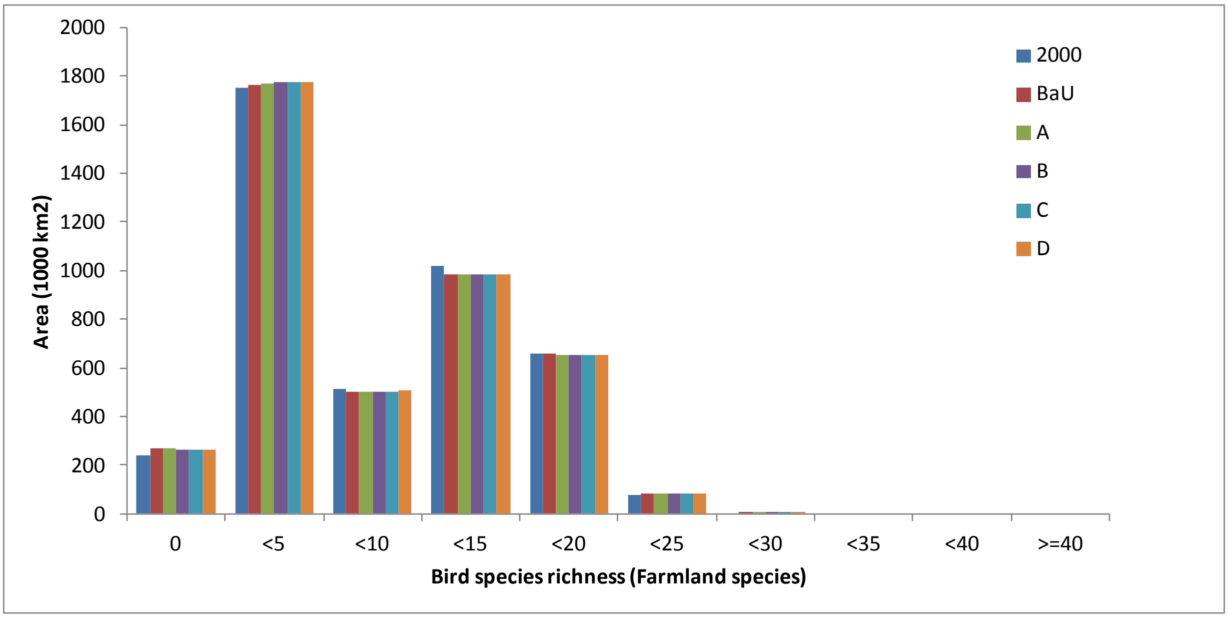
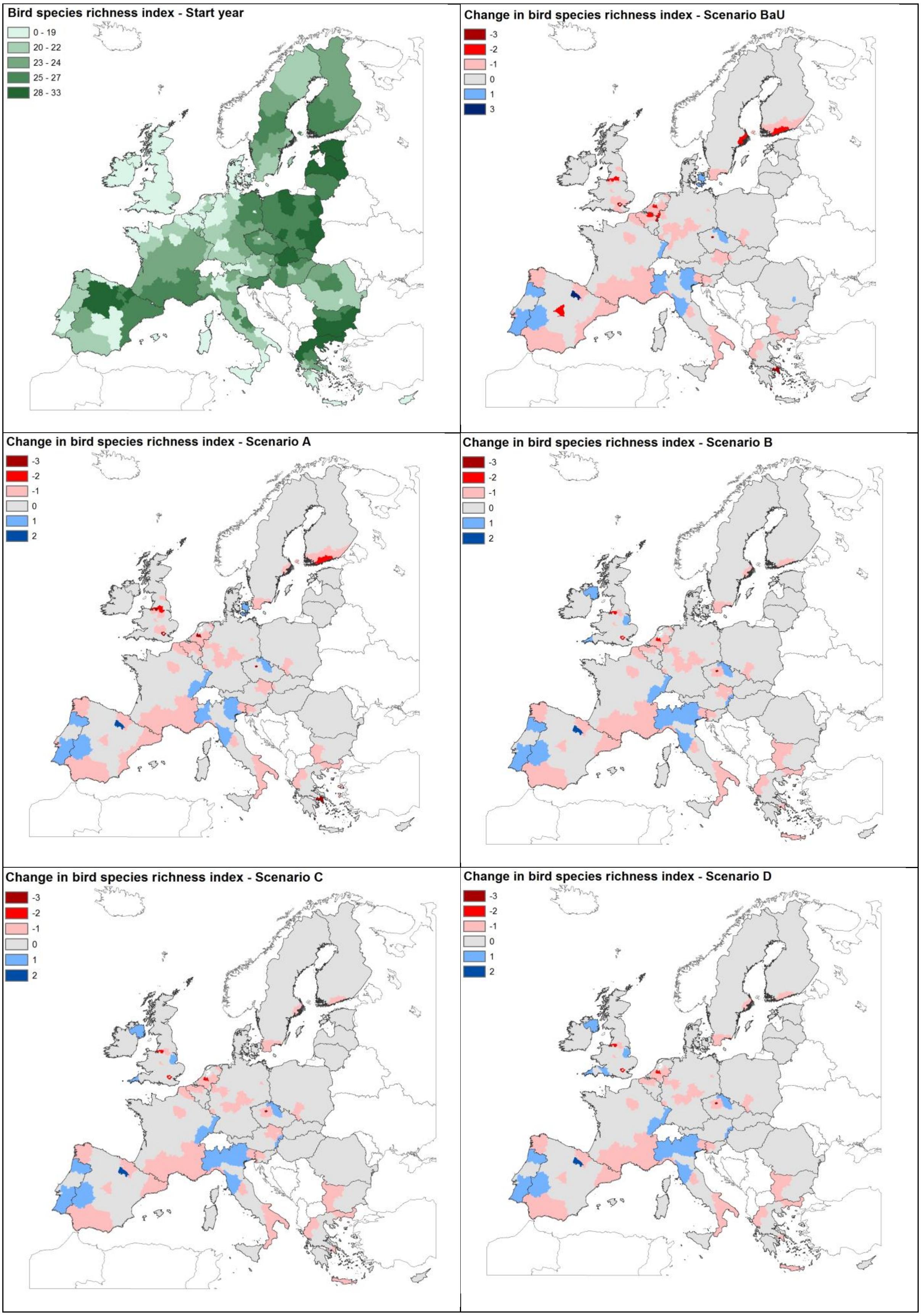


Figure 3 - 18 Change in bird species richness compared to the start year, on average per NUTS2 region



3.2.5 Mean Species Abundance

Mean Species Abundance (MSA) levels are expected to increase on average under the BaU scenario, from an average MSA value of 43 to 46 (i.e. 5.44% increase towards more pristine conditions (index=100)). Scenarios A-D all improve the MSA index further, up to 10% better than the BaU scenario (Figure 3-19). The MSA index is an aggregated index that pools several pressures. This makes it hard to discern the root causes of the changes, but overall, processes of land gain are positive, while land take has negative effects. Furthermore, the MSA index takes forest maturation into account as a positive effect, which is likely to be the driver behind the overall increase in MSA.

Despite the average positive trends, severe losses of MSA are also encountered, and losses are concentrated at locations of urban expansion such as capital regions. In the country averages, Slovenia and Malta show relatively strong decreases in MSA also due to urbanisation and little land gain (Figure 3-20). Improvements by 15% or more (average per country) are seen in Luxemburg, Austria, Portugal and Romania (Figure 3-20). Scenarios A-D all improve the MSA index further, for all countries (

Figure 3 - 20) and all NUTS2 regions (Figure 3 - 21). The number of NUTS2 regions that experience reductions in the MSA index decreases, and the strength of the decrease also becomes less severe with policy options B, C and D in particular. The MSA indicator clearly shows the effect of the increasing offset requirements in the various policy scenarios: urban regions that show decreases in the MSA index under the BaU scenario (several capital regions such as Paris, Madrid, London, Stockholm, Helsinki, Athens), show fewer or even no negative effects under scenarios B-D.

Figure 3-19 Relative change in Mean Species Abundance for the policy scenarios compared to the BaU scenario, calculated over EU27

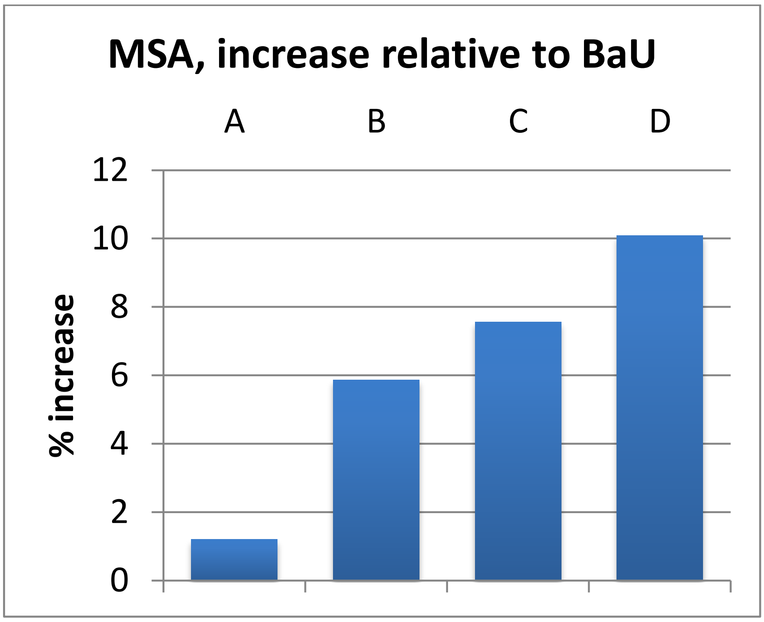


Figure 3 - 20 Relative changes in the Mean Species Abundance index per country compared to the start year (2000), for all scenarios

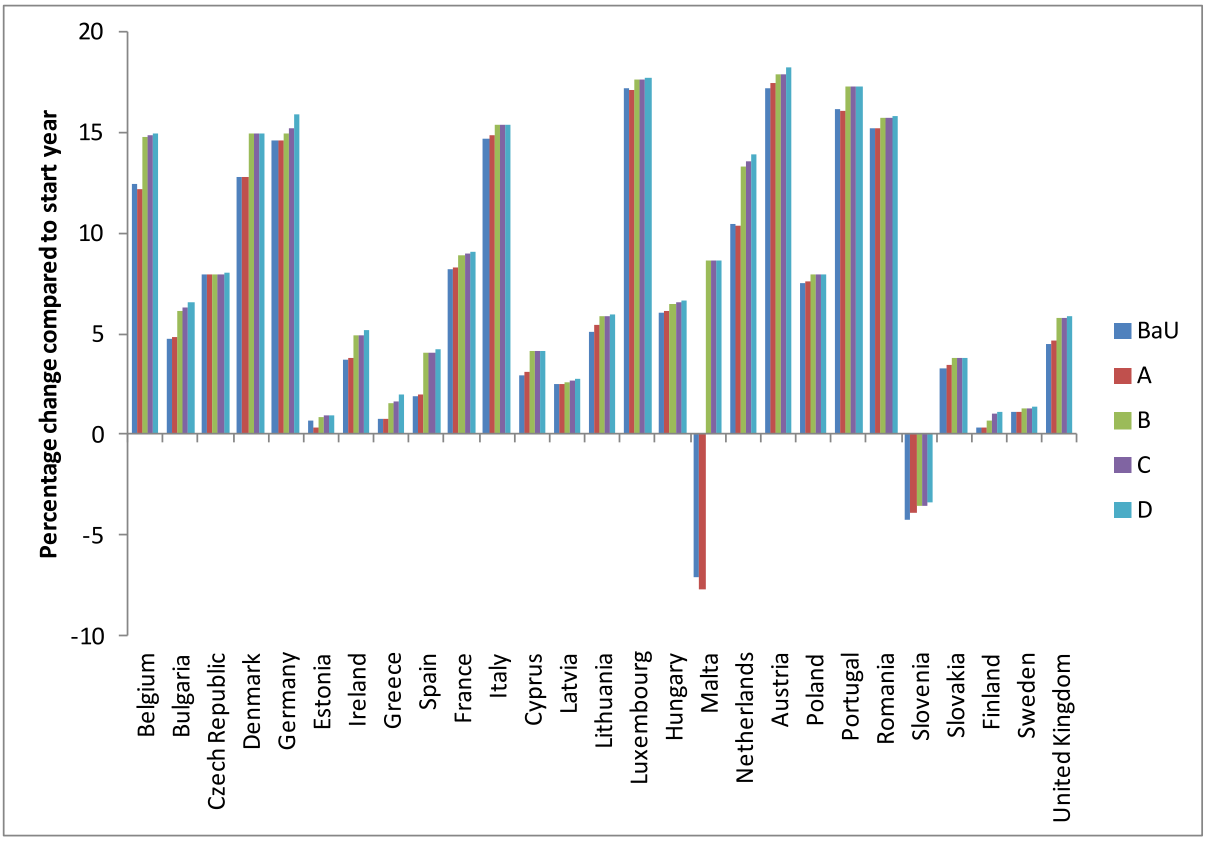
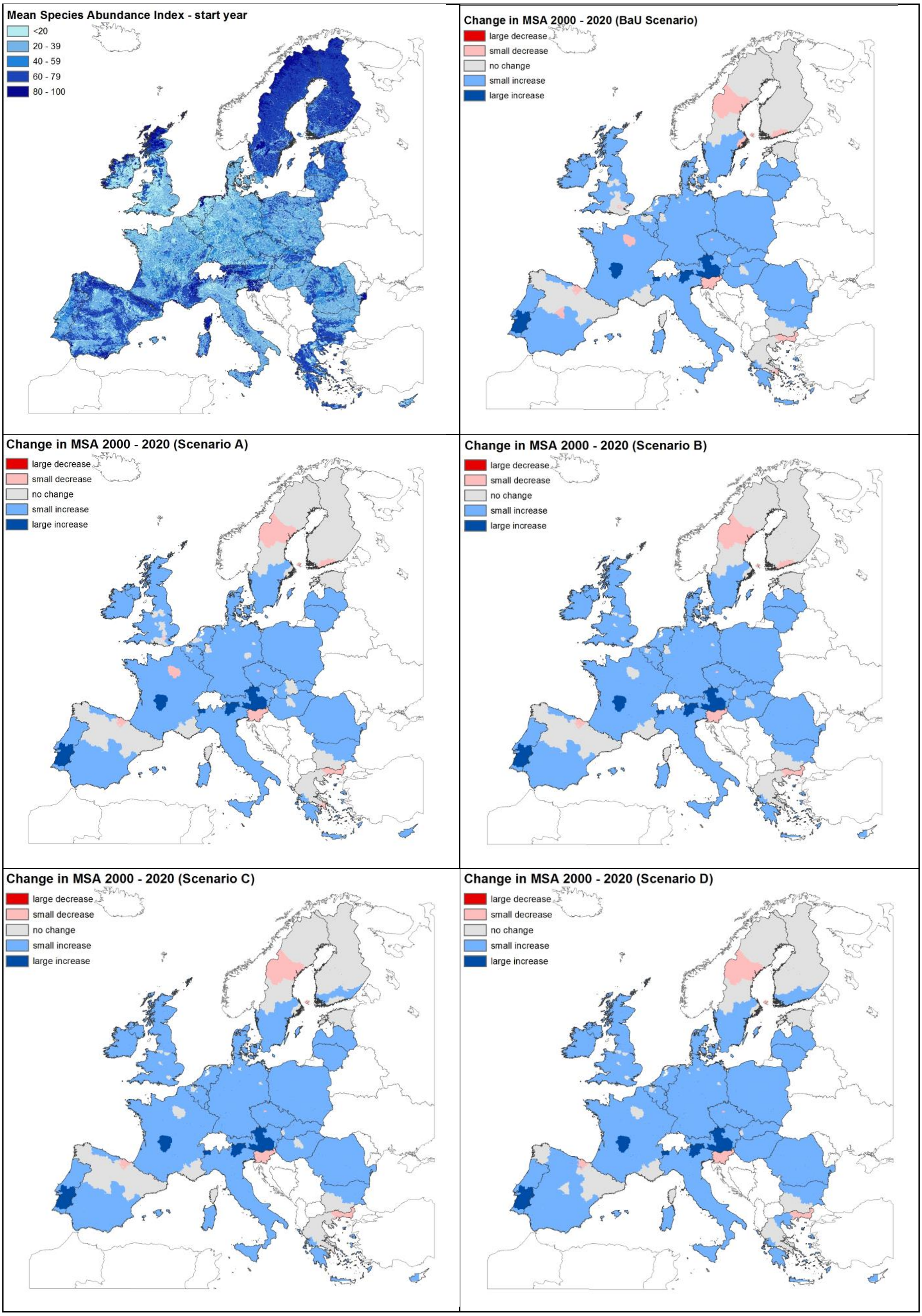


Figure 3 - 21 Change in Mean Species Abundance index between start and end year
Average at NUTS 2 level for Scenario maps. Large decrease: index decreased more than 8 points; small decrease: index decreased 1-8 points; small increase: index increased 1-8 points; large increase: index increased > 8 points.



3.2.6 Ecosystem services

3.2.6.1 Provisioning services: Nutrition – cropland production

The indicator for the ecosystem service cropland production is the area percentage cropland per NUTS2 region or country. The highest densities of cropland are found in Denmark, England, Hungary, Poland and France (**Figure 3 - 22**).

In the BaU, several parts of Europe the cropland area is expected to decrease due to increasing cropland productivity and an increased amount of import. Countries where increases of cropland area are expected generally have an increasing cropland demand for the production of biofuels, or are highly suitable for cropland production.

In Scenario A, measures to limit land take in Natura2000 buffer areas and measures to limit urban sprawl slightly reduce the cropland losses compared to the BaU. This also applies in scenarios B, C and D. For example, in the east of England increases of the cropland density are expected in all scenarios unless the decreasing cropland area in the UK. However, in these scenarios increasing amounts of land take that can be harmful to ecosystems or biodiversity is being compensated by creating new (semi-)natural habitats. This offsetting often is at the cost of arable land and reduces the cropland area in several countries. Fewer countries with an increase in crop production are seen in the scenarios B through D while more countries show a decrease (Table 3 - 7). This decreases the area of cropland in the EU as a whole by 4 018 000 km^2 in the D scenario compared with the BaU and will increase the demand for crop production (and cropland) outside the EU.

Figure 3 - 22 Food crop production in the year 2000 and changes thereof in 2020 under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.

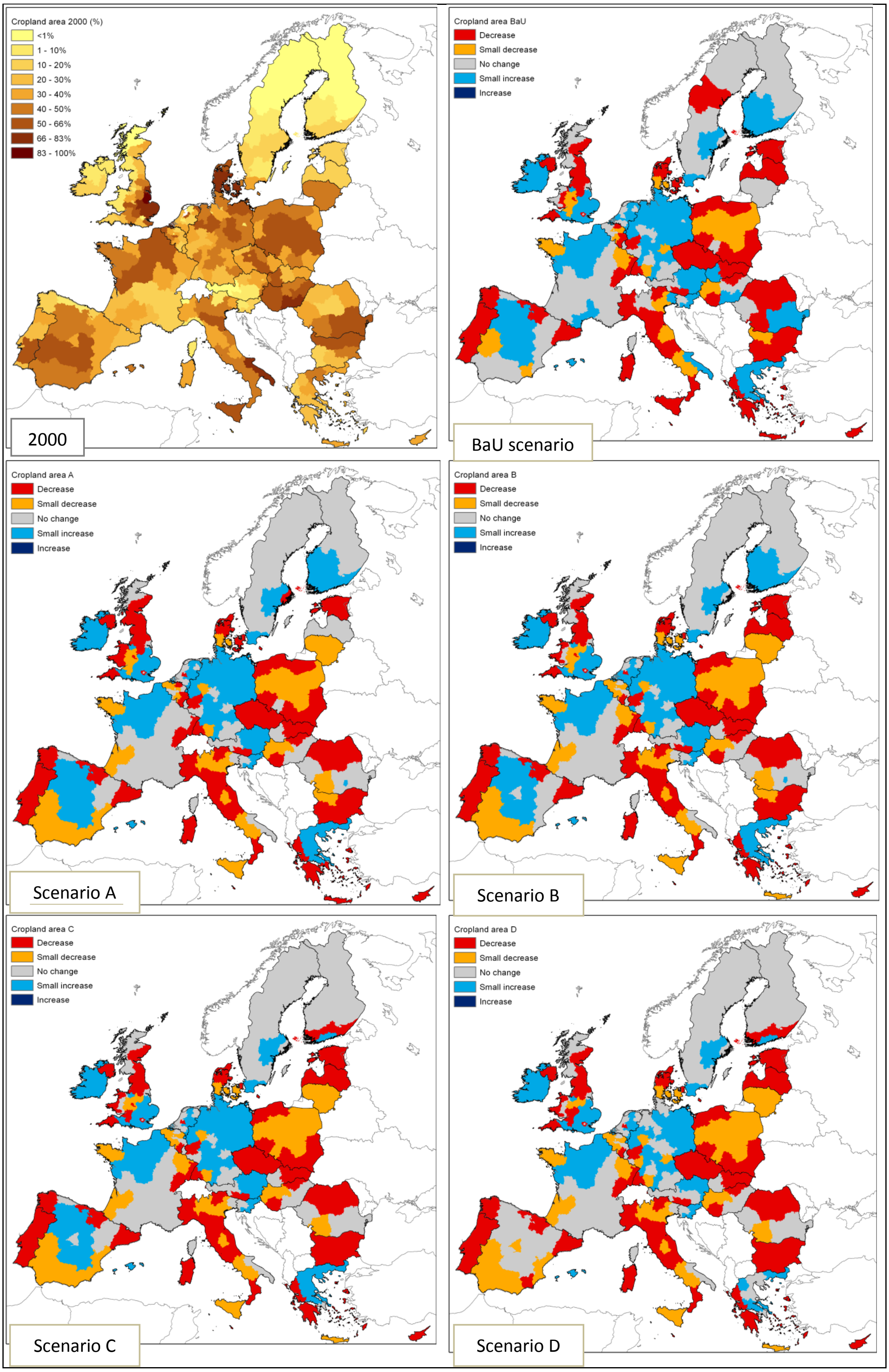


Table 3 - 7: Per-country crop production ecosystem service in the base year (km²) and changes in the scenarios (%).

Country	Cropland area 2000	Trends relative to 2000 in the scenarios				
		BaU	A	B	C	D
Belgium	10020	-2%	-2%	-2%	-2%	-2%
Bulgaria	44930	-8%	-8%	-8%	-8%	-9%
Czech Republic	34970	-12%	-12%	-12%	-12%	-12%
Denmark	29610	-7%	-7%	-7%	-7%	-7%
Germany	151660	4%	4%	3%	3%	1%
Estonia	8520	-7%	-7%	-6%	-6%	-7%
Ireland	7140	24%	24%	24%	24%	23%
Greece	37560	1%	1%	1%	0%	-1%
Spain	208660	-1%	-1%	-1%	-1%	-1%
France	201460	1%	1%	1%	1%	1%
Italy	126490	-5%	-5%	-5%	-5%	-5%
Cyprus	3770	0%	0%	0%	0%	0%
Latvia	13050	-1%	-1%	-1%	-1%	-2%
Lithuania	27720	-2%	-2%	-2%	-2%	-2%
Luxembourg	620	-1%	0%	0%	-1%	-1%
Hungary	53540	-3%	-3%	-3%	-3%	-3%
Malta	0	0%	0%	0%	0%	0%
Netherlands	11030	6%	6%	6%	5%	4%
Austria	15130	7%	7%	7%	6%	4%
Poland	153180	-6%	-6%	-6%	-6%	-6%
Portugal	34050	-18%	-18%	-18%	-18%	-18%
Romania	96410	-4%	-4%	-4%	-4%	-4%
Slovenia	3080	5%	5%	5%	4%	2%
Slovakia	18210	-4%	-4%	-4%	-4%	-5%
Finland	19260	12%	12%	7%	-1%	-1%
Sweden	32180	1%	1%	1%	1%	0%
United Kingdom	67100	-3%	-3%	-3%	-3%	-3%

3.2.6.2 Provisioning - Nutrition - potable water

The indicator for the ecosystem service *water provision* is calculated as the ratio between the water area and the area of built-up and arable land per watershed. Figure 3 - 23 (top left) shows the status of this indicator in the base year. The areas are aggregated to average values per river basin and country. High values are seen in the North of Europe because of the large areas of open water, low cropland density and low population density. Low values are most particularly seen in densely populated areas like Belgium.

As no changes of the area of open water are simulated in the scenarios, all simulated changes are due to changes in the area of built-up and arable land. In the BaU, many areas, especially in Western Europe, are expected to face a decrease of water provision. The decreases in water provision shown in Figure 3 - 23 (top right) in the Netherlands and parts of Spain are due to urban expansion while decreases in eg northwestern Germany and southern France are due to expansion of arable land. In regions that already experience water scarcity (eg Spain) a further decrease might lead to water shortage and decrease of water quality. Increases are generally a result of abandonment of arable land.

In the policy scenarios, some improvements are seen relative to the BaU. In scenario A changes compared to the BaU are due to changes in land use patterns only. Overall, the areas of land use with water demand and water supply do not change between the BaU and A scenario. Especially in Germany and Spain, the land use allocation in scenario A results in a higher demand in some watersheds, resulting in decreases of the ecosystem service in western Germany and northern Spain. In the scenarios B through D, due to the offsetting the amount of arable land decreases relative to the BaU. Therefore, the balance between water supply and demand improves. In Slovenia, Germany and Greece, many areas with a decreasing water supply in the BaU do not face a decrease of the ecosystem service in the D scenario, due to the decreased urban area and cropland area.

In a few countries (NL, IE, DE, SE, AT) a decrease of the service remains in all scenarios. These countries either have a large supply of potable water from groundwater resources (NL, DE, IE, SE) or a large supply from glacier water (AT), and therefore do not depend on surface water alone. These five countries therefore have an ample water supply. The decrease in the service is unlikely to affect the benefits derived from it.

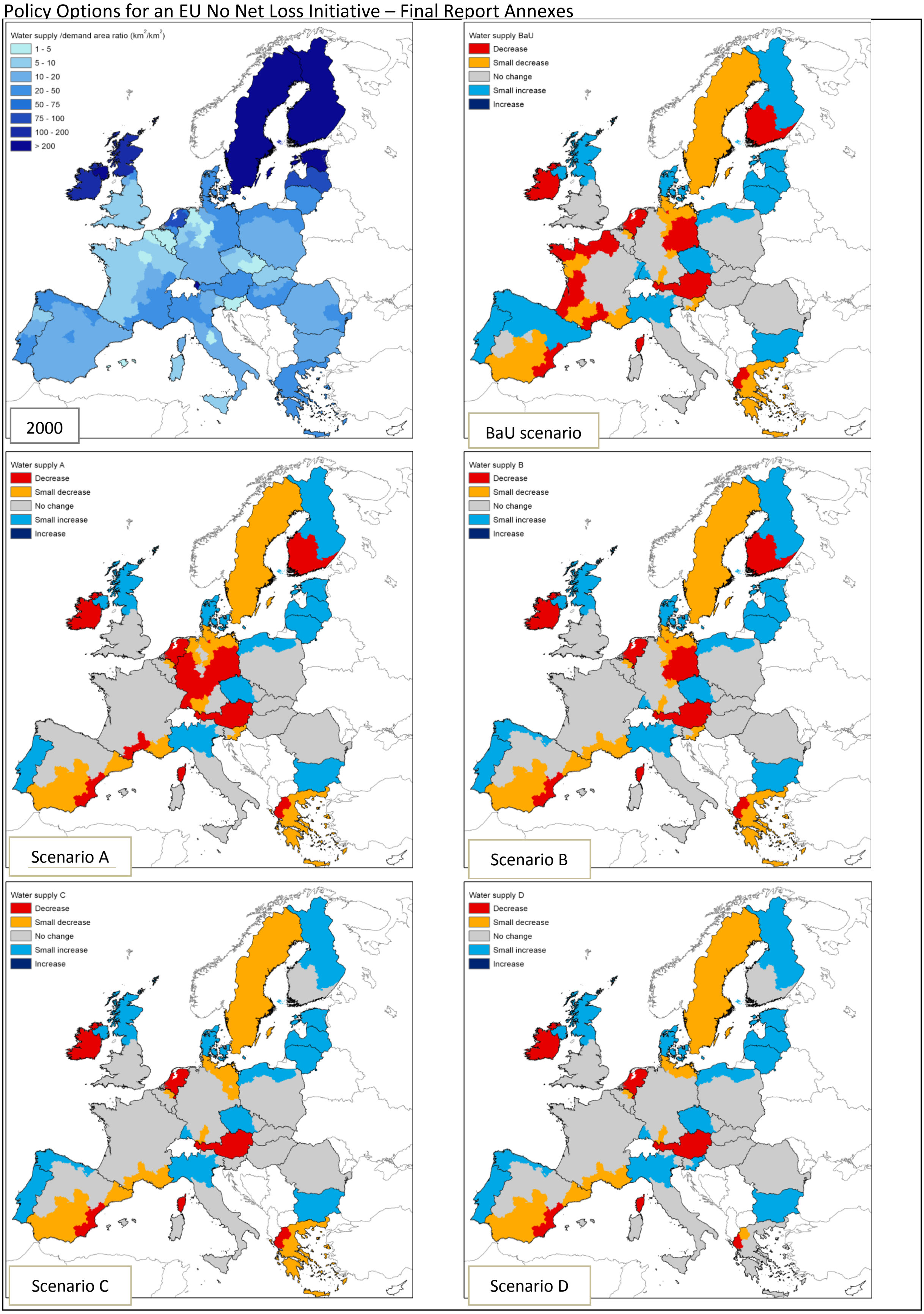


Figure 3 - 23 Water provision in the year 2000 and changes thereof in the year 2020 under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.

Table 3 - 8 Per-country water provision ecosystem service in the base year (km^2/ km^2) and changes in the scenarios (%).

Country	Water supply/demand area ratio 2000	Trends relative to 2000 BaU	A	B	C	D
Belgium	1.4	0%	0%	0%	0%	0%
Bulgaria	14.5	7%	7%	7%	7%	7%
Czech Republic	6.7	9%	9%	9%	9%	9%
Denmark	24.8	4%	4%	4%	4%	4%
Germany	14.3	-2%	-5%	-2%	-1%	-1%
Estonia	221.3	6%	5%	5%	5%	5%
Ireland	145.9	-22%	-22%	-21%	-21%	-21%
Greece	25.9	-4%	-4%	-4%	-4%	0%
Spain	18	2%	-1%	-1%	-1%	-1%
France	13.2	-3%	-1%	-1%	-1%	-1%
Italy	18.2	1%	3%	3%	3%	3%
Cyprus	0	0%	0%	0%	0%	0%
Latvia	87.4	-1%	-1%	0%	0%	1%
Lithuania	34	11%	11%	11%	11%	11%
Luxembourg	3.8	0%	0%	0%	0%	0%
Hungary	20	0%	0%	0%	0%	0%
Malta	0	0%	0%	0%	0%	0%
Netherlands	69.4	-11%	-11%	-9%	-9%	-8%
Austria	33.6	-12%	-10%	-9%	-9%	-9%
Poland	21.7	1%	1%	1%	1%	1%
Portugal	17	14%	15%	15%	15%	15%
Romania	15.1	0%	0%	0%	0%	0%
Slovenia	0.8	0%	0%	0%	0%	0%
Slovakia	5.8	0%	0%	0%	0%	0%
Finland	6926.2	1%	1%	1%	2%	2%
Sweden	823.7	-3%	-3%	-2%	-2%	-2%
United Kingdom	77.1	11%	11%	13%	13%	13%

3.2.6.3 Provisioning - Materials – Biotic materials

The indicator for the ecosystem service *biotic materials* is the forest biomass stock. Forest biomass stocks per country vary between 368 Mg / km^2 (Ireland) and 13,450 Mg/km^2 (Slovenia) in 2000 (Table 3 - 9). Generally, the highest forest biomass stocks are found in central European forests (Figure 3 - 24). These areas have favourable forest growth conditions, and a high density of ageing forests.

In most of the EU, small changes of the forest biomass stock are expected in all scenarios. This is mainly due to an increase in forest area at the cost of semi natural vegetation and agricultural land. Additionally, due to the ageing of forest the biomass stock per km^2 is expected to increase in many countries.

Forest loss (Figure 3 - 24) is mainly due to conversion to arable land and sometimes subsequent urbanization. This results in decreases of the biomass stock in scattered parts of northwest Europe, most importantly in urbanized regions around large cities. The decreases are not compensated by the offsetting related to urbanization in the C and D scenarios (Figure 3 - 24), because the biomass loss upon forest loss is larger than the biomass gain from offsetting. Forests have a higher per-area carbon stock than semi-natural habitats. Additionally, land take results in immediate carbon emission from the biomass loss. The biomass increment in the offsetting land is a much slower process and is therefore insufficient to compensate the biomass loss.

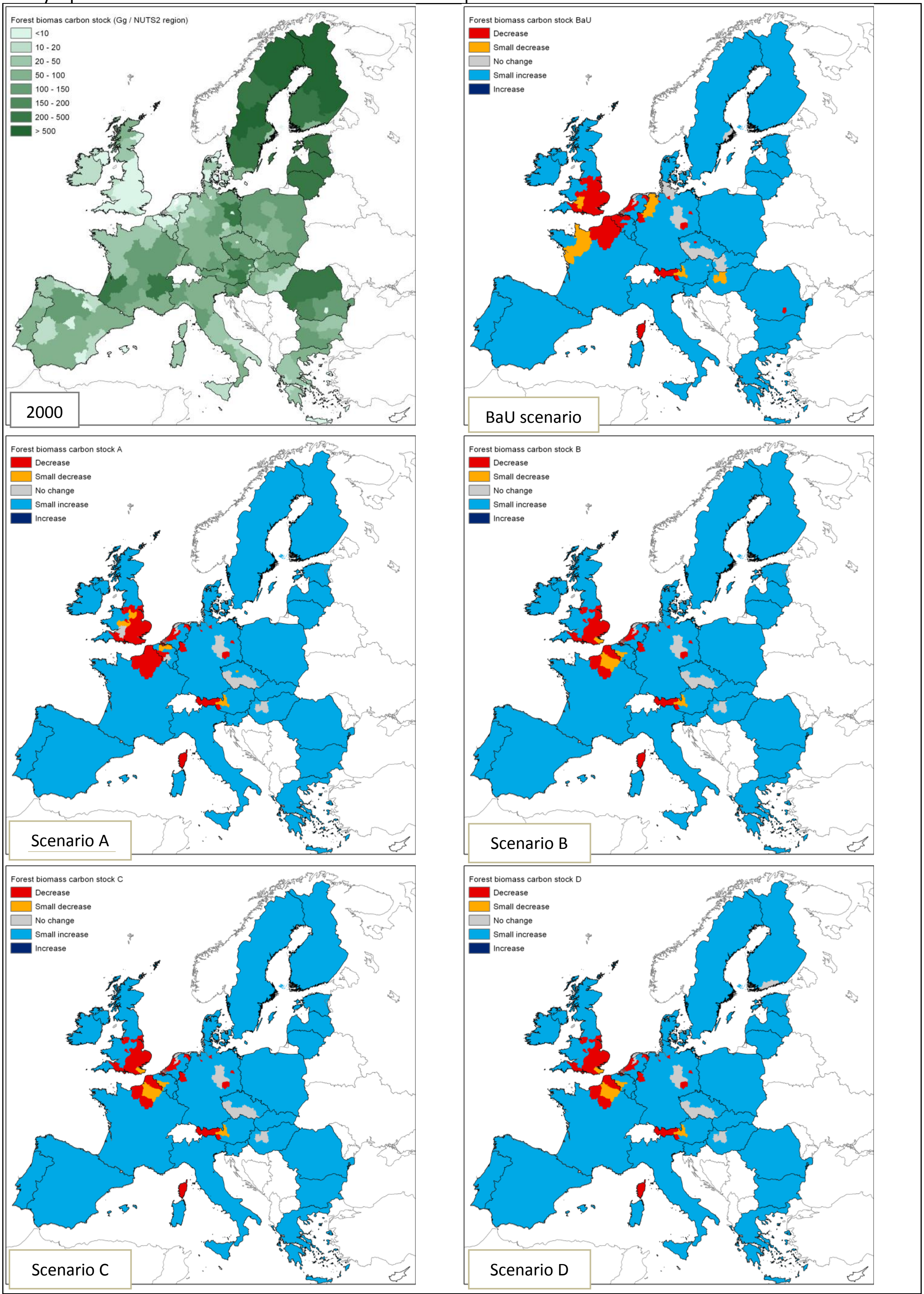


Figure 3 - 24 Timber production in the year 2000 and changes thereof in the year 2020 under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.

Table 3 - 9 Per-country forest biomass stock in the base year (Mg/km^2) and changes in the scenarios (%).

Country	Forest biomass stock (Mg/km^2)	Trends relative to 2000				
		BaU	A	B	C	D
Belgium	3748	0%	0%	5%	5%	5%
Bulgaria	4074	47%	48%	48%	48%	48%
Czech Republic	7540	0%	0%	0%	0%	0%
Denmark	1206	40%	41%	41%	41%	41%
Germany	6994	11%	11%	12%	12%	12%
Estonia	7217	0%	0%	0%	0%	0%
Ireland	368	28%	29%	31%	31%	31%
Greece	2295	37%	37%	37%	37%	37%
Spain	904	43%	44%	44%	44%	44%
France	3441	18%	18%	19%	19%	19%
Italy	3520	35%	35%	36%	36%	36%
Cyprus	n/a	n/a	n/a	n/a	n/a	n/a
Latvia	5868	0%	0%	0%	0%	0%
Lithuania	4008	8%	9%	9%	9%	9%
Luxembourg	10540	0%	0%	0%	0%	0%
Hungary	2975	0%	0%	0%	0%	0%
Malta	n/a	n/a	n/a	n/a	n/a	n/a
Netherlands	1379	13%	12%	15%	15%	15%
Austria	10562	0%	0%	0%	0%	0%
Poland	4827	0%	0%	0%	0%	0%
Portugal	1848	20%	20%	20%	20%	20%
Romania	5877	25%	27%	27%	27%	27%
Slovenia	13226	18%	19%	19%	19%	19%
Slovakia	6791	0%	0%	0%	0%	0%
Finland	4382	40%	40%	40%	40%	40%
Sweden	5501	23%	23%	23%	23%	23%
United Kingdom	1023	11%	13%	17%	17%	17%

3.2.6.4 Regulating and maintenance - Regulation of waste – Dilution and sequestration – Carbon

Currently, ecosystems in large parts of Europe are sequestering carbon (Figure 3 - 25, top left panel). Only areas with managed peat soils (western parts of the Netherlands) or intensively used arable lands and some heavily managed forests do emit carbon. At country level, in most countries ecosystems are showing net sequestration of carbon (

Table 3 - 10). A net emission is only seen in Lithuania, Slovakia and Hungary. These are countries with a high share of arable land.

In the BaU scenario, large parts of Europe are expected to show a decrease in carbon sequestration. Increases of the capacity of sequestering carbon are expected in northern and central Europe, while large parts of eastern Europe show a decrease of the capacity to sequester carbon. In southern Europe changes in the capacity of sequestering carbon are modest.

Decreases of the capacity to sequester carbon are generally due to deforestation. Although under the BaU scenario modest net changes in forest area are projected, there are gross changes. Removal of forest at one location and replacement at another location generally means that large amounts of biomass are lost. Also, somewhat older forests have a higher capacity to sequester carbon than very young forests. Upon compensation of forest loss, therefore, a forest with a high capacity to sequester carbon will be replaced by a forest with a lower capacity. Increases of the capacity to sequester carbon are generally due to abandonment of arable land.

In scenario A, some improvements are seen relative to the BaU scenario. Fewer decreases of the capacity to sequester carbon are seen, as well as some increases, e.g. in Hungary and Finland (Figure 3 - 25). This is due to the higher protection level of nature areas and small patches of forest, resulting in fewer gross land use changes. The B scenario shows a few more regions where the capacity to sequester carbon increases relative to the BaU, especially in Germany. The lower rate of urban expansion in scenario B leaves somewhat more space for forest, limiting the decrease of the carbon sequestration capacity. The scenarios C and D hardly result in additional improvements relative to scenario B, unless the offsetting. The offsetting has little effect because the new nature that is created to offset land take most often has a lower carbon sequestration capacity than the land use that is lost. Additionally, land take results in immediate carbon emissions from the biomass loss. The biomass increment in the offsetting land is a much slower process and is therefore insufficient to compensate the biomass loss.

Figure 3 - 25 Carbon sequestration in the year 2000 and changes thereof under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.

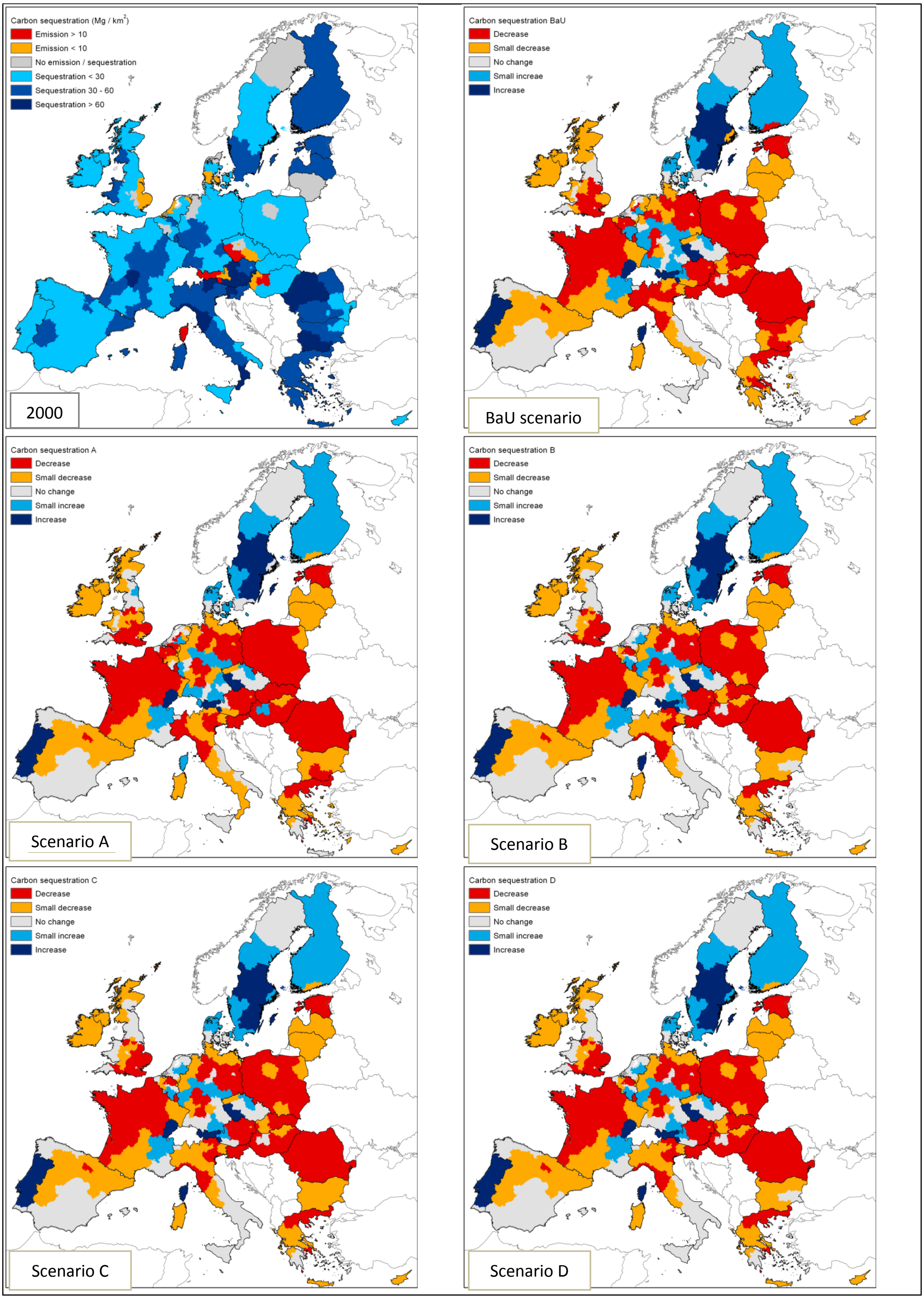


Table 3 - 10 Per country carbon sequestration / emission in 2000 (Mg/km^2) and changes in the scenarios

Country	Carbon sequestration (Mg / km^2)	Trends relative to 2000				
		BaU	A	B	C	D
Belgium	12.5	12.5	0.2	2.8	9.9	9.9
Bulgaria	47.1	47.1	39.8	41.1	42.4	42.4
Czech Republic	-0.7	-0.7	4.5	4.5	4.6	4.6
Denmark	7.1	7.1	9.9	9.9	10	10
Germany	24	24	18.4	18.7	18.8	18.8
Estonia	44.6	44.6	28.4	28.3	28.3	28.3
Ireland	13	13	10	10.3	10.5	10.5
Greece	44.6	44.6	39.3	39.2	39.1	39
Spain	25	25	22.9	22.9	23	23
France	24.9	24.9	13.2	13.2	14.4	14.4
Italy	46.6	46.6	40.9	41.6	42	42
Cyprus	8.7	8.7	6.2	6.2	6.2	6.2
Latvia	39.8	39.8	37.8	37.8	37.9	37.9
Lithuania	2.6	2.6	-3.9	-3.8	-3.7	-3.7
Luxembourg	51.7	51.7	43.7	27	38.4	38.4
Hungary	3.1	3.1	-5.6	-5.6	-5.2	-5.2
Malta	n/a	n/a	n/a	n/a	n/a	n/a
Netherlands	8.7	8.7	6.7	5.3	9.6	9.7
Austria	36.2	-14.3	22	23.3	25	25
Poland	15	15	0.2	0.2	0.7	0.8
Portugal	17.7	17.7	35.2	35.2	35.2	35.2
Romania	58.1	58.1	38.3	38.7	38.8	38.8
Slovenia	57.2	57.2	38.6	37.8	40.2	40.2
Slovakia	10.2	10.2	-1.9	-2.2	-0.8	-0.8
Finland	38.2	38.2	43.1	43.2	43.4	43.4
Sweden	17.5	17.5	23.5	23.6	23.8	23.8
United Kingdom	17.2	17.2	9.6	9.4	11.1	11.1

3.2.6.5 Regulating and maintenance - Regulation of waste – Dilution and sequestration – Air quality regulation

Generally, forests have the highest capacity to capture air pollutants, followed by other nature and pasture. Consequently, high capacities to capture air pollution are seen in northern Europe and parts of central Europe, where there is a high forest density. In areas with more arable land or built-up areas such Netherlands, England, and large urban centres, the air quality regulation capacity is lower.

In the BaU scenario, for the EU27 as a whole the capacity of the ecosystem to remove air pollutants decreases by 5% until 2020 (Figure 3 - 26). This is because the area where air quality regulation is needed (ie the built-up area) increases. This increase generally is at the cost of land use types that do have some capacity to remove air pollutants from the atmosphere. In some regions, this results in a zero capacity to remove air pollutants (Figure 3 - 26). Decreases are concentrated in the urbanizing parts of northwest Europe (Figure 3 - 27). Increases are concentrated in areas with abandonment of agricultural land (Figure 3 - 27). The abandonment of agricultural land results in replacement of land with a low capacity to remove air pollutants (arable land) by land with a higher capacity to remove air pollutants ((semi-)natural vegetation, forests). Therefore, agricultural land abandonment is often highly favourable for the regulation of air quality. However, this conversion generally takes place at areas with a low demand for urban expansion and therefore the demand for the regulation of air quality is low as well.

In the policy scenarios, the capacity to remove air pollutants generally increases. The NUTS2 regions with a zero capacity disappear and the average air quality regulation increases to the level in 2000 (Figure 3 - 26). In all scenarios, NUTS2 regions and countries remain where the air quality regulation decreases. In scenario A, new built-up area is concentrated around existing urban cores. While this results in overall improvement relative to the BaU, the new urban areas are denser in the A scenario than in the BaU scenario. This leaves less space for natural land cover that can capture pollutants in the direct vicinity of built-up areas and causes some scattered decreases relative to the BaU, e.g. in the Netherlands.

Also in scenarios B-D additional improvements are seen relative to the BaU. Regions with a decrease of the air quality regulation remain because in all scenarios expansion of built-up areas is expected. In areas with a lower rate of urban expansion, the increased offsetting over the scenarios B through D is favourable for the air quality regulation capacity, because expansion of built-up area is accompanied by expansion of (semi-)natural vegetation nearby. In countries with a high rate of urban expansion, consequently, decreases of the service relative to the base year remain. This explains the decreases of the air quality regulation capacity in parts of northwest Europe and is due to both an insufficient expansion of nature areas directly adjacent to built-up areas, and to the low capacity of semi-natural vegetation to capture air pollutants relative to agricultural land.

Figure 3 - 26 Distribution of provision of air quality regulation at NUTS2 resolution

The grey bar covers the interquartile range, with the mean indicated by the horizontal line. Error bars indicate the minimum and maximum values.

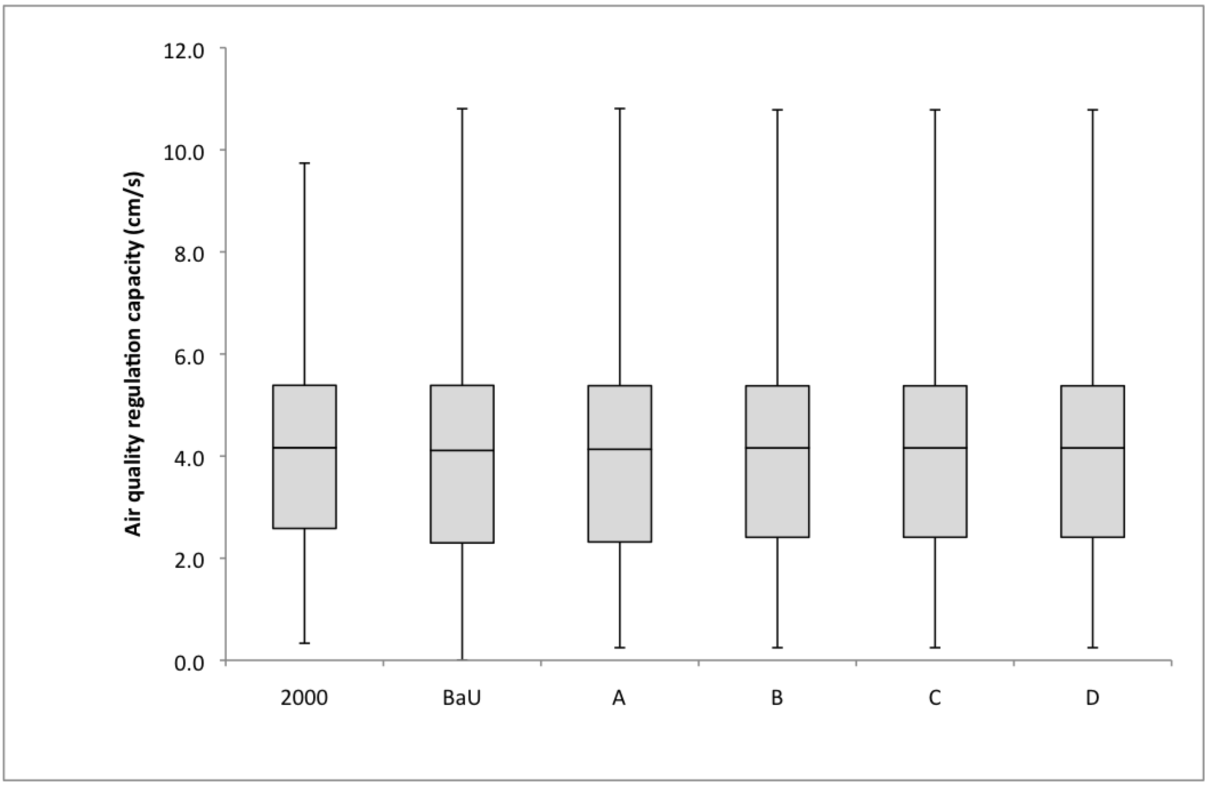
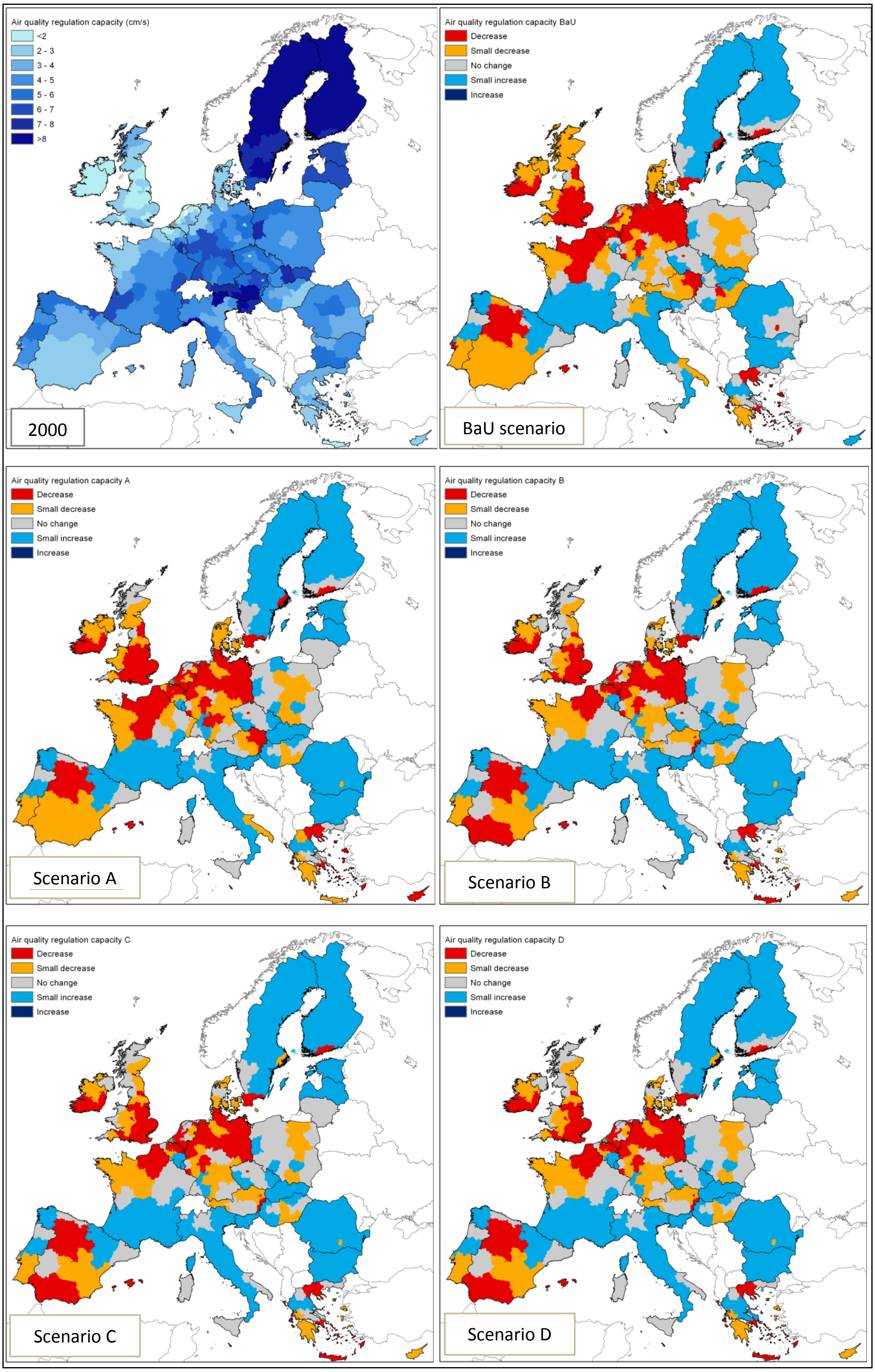


Figure 3 - 27 Air quality regulation in the year 2000 and changes thereof in the year 2020 under all scenarios

Legend classes distinguish areas with small (<5%) and larger increases and decreases.



3.2.6.6 Regulating and maintenance - Flow regulation – Water flow regulation – Storm protection

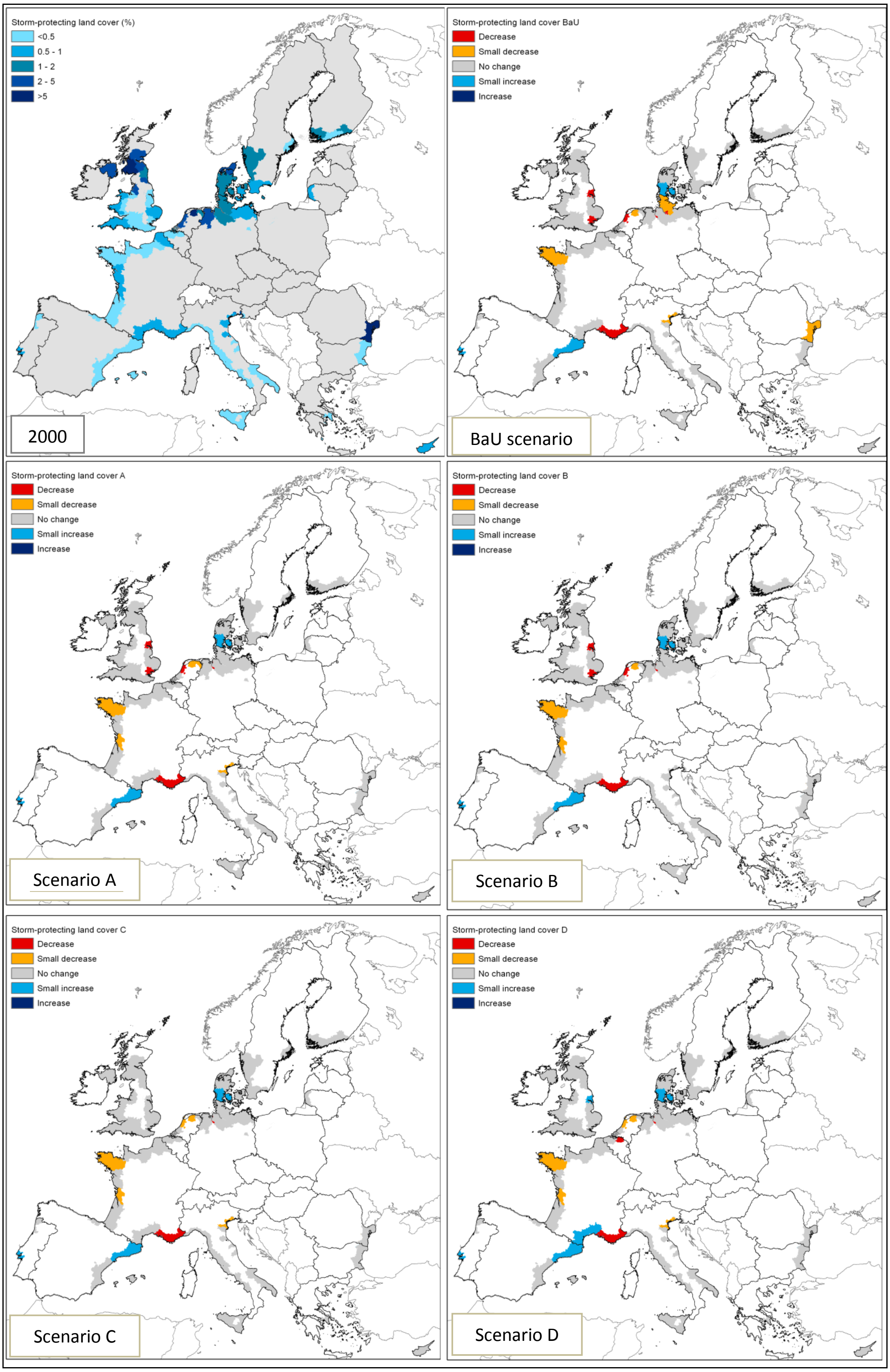
Figure 3 - 28 shows the percentage of land use area that has the capability to slow down *waves* during heavy coastal storms. Area percentages are rather low; maximum values of around 10% are found in parts of Germany Figure 3 - 28). Lowest values are seen along the Spanish Mediterranean coast and the French Atlantic coast.

In the BaU scenario, decreases are expected especially in the areas with a relatively good storm protection service, caused by the urbanization of semi-natural vegetation and grasslands that did provide storm protection in the base year. This expansion of built-up area in coastal regions means that more built-up area is in locations vulnerable to coastal storms. As the capacity of the landscape to mitigate the impact of those storms is projected to decrease, more technical protection measures would be needed to safeguard built-up areas.

In scenario A, the policy measures are insufficiently effective to improve the storm protection service relative to the BaU. The land use demands are similar to those in the BaU and only the allocation differs. Expansion of built-up area is concentrated close to existing built-up area. This does not significantly affect the built-up expansion in coastal areas. In the scenarios B through D, improvements of the ecosystem service provision are seen relative to the BaU. This is due to the increased nature area and the decreased built-up area. For this service, offsetting of land take in the direct vicinity of the land take is highly favourable because it results in joint increases of sensitive areas (mainly built-up) and protecting areas (nature). In the D scenario, marginal decreases (<1%) remain in France and The Netherlands. In all other coastal countries the provision of the service does not change or increases in the D scenario.

Figure 3 - 28 Storm protection in the year 2000 and changes thereof in the year 2020 under all scenarios

Legend classes distinguish areas with small (<5%) and larger increases and decreases.



3.2.6.7 Regulating and maintenance - Flow regulation – Water flow regulation – Flood regulation

In the base year, a high flood regulation is expected in areas with large patches of natural vegetation or extensive agriculture, like Ireland, northwestern Spain, the Pyrenees, eastern Sweden, and the Carpathians. The main restriction on the supply of flood regulation is the available water holding capacity. This leads to low flood regulation supply in eg Scotland (Stürck et al, 2014).

In the BaU scenario, increases in flood regulation capacity are expected in regions with agricultural abandonment or nature expansion, such as parts of France, Spain and Italy. Decreases are expected due to expansion of built-up areas (large cities such as Berlin, Madrid) or arable land expansion (England).

The policy options have little impact on the average per-country flood regulation capacity (

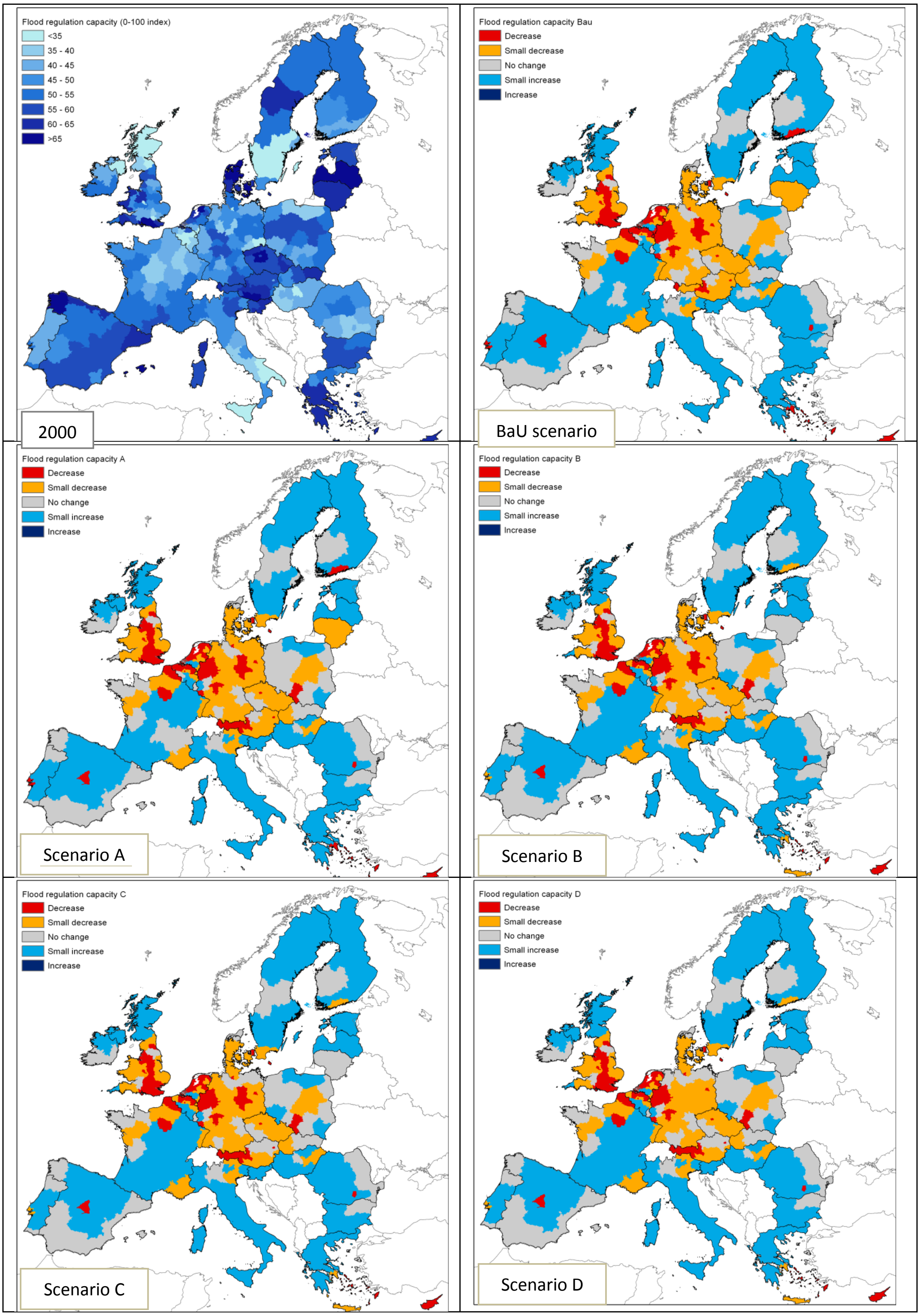
Table 3 - 11) or on the spatial patterns of increases and decreases (Figure 3 - 29). In all countries, the flood regulation capacity improves slightly relative to the BaU, but the changes are marginal. To improve the flood regulation supply or offset the decreases of flood regulation, avoidance or compensation measures should be targeted at very specific locations (like upper parts of watersheds) to be effective.

Table 3 - 11 Flood regulation capacity (%)

	Flood regulation capacity in 2000	Trends relative to 2000				
Country		BaU	A	B	C	D
Belgium	36.7	-3.80%	-3.50%	-2.70%	-2.70%	-2.70%
Bulgaria	56.3	1.40%	1.40%	1.60%	1.60%	1.60%
Czech Republic	60.4	-2.00%	-2.00%	-2.00%	-2.00%	-2.00%
Denmark	65.8	-2.40%	-2.40%	-2.40%	-2.40%	-2.40%
Germany	48.3	-2.50%	-2.50%	-2.30%	-2.30%	-2.30%
Estonia	58.9	1.50%	1.40%	1.50%	1.50%	1.50%
Ireland	48	3.50%	3.30%	3.50%	3.50%	3.80%
Greece	57.5	2.30%	2.30%	2.40%	2.40%	2.40%
Spain	56.2	1.10%	1.10%	1.10%	1.10%	1.10%
France	47.9	0.40%	0.40%	0.60%	0.60%	0.60%
Italy	45.9	2.60%	2.60%	2.60%	2.60%	2.60%
Cyprus	64.9	-5.90%	-5.90%	-5.50%	-5.50%	-5.50%
Latvia	66.2	1.10%	1.10%	1.10%	1.10%	1.10%
Lithuania	60.7	-0.80%	-0.70%	-0.70%	-0.70%	-0.70%
Luxembourg	49.7	0.20%	0.20%	0.40%	0.40%	0.40%
Hungary	40.9	1.20%	1.20%	1.50%	1.50%	1.50%
Malta	0	0.00%	0.00%	0.00%	0.00%	0.00%
Netherlands	51.6	-6.60%	-6.60%	-6.20%	-6.20%	-6.00%
Austria	59.2	-2.50%	-2.50%	-2.20%	-2.20%	-2.20%
Poland	49.7	-0.20%	-0.20%	-0.20%	-0.20%	-0.20%
Portugal	42.2	1.20%	1.20%	1.20%	1.20%	1.20%
Romania	45.9	2.00%	2.00%	2.00%	2.00%	2.00%
Slovenia	60.1	1.50%	1.50%	1.50%	1.50%	1.50%
Slovakia	57.6	-0.70%	-0.50%	-0.30%	-0.30%	-0.30%
Finland	51.2	1.40%	1.40%	1.60%	1.60%	1.60%
Sweden	48.3	1.40%	1.40%	1.40%	1.40%	1.40%
United Kingdom	45.3	-2.60%	-2.60%	-2.20%	-2.20%	-2.20%

Figure 3 - 29 Flood regulation in the year 2000 and changes thereof in the year 2020 under all scenarios

Legend classes distinguish areas with small (<5%) and larger increases and decreases.



3.2.6.8 Regulating and maintenance - Flow regulation – mass flow regulation – soil particle flow

Currently, the lowest erosion protection is seen on sloping areas in the southern parts of Europe (Figure 3 - 31). Here, large areas with a low vegetation cover are found. These regions coincide with the highest sensitivity to erosion; the south of Europe has large areas with soils sensitive to erosion due to the high silt content. Additionally, rain showers with a high intensity occur more frequently in the Mediterranean region than elsewhere in the EU. This results in high erosion rates.

In the BaU scenario, we expect increasing erosion protection overall. Figure 3 - 31, (top right panel), shows that in large parts of southern and eastern Europe increases of erosion protection are expected. This is due to decreasing cropland area. Croplands provide little protection against erosion and their replacement by (semi-)natural vegetation upon abandonment results in an increased erosion protection. Some decreases of erosion protection are seen in the areas with cropland expansion. Urban expansion has no negative effects on erosion protection, because built-up area seals the soil and decreases the soil loss. Therefore, the high urban expansion in northwest Europe has no detrimental effects on erosion protection.

In all policy scenarios, more natural vegetation remains or is established in the BaU. The natural vegetation provides a better protection against erosion, leading to no change or improvement of the service in all countries considered in the scenarios A through D. In all scenarios, larger areas with a high erosion protection (low values) emerge, and areas with low erosion protection (high values) get smaller (Figure 3 - 30). In the D scenario, small decreases in erosion protection remain throughout western Europe. This is due to the cropland expansion in these areas. At country level, erosion protection increases in all countries in the D scenario.

Figure 3 - 30 Histogram of erosion protection in the year 2000, and the year 2020 under all scenarios

Low values indicate a high erosion protection, high values indicate a low erosion protection.

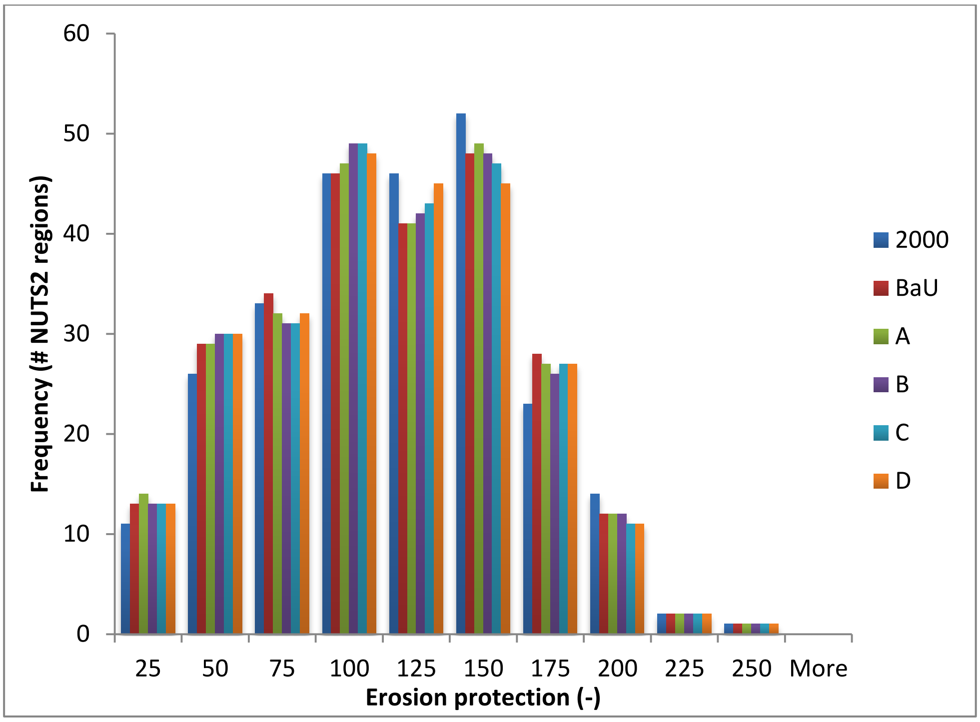
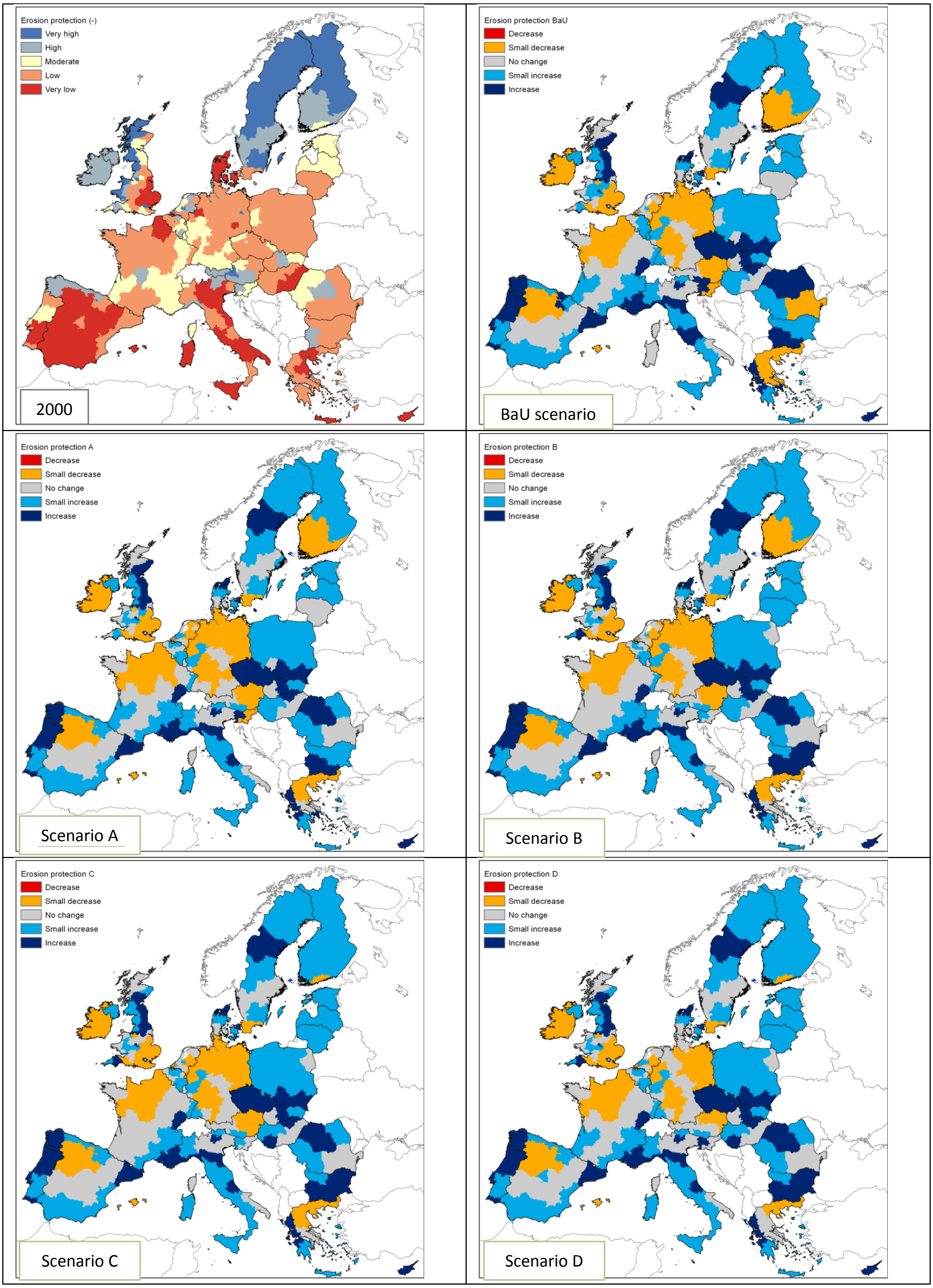


Figure 3 - 31 Erosion protection in the year 2000 and changes thereof under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.



3.2.6.9 Regulating and maintenance - Flow regulation – mass flow regulation – regulation of pollen flow

For adequate crop pollination by wild pollinators, pollinators should be able to access croplands from their nesting habitat. As a generally accepted rule of thumb, habitat should be within 2km distance from croplands (Ricketts et al, 2008; Chavez et al 2013). Figure 3 - 32 shows the percentage in a 10km radius where this condition is fulfilled. Averaged for the EU27, this is the case in 12.5% of the cropland areas. In large-scale agricultural areas with little variation in land cover, such as the Po area, there might be a lack of pollination by wild bees as a result of an insufficient density of suitable nesting habitat to support a viable population.

In the BaU scenario, the pollination supply increases in scattered parts of the EU27. These are mostly areas with a varied land cover and a low pressure on the land from demand for built-up or arable land. As a result, expansion of pollinator habitat is expected, leading to smaller distances between croplands and pollinator habitat on average. Especially areas with cropland expansion do, however, show a decrease (Figure 3 - 32). Also, in most countries the amount of cropland that is very likely to receive enough pollination (ie indicator value over 90%) is expected to increase. Austria, the United Kingdom, Greece and Ireland face loss of >10% of croplands with a high pollination at country scale (Table 3 - 12).

In the policy scenarios, improvement of pollination relative to the BaU is seen in all countries except Cyprus and Denmark. In Denmark, however, increased pollination relative to the base year remains. In all policy scenarios, Denmark shows the same decrease in cropland area. Consequently, little change in spatial patterns of cropland (scenario A) or offsetting of land take by cropland (scenarios B through D) is expected and the scenarios result in very similar patterns. In Cyprus, due to the increased urbanization and cropland expansion the area percentage cropland with a high pollination level decreases. Due to the high pressure on land, insufficient offsetting can be allocated to compensate this.

The A scenario in general results in a lower removal of small patches of nature. This has some positive effects on pollination, eg in the Netherlands and Scotland. In other countries, spatial trade-offs emerge. Because the demand for cropland per countries does not change, a higher level of nature protection at specific locations causes cropland expansion elsewhere. This is illustrated in France, where the A scenario in some regions improves the pollination supply relative to the BaU, while in other regions decreases relative to the BaU are expected (Figure 3 - 32). At country level, the A scenario shows mixed effects (Table 3 - 12). The offsetting of land take through arable land in the scenarios C and D is effective. Especially in Germany, improvements of pollination relative to the BaU are seen (Figure 3 - 32). The expansion of croplands in Germany (**Figure 3 - 22**) is accompanied by expansion of (semi)natural vegetation, which is suitable pollinator habitat. In the D scenario, the average cropland area percentage with a high pollination supply is slightly higher than in the base year (Table 3 - 12), and decreases in scenario BaU through C are offset. In many countries, decreases however remain due to remaining pressures on land from urban expansion and ongoing cropland utilization.

Figure 3 - 32 Pollination in the year 2000 and changes thereof in the year 2020 under all scenarios

Legend classes distinguish areas with small (<5%) and larger increases and decreases.

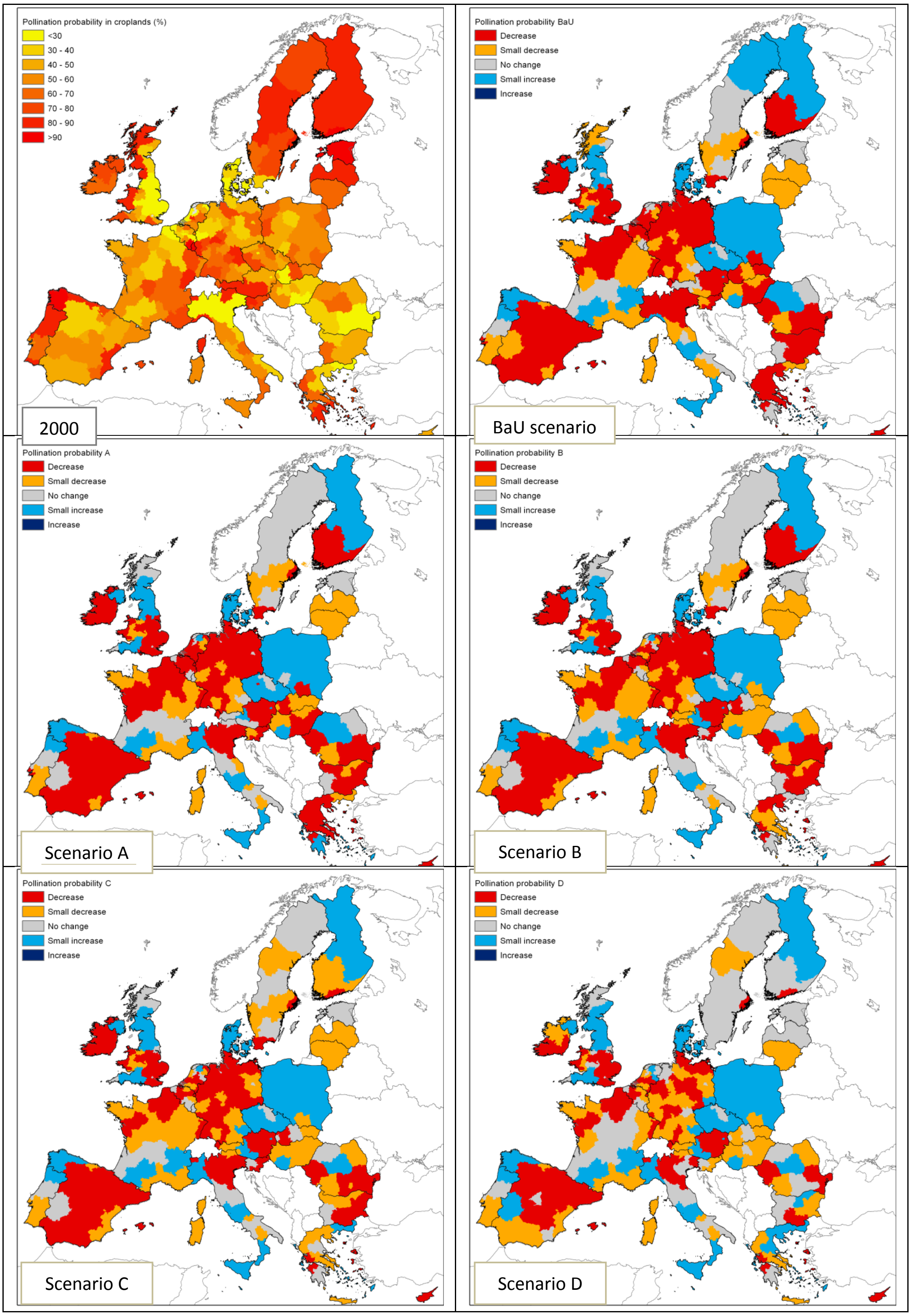


Figure 3 - 33 Distribution of pollination probability at NUTS2 resolution

The grey bar covers the interquartile range, with the mean indicated by the horizontal line. Error bars indicate the minimum and maximum values.

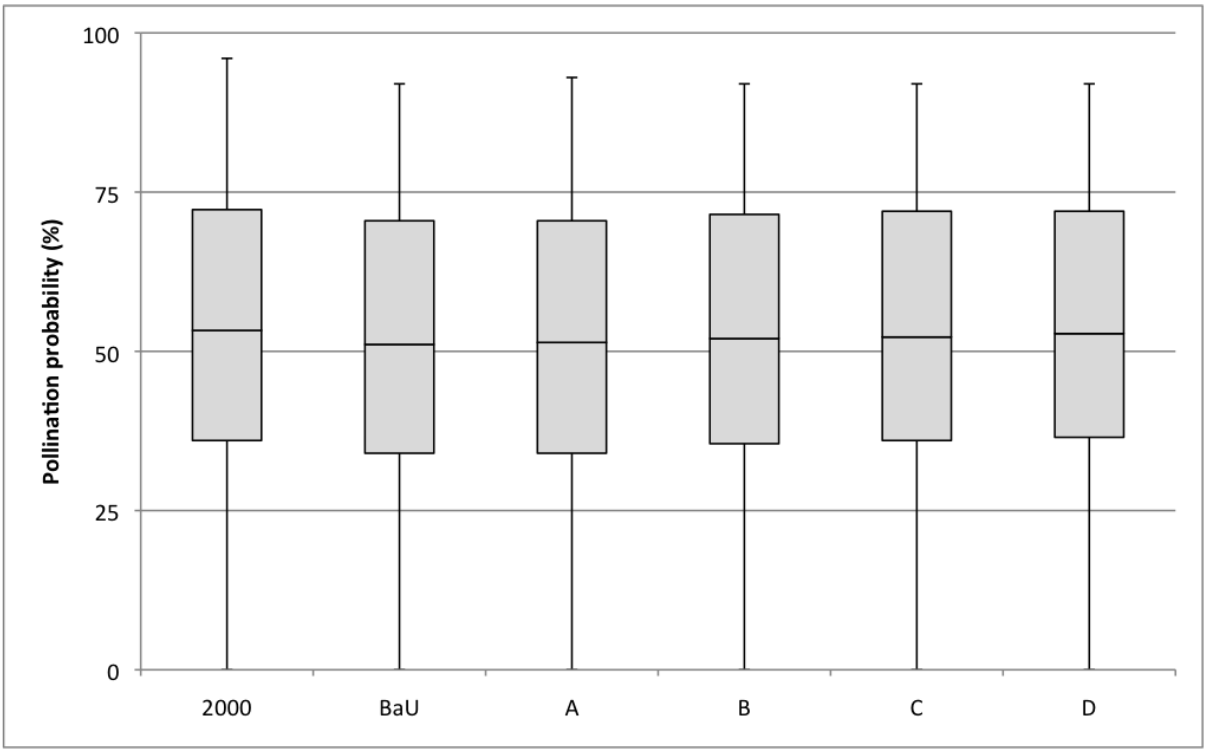


Table 3 - 12 Country level pollination supply in the year 2000 and changes thereof under the scenarios

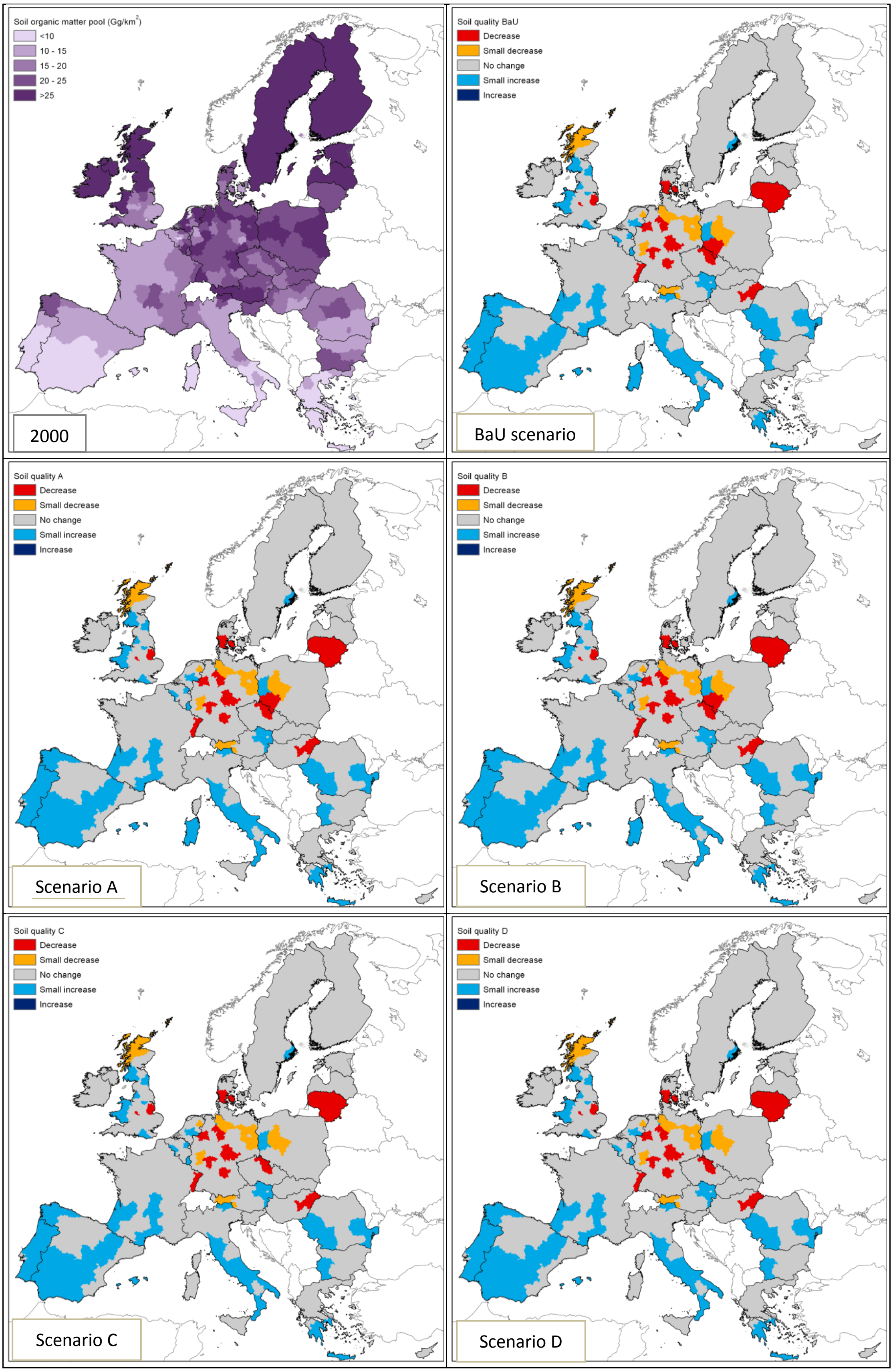
Country	% Cropland with high pollination supply	Trends relative to 2000 BaU	A	B	C	D
Belgium	41	-9%	-11%	-4%	-4%	-4%
Bulgaria	44	-8%	-6%	-6%	-5%	-3%
Czech Republic	59	6%	6%	6%	6%	6%
Denmark	29	20%	20%	16%	16%	16%
Germany	53	-9%	-10%	-9%	-7%	-4%
Estonia	91	0%	0%	0%	0%	0%
Ireland	68	-11%	-11%	-11%	-11%	-10%
Greece	51	-11%	-11%	-8%	-6%	-4%
Spain	49	-9%	-9%	-8%	-7%	-6%
France	49	-6%	-6%	-5%	-5%	-4%
Italy	39	-5%	-4%	-3%	-3%	-2%
Cyprus	49	-9%	-8%	-16%	-16%	-16%
Latvia	82	-1%	-2%	-1%	-1%	0%
Lithuania	65	-2%	-2%	-2%	-2%	-1%
Luxembourg	92	0%	0%	0%	0%	0%
Hungary	39	-3%	-3%	-2%	-2%	-1%
Malta	0	0%	0%	0%	0%	0%
Netherlands	37	-11%	-9%	-6%	-5%	-3%
Austria	52	-19%	-15%	-13%	-12%	-8%
Poland	54	6%	6%	6%	6%	7%
Portugal	72	-5%	-5%	-5%	-5%	-5%
Romania	34	-10%	-5%	-6%	-5%	-5%
Slovenia	77	-10%	-8%	-6%	-6%	-2%
Slovakia	45	-10%	-8%	-6%	-6%	-5%
Finland	87	-7%	-7%	-5%	-1%	-1%
Sweden	67	-3%	-3%	-2%	-2%	-1%
United Kingdom	27	-13%	-12%	-8%	-8%	-6%

3.2.6.10 Regulating and maintenance - Regulation of the physical environment – Soil quality regulation

The initial soil organic matter content map shows a gradient with lower values in the south of Europe and higher values in the north (**Figure 3 - 34**). This is a result of differences in climate, soil and land use. Generally, soil organic matter contents are higher in cold and wet areas, in soils with a high clay content and in forest or other natural land use.

Soil organic matter contents are relatively stable, as the annual changes are quite small relative to the soil organic matter stock. The average soil organic matter content for the EU as a whole in the base year is estimated at 22 Gg km^{-2} while annual changes generally do not exceed 0.08 Gg km^{-2}. In northern and eastern Europe there are areas where a slight decrease of soil organic matter contents is expected. These are mainly areas where continuous cropping or expansion of cropland takes place. The high level of soil disturbance in croplands (tillage) leads to mineralization of soil organic matter and therefore to losses. This applies for the BaU as well as for the policy scenarios. Very few changes are seen between the scenarios (**Figure 3 - 34**). This is because of the overall small changes of the indicator due to the short timeframe of the modelling, and because the scenarios have little effect on the areas that do result in significant changes. Significant changes are only seen in areas with continuous cropping and the location of these areas hardly differ among the scenarios, as the scenarios focus on changing the pattern of land use *change* rather than the patterns of stable land use.

Figure 3 - 34 Soil quality in the year 2000 and changes thereof in the year 2020 under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.



3.2.6.11 Cultural services

The capacity to support nature-based tourism is positively influenced by the presence of coasts, natural monuments, relief, nature areas and mosaic landscapes. Consequently, high capacities are found in Sweden, in mountainous regions and in several parts of southern Europe. Capacities are low in regions with large arable land areas, such as Hungary or parts of France (Figure 3 - 35).

In the BaU, overall, the capacity of the landscape to support nature-based tourism increases by 1.3% over 2000-2020. Increases are seen in countries with expansion of nature, such as Finland and Sweden (Figure 3 - 35). Countries with a high rate of urbanization such as the Netherlands or countries with expansion of arable land such as Denmark show a decrease of the capacity of the landscape to support nature-based tourism. Decreases of the capacity of the landscape to support nature-based tourism are scattered throughout central and western Europe (Figure 3 - 35) but large areas show little change.

In the A scenario, very similar patterns are seen as in the BaU (Figure 3 - 35). Both improvements (central Germany) and some deterioration (UK) relative to the BaU are seen. This is due to some changes in land allocation. The slightly more compact cities and higher protection of scattered nature leave slightly more mosaic landscapes intact, which is favourable for the capacity of the landscape to support nature-based tourism. This has a spatial trade-off resulting in changes of the locations of agricultural expansion. Agricultural expansion decreases the capacity to support nature tourism.

In the scenarios B through D, decreases of the capacity to support nature tourism become more widespread (Figure 3 - 35, Figure 3 - 36). The reason is the land use change in easily accessible areas. A mosaic landscape is favourable for the capacity of the landscape to provide recreation and accessible areas close to cities, which are main recreation areas. Due to the offsetting of land take, the variation of the land use decreases in many areas close to cities in the model, decreasing the ecosystem service. Probably these effects are overestimated here, because there will be variations in the newly established (semi)natural land use that are not captured in the model. Additionally, in most countries the decreases are marginal. Only in BE (-7%), CY (-6%), GR (-7%), IE (-6%) and LX (-15%) are substantial changes expected.

A limitation of this indicator for the capacity of the landscape to support nature-based tourism is that this capacity is difficult to quantify. The attractiveness of a landscape is highly subjective. Mostly, the quantification is based on inventories of preferences people have for specific landscapes. Translating such information into an indicator can be subjective and leads to a semi-quantitative indicator that should be interpreted with care. The indicator used in this analysis has, however, been compared with a map of the intensity of nature-based tourism based on empirical analysis of actual data on tourism activities. This comparison showed that the indicators used in the model do coincide with factors that have an empirical relation with tourism activity.

Figure 3 - 35 Nature tourism in the year 2000 and changes thereof in the year 2020 under all scenarios. Legend classes distinguish areas with small (<5%) and larger increases and decreases.

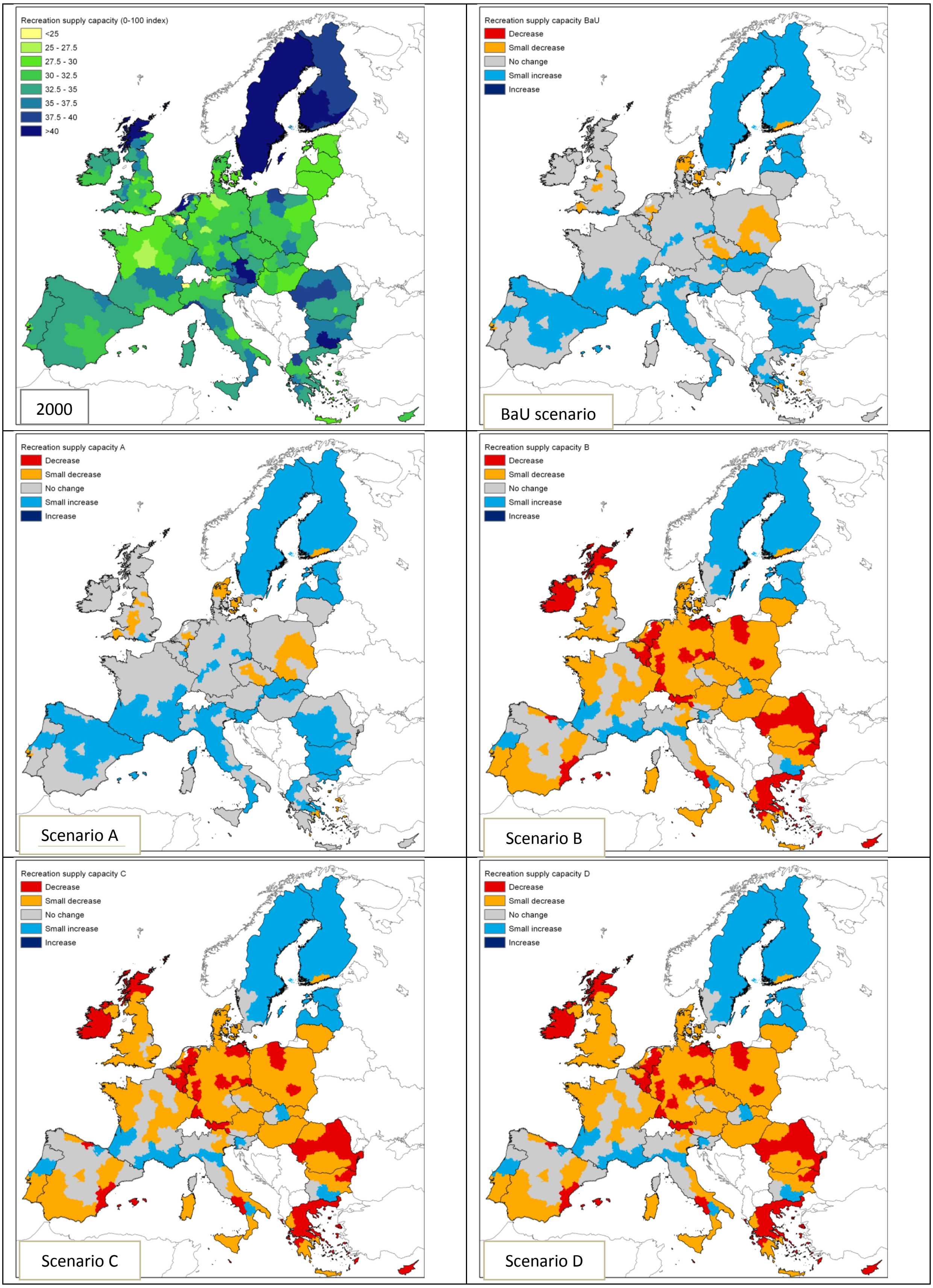
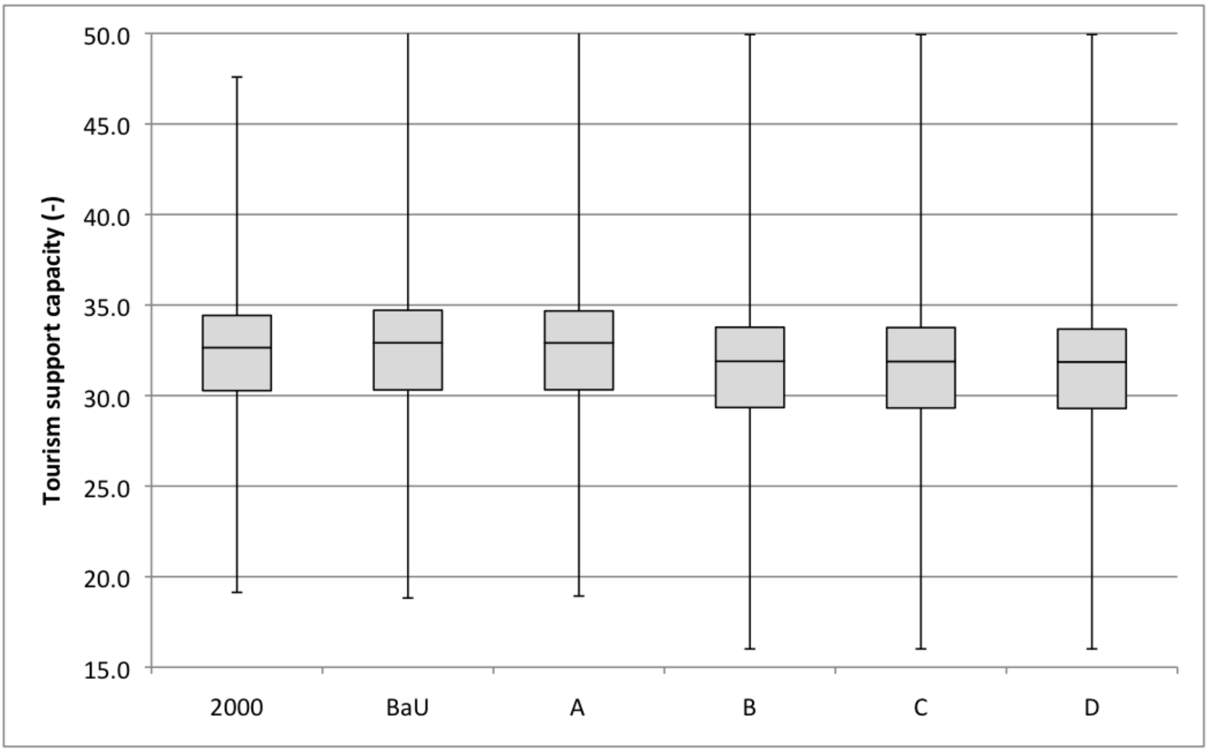


Figure 3 - 36 Distribution of capacity of the landscape to support nature tourism at NUTS2 resolution

The grey bar covers the interquartile range, with the mean indicated by the horizontal line. Error bars indicate the minimum and maximum values.



3.2.6.12 Overview of ecosystem services changes in BaU and policy scenarios

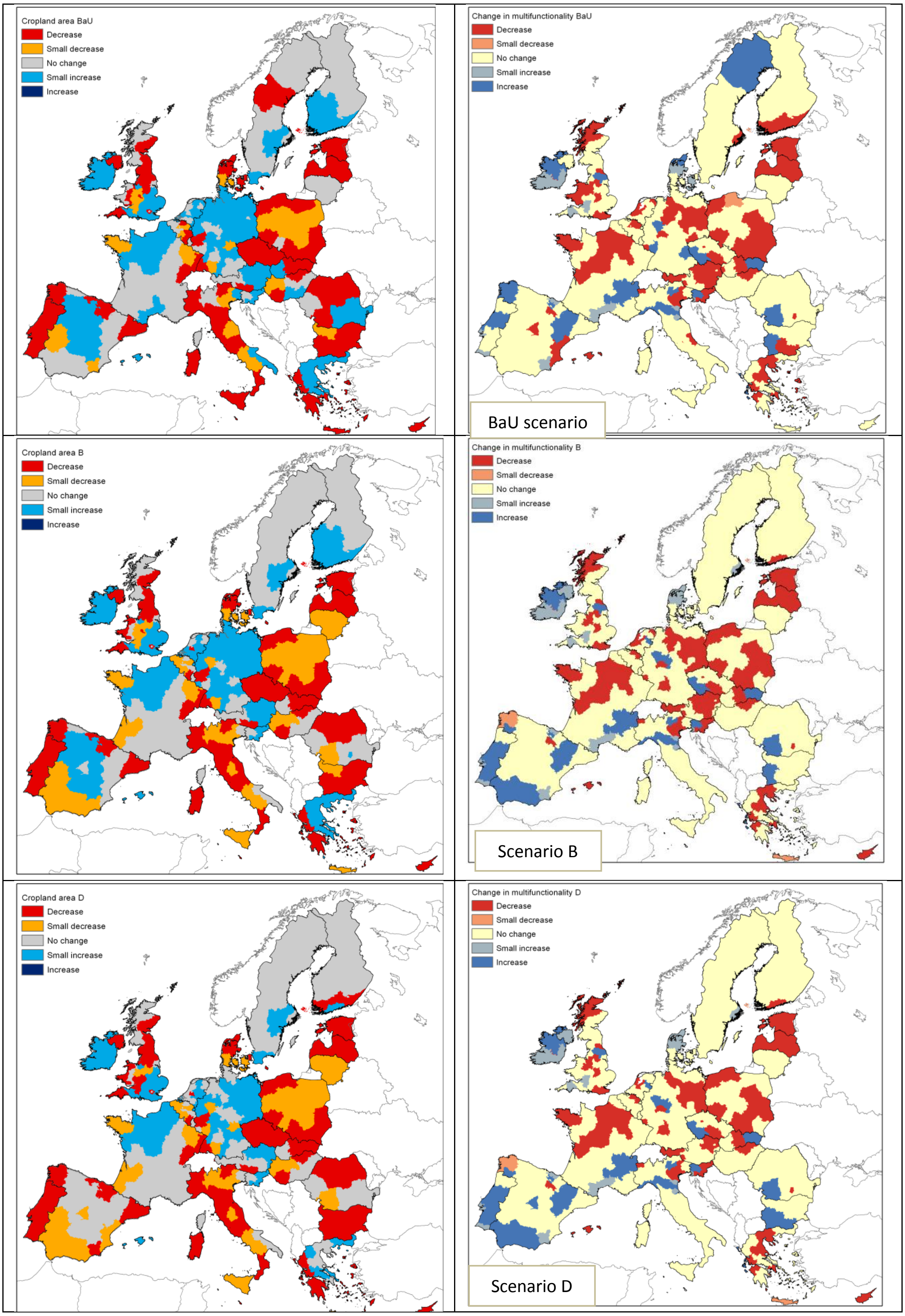
The provision of ecosystem services is strongly controlled by the land use. Each land use type supports a different set of ecosystem services at different levels. Generally, built-up areas have a low capacity to support the supply of ecosystem services, followed by arable land. For pasture and nature, the capacity to provide ecosystem services is highly variable. Furthermore, the supply of ecosystem services depends on relief, soil, climate, topography and land use patterns. These conditions interact with the impact of land use on the ecosystem service supply.

As a rule of thumb, conversions from nature to agriculture and built-up will decrease the overall ecosystem supply while conversion from agriculture to nature increase the ecosystem supply. This rule does not always apply and most land use changes will increase the supply of some ecosystem services and at the same time decrease the supply of other ecosystem services. Most importantly, there is a trade-off between crop production and the supply of regulating ecosystem services. This is illustrated in Figure 3 - 37 for the scenarios BaU, B and D. In many regions with increases in cropland area (left maps, blue regions), the supply of regulating ecosystem services generally decreases (right maps, red values), and vice versa. The correlation between the cropland percentage per NUTS region and the overall supply of regulating services is -0.62 in all scenarios.

Areas with both a decrease of cropland area and a decrease of supply of regulating services, are expected to face expansion of built-up area (eg southern Poland) or farmland abandonment that is insufficient to result in an increase of supply of regulating services. Areas with both an increase of cropland area and an increase of supply of regulating services are expected to face a cropland expansion that is accompanied by sufficient offsetting of land take to ensure a sustainable supply of regulating services. These areas are very scarce. Only in scenario D, this is observed in a few regions (Ireland, eastern Netherlands, central Germany).

Figure 3 - 37 Trade-offs between cropland fraction and supply of regulating services

Left: Cropland fraction change at NUTS2 level. Right: Change in number of regulating ecosystem services with a high supply. For the scenarios BaU (top), B (centre) and D (bottom).



Overall, the scenarios A through D result in less urban sprawl, less cropland expansion, fewer gross land use changes and more space for nature. At country level, these changes in ecosystem coverage and pattern result mostly in improvements of the supply of regulating services, decreases of crop production and decreases of the capacity to support nature tourism (

Table 3 - 13).

Figure 3 - 38 shows 1km changes in the overall provision of regulating services. The chart indicates the area over which *n* regulating services have a provisioning hotspot in each scenario. A hotspot is defined as a place where ecosystem service map values are in the upper tail of the distribution of the map values. The upper quartile was used as the threshold. Hotspot maps were made for each of the regulating services and an overlay was made, indicating how many regulating services have a hotspot value at each location.

In the BaU scenario, the area where no regulating service has a supply hotspot expands by 7% relative to the base year, whilst the area where one or more regulating services have a supply hotspot decreases. In the policy scenarios, these overall changes are offset to some extent. In the D scenario, the area where no regulating service has a supply hotspot still increases, but by a smaller amount (3%). The area with hotspots of multiple regulating services increases relative to the base year. These improvements are seen in all EU countries. Thus, in the start year, considerable areas supply a broad range of ecosystem services. This multifunctionality decreases in the BaU: the area with a low supply of multiple ecosystem services expands. In the policy scenarios, this expansion is partly being offset.

Figure 3 - 38 Overall supply of regulating services

The chart indicates the area over which N regulating services have a provisioning hotspot (i.e., a value in the upper quartile) in each scenario.

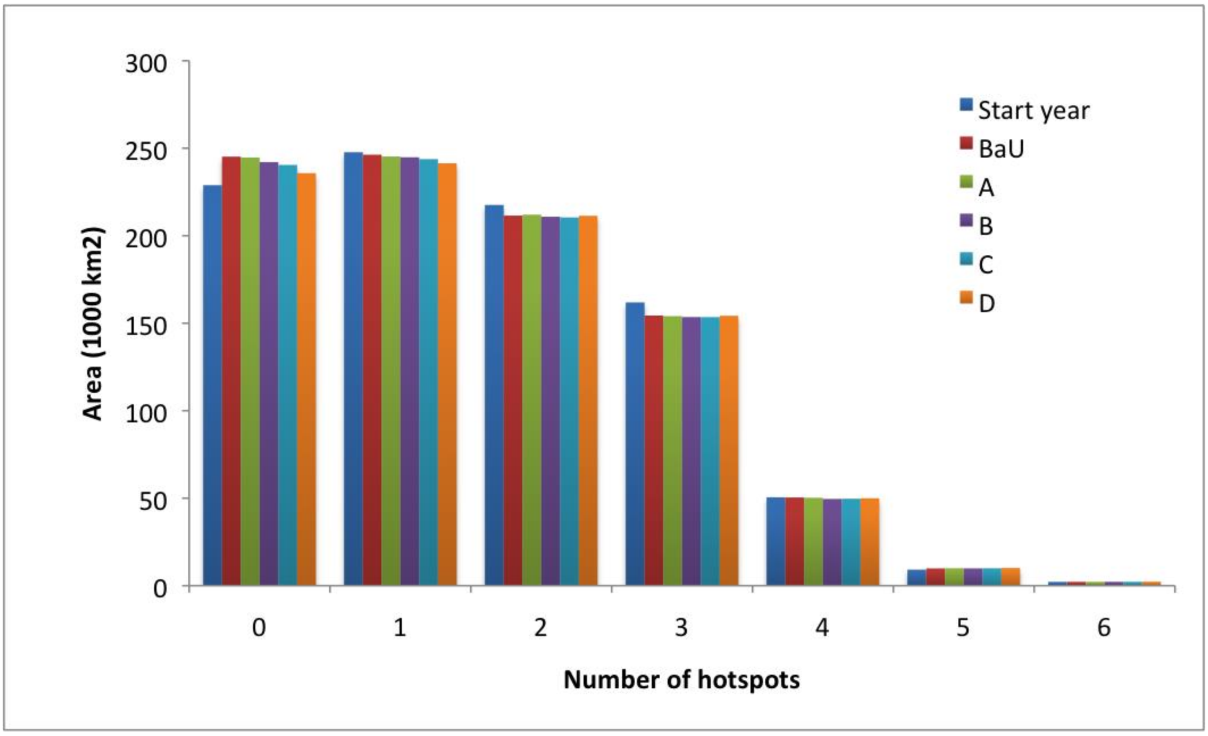


Table 3 - 13 Trends of ecosystem service change per country relative to 2000. Area (1000 km[2]) per trend per ecosystem service. Cell shading indicates the trend in the scenarios. Areas were calculated on a NUTS2 basis to ensure comparability among the services. Not all areas per service-scenario combination add up to the same area because not all ecosystem services are relevant throughout the EU, and due to data gaps. **Key** No Net Loss; Improvement relative to BaU; No effects relative to BaU; Deterioration relative to BaU

Category, Service	Trend 2000-2020	Scenario A	Scenario B	Scenario C	Scenario D
Provisioning services					
	Increase	1037	1022	925	636
	Neutral	1211	1165	1219	1487
	Decrease	1816	1877	1920	1942
Crop production	% change in scenario relative to BaU	0.0%	-0.1%	-0.3%	-0.7%
	Increase	3948	3980	3980	3971
	Neutral	73	63	63	73
	Decrease	220	197	197	197
Forest biomass	% change in scenario relative to BaU	0.4%	0.7%	0.7%	0.7%
	Increase	948	1010	1010	1018
	Neutral	1818	1892	2113	2192
	Decrease	1476	1340	1118	1031
Water provision	% change in scenario relative to BaU	-0.1%	0.6%	1.3%	1.4%
Regulating services					
	Increase	1934	1953	1953	1933
	Neutral	679	933	933	953
	Decrease	1628	1355	1355	1355
Air quality regulation	% change in scenario relative to BaU	0.3%	0.7%	0.7%	0.7%
	Increase	1371	1404	1404	1408
	Neutral	196	312	292	317
	Decrease	2681	2532	2551	2523
Carbon sequestration	% change in scenario relative to BaU	0.7%	3.4%	3.4%	3.6%
	Increase	2588	2550	2667	2727
	Neutral	695	671	733	799
	Decrease	968	1030	850	725
Erosion prevention	% change in scenario relative to BaU	0.1%	0.1%	0.3%	0.7%
	Increase	2138	2222	2222	2222
	Neutral	1122	1040	1063	1078
	Decrease	982	979	956	941
Flood regulation	% change in scenario relative to BaU	0.0%	0.1%	0.2%	0.2%
	Increase	12	12	12	48
	Neutral	643	646	654	615
	Decrease	45	42	34	37
Storm protection	% change in scenario relative to BaU	-2.8%	-1.0%	-1.0%	-1.0%
	Increase	974	988	1030	1157
	Neutral	809	812	618	1051
	Decrease	2452	2435	2587	2027
Pollination	% change in scenario relative to BaU	0.5%	1.3%	1.7%	3.0%
	Increase	899	899	875	875
	Neutral	3055	3055	3088	3088
	Decrease	282	282	272	272
Soil quality regulation	% change in scenario relative to BaU	0.0%	0.0%	0.0%	0.0%
Cultural services					
	Increase	1986	1054	1054	1054
	Neutral	2126	836	834	789
	Decrease	129	2351	2353	2397
Recreation	% change in scenario relative to BaU	0.0%	-2.4%	-2.4%	-2.5%

3.3 References

Lotze-Campen, H, A Popp, P Verburg, M Lindner, H Verkerk, E Schrammeijer, N Schulp, E van der Zanden, H van Meijl, A Tabeau, T Kuemmerle, C Lavalle and D Eitelberg (2013) VOLANTE Deliverable No: 7.3. Description of the translation of sector specific land cover and land management information. EC Contract Ref: FP7-ENV-2010-265104. Available on http://www.volante-project.eu/

4 ANNEX 4: SUMMARY OF EXISTING KEY MEASURES THAT MAY CONTRIBUTE TO NNL AND KEY GAPS IN MEASURES

NB. Fishing impacts and measures are not covered as these are under reform and outside the scope of this contract. Climate change measures are also outside the scope of this contract.

Impact source	Existing key measures	Weaknesses and major gaps
Housing and non/light-industrial commerce: Buildings and associated lighting[*1]	Habitats Directive - only for the Natura 2000 network	HD does not provide any practical definition or information related to the 'compensatory measures', although guidance is available defining terms. However, no guidance has been produced on how losses/ gains should be measures or accounted for. Overall, lack of clarity as to the nature of compensation to be required for N2K impacts
	EIA of projects (see Box xx) and SEA of plans/programmes (see Box xx), which are applicable to all types of land (ie not just that which is protected)	**EIA**: Biodiversity loss unlikely to be sufficiently covered by EIA requirements outside Natura 2000 sites; low requirements for compensation from development or other activities in unprotected areas, and in particular outside Natura 2000 areas, although requirements apply for strictly protected species Lack of effective compensation for or mitigation against impacts that are small but cumulatively result in significant biodiversity losses. **EIA** only required if project means criteria under Annex 1 and 2. **SEA** only required if criteria under Annex 2 are met. Only some developments therefore covered. In the case of infrastructure projects and EIA, this falls under the discretion of Member States (Annex 2). In the case of terrestrial and air transport only some types covered (eg motorways, express roads, and lines for long-distance railway traffic, airports with runway lengths >2,100m), otherwise falls under the discretion of the Member State. Only for "significant" impacts - 'Significant' is not defined in either the EIA or the SEA Directives, however, cumulative effects are mentioned as a criterion to decide whether impacts are significant Only require action 'if possible', which opens a significant loophole in achieving 'NNL'. Largely procedural rather than substantive – no requirement to either implement or monitor the measures taken to address biodiversity loss, only to identify and describe the effects (however, proposed amendments to EIA suggest that monitoring of adverse environmental effects will have to be monitored in the future, as is currently the case under SEA). Previously, no mention of biodiversity in EIA, only environment, flora and fauna. Impacts on fauna and flora are mostly interpreted as relating to whether or not developments affect Natura 2000 areas, and are not taken in a broad sense - in particular, species protection provisions tend to be neglected. But this is now addressed in the EIA reform proposals In theory SEA/EIA could trigger measures to ensure NNL, but no formal requirement to do so. Extent to which compensation is required depends both on the project itself and the permitting authorities. Evaluation demonstrates that mitigation and compensation requirements are not stringently applied. Also no established means of assessing gains and losses.
	National planning regulations	**National planning permits** can include requirements for compensation as a condition of the permit, which are then legally binding. These can be quite weak, however, where they relate to compensation outside Natura 2000 sites, and are not always fully enforced. There are some cases where separate legally binding agreements can also be made which can provide

Impact source	Existing key measures	Weaknesses and major gaps
		greater scope for involving different stakeholders and have the potential to include a wider variety of terms and conditions (eg Section 106 agreements in the UK), although these agreements can take much longer to negotiate
	Thematic Strategy on Air Pollution	**Thematic Strategy on Air Pollution** aims to significantly reduce emissions of harmful sources of air pollution (SO2, NOx, PM) with impacts on human health and the environment (eg acidification / eutrophication and associated biodiversity losses). However, the Strategy has been criticised for its low level of ambition in terms of emissions reductions, such that even with perfect implementation ecosystems would still be at risk from eutrophication and exposure to ozone in excess of critical levels.
Recreation, sports and leisure: buildings, playing fields , stadia, tracks, marinas etc	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) National planning regulations	**See above**
Terrestrial transport and infrastructure: roads & vehicles, railways	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) National planning regulations Thematic Strategy on Air Pollution	**See above**
	Biodiversity Proofing. Some projects, such as those relating to transport, energy, water supply and treatment etc are partly funding through EU instruments. These funds should now be subject to Biodiversity Proofing, which is a structured process of ensuring the effective application of tools to avoid or at least minimize harmful impacts of EU spending and to maximise the biodiversity benefits. This should apply to all spending streams under the EU budget, across the whole budgetary cycle and at all levels of governance, and should contribute to a significant improvement in the state of biodiversity according to the 2010 baseline and agreed biodiversity targets.	High level objectives for EU funding instruments do not always include biodiversity objectives, which restricts their use for projects that may provide biodiversity and ecosystem benefits and limits the consideration of potential detriment al biodiversity impacts. Furthermore, although there are many tools and opportunities or biodiversity proofing of EU funds, these tend to be inconsistently and often weakly applied
Air transport: aircraft and airports	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) National planning regulations Thematic Strategy on Air Pollution Proofing of EU funding instruments	**See above**
Marine transport: shipping and ports	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Thematic Strategy on Air Pollution Proofing of EU funding instruments	See above, also: HD: Proposals for marine N2K sites are inadequate and therefore many important areas are currently unprotected under the Directive EIA: only some developments must be covered (eg for ports / waterways which permit the passage of vessels of over 1,350 tonnes), otherwise falls under the discretion of the Member State.
	Regulation (EC) No 782/2003 prohibiting the use of paint with organotin or TBT components which are environmentally harmful	
	Directive 95/21/EC on Port State Control to ensure all ships meet international safety standards, incl on vessel-source pollution; Directive 2006/16	
	Regulation 417/2002 ban on single hull tankers	
	ELD (only for protected habitats, spp, water under the WFD and some damage to land; not limited to N2K areas; only ex-post).	Damages only covered which relate to species and habitats of Community interest (eg under Habitats Directive), water (under WFD) and land; only applicable therefore to areas of protection in relation to which the EU has made specific rules (eg water status and protected species and habitats). In the case of damage to land, the ELD refers to

Impact source	Existing key measures	Weaknesses and major gaps
		contamination/pollution that creates (directly or indirectly) a significant risk of human health being adversely affected; many impacts that do not affect human health may still negatively impact biodiversity. Overall, some damages are not covered for certain types of activities. Only two forms of liability are defined (strict and fault-based), where damages are not covered under these, net loss may occur. Strict liability only in relation to activities listed in Annex III. For others, basically other commercial / business activities, liability is fault-based. No liability in relation to water/soil damage. Water damage is not included in fault-based liability, limiting the requirements to those activities that are listed. Remediation measures only required if certain threshold criteria are met. The damage thresholds that trigger liability under the ELD are set at a very high level which is very hard to establish, meaning it has rarely been used in practice. Only covers damage ex-post.
	Water Framework Directive (WFD)	**WFD** seeks to protect aquatic ecologic, unique/valuable habitats, drinking water and bathing water. The WFD regards species as status indicators, rather than focusing on their protection. Also does not require compensation explicitly, and would probably not impede a development from going ahead unless biodiversity losses have been addressed. Where River Basin Management Plans (RBMPs) include restoration objectives, these have been criticised for lack of ambition and lengthy timescales. Applications for exemptions used extensively. Major deficiencies identified in transposition of national laws, set up of admin. Structures and economic analyses. WFD overall been criticised in general for being ineffective, “not meeting basic expectations for legal correctness, let alone expectations for environmental ambitions and systemic reforms as required to set the path towards sustainable water management”.
	Marine Strategy Framework Directive (MFSD) Directives / Regulations (~20) dealing with maritime safety which aim at protecting the environment. Eg Proposal for the Regulation on Ship Recycling (COM/2012/0118 final), Directive 2005/35 on ship-source pollution and on the introduction of penalties for infringements (amended by Directive 2009/123), Regulation (EC) No 782/2003 , Directive 2002/59) on vessel traffic monitoring and information system to prevent accidents and pollution at sea and to minimise their impact on the marine and coastal environment, also Directive 2008/99/EC on the protection of environment through criminal law; Reg. (EC) 1013/2006 on shipments of waste; Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (repealed by WFD at end of 2013) NB. IED a recast 7 existing pieces of legislation, and will only be transposed into legislation in 2013. It is unclear therefore at this stage what gaps there might be in its transposition / implementation at the MS level.	**The MSFD’s** scope is broader than the WFD’s. Good Environmental Status (MSFD) covers a greater range of biodiversity components / pressures for coastal water bodies than the WFD’s good ecological/chemical status. This includes, for instance, noise, litter, and some other aspects of biodiversity (eg marine mammals). Where WFD and MSFD overlap, ie in coastal waters, MSFD makes it clear that MSFD only applies to aspects of GES not already covered by WFD. The MSFD also includes (Recital 43 and Article 2(a)) mention of the restoration, where practical, of environmental areas that have been adversely affected. Although providing a comprehensive framework, the MSFD is based on general normative standards of environmental protection (GES lacks legal clarity) – unclear whether this provides a legal solution to some of the pressures. Although ambitious in scope and intent, too early to determine whether and what specific gaps there might be with MSFD’s implementation. However, number of inherent weaknesses identified: MS only have to give ‘due consideration’ to sustainable development; measures do not have to be taken where costs ‘would be disproportionate’ taking into account the risks to the marine environment provided there is no further deterioration and that GES is not ‘permanently compromised’; MSs can be excused from achieving GES where there are reasons of ‘overriding public interest’; MSFD doesn’t mention any penalties or sanctions where the provisions are breached (considerable discretion by MS). Burden for implementation rests

Impact source	Existing key measures	Weaknesses and major gaps
		with MS, thus dependent on their capacity. **Ship source pollution** Directive allows for penalties, both criminal and administrative, and sanctions (including fines) where water quality deteriorates due to pollution offenses (ie if committed with intent or by serious negligence). Member States are able to determine the nature and level of penalties (according to 2009/123 amendments). The Directive does not state what should be done with any fines that are collected (eg whether they are used to improve the water quality) and does not mention any kind of restoration, rehabilitation or compensation measures. Although the Directive should therefore seek to discourage environmental damage, there seems to be no requirements to compensate for any damage where it does occur. **Directive 2008/99/EC** also obliges MS to provide for criminal penalties for serious infringements of EU law on the protection of environment. This includes unlawful discharge of materials into water, and the unlawful transport or disposal of waste (including unlawful shipment) which causes substantial damage to the quality of water, animals or plants. Extent of penalties left to MS discretion. Similarly to Directive 2005/35, no mention of rehabilitation, restoration or compensation if environmental damage occurs.
Industrial / energy built developments: chemical plants, incinerators and power stations etc	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) ELD (Env. Liabilities Directive) Thematic Strategy on Air Pollution Proofing of EU funding instruments	**See above, also:** **EIA** only some developments must be covered (eg installations with a heat output of 300 megawatts or more, integrated chemical installations, waste disposal incinerators), otherwise falls under the discretion of the Member State.
	Industrial Emissions Directive (IED) – covering energy, mineral, chemical, waste industry and production / processing of metals (replacing IPPC)	**The IED** is designed to protect air, water and soil from industrial installations and to improve energy and resource efficiency, seeking to address major shortcomings in the IPPC Directive. However, has been criticised due to some provisions, eg MS retained flexibility to evade BAT based performance by providing specific derogations under certain conditions. Current minimum binding requirements (European Safety Net) arguably doesn't currently cover sufficient number of sectors / pollutants. Also, gaps regarding large combustion plants, where operators allowed to evade pollution abatement techniques – derogations optional for MS.
	Seveso II / III Directive on the control of major-accident hazards involving dangerous substances – covers an accident leading to serious danger to human health or the environment.	**The Seveso II Directive** only covers establishments where quantities of 'dangerous substances', at, or in excess of, specified thresholds, are used or stored. Therefore only covers accidents involving dangerous substances, so does not cover all pollution or accidents that may damage the environment (eg cumulatively). It does cover immediate or delayed dangers, both inside and outside the accident area. Danger to the environment constitutes severe, widespread, long-term or permanent damage to ecosystems. However, there is some flexibility for Competent Authorities of MS to determine whether an event constitutes a "major accident". However, amendments to Seveso II through **Seveso III** should deliver some improvements, given a focus on environmental protection and that the scope is broadened. For instance, substances now considered dangerous to the environment (eg aquatoxins) are included. However, the carriage of dangerous substances by road, rail, air and inland waterways are still not included (only establishments).
	Environmental Quality Standards Directive (EQSD)	**EQSD** sets standards to limit the concentration of certain chemical substances. However, only relates to chemical substances that pose a significant risk to

Impact source	Existing key measures	Weaknesses and major gaps
		water quality
	Groundwater Protection Directive (GPD)	**GPD** aims to protect groundwater from pollution by controlling discharges and disposals of certain dangerous substances. However, as only certain dangerous substance are covered, not all potential impacts will be mitigated.
	REACH chemicals regulation	**REACH** aims to improve the protection of human health and the environment from the risks that can be posed by chemicals. However, does not include direct risk assessments for biodiversity, so can only be expected to indirectly reduce the negative effects of chemicals on biodiversity.
Terrestrial extraction sites: mines open cast / underground, aggregate extraction & spoil heaps etc	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) ELD (Env. Liabilities Directive) Seveso II Directive on the control of major-accident hazards involving dangerous substances, modified by Seveso III Directive (2012/18/EU) (to be transposed 2015).	See above, also: EIA only some developments covered. In the case of extraction sites, this falls under the discretion of Member States (Annex 2).
	Mining Waste Directive (2006/21/EC) NB. Mining Waste Directive also contains provisions for major accident planning	**Mining Waste Directive**: applies to risks to the 'environment' in general. It provides for measures to prevent or reduce, as far as possible, adverse effects on the environment, particularly water, air, soil, fauna and flora, and landscape. No explicit mention is made of biodiversity. Covers waste from prospecting, extracting and processing mineral resources. However, the Directive excludes from its scope extractive waste resulting from:[2] - Offshore activities; - The injection of water or re-injection of pumped groundwater - Extraction, treatment and storage of peat (unless deposited in a Category A waste facility).
Marine extraction sites: marine oil & gas exploration and production, marine aggregate & mineral extraction; dredging		
Flood control and coastal protection: flood embankments, washlands, land reclamation	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments WFD MSFD National planning regulations	See above, also: In the case of infrastructure projects and EIA, this falls under the discretion of Member States (Annex 2).
	Floods Directive	**Floods Directive** has encouraged a move away from constructing technical works for flood protection which are often expensive, environmentally damaging and inefficient to an approach of managing the risks by placing a greater emphasis on non-structural measures (eg natural floodplains). However, some technical difficulties in its implementation have been identified (eg the current knowledge basis, available data, method and tools for flood risk estimation and management) which casts some doubt on how effective it will be. Much of the implementation is left to the discretion of MSs making its effectiveness dependent on their commitment and use of exemptions (eg to the WFD).
Water supply, treatment and disposal	Habitats Directive - only for the Natura 2000 network	See above

[2] http://ec.europa.eu/environment/enlarg/handbook/waste.pdf

Impact source	Existing key measures	Weaknesses and major gaps
infrastructure: plants, drains & outfalls	EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments WFD	
Water supply - impounded reservoirs: for hydro-power or water storage	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments WFD	See above
Waste disposal: land fill sites and at sea dumping	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments ELD	See above
Communications: telephone lines, aerials and masts	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes)	See above
Terrestrial energy production structures: wind turbines, hydro-power pipelines, solar farms	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments	
Marine energy production structures: wind turbines, wave power, tidal flow turbines, tidal impoundments	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments MFSD	See above
Energy supply: Overhead electricity transmission lines	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments	See above
Energy supply: Underground electricity transmission lines, gas and oil pipelines and storage	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Proofing of EU funding instruments	See above
Energy supply: Dedicated bioenergy crops	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes) Renewable Energy Directive (RED) Sustainability Criteria	See above, also: [RED]
Agriculture: food, biofuels etc	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes)	See above, also: EIA: frameworks and criteria that have been introduced by Member States for screening whether or not a full environmental assessment of projects for restructuring or intensifying agricultural land is needed are generally weak, and therefore most are exempts for impact assessment – see text for details
	CAP Payments (greening payments under Pillar 1 and EAFRD measures) and Cross Compliance requirements	Issues include: Cross compliance: Fewer GAEC standards exist for 2014-2020 than previously, leaving a gap that will need to be picked up by other CAP measures (greening, rural development measures). In the past, the design of GAEC standards has been very variable as has control and enforcement. Greening measures: the exemptions to the arable measures (crop diversification and EFA) mean that large areas of land in many countries will not be subject to the greening requirements. The setting of the baseline year for the protection of permanent grassland to 2015 means that the cap on decreases in permanent grassland starts afresh, ingoring any losses prior to that date. Rural development: Funding under Pillar 2 is insufficient to address all the environmental challenges in relation to forestry and agricultural land and the majority of Member States are not taking advantage of the possibility to transfer funds from

Impact source	Existing key measures	Weaknesses and major gaps
		Pillar 1 to Pillar 2. Pillar 2 measures are voluntary and farmers cannot be required to enter into schemes to enhance the environment Improved design and targeting of measures is needed to address the environmental needs identified in the region concerned and to target resources in the most effective and efficient means possible.
Forestry	Habitats Directive - only for the Natura 2000 network EIA (projects), SEA (plans/programmes)	See above, also application of the EIA Directive to forestry is variable, eg concerning assessments of impacts of the establishment of new plantations and clear felling. Forestry intensification and replanting with non-native species is not addressed [check]

5 ANNEX 5: NO NET LOSS POLICIES AND OFFSETTING IN FRANCE

Compiled by Laurence Mathieu (eftec) and Fabien Quétier (Biotope)

5.1 Consultees and sources of information used

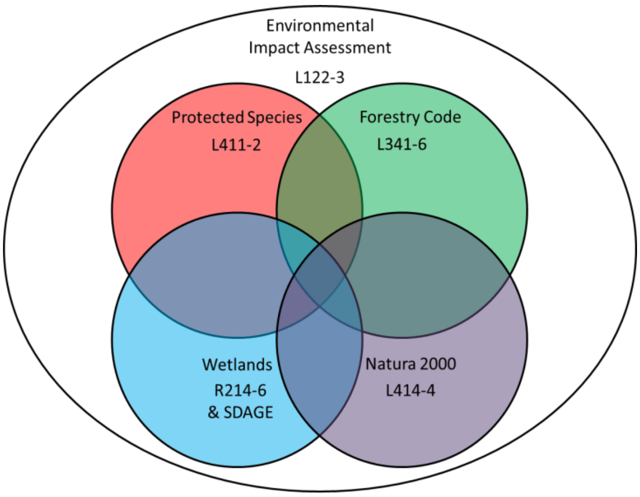
The content of this document is based on a review of the literature, personal communications with Coralie Calvet (INRA), Frédéric Dalvai (Conseil général de l'Isère), Marc Maury (FCEN) and Camille Pousse (CISALB), and Fabien Quétier's expertise.

5.2 Overview of offsetting and other key NNL policies

In France, the obligation to assess the impacts of development projects on biodiversity and to apply the mitigation hierarchy goes back to the law on nature protection dated 10th July 1976[3]. This law established the notion of impact assessment and also stated that the assessment of the impact should describe the measures planned to avoid, reduce and if possible offset any predicted negative impacts on the environment.

Offsets remained, for the most part, ignored or ill-applied until EU Nature Directives were progressively transposed into French legislation from 2007 onwards (see Figure 1). This has drawn the attention of both developers and public authorities to previously neglected "ecological offset" requirements (Regnery et al. 2013a).

Figure 1. EU directives in French legislation



Source: Figure adapted from Quétier et al. (submitted).

In France, there are several permitting procedures that refer to the mitigation hierarchy. Environmental impact Assessment (EIA) applies across the board, and provides a context in which more specific issues are dealt with: protected species, forest clearing, wetlands, and Natura 2000 sites. Coding refers to articles in the Environment Code (for EIA, wetlands, Natura 2000 and protected species) and Forestry Code (for forests). SDAGE refers to river

[3] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=LEGITEXT000006068553&dateTexte=20101109

basin management plans. All these procedures are covered in the 2012 guidance which sets no net loss as the expected outcome of the application of the mitigation hierarchy.

Article 16 of the Habitats Directive (92/43/EEC) was only transposed through article 86 of Law 2006-11 dated 5th January 2006 and until 2007, no procedure existed for allowing impacts on species of 'community interest', and their habitats (except for scientific purposes). The subsequent decree, dated 19th February 2007[4], defines the conditions for requesting exemptions for impacting on protected species. These conditions include an official consultative comment by the National Council for Nature Protection (*Conseil National de la Protection de la Nature* - CNPN) which has acted as a third party verifier that favourable conservation status will not be affected by the derogation. The CNPN initiated offset requirements on the basis of the 2007 decree which led to offsets being "rediscovered" (Regnery et al., 2013a).

As a consequence, the issue of biodiversity offsetting has mainly focused on protected species. This doesn't automatically translate into offset requirements whenever a species is impacted. A study conducted by Regnery et al. (2013b) assessing the type of offsets proposed in 85 applications made in 2009 and 2010 requesting exemptions for impacting on protected species, showed that the main characteristic associated to the species for which offset was sought was their conservation status: the proportion of compensated species varied from 26 per cent for threatened species to 82 per cent for endangered species. In practice, this focus on protected species also means that, although offsetting remains supported by the Habitats Directive and the Birds Directive (2009/147/EC), they mainly apply to projects with residual impacts outside the Natura 2000 network.

It should be noted that in France, the term "compensation" is used to qualify the measures that are applied on residual impacts on the environment in general, once the "avoidance" and "reduction" measures have been considered. However, since no official methods exist to assess loss and gain, compensation can involve measures that fall short of achieving no net loss.

5.3 NNL and offsetting policy framework and development

5.3.1 The key policies that contribute to NNL

For impacts in or on the Natura 2000 network itself, the Habitats Directive requires a two-step process described in its articles 6(3) and 6(4). On June 2nd 2008, the European Commission took France to court for not complying with these requirements (case C-241/08). In response, France reformed its legislation through law 2008-757 dated 1st August 2008.

Offset requirements have also been built into River Basin Management Plans (*Schémas Directeur d'Aménagement et de Gestion des Eaux or* SDAGE[5]*)* established under the Water Framework Directive when they were reviewed and updated in 2009 (Nion, 2009). Several

[4] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=LEGITEXT000006055961

[5] Established through the Law on Water and Aquatic Environments (LEMA) dated 30th December 2006: http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000649171; http://www.eaufrance.fr/agir-et-participer/planifier-et-programmer/schemas-directeurs-d-amenagement

of these SDAGE now require offsetting for residual impacts on wetlands. For example, the SDAGE of the Loire river basin requires the re-creation or restoration, in the same catchment area, of a wetland with equivalent function and biodiversity to the wetlands destroyed.

The offset requirements mentioned above generally apply to plans as well as projects. For example, the modifications of Local Urban Development Plans (PLU[6]) or Territorial Coherence Scheme (SCOT[7]), which delineate the areas to be urbanised, agricultural areas or natural areas, must describe measures to avoid, reduce and offset their impacts. From September 2013 (in the context of the Grenelle 1 law[8] dated 3rd August 2009), offset measures will also apply to residual impacts on the green and blue veins network, under the EIA process. The "green and blue veins" network (*trames vertes et bleues*[9]) are a new form of regional level planning document (*Schéma Régional de Cohérence Ecologique*). The planning process is described in the section entitled "Strategic planning of offsetting".

Concerning accidental impacts, the Environmental Liability Directive (2004/35/EC) and its offset requirements were transposed through the Law on Environmental Responsibility of 1st August 2008[10]. Interestingly, this law introduced the term "ecological services" into French legislation. It must be highlighted, however, that since 2008, this law has never been applied. There appears to be limited political will to use its provisions even in obvious cases of accidental damage to biodiversity listed under the Habitat Directive (as per the Environmental Liability Directive). In 2013, the French government proposed a legal framework for civil cases against damages to biodiversity but, at this stage, it is too early to draw conclusions on the possible outcomes.

5.3.2 Developments in offsetting policies and legislation

Despite the attempts to address the issue of biodiversity decline, the quality of offsetting measures, their implementation and efficiency are still incomplete due to the multiplicity of instruction processes (Figure 1), the absence of a methodological framework and a lack of monitoring of measures undertaken. In order to contribute to halting the decline in biodiversity by 2020, a new dynamic has been launched together with improved regulatory enforcement and the establishment of a methodological framework (Commissariat général au développement durable, 2013).

The Grenelle 2 law[11] dated 12th July 2010 (and the associated decree 2011-2019[12] dated 29th December 2011) reformed the implementation of the EIA Directive in France (Etd and Certu, 2012). Decisions to authorise projects will now have to mention the type of offsetting measures to be implemented and a monitoring of the achievement of these measures will

[6] http://www.developpement-durable.gouv.fr/Le-Plan-Local-d-Urbanisme.html
[7] http://www.developpement-durable.gouv.fr/Presentation-generale,13896.html
[8] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000020949548
[9] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000026855992&dateTexte=&categorieLien=id
[10] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000019277729
[11] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000022470434
[12] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000025054134&dateTexte=&categorieLien=id

have to be conducted in order to verify the efficiency and continuity of those measures. Measures will have to be implemented on - or close - to the degraded site and if possible will have to improve the environmental quality of the area. A procedure of disciplinary measure for non-compliance was also implemented by the decree; this procedure is described in Commissariat général au développement durable (2013). On 1st June 2012, the date of entry into force of the decree, developers became liable for their offsets. The characteristics of projects which are automatically subject to an impact assessment are presented in an annex to the decree[13], together with the characteristics of the projects for which these requirements will be assessed on a case by case basis. Case law is still emerging in this respect.

The article 230 of the Grenelle 2 law, states that the reform must include "the proportionate measures planned in order to avoid, reduce and when possible offset the negative effects of a project on the environment or human health". However, until recently, the impact assessments making possible the establishment of these measures were undertaken at a late stage in the project approval process, and therefore avoiding or even reducing and offsetting the impacts was not always possible (Vanpeene-Bruhier et al, 2009).

In May 2012, the French Ministry of Ecology, Sustainable Development and Energy (MEDDE) adopted "guidance" with regard to the avoidance, reduction and offsetting of impacts on the natural environment (MEDDE, 2012a) and established an accompanying document[14] clarifying the "avoid, reduce, offset" sequence in order to complement the methodological aspects of the guidance. Although the guidance was published over a year ago, the accompanying document was only published in October 2013: "*Lignes directrices nationales sur la séquence éviter, réduire et compenser les impacts sur les milieux naturels"* (Commissariat général au développement durable, 2013). Neither of these documents have official legal status and cannot be upheld in court.

The guidance refers to the mitigation hierarchy, and confers to the authority in charge of approving a particular project the power to ensure that there exists no alternative that would have less impact on the environment (via supplementary assessments carried out by the developer); this happens very early in the decision making process of approving a project. Offsetting is the last step in the sequence and consists of implementing measures making possible the offset of the loss in biodiversity due to a development. If offsetting occurs, there should be an ecological equivalence between the predicted impacts of the development (loss) and the benefit induced by the offsetting measure in terms of biodiversity type and quantity (Regnery et al., 2013a). The legislation related to biodiversity loss and benefit through offset is part of the "No Net Loss" objective included in public policies such as the Habitats Directive that requires that the state of conservation of particular species or habitats should not be degraded, or master plans such as the Water Development and Management Master Plan (SDAGE) aiming to preserve humid areas within catchment basins.

[13] http://www.legifrance.gouv.fr/affichCode.do;jsessionid=1AFF643DE1DE68E43D589FD7956538B6.tpdjo12v_3?idSectionTA=LEGISCTA000006108640&cidTexte=LEGITEXT000006074220&dateTexte=20120601

[14] http://www.cotita-centre-est.fr/IMG/pdf/2_S_Hubert_CETELyon_Cotita_ERC.pdf

5.4 Principles incorporated into offsetting policies

The following principles are identified in Commissariat général au développement durable (2013):

- Art. L. 110-1 2 of the Environmental Code is based on the principle of preventive action and rectification of damage to the environment at source.
- Art. R. 122-5 of the Environmental Code is based on the proportionality principle; the content of the impact assessment is proportional to the environmental sensibility of the area potentially affected by the project, to the importance of the nature of the works to be undertaken and infrastructure planned, and to the expected impacts on the environment or human health. The proportionality principal implies that the assessment is conducted on a case by case basis.
- The Environmental Liability Directive provides a framework of environmental responsibility based on the polluter-pays principle. The Directive applies if an accidental damage has been caused to the environment and advocates offsetting operations that must be borne by the developer.
- The transactions conducted by the project developer with regard to the choice of the site on which the offset will take place are completed on the basis of an amicable agreement (between the developer and the land owner/manager) according to the principle of contractual freedom.

5.5 The scope of offsetting policies

5.5.1 Biodiversity and ecosystem coverage

The new guidance of May 2012 (MEDDE, 2012a) applies to “natural environments”, which are defined as terrestrial, aquatic and marine environments encompassing natural habitats, animal and plant species, features contributing to functional connectivity, and ecosystems, including their physical and biological components and the services they provide. Avoiding “major issues” is the first priority in the guidance. Here “major issues” relate to outstanding biodiversity such as threatened species or Natura 2000 sites, and main ecological continuity including for example migratory areas; main ecosystem services are also taken into account and include amenity, recreation, water purification, health, etc.

In relation to biodiversity, the Grenelle I law required that offsets should also be applied to “common” species and ecosystems as well as to protected species. In addition to protected species and habitats, offsetting measures can also be applied to biodiversity in general and more specifically to hedgerows, unprotected wetlands, green lands in urban areas or woodlands (Morandeau and Vilaysack, 2012).

Habitat or species offsetting approaches are currently applied rather than the ecological services offsetting approach which is not well developed (UICN France, 2011). Although offsetting in terms of surface area or species/habitat (resource-resource approach) as well as in terms of ecological functionality (service-service approach) is necessary, an approach involving ecosystem functions (hydrological, physical and climatic) and the services provided would be more appropriate (Forum des Marais Atlantiques, 2013).

5.5.2 Sectoral coverage

The main drivers of loss that are covered by the offsetting requirements include urban expansion, infrastructure, and industrial projects (eg renewable energy, extractive industries, etc). There are no offsetting requirements for residual impacts from farming and forestry practices or fisheries.

5.5.3 Levels of residual impact requiring offsets

Any project having a "significant (adverse) impact" on the environment will require offsets. The analysis of the impacts will determine whether they are considered as significant or not significant. The impacts of development projects have to be analysed and measured in relation to the initial condition of the land where the project will take place, taking into account the restoration objectives of the natural environments concerned, set by public policies.

5.6 Offset design elements

A summary of the characteristics of offset measures for France is presented in Table 1.

5.6.1 Allowable forms of offset provision

In France, no recommendations are given on the type of measure to apply. The national guidance specifies that ecological measures proposed by developers should be applied near the affected site ("functional proximity") and should involve: restoration, rehabilitation, creation and preservation. However, the measures generally applied in practice include restoration and rehabilitation (Morandeau and Vilaysack, 2012). Within the framework related to the protection of protected species, the measures proposed should involve (in order of importance): rehabilitation or restoration, preservation and creation (Morandeau and Vilaysack, 2012).

The guidance also specifies that "offset programmes have to include ecological measures, such as habitat rehabilitation or improvement, or population enhancement activities for specific species, as well as any other appropriate activity" (MEDDE, 2012a). Supporting measures can also be implemented by project developers in addition to offset measures. Supporting measures are applied to improve the efficiency of offsets, or give further assurance of the environmental success of offset measures. In France (unlike in Japan), the transfer of individuals is not considered as a compensation measure; it is seen as an accompanying measure for an operation to restore a habitat in support of the introduction of a species.

The objectives of the offsets proposed by developers should be to recreate and restore the ecosystems that will be affected by the development. Consequently, the measures implemented will have to result in (at least) no net loss of biodiversity and work towards a gain in biodiversity for the affected habitats and species (as discussed in a report by the Comité Français de l'UICN in 2011).

In France, using financial transfers as offsets is generally not authorised; only ecological measures qualify as compensation and must therefore be made “in-kind” rather than through the use of financial transfers (Morandeau and Vilaysack, 2012). They can only be used as offsets within the framework of the Forestry Code although they are only very rarely used in this context. However, financial transfers can constitute optional "supporting" measures provided by the project developer (in addition to offsets).

Offsets have to be applied to habitats, species or functions that are similar to those affected, and have to be located close to the area impacted upon. In practice, the average duration of commitment for a developer ranges from 5 years to 60 years. Although there is no legal minimal duration, the law specifies that the period of commitment for a developer should be determined according to the duration of the impacts, the type of natural environment mainly targeted by the offset, the management criteria and time considered as necessary to reach the objectives (MEDDE 2012a).

Table 1. Summary of the characteristics of compensation measures in France

Ecological measure implemented	Type of compensation measures	Rate of compensation	Financial transfers	Length of commitment	Instruments ensuring the sustainability of measures	Regulations requiring compensation[15]	Monitoring	Main characteristics
Restoration; Rehabilitation; Creation; Preservation.	Ecological measures made "in-kind"; Measures applied to species, habitats, functions (similar to those affected); Measures applied close to the impacted area; "Trading up" not allowed.	On a case by case basis, vary from 1:1 to over 1:10 (ha compensated : ha destroyed) Forest Code: 1:1 or from 2:1 to 5:1 SDAGE: different ratios for each SDAGE, (1:1.5 or 1:2).	Not authorised as compensation measures except within the framework of the Forestry Code; Can be used as optional "supporting" measures.	**Regulations**: no minimum duration; **In practice**: from 5 years (eg contract with a farmer) to 60 years (duration of an infrastructure concession); a minimum of 30 years for habitat banks within the current pilot scheme.	Land acquisition; average price per ha at the national level in 2009: 5090€ (for land) and 3286€ (for forests)[16] Contract with an owner or land manager; average price per ha at the national level in 2006: 121€ Regulatory measures for the protection or transfer of compensation sites to public utility bodies.	Environment and health; Environment; Protected species; Forest; Water/wetland; General biodiversity.	Information from developers; Field visit by the relevant department; Civil society monitoring. Description of the monitoring mechanism within the authorisation act Penalties for non-compliance	National guidance: "avoid, reduce, compensate" impacts on the natural environment (May 2012). France is a member of the Business and Biodiversity Offsets Program (BBOP)

[15] See also Figure 1

[16] Source: Commissariat général au développement durable (2013)

5.6.2 Rules regarding like-for-like compensation and trading

In terms of equivalence, the targets are: species/habitats/functions (Morandeau and Vilaysack, 2012). "Trading up" is not allowed in France (unlike in Australia and in the English pilot scheme[17]). Offsets have to be equivalent to the impacts of the project, ie the aim is to maintain the environmental quality of the habitat or the species affected. In France there is no ecological equivalence methodology to rigorously assess the level of offset required by a specific impact. When a methodology does not exist, offsets are determined by offset ratios. Ratios are currently defined in France on a case by case basis and can vary from 'one hectare compensated for one hectare destroyed' to 'ten hectare compensated' for one hectare destroyed' (UICN France, 2011). This depends on the characteristics of each development project and also on the ecological potential of the site where offsets are taking place.

The Forest Code, in relation to the clearance of wooded areas, specifies that compensation ratios should range from 'one hectare compensating for one hectare destroyed' or two to five hectares compensating for one hectare destroyed' according to the social or ecological function of the forest cleared (Morandeau and Vilaysack, 2012).

Ratios or adjustment coefficients are not used systematically except when the minimum requirements for the offset of impacts are specified in framework documents such as for example the Water Development and Management Master Plan (SDAGE). This is a policy instrument for water management at the level of river basin, which contains requirements about offsets of impacts on wetlands. The SDAGE Loire-Bretagne sets the following requirements in relation to the offset of a development if it leads (without an alternative) to the destruction of wetlands: recreation or restoration in the same catchment area of a wetland with equivalent function and biodiversity. If the offset cannot take place within the catchment area or takes place further than 25km of the wetland that is to be destroyed or if the catchment area is greater than 500 km^2, and/or the optimal equivalence related to functions and biodiversity cannot be found, then the compensation should apply to an area equal to twice the size of the area which is being destroyed (Secrétariat technique du bassin Loire-Bretagne, 2010). Such requirements (with different ratios) can be found in each SDAGE (for example, the SDAGE Seine-Normandie sets a minimum ratio of 1.5, Agence de l'Eau Seine-Normandie, 2010).

5.6.3 Strategic planning of offsetting

The main characteristic of the French planning system is that planning powers are held at three different levels including national, regional and local levels (Oxley, 2009). The government establishes national planning policies which will be implemented at the regional level; those policies provide the basis for local regulation. The Solidarity and Urban Renewal law (SRU) dated 13 December 2000 aims to reinforce spatial planning at urban level; in order to do so, the SRU law produced new urban planning documents, the Territorial Coherence Scheme (SCOT) and the Urban Development Local Plan (PLU) (see Table 2). SCOT involves several local authorities and aims to ensure consistency between sectoral policies in relation to urban development, housing, transportation and

[17] https://www.gov.uk/biodiversity-offsetting

infrastructure provision while protecting and valuing the natural environment. The PLU is the main urban planning document at the local level. It provides the general planning rules that will apply to a site within a local authority or a group of local authorities. The PLU establish areas for new and future developments, areas for agricultural purposes only, and areas that will be protected for biodiversity. The PLU divides a locality into different zones (Verhage and Boino, 2006) that are to be developed (eg for housing) or not developed (eg creation of a protected area).

Table 2. Summary of roles within the planning system in France

Level	Document	Function
National	National codes (basis for local regulation)	• Establish policies (to be implemented by regional/local government). • Coordination national/regional planning.
Regional	SCOT	• Involves several local authorities and aims to ensure consistency between sectoral policies (urban development, housing, transportation, infrastructure provision and environmental protection).
Local	PLU	• Provides the development plan for the local authority or groups of authorities. • Establishes planning zones.

Local authorities are important stakeholders with regards to territorial planning (unlike “departments” which powers in terms of territorial planning are not very important). They are responsible for developing the PLU and the mayors are in charge of issuing building permits (developers can make proposals for their development projects; a permit will be granted if the development is in line with the PLU). However, local authorities are often considered too small to implement territorial planning efficiently. Consequently, part of the competency of the local authorities is transferred to inter-communal structures or public institutions for inter-local authority cooperation (EPCI). The particularity of those public institutions is that they are not directly elected and local authorities can delegate part of their competences to them. One type of EPIC is the Urban Community (CU) which group several local authorities together and have important functions in terms of territorial planning such as the development of the PLU or SCOT for their own territory.

The environmental evaluation of urban development documents is an ex-ante evaluation. The objective of the evaluation is to include environmental issues within the SCOT and PLU so that they are taken into account on the same basis as urban development, economic, social or transport issues (Commissariat général au développement durable, 2011b).

Urban development documents integrate avoidance, reduction and offset measures. With regard to avoidance measures, the environmental evaluation (of schemes, plans or programmes) has to justify the “*choice made in relation to other solutions considered*” (PLU) or explain “*the reasons for which alternative projects have been excluded*” (SCOT). Within the PLU, measures can be defined in a very accurate way; the zoning system makes possible the protection of sensitive areas and is complemented with an authorisation or restriction of use according to the level of sensitivity of the area. Although offset measures can also take place within Urban Development Local Plans, there are few examples of “offset measures” within SCOT and PLU (Commissariat général au développement durable, 2011a).

The Grenelle II law has reinforced the objectives of the SCOT and PLU; these plans or schemes have to support the protection of biodiversity and ecosystems via the protection and enhancement of ecological networks. PLU also has to take into account nature protection measures such as Natura 2000 and instruments related to water management such as SAGE and SDAGE.

5.6.4 Methods and metrics quantifying impacts and expected offset outcomes

According to the new French guidance, offsets should be designed to achieve no net loss through equivalence and additionality. Nevertheless, they are no official methods in France to assess losses and gains, so offsetting can involve measures that fall short of achieving no net loss.

5.6.5 Approaches to ensuring additionality of offsets

The new national guidance specifies that offsetting measures have to demonstrate:

- ecological additionality: the measure should achieve an ecological enhancement on the site where it is being implemented.
- additionality with regard to existing or planned public measures in terms of environmental protection: offsetting can strengthen those public measures (for instance by being located on a Natura 2000 site) but should not be a substitute for those measures.
- additionality with regard to private commitments: offsetting should not be used to implement existing commitments such as a prior offset.

The project developer has to demonstrate additionality when applying for exemption (Commissariat général au développement durable, 2013).

5.6.6 The location of offsets

Although the new guidance mentions that offsets should preferably take place *in situ* or near the area affected by the development, it also mentions "functional proximity" to underline the overarching requirement for offsets to be effective in terms of their ecological outcomes. Finding and securing sites for offsets, in particular near the affected area, is generally a major impediment to implementing offsets.

5.6.7 The timing of offsets with respect to impacts

In principle, the site which is going to be impacted by the development project should not be subject to irreversible damages before the implementation of offsets; however, request of exemption can be granted when it is established that the efficiency of the offset will not be compromised.

Offsets should be implemented in advance of impacts if the damage results in the reduction of the population of a protected species and if the outcome of the offsetting measure is to provide a new habitat for species which will have their habitat destroyed by the development (ie a replacement pond has to be operational before filling in the impacted pond).

With regard to Natura sites, when it is not possible for the offset measures to be implemented before damage to the impacted site has happened then additional offsets can be requested to compensate for the loss that has occurred during the time interval.

5.6.8 Performance standards

There are no published national performance standards for offsets, however, the Commissariat général au développement durable (2013) gives an indication of the expected likelihoods of reaching the expected objectives according to the type of ecological measure implemented:

- Restoration and rehabilitation: reaching the objectives will vary according to the level of scientific knowledge of the environment impacted, the state of degradation and resilience ability of that environment and experience feedback on the methods used;
- Creation: the likelihood of reaching the expected objectives varies according to the type of environment but is generally assumed to be low (experimental techniques are sometimes used);
- Preservation / management of a particular environment or species and their habitats: whether or not the objectives will be reached depends on the developer or the individual responsible for managing the land or the species.

5.6.9 Monitoring and reporting requirements

In France, the monitoring of compensation measures and their effects is compulsory. Currently the results from those controls are collected within sectoral databases (eg the law on water) or at the local level in a non-harmonised way. In the long run, those results will be recorded in an online national monitoring tool that will include links with existing sectoral tools. This tool will be used for monitoring avoidance, reduction and offset measures in order to guarantee better traceability of the measures, to make sure that the measures are implemented and to encourage experience feedback (Morandeau and Vilaysack, 2012). This national tool is currently being investigated by the French Ministry of Environment (Commissariat général au développement durable, 2012) but to date has not been implemented has no tool has yet been agreed on. Instead, local environmental authorities (*Direction Régionale de l'Environnement, de l'Aménagement et du Logement*) have started developing their own monitoring tools (eg in Languedoc Roussillon and Rhône Alpes).

Regarding the recently launched compensation bank trials, a credit record is kept by each local authority involved. Hopefully, in the future, the data will be consolidated at the national level.

The *Federation des Conservatoires d'Espaces Naturels* (FCEN, see below) would be in favour of the establishment of a register for offsets in order to keep a record of the type of measures implemented and the location of the sites where those measures have been applied. A record of the proportion of lands, managed by the *Conservatoires d'Espaces*

Naturels (CEN), coming from compensation plans does not exist. However, a land register is being implemented by the CEN where lands from offset plans will be recorded; the FCEN has also requested the CEN to establish the proportion of the budget coming from offset plans for 2012[18].

5.6.10 Contingency measures required to address possible offset failures

Supporting measures can be used in addition to offsetting measures in order to increase the chance of success.

5.6.11 The institutions involved in the offsetting and their roles

A number of actors are involved in the application of the mitigation hierarchy, and in the design, execution and monitoring of offsets:

- The project developer and service providers, who are responsible for proposing and implementing the compensation measures;

- The decision-making administrative authority (Prefect or Ministry of Ecology for large projects) and relevant government department (for example the Regional Department for the Environment, planning and Housing, DREAL); their role is to check whether the compensation measures proposed by the developer will actually meet the requirements associated with the restoration of the ecological situation. Where necessary, the opinion of various consultative bodies is also sought.

- The independent environmental authority is responsible for verifying that the different steps in the mitigation hierarchy (avoid, reduce, offset) have been followed, and for determining the quality of compensation measures.

We will not detail here the role played by developers and environmental authorities, but instead describe briefly some of the key intermediaries.

5.6.11.1 Consultative bodies

As well as the public enquiry requirements, France has different specialized consultative bodies that are involved in commenting on permit applications, depending on the types of project and the particular procedure concerned (eg for permits under water legislation, local water commissions or *Commission Locale de l'Eau* are consulted to give an opinion on the project, its impacts, and the mitigation measures proposed).

As mentioned above the *Conseil National de Protection de la Nature* (CNPN) played a key role in requiring offsets for residual impacts on protected species. It continues to do so, and now plays a vital role as a critical third-party reviewer of the biodiversity outcome of any set of mitigation measures. In fact, although its role is only consultative, it is usually the case that the CNPN sets the bar for the permit applications. There are on-going discussions to reform the CNPN and split its more "scientific" components (researchers and experts) from its more "political" components (environmental NGO representatives).

[18] Marc Maury, FCEN, pers. comm.

Regional level equivalents to the CNPN, called CSRPN (*Conseil Scientifique Régional de Protection de la Nature*), can be asked to comment on permit applications by regional environmental authorities. Their comments, together with comments by technical government agencies (e.g; ONCFS[19], ONF[20], ONEMA[21], etc) or protected area managers (eg National Parks and National Nature Reserve), feed on-the-ground information into the process and can inform the CNPN at the national level.

5.6.11.2 Specialized consultancies and professional ecologists

Given the specific constraints and uncertainties surrounding biodiversity-related risks to projects, an array of consulting firms specialized in biodiversity and ecosystem has emerged in France. These firms are hired by developers or by generalist EIA firms to assist developers conduct their impact assessments and procedures specifically related to biodiversity and ecosystems. Impact assessments, and in particular the analyses of whether an impact is significant on a given species, habitat or ecosystem function, are generally carried out by trained and experienced professionals. A number of specialized firms provide these services, as do local nature conservation NGOs. While some guidance is provided on how to proceed (eg MEDDE 2012b) there are no compulsory methods[22] and developers and their consultants are free to suggest methods. Best professional judgement by recognized ecologists is usually relied upon. Their certification is being considered (MEDDE 2011a).

5.6.11.3 Private land trusts (Conservatoires d'Espaces Naturels)

The *Conservatoires d'Espaces Naturels* (CEN) are non-governmental and non-profit organisations that manage land and run conservation programs across France. There are 29 CENs in France (21 regional CENs and eight departmental CEN) which are gathered within a network, the Federation of "Conservatoires" (FCEN). Together, the CEN have an annual budget of €45 million, currently employ 750 people, and have about 9,000 members with more than three thousand volunteers participating in their activities. The first CEN was created in 1976; in 1989, the CEN joined together to form a national federation (FCEN). Recently, the CEN has been recognized by law (3rd August 2009 and 12th July 2010).

The CEN take part in the management of 144,000 ha (or 2,700 sites) in France; 15 per cent of the area is owned or rented by the CEN and the remaining sites are managed via agreements with public and private land owners (eg the CEN manage 65,000 ha of military lands). The CEN manage 30 per cent of the national natural reserves.

The success of the CEN rests on the fact that they have developed strong partnerships with the different actors involved in nature conservation in France, both public (eg local authorities) and private (eg hunting associations). The CEN are not activists and have no statutory powers (eg for law enforcement); their approach is based on the management and

[19] Office National de la Chasse et de la Faune Sauvage – which deals with hunting and wildlife
[20] Office National des Forêt – which manages public forests
[21] Office National de l'Eau et des Milieux Aquatiques – which deals with water, wetlands, and recreational fishing
[22] The only exception concerns the Common Hamster (*Cricetus cricetus* L.) for which a single assessment method is accepted under Ministerial Order DEVL1231144A of August 2012. This specificity results from court action by the European Commission (Case C-383/09) arguing that France was not fulfilling its obligations towards the conservation of the species, which is listed in Annex IV of the Habitats Directive.

use of the land through a collaborative method, taking into account environmental, social and economic issues associated with particular sites.

The CEN network is the main private manager network for natural areas in France. The Grenelle laws provide a right to a legal agreement on the role of the CEN. This agreement does not guarantee a specific budget or subsidies but implements a five-year action plan subjected to the opinion of the CSRPN and the FCEN; this action plan can be approved by the government. The five-year action plan has to be able to demonstrate that it supports public policies as well as their implementation. CEN are authorised nature conservation associations, some of which are registered public associations.

Across France, the CEN are involved in offset plans; their involvement can take place during the initial stage of the project (where they can be asked to provide data and technical advice) or later in the process during the implementation of compensation measures. Sometimes, CEN are requested to get involved both at the initial stage of the project and during the implementation of the measures. In 2008, a code of ethics ("*Charte d'Ethique*[23]") clarifying the position of the CEN with regard to their role within compensation plans was published. A new code of ethics will be published in 2014 updating the previous code in response to the changes which have recently occurred in connection with offsetting.

The FCEN participated in the elaboration of the new national guidance and are regularly involved in the application of the mitigation hierarchy, and in the design, execution and monitoring of offsets. Although the federation is, in general, very optimistic with regard to its content, they believe that there are some limitations associated with the guidance[24]. Those potential issues are described in the section "observed problems" below. It should be noted that despite these observations, the FCEN is very positive about the guidance itself and considers that it reflects a major step forward in the interpretation of the law related to compensation.

5.6.11.4 Local governments (Conseil Général des Départments)

Local governments typically have policies that target social and economic development, including development projects, and policies that target biodiversity and ecosystem conservation or restoration. As an example, at the *Département* level, all local governments build and maintain roads, and some have developed protected area (PA) strategies. How compensations from road projects and these PA strategies should or could be articulated is still open to discussion and we illustrate some initiatives in the next sections.

The PA network of the *Département* is funded through a dedicated tax on building permits: the *taxe d'aménagement (*eg Conseil Général de l'Essonne, 2011). As of 21 December 2012, most new buildings must pay a tax of €724 per m^2 of which 1.3 per cent is earmarked for the protection and management of natural areas and landscapes. The funds can be used to purchase and restore natural areas and fund their management (Articles L 142-1) and the following of the Urban Code (*Code de l'urbanisme*). The funds are managed by the *Département* council. Although this tax could be considered as an offset mechanism, it has

[23] http://reseau-cen.org/mediatheque/actualite/compensation_docvalide.pdf
[24] Marc Maury, FCEN, pers. comm.

no explicit requirements in terms of ecological equivalence, and the amounts paid by developers are not related to a measure of their actual impacts on biodiversity. There is, however, scope for articulating the *Département*'s actions that are funded by this tax and the offsetting requirements applied to the road works of the same *Département*.

Several French *Département*s are exploring ways to achieve this. One suggestion[25] is to use resources from the tax to fund the long-term management of offset sites, once they have been restored. Establishing when this transition is most suitable raises complex questions in terms of additionality. It also challenges current practice by French environmental authorities in setting the duration of developers' liabilities concerning their offsets (which is currently limited in time, even for development projects with irreversible impacts).

The French Coastal Trust (*Conservatoire de l'Espace Littoral et des Rivages Lacustres - CELRL*) is a public organisation that was created in 1975. The main objective of the CELRL is to acquire a third of the French coast in order to prevent over-development in these areas; by 2012 it was securing the protection of 12 per cent of the coastline. In coastal and lakeshore areas where the *Conservatoire de l'Espace Littoral et des Rivages Lacustres* has a mandate to purchase land for long term protection, it is often the final recipient of land purchased by developers through offset requirements. Through its statutes, it guarantees, into perpetuity, that land will not be developed. The CELRL does not, however, manage its own land and developers can be asked to fund the management for the duration of the offset commitments. The CELRL has established an internal policy on offsets to ensure this.

5.6.12 Measures taken to ensure compliance with regulations and offset requirements

The decision-making administrative authority keeps a record of the measures the project developer is responsible for. The developer regularly complements this record by providing an update on the implementation and efficiency of the offsets. On-site control can take place to ensure that the measures are implemented and the expected objectives reached.

5.7 Offsetting achievements and lessons learnt

5.7.1 Observed problems

Some problems (observed by the FCEN[26]*)* are presented below.

The FCEN believes that in order for offsets to succeed, all the individuals concerned or affected by a development project and its associated offsets, should be involved in the process and their opinion taken into account. Intermediary organisations should also be involved in the process and associated with offsetting and development measures[27].

[25] Frédéric Dalvai, Conseil général de l'Isère, pers. comm.
[26] Marc Maury, FCEN, pers. comm.
[27] the CEN could represent such intermediary organisations

The current offsetting approach focusing on protected species is not necessarily appropriate since the way the public perceive different species could have a disproportionate impact on the outcome.

There is a lack of focus on offsets in terms of management agreements with farmers. Those short-term management measures (5 years) related to agricultural and forestry practices might not be sufficient and there is a risk that funding for offsets will become a substitute for Common Agricultural Policy funding; agriculture might find a new form of funding for its activities through offsets.

The FCEN also believes that sites where offsets take place should be given a particular status in order to be preserved; however, the risk associated with the allocation of a specific status would be that those “restored” sites could benefit from better protection than a “natural” site or a site under specific protection measures for which development requests are possible.

The technical feasibility and likelihood of success of offsets should be appropriately assessed and measures undertaken should be “sustainable” and should not need to be continually funded (compensation measures can be associated with a risk of creating costly artificial systems). In order to address these issues, a record of technical measures should be implemented.

The national guidance does not mention the notions of “common goods”, general interest or public interest. The destruction of common goods should be compensated by common goods. Different initiatives related to offsets could lead to the privatisation of common goods (eg if the private sector is involved). The question of public access and land ownership regarding sites where measures are being implemented has not been studied in detail in the guidance.

There is a risk associated with the notion of “No Net Loss”, which is that it is easy for people to think that the greater the destruction of natural areas, the larger the gain in biodiversity. NNL cannot occur if destruction takes place and concerns species or natural habitats which cannot be restored or re-created (eg no net loss in peat or “*coussoul*” in La Crau is only possible if destruction does not take place). Although the national guidance states that if offsetting cannot happen then the development should not be permitted, this might be difficult to apply in practice; biodiversity gains are only possible in very specific situations and merely translate a particular idea of biodiversity.

The CEN method is to focus on a dynamic habitat approach, where the notion of time and space are taken into account (eg offsets for a 300 years old forest). The measures taken should be realistic as offsets might not necessarily be achieved if too specific.

The FCEN also raised the issue of the high level of uncertainty relating to what happens in the long run to the lands where offsets have been implemented (eg after 30 years).

5.7.2 Costs and/or economic benefits of current policies

The different types of costs associated with measures to avoid, reduce and offset impacts are listed in Fiche 19 in Commissariat général au développement durable (2013). The only figures provided include the average price for land acquisition, at the national level for 2009: €5,090/ha (for land) and €3,286/ha (for forests); and the price for renting land (contract with an owner or land manager) in 2006: €121/ha (average price at the national level).

Examples of costs incurred by developers are given in the section entitled “Examples of development projects and related offsets”.

5.7.3 The overall environmental impacts of offsetting policies and measures

To date, no impact assessment of the law related to “no net loss” of biodiversity in France has been conducted[28]. France does not generally conduct a formal impact assessment of its policy proposals. Laws such as the Grenelle law are discussed in parliament, and through stakeholder consultations, but there has not been a formal impact assessment of the law itself, or of the policy outcomes of the law. Conducting such an assessment would require base-line data on the type and extent of offsets used, and such data are not available. A few attempts have been made at conducting this type of assessment (for example by Enviroscop et al. 2011) but due to the unavailability of quantitative evidence (except, for instance, the number of derogations sought for protected species) the exercise mainly resulted in recording anecdotal evidence on the positive or negative outcome of specific offset measures.

5.7.4 Expected future policy and legislative developments

The following new initiatives are being undertaken in France:

5.7.4.1 Wetland Action Plan – Chambéry Métropole

In 2012, a Wetland Action Plan (*Plan d'Actions en Faveur des Zones Humides* - PAFZH) was established to limit the degradation of wetlands and restore, maintain and protect 113 wetlands (totalling 560 ha) around the city of Chambéry[29]. It involves the local government, (*Chambéry Métropole*), a regional government agency in charge of managing the local watershed (*CISALB*), a local conservation NGO (*CEN Savoie*) and funding agencies including the Watershed Authority (*Agence de l'Eau Rhône – Méditerrannée- Corse*). Together they aim to establish a framework in which offsets for impacts on wetlands can be located and executed so as to contribute to a broader strategy of wetland restoration (Chambéry Métrople, 2012). A prior assessment established that 10ha of wetland were likely to be impacted through urban expansion and that another 85ha of degraded wetlands needed restoration. This restoration will be partly funded by developers through their offset requirements with the local government taking charge of the proper execution of the offsets as part of the broader plan and billing the developers for this service. The remaining restoration will be funded through subsidies by various public funding agencies. The total

[28] Fabien Quétier, Biotope, pers. comm.
[29] Camille Pousse, CISALB, pers. comm.

cost of restoring the 85 ha of degraded wetlands has been estimated at €990,000 over six years.

This plan is seen as a win-win situation. At the environment level, the objective is to restore 50 new wetlands; at the socio-economic level, a large area of wetlands suitable for implementing offsets required by regional development will be available. In addition, the urban development documents included in the plan are more demanding in terms of protection.

The initiative in Chambéry is an example of a public-private partnership for conservation, where local governments designate land where restoration and management will be funded (or co-funded) by developers.

5.7.4.2 The experimental habitat bank of Cossure

In 2008, the French government launched an experiment with habitat banking, in partnership with a specialized subsidiary of a state-owned sovereign fund called CDC Biodiversité (Chabran et Napoléone, 2012). The company has purchased over 300ha of industrial orchards in the Crau area (near Arles, Southern France) and restored them as natural grasslands that it now manages as breeding and wintering habitat for endangered steppe-land birds such as the Little Bustard (*Tetrax tetrax*). The initiative has faced considerable criticism over its expected outcomes (eg if a true biodiversity gain is being delivered) and the way transactions are made (eg how are prices set). In spite of this, the bank has already sold publicly authorized credits to developers, but remains a long way from breaking even. This has raised concerns regarding the economic viability of the operation in a context where biodiversity offset rules have strict requirements in terms of ecological equivalence. In June 2011, the French government chose to expand this experiment to four additional operations in different regions.

5.7.4.3 Offsetting measures and agriculture

Offsets are regularly implemented as agri-environment measures (such as those under the CAP) where farmers are paid to adopt specific types of farming practices, which will have a positive impact on a particular protected species or habitat. The implementation of a relatively intensive grazing system on permanent grasslands in the Crau steppe (Bouches-du-Rhone) benefits Little Bustard's (*Tetrax tetrax*) populations (MEDDE, 2011b). Another example relates to the protection of the common hamster in Alsace where the development of crops and farming practices beneficial to the needs of the species is due to take place (MEDDE, 2012a).

In addition, the French National Institute for Agricultural Research (INRA - Avignon) is currently conducting research on the identification of agricultural changes in favour of biodiversity with the aim of integrating them into the offsetting process[30]; eg could the help provided by a developer to a farmer with regard to changing their current farming practices to organic farming be part of offsets? This requires being able to identify the types of farming having a positive impact on the environment.

[30] Coralie Calvet, INRA, pers. comm.

5.7.4.4 Examples of development projects and associated offsetting measures

Some examples of development projects and associated offsets are described in this section. It should be noted that the figures provided in these examples are extracted from complex sets of commitments and do not cover the complete set of offset measures that have or might be implemented.

5.7.4.5 Motorway A65

The motorway A65 between Langon and Pau (150km long) was the first French motorway built after the implementation of the Grenelle law; the construction of the A65 also resulted in the first large scale offsetting programme being implemented in France (Caisse des Dépôts et EIFFAGE, 2013). The motorway had an impact on 1,603ha of land in total. Despite the measures taken to avoid and mitigate the effects of the development project on biodiversity, 590ha of natural habitats, home to several types of protected species, were affected. The actions taken to offset the loss in biodiversity included securing 1,372ha of natural habitat and ensuring the restoration of the area and management of its species over a period of 60 years. In addition, the project developer is also funding supporting measures aiming to enhance declining species such as the European Mink (Mustela lutreola) at an expense of €1.5 million. In total, 15 per cent of the construction costs of the project were spent on reduction and offsets. This offsetting programme was regarded (by IUCN) as a successful example of biodiversity protection (Caisse des Dépôts et EIFFAGE, 2013).

5.7.4.6 High Speed Rail (LGV) Tours – Bordeaux

The High Speed Rail development project between Tours and Bordeaux (340km long) is a public-private partnership which was granted permission before the adoption of the national guidance. The construction of the high speed rail, which should be completed by 2017, will have an impact on 4,200ha of land which is home to 221 protected species (this represents 50 per cent of protected species in France). Since the beginning of the construction work, the law has been reinforced and offsets as well as measures to reduce the impacts of the project have been imposed on the developer. The actions taken by the developer to offset the loss in biodiversity will include the potential restoration of 3,500ha which will be used as new habitats for the species affected by the development; 1,300ha of trees will also be replanted[31]. The developer will buy approximately 20 per cent of these areas and the rest will be rented from farmers for €600 per hectare. The offset was calculated by the developer on the basis of 1,000 metres of linear re-afforestation required for 1ha cleared (LISEA Express, 2012). It is important to note that the figures provided in this example are not necessarily accurate and might change, since the project has not yet been completed.

[31] http://www.capital.fr/enquetes/economie/tgv-tours-bordeaux-les-folies-du-plus-grand-chantier-d-europe-839593/(offset)/1

5.7.4.7 Nîmes – Montpellier rail-link

A recently permitted 80km mixed freight and passenger rail link in Southern France, between Nîmes and Montpellier, provides an interesting and recent example of offsets in France. Known as the *Contournement ferroviaire Nîmes - Montpellier* (henceforth, CNM), the rail line is part of a broader program of work established in 1992 which aims to strengthen the high speed rail lines between Lyon, Marseille and Montpellier. It will shorten travel times between the Rhône valley and the cities of Nîmes and Montpellier, enable a transfer of traffic from road to rail, and allow higher frequencies for local and regional passenger lines. The project was declared to be of public interest on May 17th 2005, following a public enquiry (*enquête d'utilité publique*) where an Environmental Impact Assessment (EIA) was made available to the public.

The public rail company *Réseau Ferré de France* (RFF) led the initial phases of the project and conducted the EIA, including its ecological components. On CNM, ecological field surveys started in 2003, 10 years before construction began, and are still on-going. The local population of the Little Bustard (*Tetrax tetrax*[32]) was a key concern. Mitigation measures, aimed at avoiding, reducing and offsetting impacts were planned at the EIA stage. Concerning offsets, RFF had committed to purchasing 500ha and restoring them as favourable habitat for the Little Bustard before leasing the land to farmers required to manage them favourably, and signing similar contracts over 640ha with farmers willing to engage in favourable management on their own land.

CNM is a public-private partnership and a call for tender was set up to identify a suitable company to finance and execute the building of the line and to run it for 25 years. A subsidiary of Bouygues won the bid and following the concession agreement (signed in January 2012), RFF's commitments concerning offsets were transferred to Oc'via Construction, a project-company. The overall cost of the line, including interconnections with existing lines and two new stations is estimated at around €1.98 billion. Once the line is finalised, in 2017, management will be transferred to Oc'Via Maintenance. After 2037, RFF will get full ownership and management of the line.

In addition to the EIA, Oc'via Construction had to seek consent for the works under a number of sectorial policies, including those related to water, Natura 2000 and protected species. Concerning the latter, with 126 protected species impacted, a set of avoidance, reduction and offset measures were designed. We detail here the offset measures aimed at addressing the residual impacts of the project that remain after avoidance and reduction measures were taken (such as displacing the line's trajectory to avoid impacting a site of the endangered plant species *Lythrum Thesioides*).

Biotope, a French consultancy specialised in biodiversity and ecosystem services assessment and management, developed a methodological framework for demonstrating ecological equivalence between the residual impacts ("losses") and the offset measures ("gains"), for each impacted species for which derogation was sought (Quétier & Lavorel, 2011). The method focuses on habitat quality for the species, which is assessed before and after

[32] The Little Bustard is a nationally protected species in France (under Ministerial Order of April 17th 1981), and benefits from a National Action Plan. The species is listed in Annex I of the 'Birds' Directive 79/409/CEE which led to the designation of Special Protection Areas (SPA), including the *Costières Nîmoises* affectées affected by CNM.

development, and before and after management measures are implemented as part of the offset, at an appropriate spatial and temporal resolution. Losses and gains were expressed as quality-hectares. The assessment of habitat quality for the Little Bustard was supported by over 10 years of field survey data, and parallel investigations on habitat use by the Little Bustard through radio-tracking.

Overall, 560ha of Little Bustard habitat lost to the footprint of the project were counted as 832 quality-hectares. Offsets therefore aimed to generate an increase of at least 832 quality-hectares. This can be done through larger increases in quality on a smaller area or smaller increases on a larger area. In fact, a mix of both approaches allowed the developer to respond to opportunities in terms of access to land and coalition-building with the farmers and nature conservation organisations. Quality-hectares were further modulated on the basis of the level of protection offered (ie land ownership to a nature conservation NGO vs. agri-environment contracts).

The Little Bustard was not the only impacted species, and in fact, the overall tally of CNM reaches 3,279 quality-hectares lost, of which 95 per cent are open farmland habitat. It has been estimated that generating this amount of offset would require between 1,700 and 2,100 hectares, on which enhancements would have to be maintained for at least 25 years (until the rail line is handed back to RFF). RFF had begun implementing offsets in 2008, and a total of 978 quality-hectares had been secured before works began. Since 2010, a specialised company set up by Bouygues, called Biositiv, has been responsible for securing access to land and signing contracts with farmers.

A number of lessons can be learned from the approach developed for CNM. It has an explicit focus on ecological equivalence and no net loss and has benefited from a large volume of data to demonstrate this. Furthermore, as offsets were already being implemented prior to the impacts, a realistic set of measures could be proposed. Close collaboration with permitting authorities, and stakeholders on the ground, was also essential for the approach to be accepted. The success of the offsets rests, now, on adequate monitoring and enforcement of the required on-the-ground actions. Whether or not the project achieves no net loss of biodiversity will also depend on the quality of the design of the offset approach, and this should also be monitored.

5.8 Conclusions

The French NNL policy has been established very incrementally since 1976, by building on a disparate set of sectoral policies (eg that target protected species of fauna and flora, natural habitats, wetlands, forests, etc). The preferred approach appears to have been “learning by doing” (or rather “not doing”) but has culminated in an ambitious policy spelt out in the 2012 guidance. Strict like-for-like equivalence is sought and this could significantly raise the stakes for appropriately accounting for biodiversity in the design and approval of development projects. In fact, the constraint of offsetting obligations and the “demand” for offset solutions are now firmly established for most plans and projects that are likely to have residual impacts after appropriate avoidance and reduction measures have been taken.

The current debate on NNL and offsets in France is focused on impacts caused by development (urban expansion, infrastructure, and industrial projects, including renewable energy, extractive industries, etc), in the context of permitting procedures. Human activities that cause losses of biodiversity but for which permits are generally not required (eg farming and forestry practices or fisheries) are not currently required to achieve NNL. By design, the French NNL policy should therefore be understood as limited to pressures on biodiversity arising from urbanization, infrastructure and industry.

In addition, the NNL policy's ambition is not immediately operational: it does not outline the institutional arrangements that could enable effective implementation (eg individual offsets, habitat banking, in-lieu fees or other financial compensation schemes), or the standards and performance criteria under which these arrangements will be designed and monitored. Audit, certification and accreditation systems are not discussed and little detail is provided on enforcement.

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6 ANNEX 6. NO NET LOSS POLICIES AND OFFSETTING IN GERMANY

Compiled by Graham Tucker (IEEP) and Wolfgang Wende (Leibniz IOER)

6.1 Consultees and sources of information used

This account is mainly based on contributions provided by the participants at a one-day expert workshop held at Leibniz IOER, Dresden, on 17th May 2013. Discussions were held according to Chatham House rules whereby the expressed views are not attributed to any individuals or organisations, with the exception of agreed for specific issues. The workshop was arranged and chaired by Professor Wolfgang Wende (Leibniz IOER, NNL WG member and expert adviser to this Policy Options contract), and also involved Dr Elke Bruns (Federation of German Professional Conservationists / Dr. Bruns Environmental Planning Consultants), Matthias Herbert (Head of Department 'Nature and Landscape in Planning and Project Permission, Renewable Energies', Federal Nature Conservation Agency), Michael Höhlschen (GASCADE, Gastransport GmbH), Stephan Köhler, (Road Building and Traffic Administration Lower Saxony), Anne Schöps, and with additional input and a phone call after the workshop Martin Szaramowicz (German Association of Compensation Agencies), Jochen Schumacher (Editor of German Journal Natur und Recht/Nature and Law; Springer Publishing House), Marianne Darbi and Dr. Juliane Albrecht (Leibniz IOER).

It has also drawn on a pre-workshop site visit to a recently restored grassland and archaeological feature (Burgberg Zschaitz) in Saxony, that is part of a habitat bank established by the Saxony Sites Agency, Sächsische Landsiedlung GmbH, Meißen. The visit was guided by Jörg Voß, from the Agency along with a representative from the Freestate Saxony Agency for Archaeology and discussions were also held with the farmer who is managing the land on behalf of the agency, and who is head of the local farming co-operative.

As noted below, various studies have been carried out and are referred to below, but particular reference is made to an unofficial English translation of the 2009 Federal Nature Conservation Act, which was supplied by the Federal Nature Conservation Agency. Written responses were also provided by Matthias Herbert (Federal Nature Conservation Agency) with respect to some of the specific detailed questions listed below. A review of offsetting in Germany in the previous Habitat Banking Study (Conway et al, 2013) and preliminary results of a current in-depth study of the use of eco-accounts (ie a form of habitat banking) in Baden-Württemberg.

6.2 Overview of offsetting and other key NNL policies

Article 13 of the Federal Nature Conservation Act (FNCA) [*Bundesnaturschutzgesetz*) requires that 'Intervening parties shall primarily avoid any significant adverse effects on nature and landscape. Unavoidable significant adverse effects are to be offset via compensation measures (*Ausgleichsmaßnahmen*) or substitution measures (*Ersatzmaßnahmen*) or where such offsets is not possible, via money substitution'. However, it is important to point out that this translation is not consistent with the terminology used in this policy options report. As noted above *Ausgleichsmaßnahmen* is sometimes referred as compensation measures (see also for example Darbi and Tausch, 2010) or restoration compensation. According to the law, these measures must have a direct spatial and functional connection to the lost nature and landscape components and must therefore be 'in-kind' and 'on-site'. Thus with respect to the terminology used in this report, they appear to be analogous to offsets, but must be on-site and like-for-like offsets. *Ersatzmaßnahmen*, is translated as substitution measures or replacement compensation, but these do not necessarily have to restore the same functions, and may have only a loose spatial and functional relationship to the impact area (Louis, 2004; 716). Thus, these measures are broadly equivalent to offsets in general (which may be off-site and 'out-of-kind').

The FNCA requires adherence to the mitigation hierarchy, and accordingly under Article 15 intervening parties are obliged to refrain from any avoidable impairments of nature and landscape. Any remaining unavoidable adverse impacts must then be addressed through offsets. In general on-site and like-for-like offsets are preferred, but amendments to the law ten years ago loosened the functional and temporal links between impact and compensation. Consequently, some offsets may be off-site or not like-for-like if this results in overall benefits for nature and landscape. Lastly, monetary compensation may be made, but only as a last resort if residual impacts remain that cannot be offset.

Offsets can be provided through tangible measures such as habitat creation, restoration or enhancement, but offsetting through protection measures (risk aversion) without reaching a net improvement is not allowed. Since 2002 offsetting has been allowed through habitat banking.

The requirements for mitigation and offsets relate to interventions in nature and the landscape, which according to Article 14 of the FNCA are 'any changes affecting the shape or use of areas, or changes in the groundwater level associated with the active soil layer, which may significantly impair the performance and functioning of the natural balance or landscape appearance.' Thus the Act clearly covers changes in land-use but also functions, and in this respect captures changes in biodiversity and ecosystem services. However, the impacts of agriculture, forestry and fishing are not covered by the FNCA.

The combination of Articles 13 to 19 of the FNCA and Articles 1a, 13 and 13a of the Federal Building Code (which regulates impacts on nature and landscape in the urban environment) comprise what is often referred to as the Impact Mitigation Regulation (IMR).

6.3 NNL and offsetting policy framework and development

6.3.1 The key policies that contribute to NNL

The key mandatory measures that contribute to NNL are SEA, EIA (Appropriate Assessments for Natura sites) and the FNCA measures that aim to avoid and minimise impacts. These measures are supported by spatial planning. Regarding Art. 5, paragraph 2, no. 10 and paragraph 2a of the Federal Building Code the preparatory land use plan for every municipality should identify all the usable sites for offset measures. Thus, every preparatory land use plan (normally at a scale of 1:10,000)– shows an overall offsetting concept for the local community. Additionally, and via the SEA of any regional plan (spatial plan on a scale of 1:50,000) measures for avoidance, minimization and offset should be described (appendix 1, number 2a) related to Art. 9 of the Federal Spatial Planning Act [ROG]). Thus these spatial plans introduce opportunities to minimise impacts and identify offsetting opportunities.

Article 13 complements other FNCA measures by requiring offsetting by 'restoration compensation' and 'substitution compensation' (see above terminology discussion) for 'unavoidable significant adverse effects (ie residual impacts). Thus the policy framework has the potential to deliver NNL of biodiversity and ecosystem services with respect to impacts from all developments.

The FNCA states that 'the use of soil for agriculture, forestry and fishing purposes shall not be deemed an intervention, provided the purposes of nature conservation and landscape management are taken into account'. In practice this means that offsetting of residual impacts from agriculture, forestry and fisheries is not required, as long as agriculture, forestry and fisheries follow the rules of 'good practice', and specific requirements detailed in Art. 5 paragraph 2 to 4 in the FNCA are taken into account(see further discussion below). This means, for example, that on slopes at risk from erosion, in flood plains, at sites with a high groundwater level and in boggy locations, ploughing of grassland is not allowed, and would be seen as an impact/intervention underlying the IMR.

The Federal Forest Act requires offsetting for the cutting of wood land under Art. 11. Offsetting in this case means reafforestation, which does not need to address biodiversity and ecosystem services issues explicitly. However, if the forest administration, normally also incorporating the view of the local nature conservation administration, considers it necessary, such reafforestation may include ecological targets, but this is not mandatory.

6.3.2 Developments in offsetting policies and legislation

Voluntary schemes were not tried in Germany, as there was general recognition that such an approach would not be effective, primarily because economic considerations would dissuade developers etc from taking measures to achieve NNL. Therefore the requirement for offsetting to achieve NNL was introduced as a legal obligation in the original FNCA in 1976.

Initially under the FNCA, on-site and like-for-like offsets ('compensation restoration') was a mandatory priority over other forms of offsets ('substitution compensation'). Such that the offset had to have a direct spatial, temporal and functional connection to the lost nature and landscape components. However, the FNCA was revised in 2009 resulting in a relaxation of the preference so that the location and form of offsetting can be appropriate to the situation.

The FNCA also originally required offsets to address specific impacts. But due to various problems, including a lack of suitable sites, the 2002 and 2009 revisions to the FNCA also loosened the link between the impacts and offsetting, so that federal states were able to introduce compensation pools or eco-accounts (Öko-Konten) which can be regarded as forms of habitat banking. One stakeholder (Mr Szaramowicz), stated that compensation pools or eco-accounts from the German perspective might be regarded as one form of habitat banks, but, are actually not synonymous. Compensation pools fulfil strict legal compensation requirements, thus, supply a demand resulting from mandatory compensation requirements, whereas habitat banks in the international context can also serve voluntary offsetting demands. For this reason we henceforth refer to compensation pools/compensation agencies (comparable with habitat banks) as the exact terminology. The change to the FNCA was brought in to increase the potential benefits for biodiversity through:

- pooling and thereby increasing the area / size of offsets;
- improving monitoring by establishing compensation agencies or entitling other institutions and assigning them with a clear task of monitoring; and
- making it easier to fulfil compensation obligations for the *Eingreifer/Polluter*.

6.4 Principles incorporated into offsetting policies

Article 14 of the FNCA shows strong adherence to the precautionary principle as mitigation and offsetting requirements apply to any project that “might” cause a significant detrimental change.

It is also based on the mitigation hierarchy, and importantly under Article 15 intervening parties are obliged to ‘refrain from causing any avoidable adverse effects on nature and landscape. Adverse effects shall be considered avoidable if reasonable alternatives are available for achieving the purpose of the intervention, at the same location, with lesser or no adverse effects on nature and landscape. Where adverse effects cannot be avoided, reasons for such unavoidability must be provided. ‘

In fact this Article appears to be give absolute priority to avoidance measures, which could be deemed unrealistic and could require measures be taken that do not result in the best environmental outcomes. However, according to most of the participants in the workshop, there is in practice reasonable interpretation of the law on this point. It recognises that it is essential to take into account the context of biodiversity and ecosystem functions, and is therefore flexible enough to allow NNL requirements to be identified and delivered on a case by case basis.

The FNCA follows the polluter-pays principle, in that the costs of mitigation and offsetting measures must be borne by the project proponent. Third party funding is only allowed if this contributes to additional measures / benefits. However, the site visit revealed that the costs of managing a grassland restoration offset (habitat bank) were in fact partly dependent on CAP direct payments.

6.5 The scope of offsetting policies

6.5.1 Biodiversity and ecosystem coverage

The FNCA requirement for mitigation and offsetting applies to interventions that affect all land areas and types (whether protected or not) and have impacts on soil, water, air and climate functions and associated biodiversity and landscape values. In other words the policy aims to achieve NNL of natural resources and the diversity, characteristic features and aesthetic qualities of nature and landscape, as well as associated recreational values. Thus the Act clearly covers changes in land-use but also functions, and in this respect captures changes in biodiversity and ecosystem services.

The legal requirements focus on habitats and their functions, and there are no particular measures that are needed for most species under the law, as it is expected that they will be covered by the necessary requirements for the other requirements (biotopes etc).

Compensation requirements concerning impacts on Natura 2000 sites are separated from IMR compensation and/or offsets. Measures cannot be mixed with each other or substitute the mutual measures as IMR offset requirements are to be established clearly in addition to the compensation measures that are required (under Article 6.4 of the Habitats Directive) to maintain the coherence of the Natura 2000 network. In exceptional cases IMR offset measures may be placed in Natura 2000 sites, but they must clearly demonstrate that they are additional to (ie do not substitute) Natura 2000 management measures, which have to be carried out and financed by the local management authority anyway, in accordance with the requirements of the Habitats Directive.

There are also additional requirements for species requiring special protection in accordance with requirements under Article 12 of the Habitats Directive.

In practice impacts and mitigation and offsetting measures are normally also taken for threatened, ie national red listed species. But there is currently no official list of nationally protected species that should require offsetting. There are legal powers to prepare such a list of nationally protected species, but this has not been done so far.

6.5.2 Sectoral coverage

The key drivers of loss that are covered by the FNCA mitigation and offsetting requirements are transport infrastructure (roads, railways and waterways), electricity infrastructure (wind-turbines, power plants, solar power, hydro-power and powerlines etc), building, housing and mining.

As noted above, agricultural, forestry and fishery activities are excluded as long as carried out in a way that follows good practice, and specific requirements detailed in Art. 5 paragraph 2 to 4 in the FNCA are to be taken into account. But interpretation of what good practice means is not easy, and in practice there is no implementation of offsetting requirements for these sectors. However, it should be noted that, in accordance with CAP requirements the area of permanent grassland (which means land that is grassland for more than 5 years) must be maintained. This regulation was implemented at a regional level until recently. But there is now a requirement for the area of permanent grassland to be maintained at a farm-level in some States, which effectively means that offsetting is required for any permanent grassland loss.

All agreed at the consultation meeting that NNL policies need to cover all sectors, at least for some significant actions (eg ploughing up grassland) but it was recognised that identifying some impacts addressing the intensification of land use (eg fertilisation of semi-natural grassland) may not be easy. So some thought it would probably be better to focus on strengthening measures to avoid and minimise impacts, eg through cross-compliance. There is already some protection of landscape features (such as hedgerows etc) and the Soil Protection Act, but not protection of farmland itself from impacts of more conventional farming activities.

6.5.3 Levels of residual impact requiring offsets

All 'significant adverse effects' are in principle covered, but in practice the interpretation of what is significant is difficult. To aid this lists of projects that are impacts by definition when they exceed a certain size have been produced in some States. But these project types and thresholds differ between States, which causes a complex situation and some confusion.

6.6 Offset design elements

6.6.1 Allowable forms of offset provision

Under the FNCA offsets can only be provided through habitat creation, re-creation or restoration, and risk aversion offsets (eg through a simple protection or management of protected habitats or sites that are at risk of degradation or loss) are not allowed. Measures that already result from other legal requirements or which are public funded cannot be considered as compensation measures. A simple 'protection/conservation' of already valuable existing habitats is not a compensation/offset according to the German legal nature conservation perspective.

There was general agreement amongst the workshop participants that risk aversion offsets are not appropriate in EU, mainly due to the difficulties of measuring and ensuring they provide long-term additional biodiversity and ecosystem service benefits.

6.6.2 Rules regarding like-for-like compensation and trading

Due to some legal changes in the past (amendment of the FNCA) it is easier nowadays to override the strict hierarchy of (1) in-kind and like-for-like and (2) out of kind/not like-for-like measures. But the preferred form of offsetting is still 'Compensation restoration', which according to the law, must have a direct spatial and functional connection to the lost nature and landscape components, and must therefore be 'in-kind'. But it is important to note that this is interpreted in terms of functions (eg the need to retain flood prevention, or ecological connectivity) rather than physical or biodiversity components. Where this is not feasible or appropriate, then offsetting may be through 'substitution measures' or 'replacement compensation', which only requires a loose spatial and functional relationship to the impact area (Louis, 2004). Thus, offsetting may be 'out-of-kind', 'of-site' and involve trading up provide that functions are maintained. But woodland, has special requirements, and offsets must be for like-for like in broad terms (ie a type of woodland, but not necessarily the same type; see described above).

6.6.3 Strategic planning of offsetting

Regional spatial planning enables the designation of areas for offsetting measures, eg to help complete ecological networks / corridors. Furthermore, there is also a national defragmentation strategy and map, which indicates broad national priorities, and some states have more detailed plans which also include lower priority measures to reduce fragmentation. Consequently offsets are sometimes used to help implement defragmentation measures (eg by road authorities). However, it should be noted that on privately owned offset sites there is little influence over their use without purchase. Indeed, whilst some landowners may not be concerned about the zoning of their land when it is carried out at a high Federal Defragmentation Programme level, there are concerns amongst some farmers when offsetting is actually established that farmland is lost as a result of the development and for the offset (thus resulting in 'double land-take'). But views on this appear to differ, as the farmer met during the pre-workshop field trip stated that the local farming co-operative considered that there are economically benefits from providing and maintaining offsets. What makes it attractive for the local farmers are the long-term maintenance contracts with a compensation agency, which ensure also a long-term and *stable* income.

All agreed at the workshop that it is important to try and integrate offsets into strategic spatial plans to increase their potential value (which may lead to net positive gains). Consequently, it has been observed that development offset proposals are more likely to be approved if they contribute to strategic aims.

6.6.4 Methods and metrics quantifying impacts and expected offset outcomes

There is no federal level standards or guidance on the assessment methods and metrics that should be used to quantify impacts and required offsets (ie credits), which has resulted in wide variety of approaches being used (Bruns, 2007; Darbi and Tausch, 2010). However, according to Darbi and Tausch, the methods comprise the following four types:

- Simple compensation area coefficients / ratios for biotope types which allocate area
- Biotope valuation procedures, which are based on the ecological value and area of biotopes – and thus equivalent to habitat hectares (see section xx of the main report)
- Cost of restoration approaches, which estimate the cost of restoring the impacted area and use that cost as a basis for ensuring equivalency (ie an equivalent amount must be spent on offsetting irrespective of what biotope is restored)
- Verbal argumentative methods, which are case by case expert judgements and allow special characteristics of impacted and offset sites to be taken into account (which would not be through simple metrics) and decisions to be made when data are lacking.

Each State has different requirements and standards, and although biotope valuation procedures are the most commonly used valuation methods, other approaches and various forms of biotope valuation procedures are used. Bruns (2007) notes that this multiplicity of approaches undermines the acceptance of valuations amongst developers. The workshop participants also felt that it creates confusion over what are acceptable standards and what is required to achieve NNL goals. This complexity can lead to uncertainty over offsetting requirements and costs (and therefore business risks), high transaction costs and possible project delays or abandonment. It may also result in poor assessments that undermine the ability to achieve NNL.

Some at the workshop therefore felt that there should be a national assessment framework, which should take into account project type (because they vary greatly in their types of impacts and other important factors). It should not prescribe detailed methods, but should advocate clear and transparent methods that are based on biotope value, but also take into account biotope functions, the time required for offsetting and risks.

However, opinions differed amongst the consultees on what is and is not allowable and typical practice. Some felt that it is important to ensure functions are maintained (ie the offset has a connection to the function) but some practitioner's say this may be too constraining.

6.6.5 Approaches to ensuring additionality of offsets

According to the national law offsets are allowed in Natura sites (this is a recent change to the law in 2010 and/or a clarification to the former regulations), but they must enhance the site (not just maintain or protect it). The law changed due to problems with finding suitable offset sites. But in some states, eg Baden-Württemberg, it is not allowed. During the pre-workshop field trip Jörg Voß from the Saxony compensation agency described one existing case where additional measures were carried out in a Natura 2000 site. The outcome of this 'test' – as Voß stated – was that the offsetting measures were the most expensive ever done by the agency (due to the requirement to 'add' to the already existing high natural value of the habitats present). As a consequence the Saxony compensation agency will not try again to implement measures based on the IMR in Natura 2000 sites. Nevertheless, the agency still tries to 'enter the overall market' for enhancing the coherence of the Natura network through external landscape measures in accordance with the Habitat Directive.

Several agreed at the workshop that it is important to ensure offsetting does not happen within Natura sites because it will have no or little additionality. This is because under the Habitats Directive Member States are obliged to ensure species and habitats of Community importance achieve a Favourable Conservation Status, and therefore if necessary measures should be taken anyway to enhance the condition of Natura sites. In theory it could be possible to carry out offsetting by going beyond the enhancement necessary to achieve Favourable Conservation Status, or addressing habitats and species that are not European features. However, in practice it would be very difficult to define and measure such additional offsetting benefits, and in turn ensure NNL is achieved.

6.6.6 The location of offsets

As discussed above there is a preference for on-site offsetting if it is possible and appropriate, but since 2009 it is no longer a mandatory priority. However, off-site offsets have to be in the same natural region ('*Naturraum*') 73 of which have been defined for Germany. Furthermore, according to one participant at the workshop in practice local administrations want offsetting to be within their county areas, although it is not a legal requirement.

6.6.7 The timing of offsets with respect to impacts

According to the FNCA (Art 15.4) offsets 'shall be maintained throughout the relevant required period' which is 'set forth by the competent authority in the relevant official approval notice'. This suggests that the offset should be maintained at least whilst the impact; it is designed to compensate for persist. However, there is much scope for interpretation and consequently there is no clear national legal obligation regarding the timing off offsets, either in terms of their initial delivery or the length of time these must be provided. Instead this is decided on a case by case basis by each state. Agreements on measures within the Saxony compensation agency last up to 30 years.

In practice IMR offsets are required within a reasonable time, and, in some cases even before the impact takes place (e.g. for re-settlement of amphibian populations to newly created reproduction habitats, before the old reproduction habitats will be destroyed), but there is no clear legal requirement for offsets based on impact mitigation legislation to be in advance of impacts or to deal with interim impacts. However, concerning the Habitat Directive requirements, as transposed in German legislation, there is a clear necessity for offsets to be in advance of impacts.

6.6.8 Performance standards

There are no published national performance standards for offsets. However, the German Federal Association of Compensation Agencies[33] developed quality standards for the work of compensation agencies and the establishment of compensation pools for environmental conservation purposes [BFAD 2008a]. According to these compensation pools and agencies can be officially recognised if they fulfil a series of criteria including:

- ensuring enhancement from a nature conservation perspective;
- safeguarding areas and measures over the long term;
- monitoring and follow up of the development of the pool areas;
- integration of offsets into other strategies and instruments; and
- compliance with high performance standards [BFAD 2008b].

6.6.9 Monitoring and reporting requirements

It is widely recognised that in the past there has been insufficient monitoring of offsets, due to a lack of clear obligations and complex and confusing requirements under the Building Code and nature conservation legislation. As further discussed below, this has caused some problems in terms of the delivery and quality of offsets.

This weakness has been recognised and addressed through the strengthening of the FNCA. Under Article 17.7 competent authorities are now required to review whether the required project mitigation measures and offsets, including maintenance measures are carried out properly and on time. The authority may also require the intervening party to provide a report. Planning officers within the competent authorities therefore have an important role in firstly ensuring the offsetting objectives are clear so that it can be reliably established

[33] Bundesverband der Flächenagenturen in Deutschland e.V. (BFAD)

whether or not the offset has been achieved. Secondly they need to check outcomes, eg by requiring a certificate of completion by the provider.

An important issue noted at the workshop is that transparency is a key requirement (which can for example be achieved by placing information on the objectives and location of offsets on the internet), so that there is an opportunity for public scrutiny of offset compliance and quality. Some felt that offsets are always put in place, but it was agreed that compliance with longer term maintenance is a more frequent problem.

There was general agreement amongst the workshop participants that offsetting must be properly monitored, verified and reported on, initially and in the longer-term. However, streamlined systems should be used, to keep burdens to reasonable levels, with for example verification checks by the competent authorities, limited to some random checks, and/ or targeted to risky or large offset.

6.6.10 Contingency measures required to address possible offset failures

Some states' regulations include a requirement for additional actions to be taken if the existing offsetting measures appear unlikely to result on the achievement of the agreed offsetting objective (Marcus, 2011).

6.6.11 The institutions involved in the offsetting and their roles

Legally, the developer is responsible for planning, financing and implementing required mitigation measures and offsetting. Therefore, in the context of administrative procedures, the developer needs to submit to authorities a so called "accompanying landscape conservation plan" ("landschaftspflegerischer Begleitplan") outlining what measures are to be implemented.

Some project proponents, such as road building authorities, carry out their own offsets as this can be cost effective for them if they have the necessary expertise, land and equipment. In fact public authorities are required to ensure that funds are spent in the most cost-effective way and this can therefore preclude their ability to use private compensation pools/habitat banks.

However, offsets for most private developments are delivered by third parties, such as local government agencies relating to land given their strong existing capacity for biodiversity management and policy planning. For example, the pre-work site visit was to a compensation pool (habitat bank) established by the Saxony Landsiedlung GmbH with its Compensation Agency that, amongst other things, is responsible for land consolidation (to address landownership issues resulting from the creation of collective farms in the former GDR). These responsibilities require a good knowledge of legal and economic issues concerning landownership, as well as the region it covers and land owners and organisations within it. Such knowledge and contacts therefore facilitate the organisation's ability to identify potential habitat banking sites, and to undertake the necessary negotiations and contractual arrangements etc to establish them.

Some organisations, such as the Saxony Compensation Agency, may receive state endorsement / accreditation as an approved habitat banking provider. Although, there is no legal requirement for habitat banks or offsets to be provided by officially approved organisations in the FNCA, there are legal requirements at the Länder/states level. In almost all cases in practice compensation agencies (habitat banks) need at least an authorisation by the regional or local nature conservation administration. Every county or local municipality has a nature conservation administration with at least one person being responsible for IMR and for monitoring and regulating measures and/or compensation agencies. In Saxony, as part of the licensing contract between the Saxony Compensation Agency and the State administration, the nature conservation administration is allowed to control and monitor the work done by the Saxony Compensation Agency at any time and at any place it chooses.

Some compensation pools, eco-accounts (and, thus, habitat banks) are delivered by private companies or third sector organisations. But there is no evidence and knowledge on how many pools/habitat banks are operated by private owners. The workshop participants believed that most of the pools/banks are set up by local government agencies. Up to now, nobody within the stakeholder group was aware of a case where an NGO operates a habitat bank.

6.6.12 Measures are taken to ensure compliance with regulations and offset requirements

Under Article 17 (5) of the FNCA competent authorities may require payment of a security of up to the cost of the anticipated offset measures to ensure fulfilment of the offsetting obligations.

6.7 Offsetting achievements and lessons learnt

6.7.1 Observed problems

A common concern over the introduction of offsetting is that it will reduce the protection of biodiversity and ecosystem services, thereby resulting in damage that could and should be avoided or reduced. To reduce this risk the mitigation hierarchy is clearly followed in the FNCA, through an explicit requirement to avoid impacts as far as possible. Development projects will not get a permit if the impact can be avoided. This results in a great deal of emphasis being placed on agreeing the location of projects. Avoidance requirements are also stronger for Natura 2000 sites in accordance with the Habitats Directive.

Nevertheless some workshop participants consider that in practice the avoidance principle is not followed as strongly as perhaps it could. For example, some so called 'avoidance' measures are not very strong (eg avoiding activities in the bird breeding season) and more effective avoidance measures (eg avoiding sensitive areas) are not adequately adopted. Consequently, some felt that in some cases not all appropriate avoidance measures are taken and offsets are employed too readily, particularly in recent years. But those that raised the concern at the meeting agreed that there does not appear to be evidence that inappropriate offsetting is a frequent significant problem.

The 2010 revisions to the FNCA introduce a requirement for the project proponent to provide a justification why avoidance cannot be undertaken if offsetting is proposed and this may increase avoidance measures. At the same time, it also increases the transparency of the process and provides an opportunity to propose offsetting measures that may be more appropriate because they provide better and more reliable outcomes than some feasible avoidance or reduction measures. It was suggested by a majority at the workshop that EU measures should include requirements for such a step to ensure that all appropriate measures to avoid impacts have actually been taken, or at least to show why it is not possible.

The most serious problem with the offsetting policy is that a number of studies have shown a significant proportion of offsets were not implemented or did not actually achieve the ecological compensation goals (eg Tischew et. al 2010; Jessel 2006; Rexmann et. al 2001). This implementation deficit arose as a result of a limited availability of land (under the former stricter like-for-like and on-site requirements) and a lack of clarity over monitoring and control responsibilities. Due to the changes in the FNCA it is now anticipated that offset implementation and achievement of ecological objectives is more certain. However, there is no current empirical evidence to examine this assumption.

Some at the workshop also expressed concern over the quality of offsets, which is also supported by the study by Tischew et al (2010). This found that of 57 studied offset areas, 26 (45%) had insufficient or poorly described restoration goals (which therefore precluded assessment of their achievement) unrecognisable implementation or were simply not carried out. In the remaining 31 compensation areas, analysis of 326 compensation goals after 8 years of establishment of the measures (in 199 sites) revealed that only 33% were fully or mostly achieved. Closer examination shows that goals were fully achieved, mostly achieved or partly achieved in:

- 51% out of 81 goals for plant communities
- 65% out of 96 goals concerning fauna
- 70% out of 111 goals for biotope structure
- 50% out of 38 goals concerning hydrological and nutrient balance

The main problems were unsuitable site conditions, improper implementation methods as well as deficient follow up management.

Some of the failings reported by the study may be dealt with by strengthened planning and monitoring requirements in the FNCA (see above). Moreover, Tischew et al also note that many of the observed technical pitfalls could be avoided through adoption of state-of-the-art restoration techniques. However, it seems likely that market forces and public spending rules will constrain the use of such techniques (eg soil striping to remove nutrients from arable land before grassland establishment), as these tend to be expensive. Developers will seek offsets that meet the necessary legal requirements at the lowest cost, rather than higher quality offsets that are more expensive. This problem was referred to by the Saxony Compensation Agency responsible for the habitat banking offset visited during the pre-workshop site visit. According to Jörg Voß, of the agency, only about 30% of their available habitat banking credits have been taken up and they are struggling to sell more because their offset credits are more expensive than others.

Provided that legal standards and locational requirements etc are met commercial pressures will clearly result in the lower cost offsets being taken up instead of others if supply exceeds demand, as appears to be the case. Furthermore, public bodies are obliged to demonstrate that their spending maximises value for money, and therefore offsets for roads etc need to be obtained at the lowest acceptable cost. The agency claims that the high cost of their offsets is due to their quality, and although this claim could not be verified there is good evidence to show that high quality biotopes are generally more expensive to create or restore.

The problem is also exacerbated by the widespread use of metrics that only provide very simple assessments of biotope value that do not properly take into account their ecological condition, functions or context. Whilst these simplistic metrics may ensure legally acceptable offsets meet basic levels of equivalency, they do not ensure the creation or restoration of biotopes that match the diversity and complexity of lost biodiversity components, functions and ecosystem services.

6.7.2 Administrative burdens on project proponents, offset providers and authorities

Workshop participants felt that views amongst developers on acceptability of the regulatory and administrative burden varies. Larger organisations (such as road authorities and gas companies) with dedicated personnel who are experienced in offsetting may not have problems with offsetting administrative requirements. However, for smaller companies who carry out offsets themselves administrative procedures and requirements may be more difficult to deal with and therefore a problem. Costs will also be proportionately greater for small offset requirements

However, the development of compensation agencies (habitat banks) and land agencies has made it much easier to carry out offsetting. For example, it is now possible in the state of Brandenburg for housing developers to deal with offsetting requirements through a simple fixed fee system, which only takes 24hrs to prepare a contract. This was stated by Anne Schöps in the Workshop who operates the Federal State of Brandenburg Sites Agency (http://www.flaechenagentur.de/).

6.7.3 Costs and/or economic benefits of current policies

The costs of offsets for road construction are typically in the order of 5.4% of the total project costs (TU Berlin, without year, p. 127).

As mentioned above, developers may also be required to pay a security fee up to the cost of the offset.

6.7.4 The overall environmental impacts of offsetting policies and measures

Despite some problems outlined above, it seems highly likely that the offsetting policy and legislative framework leads to beneficial biodiversity and ecosystem service outcomes that do offset residual impacts to some degree. Thus the introduction of mandatory offsetting requirements has some beneficial impacts compared to the former situation whereby residual impacts were not addressed. There has, however, been no impact assessment or overall study of the effectiveness of offsetting measures at a national, or any state level, and therefore the overall magnitude and extent of the impact cannot be quantified.

6.7.5 Expected future policy and legislative developments

It is expected that a draft ordinance on detailed implementation of offsetting is likely to be published in the near future and this may include measures to reduce burdens for smaller companies.

Currently the roads authority, eg in Lower Saxony, is not able to use funds for compensation agencies and habitat banks because of legal constraints on their spending, which cannot be on anything that has already been created. But legal constraints are being looked at and it is likely this constraint will be removed, although it may take some time.

6.8 Conclusions

The offsetting policy framework in Germany generally seems to be beneficial whilst also practical, resulting in relatively low costs and administrative burdens etc, and therefore businesses have accepted it and grown used to following it. However, some processes could be further streamlined, such as through adoption of more consistent approaches (eg re use of metrics) amongst the states, as the variation in approaches creates confusion and additional costs for business. The legal text includes a very strong requirement to take avoidance measures first and foremost, and does not refer to ensuring measures are appropriate such that it might appear to be too inflexible. But in practice most feel there is reasonable flexibility.

On the other hand, there is some concern that the mitigation hierarchy may not always be appropriately followed, such that some possible and more effective avoidance measures (eg location) may not be taken, and that avoidable impacts are dealt with by rehabilitation and offsetting. It was therefore agreed that greater scrutiny should be given to ensuring all reasonable and appropriate avoidance measures are taken.

Of most concern is that under the old legislation some offsets never happened, even immediately, and there are greater concerns over long-term maintenance and protection. With the new legislation and with the establishment of compensation pools (habitat banks) it seems no longer possible to avoid compensation requirements with the argument that there are no suitable sites. However, up to now there is no additional empirical evidence on how the change of the legislation actually leads to better implementation, although all participants of the workshop believe that the situation has improved. Stronger monitoring and enforcement is therefore needed, and this is addressed in the revised FNCA. However, it remains to be seen how the monitoring requirements will be interpreted and acted on in practice.

The quality of offsets is also uncertain and of concern as the use of simple metrics enables the legally acceptable provision of offsets that meet basic standards but result in significant biodiversity and ecosystem service losses.

Despite some of the problems, overall it is likely that the policy makes a significant contribution towards achieving NNL for built developments, but as a result of a lack of monitoring and impact studies, this impact cannot be quantified. Furthermore, there is a major policy gap in that there are no offsetting requirements for residual impacts from forestry, agriculture or fisheries. It was agreed by the workshop participants that these are in fact the main causes of ecosystem degradation and biodiversity loss – so this policy gap needs to be addressed – although it would be a major challenge.

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7 ANNEX 7: NO NET LOSS POLICIES AND OFFSETTING IN THE NETHERLANDS

Compiled by Elta Smith, ICF GHK

7.1 Consultees and sources of information used

This case study is based on a combination of desk research and consultation with Dutch stakeholders, including two public officials and two stakeholders involved in the development of voluntary compensation efforts in the Netherlands. Three interviews were conducted by phone and the case study findings were reviewed by the public officials through email correspondence. The consultees were:

- **de Bie, Steven** – Independent consultant and owner, Conservation Consultancy; and Partner, De Gemeynt Cooperatie.
- **Koopmans, Marnix** – Senior Nature and Biodiversity Management Policy Advisor, Ministry of Economic Affairs, Agriculture and Innovation (Ministerie van Economische Zaken, Landbouw en Innovatie), the Netherlands.
- **Simons, Henk** - Chief Expert, IUCN Netherlands Committee.
- **de Wit, Niek -** Senior Policy Coordinator, Biodiversity and Ecosystem Services, Ministry of Infrastructure and the Environment, Directorate-General Environment and International Sustainability Management (Ministerie van Infrastructuur en Milieu, Directoraat-Generaal Milieu en Internationaal Directie Duurzaamheid), the Netherlands.

Documentation on offsetting in the Netherlands is limited. This case study relies predominantly on a 2011 report to the Netherlands' Taskforce on Biodiversity and Natural Resources co-authored by Steven de Bie and Bopp van Dessel (de Bie and van Dessel, 2011). Information was also obtained from a 2013 study for DG Environment of the European Commission on EU habitat banking (Conway et al, 2013).

7.2 Overview of offsetting and other key NNL policies

No Net Loss (NNL) policies in the Netherlands include regulatory and voluntary mechanisms to compensate for residual impacts on biodiversity. Compensation is required for activities that adversely affect the integrity of any site designated as an SAC/SPA under the Nature Conservation Law (Natuurbeschermingswet), in accordance with Article 6(4) of the Habitat's Directive; ie, despite a negative assessment of the implications for the site, the activities have been granted permission to proceed on the basis of overriding public interest. The National Nature Network (also known as the Ecological Infrastructure Network) focuses on land take: ie, activities that result in land use change within the National Nature Network should only be permitted if compensatory measures are taken to ensure overall no net loss of biodiversity. Compensation is mandatory for land use change in these areas. This means that in order for permission to be granted for development that results in land use change with the National Nature Network, an agreement must be made regarding the level of compensation required to change the land use from a natural or semi-natural state.

The Dutch Government's approach to NNL policy is embedded in other strategies and legal frameworks. But the Dutch Government foresees that it is insufficient to focus only on species and habitats in protected areas as the pressure exerted outside those areas also impacts on those species in the protected areas.

7.3 NNL and offsetting policy framework and development

7.3.1 The key policies that contribute to NNL

Compensation is mandatory in the Netherlands in Natura 2000 areas under the Nature Conservation Law (Natuurbeschermingswet) and is a condition for permitting developments.[34] The Netherlands also established the National Nature Network, embedded within the 'Infrastructure and Spatial Planning' policy[35]. Compensation is required for negative impacts within the network on protected species that are listed as threatened in the Red Lists according to the Nature Conservation Act 1998 and the EU Birds Directive (Directive 2009/147/EC) and Habitats Directive (Directive 92/43/EEC).

Mandatory compensation may also apply under the Forestry Law ('Boswet'), the Flora and Fauna Law, or under provincial regulations for smaller public natural areas or areas other than nature areas. The Law on Spatial Planning provides the legal framework for the conservation of these areas under provincial regulations. Further provisions on the implementation and regulation of compensation are formalised in regional and local spatial and development plans (de Bie & van Dessel, 2011). Existing rules and regulations have been set as a result of binding commitments to certain targets under, for example, the Convention on Biological Diversity.

7.3.2 Developments in offsetting policies and legislation

The use of biodiversity offsetting, as defined in this contract report, has been limited in the Netherlands due to the high administrative burden associated with their implementation and the lack of available land in the Netherlands for offset provision (de Bie & van Dessel, 2011).

Voluntary compensation is being pursued in the Netherlands by the Platform Biodiversity, Ecosystems and Economy (BEE)[36] and is the basis of the 'Biodiversity and Economy' Green Deal agreed upon by the Platform BEE and the Dutch Government in December 2011 (Simons and van Zadelhoff, 2013). The objective of this voluntary initiative is to achieve NNL for biodiversity in the Netherlands, with no further loss of species and their habitats. Under its Nature Policy, the Dutch Government has chosen 1982 as the reference year against which to formulate NNL targets because of policy commitments made in that year. The reference year of 2011 has been adopted by the business community, marking the year in which the Platform BEE signed the Green Deal with Government (Simons & van Zadelhoff, 2013). This year was chosen to measure voluntary efforts that go beyond the mandatory compensation already required under national and European legislative frameworks (Simons and van Zadelhoff, 2013).

[34] In accordance with Article 6((2), (3) and (4) of the Habitats Directive regarding the need for avoidance, appropriate assessment and overriding public interest

[35] In Dutch: Structuurvisie Infrastructuur en Ruimte, or SVIR

[36] The Platform Biodiversity, Ecosystems & Economy (Platform BEE) is a joint initiative of IUCN NL and the Confederation of Netherlands Industry and Employers (VNO-NCW).

The Platform BEE strategy is being implemented at one level by establishing protected areas through national laws that implement the Birds and Habitats Directive and through Natura 2000 areas. The approach is about more than offsetting, however, as it attempts to look more comprehensively at the burden that an individual or a business places on biodiversity (de Bie, pers. comm. 2013). This depends in part on 'pressure factors' - such as dependencies on water or raw material use, spatial occupation, emissions, solid waste, light, etc - that together impact on biodiversity. The approach also attempts to facilitate business engagement to have a positive impact on biodiversity (eg greening production sites or engaging with local partners).

Businesses that have signed up to the Platform BEE pledge to adopt the mitigation hierarchy, including compensation for any residual impacts. But the system is entirely voluntary except for developments within European and national protected areas where national regulation already applies.

The Dutch Government's policy approach thus includes mandatory compensation under existing legal frameworks, but seeks greater efficiency and harmonisation of compensation requirements through voluntary initiatives to develop 'biodiversity neutral' approaches to conducting business. The Dutch NNL policy has not yet been translated into legislation, but piloting studies are currently on-going with companies through voluntary participation.

7.4 The scope of offsetting policies

Current Dutch laws and regulations already establish a system of protection for designated areas. The voluntary approach that is being developed by Platform BEE accepts that managing biodiversity is about managing and reducing the pressure factors, and taking opportunities to ensure a positive biodiversity impact in the wider countryside beyond protected areas. The focus of the voluntary initiative is in principle open to all sectors. A group of consulting companies has developed a cooperative to execute the NNL pilot studies and prepare profiles for companies in the southern part of the country. At this stage, no decision has been taken on how the initiative will be implemented.

The Dutch Government has also put in place two initiatives, the first of which focuses on developing links between biodiversity and other decision-making processes (eg agriculture and water) and the second engages with businesses to encourage the integration of biodiversity objectives into their activities.

Marine systems are also covered by the Dutch Government initiative, although attempting compensation in marine environments is more difficult than in terrestrial ecosystems due to the challenges of linking human activities to biodiversity impacts. Additionally, marine-related activities are not well-defined as a sector and it has been difficult to apply policies in this area without a sector to target.

The laws that protect species and habitats do not address ecosystem services as such, but the EU Water Framework Directive is translated into water management policy in the Netherlands, and covers issues related to provision of ecosystem services which are part of environmental quality laws.

7.5 Offset design elements

7.5.1 Rules regarding like-for-like compensation and trading

Compensation for the loss of protected areas must be compensated for by establishing a new area of land to perform that function (like-for-like compensation). This is always subject to the mitigation hierarchy, whereby biodiversity offsets are considered to be a last resort (Doswald et al, 2012). Individuals who wish to undertake a particular activity are required to demonstrate that there is no alternative but to have a particular activity on a particular site in a particular way (Koopmans pers. comm., 2013). There is a system of public consultation to enable citizens to view any such development plans and object to it if they wish (ie file a complaint in a court). Trading-up is required if compensation cannot be provided in the same quantity of land taken.

The National Nature Network requires that a correction factor be applied to the areas that are developed within the Network in order to compensate for the qualitative loss of nature values during the time that the new area needs for development to a mature stage (de Bie & van Dessel, 2011; cited in Conway et al, 2013).

7.5.2 The location of offsets

Compensation measures should be undertaken at or near the site affected by development. Recent changes to the legislation permit an activity to be undertaken if the quality of the remaining area of the site affected is enhanced, rather than by creating new habitat elsewhere to compensate for losses.

7.5.3 The timing of offsets with respect to impacts

In principle, compensation must begin before the development activity is undertaken, but in practice compensation often occurs afterwards (de Bie, pers. comm., 2013).

7.5.4 Monitoring and reporting requirements

There is no official monitoring system to assess whether long-term offsets are realised. Dutch authorities maintain a database of flora and fauna that quantifies increases or decreases in species numbers over time, but there is no link between this information and the outcomes of any compensation scheme (de Bie, pers. comm., 2013).

7.5.5 The institutions involved in the offsetting and their roles

In the Netherlands, policy concerning nature compensation is decentralised to provinces. This has resulted in 12 different schemes for compensation within the National Nature Network (Koopmans, pers. comm. 2013).

7.5.6 Measures taken to ensure compliance with regulations and offset requirements

Offsetting activities are linked to permits to ensure compliance; that is, planning permission permit granted only after an individual has provided authorities with a plan detailing how the offset will be provided. Compliance with the compensation requirements should be enforced through fines if the activities are not undertaken in accordance with the agreed offset provision plan. While ensuring adequate compensation is strictly enforced under the Birds Directive and Habitats Directive, enforcement of the National Nature Network compensation scheme has been very weak to date (de Bie, pers. comm., 2013).

7.6 Offsetting achievements and lessons learnt

7.6.1 Observed problems

Generally, compensation that has been required under the NNN either has not been carried out at all or, in cases where compensatory measures have been put in place, they have been of poor quality (de Bie, pers. comm., 2013). Overall, it was felt that the scheme should work well in principle, but it has not been properly implemented to date.

Current efforts to develop a biodiversity indicator to benchmark sectors and companies should help to assess both the environmental and business effects of compensation requirements in the future.

The key challenge for offsetting initiatives in the Netherlands is the lack of available land for offsets (Koopmans and de Bie, pers. comm., 2013).

7.6.2 Expected future policy and legislative developments

The new focus on NNL accepts as its premise that species protection alone does not guarantee their survival (de Bie, pers. comm., 2013). The reduction of pressures outside of the protected areas where protected species can be found are equally or perhaps more important than the conservation of protected areas (de Bie, pers. comm., 2013).

7.7 Conclusions

Offsetting is required in Dutch law for areas outside the Natura 2000 network, applying to areas within the National Nature Network, but rarely implemented in practice. Dutch policy development has begun to focus on voluntary compensation rather than mandatory compensation, but these initiatives have not been translated into legislation.

7.8 References

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de Bie, S and van Dessel, B (2011) *Compensation for biodiversity loss. Advice to the Netherlands' Taskforce on Biodiversity and Natural Resource*. Advice to the Netherlands' Taskforce on Biodiversity and Natural Resource. De Gemeynt, http://www.gemeynt.nl/files/Pb2011-002.pdf.

Doswald, N, Barcellos Harris, N M, Jones, M, Pilla, E and Mulder, I (2012) *Biodiversity offsets: voluntary and compliance regimes. A review of existing schemes, initiatives and guidance for financial institutions*. UNEP-WCMC, Cambridge and UNEP FI, Geneva.

Simons, H and van Zadelhoff, E (2013) *No Net Loss of biodiversity. Working paper*. Platform Biodiversity, Ecosystems and Economy, http://www.bedrijfslevenenbiodiversiteit.nl/assets/Working-Paper-No-Net-Loss.pdf.

8 ANNEX 8: NO NET LOSS POLICIES AND OFFSETTING IN SWEDEN

Compiled by Graham Tucker

8.1 Consultees and sources of information used

Mainly based on information provided by Jörgen Sundin of the Swedish Environmental Protection Agency (SEPA) [Naturvardsverket] supplemented by discussions with Jörgen Sundin and Scott Cole (EnviroEconomics Sweden - consultancy) and comments by Anders Sjölund (Swedish Transport Administration [Trafikverket]) and Jesper Persson (Swedish University of Agricultural Sciences).

8.2 Overview of offsetting and other key NNL policies

There is no overall policy framework that aims to achieve no net loss (NNL) of biodiversity and ecosystem services in Sweden. Compensation measures are mandatory requirements for impacts on Natura 2000 sites and species protected under the Habitats Directive (as they are in all EU Member States), but also for some nationally protected areas. The Environmental Code also provides regional authorities with the powers to require compensation[37] for substantial residual impacts outside protected areas as part of the permitting procedure[38]. However, these powers are rarely used and most residual impacts are not compensated for. Some voluntary compensation is undertaken, mainly with respect to urban and transport related developments, but this is also rare.

Where compensation is carried out for impacts outside protected areas, it is usually through some form of direct measures that aim to create or restore lost resources (eg habitat), but there is no habitat banking in Sweden. However, a fee-in-lieu system ('the fisheries fee') is used where activities, such as hydropower operations or coastal developments, have impacts on fish stocks.

8.3 NNL and offsetting policy framework and development

8.3.1 The key policies that contribute to NNL

Chapters 1-7 of the Environmental Code form the backbone of the Swedish regulatory framework for nature protection. The Code includes provisions that implement the requirements of the Habitats Directive, and accordingly compensatory measures (equivalent to offsets) are required for activities that have unavoidable detrimental impacts on Natura 2000 sites (Chapter 7, Sections 28b and 29). Residual impacts on species listed in Annex IV of the Habitats Directive that require strict protection wherever they occur are also subject to compensation requirements under the Species Protection Ordinance.

[37] The term compensation is used here because there is no requirement to achieve no net loss, in contrast to the aims of offsetting.
[38] Proceeding för att även omfatta dispenser. Gäller hela dokumentet

The remainder of this national case study report focuses on compensatory requirements for habitats and species that are not protected by the Habitats Directive.

According to the Environmental Code, mandatory compensation is required for significant damage to nature reserves. Such compensation must focus on the values that have led to the designation as a nature reserve. There is no mandatory requirement for compensation for residual impacts on biodiversity outside protected areas. However, the Environmental Code enables authorities to require environmental compensation for residual impacts when granting an environmental permit or exemption to prohibitions. According to Chapter 16, Section 9 of the Environmental Code:

'Permits and exemptions and decisions to withdraw permits or exemptions may be issued subject to the obligation to carry out or pay for the following measures:

1. *a special examination of the area concerned;*
2. *specific measures for conservation of the area; and*
3. *specific measures to compensate for any encroachment on public interests due to the activity.'*

These measures do not explicitly require the achievement of NNL but they do provide a legal mechanism that can require some levels of compensation, which normally focus on public interests, including biodiversity, but also recreation and other ecosystem services.

However, the measures only apply to substantial impacts and in practice compensation has only been required in a fraction of all cases where permits or exemptions are issued; although it should be noted that in most cases the resulting impacts are minor. For example, results from an on-going study[39] indicate that the average number of road and rail projects with some form of compensation has been about 8 per year between 2004-2013 compared to some 2,800 rail and road projects that were in the planning or construction phase in 2013[40].

Compensation is required where activities result in declines in fish stocks. For example, this applies to large-scale hydropower development impacts on river habitats and their constraints on fish passage, and the impacts of costal developments (eg docks or marinas) on cod spawning in sea-grass beds. In such situations compensation is carried out through a kind of fee-in-lieu scheme to provide resource-based or monetary compensation for damage to fishing interests. Thus there is direct compensation for fishery related ecosystem services, but not others.

[39] Persson, J. Utvärdering av miljökompensation vid väg- och järnvägsprojekt" [Evaluation of environmental compensation in road and rail projects]. http://www.slu.se/sv/fakulteter/ltj/institutioner-vid-ltj-fakulteten/institutionen-for-landskapsarkitektur-planering-och-forvaltning-/forskning/forskningsprojekt/utvardering-av-miljokompensation-vid-vag-och-jarnvagsprojekt/

[40] Anders Sölund, Swedish Transport Administration, pers. comm.

Spatial planning is not covered by the Environmental Code but by the Planning and Building Act, which is more tailored towards development than conservation. The Act contains general provisions on nature protection, including the need to minimize impacts, but there are no explicit requirements for compensation/offsetting or NNL.

8.3.2 Developments in offsetting policies and legislation

According to the consultees, although low levels of compensation have been carried out in the past, it is becoming more common (although some might be considered to be mitigation). This is not the result of any changes in legislation or policy, but greater awareness of the need for compensation and offsetting schemes abroad, for example through a number of recent conferences[41]. Public awareness of compensation issues was also raised as a result of a recent controversial rail project that led to significant impacts on a Natura site (Botniabanan) and substantial compensatory measures. Although no studies have been conducted on the subject, some consultees felt that attitudes to offsetting have also changed amongst nature conservations; in the past many have been sceptical about the potential for effective offsetting (for example because in practice many habitats in Sweden cannot be easily re-created / restored in reasonable time). There is also concern that increasing offsetting may reduce protection levels and open up areas where development would not have occurred if compensation was not an option. On the other hand, there is growing concern over the cumulative impacts of small projects and a realisation that their impacts need to be addressed. As a result County Administration Boards and municipal authorities are increasingly using the provisions in Chapter 16, Section 9 of the Environmental Code, to require compensation for significant residual impacts. Nevertheless, compensation for impacts outside protected areas is still currently very uncommon.

8.4 Principles incorporated into offsetting policies

The polluter pays principle and precautionary principles are probably the main factors influencing current environmental legislation. Problems concerning cumulative impacts are also taken into account but references to the proportionality principle are made to justify the decision to follow a case-by-case approach rather than a requirement for mandatory compensation system outside protected areas[42]. However, when it comes to nature reserves, it is stated that these should have a high standard of protection, and the requirement to compensate residual impacts on these was introduced to support this level of protection in cases where permits are granted in spite of adverse effects on the reserves.

SEPA remains concerned that the mitigation hierarchy may not be properly incorporated in the current legislation and policy framework, and that as a result protection levels may be lowered. Their view is that compensation should not justify an impact on the environment that can be avoided through suitable localisation, design and/or mitigation measures. However, in practice there is a lot of confusion over what appropriate mitigation is, and what unavoidable residual impacts that require compensation are. As a result the hierarchy may not be properly followed.

[41] http://www.enetjarnnatur.se/static/sv/237/

[42] Swedish government office 1997. DS 1997:52 Kompensation för förlust av naturvärden

8.5 The scope of offsetting policies

8.5.1 Biodiversity and ecosystem coverage

Compensation for habitats and species not covered by the Habitats Directive is decided on case by case basis (in accordance with Chapter 16 Section 9 of the Environment Code). In practice compensation for the species and habitats is uncommon, but more likely where rare or threatened habitats or species are adversely affected.

The Environmental Code does not explicitly refer to the need to compensate for 'ecosystem services', but some are taken into account to some extent through the requirement to consider impacts on 'public interests' (EC chapter 16, section 9). For example, a 2005 court case concerning a fish farm resulted in the proponent having to create a wetland upstream to compensate for nutrient emissions from the development. Recreational facilities are also mentioned in the legislative history preceding the general provisions on compensation in chapter 16 of the Code.

8.5.2 Sectoral coverage

Compensation requirements outside protect areas and for species not listed in Annex 4 of the Habitats Directive only relate to activities covered by the Environmental Code, which include large infrastructure projects, and industrial and energy developments. The Code does not cover housing and urban developments, but some voluntary compensation is carried out for such developments.

Recent changes to acts governing road and railway construction have been made with the intention of reducing permitting delays and uncertainty (eg relating to differing interpretations and practices amongst boards and planning officers). Important changes included reducing the requirement for Environmental Impact Assessments to cases where considerable impacts on the environment are expected. The combined result of the changes can be less consideration of biodiversity impacts and a step away from the achievement of NNL.

No compensation occurs for impacts of agricultural or forestry related activities, although under the Swedish policy on forestry, which is based on a principle of freedom under responsibility, landowners are expected to voluntarily set aside a small (≈5%) proportion of their woodland for conservation purposes.

8.5.3 Levels of residual impact requiring offsets

There is no clear indication in the Environmental Code of the appropriate threshold for compensation requirements outside protected areas. Given that the legal powers included in the Code to demand compensation are used infrequently, it appears that the damage threshold before compensation can be legally required is in practice very high. However, there is a difference in practice between different Counties when it comes to the damage threshold. It should also be noted that in some cases legal powers are not required because the proponent may be willing to compensate 'semi-voluntarily' (although this may not be sufficient to achieve NNL).

There are some indications, as discussed above, that demands for compensation seem to have become more frequent in environmental permits during the last couple of years, which may indicate a lowering of the damage threshold (although it may also be due in part to misuse of the term compensation).

8.6 Offset design elements

An indication of the typical approach to offsetting in Sweden is outlined below, but it is important to note that no national guidance or standards exist, and therefore it is difficult to summarize principles and processes in detail.

8.6.1 Allowable forms of offset provision

Where compensation is required it is normally through restoration and habitat creation/enhancement, but there have been cases of protection/risk aversion as well.

Compensation for impacts of water activities on fishing are partly dealt with through a fee-in-lieu system. For example, some fees are paid to a state fund according to a simple size-based fee by Water Companies for permits to produce hydro-electric power. The funds are then used for research related to fish stocks and commercial fishing and in some cases restoration projects, but not necessarily in the same water-shed. In addition, local assessments of impacts are also carried out as part of the planning agreement, and some of the collected funds are given to those with fishing rights (through fishing associations) that are likely to be impacted by the development. The fishing association may then spend the money on measures to improve river habitat and fishing (ie to compensate impacts on fishing interests) but they do not need to. Some funds may also go to local communities for local projects, which are not necessarily linked to environmental issues. This system does not therefore aim to achieve overall NNL (or address all impact ecosystem services), although it may do so for some impacts if the level of funding is sufficient and stakeholders decide to direct the funds to measures that directly address the impacts.

8.6.2 Rules regarding like-for-like compensation and trading up

Like-for-like compensation is the norm, and there are no references to trading up in the Environmental Code or in the legislative history (ie legal bills or related reports on the purpose or interpretation of legislation). But trading up has in some rare cases been accepted when there has been a strong rationale to do so.

8.6.3 Strategic planning of offsetting

There is generally no strategic planning of compensation, although there are some rudimentary city/municipal level initiatives. Some Counties have developed landscape (ecology) strategies that might support strategic decisions on compensation, but they have not been developed for this purpose.

8.6.4 Methods and metrics quantifying impacts and expected offset outcomes

There are no official methods to assess compensation requirements outside Natura 2000 sites. In practice the required compensation approach has most often been based on an assessment of what can be agreed to with the project proponent. This is a flexible approach but results in the degree to which compensation contributes to the achieving NNL, or even net gain, being highly dependent on the attitude of the operator/proponent. There have therefore been discussions about how to decide the correct amount of compensation, based on an objective assessment of valuation of losses and gains. As a result, some local authorities (Stockholm, Gothenburg, Helsingborg, Örebro and others) have developed their own guidelines, with varying degree of sophistication. Some have also financed a study that aims to provide guidance (which will be based on the REMEDE approach) on appropriate compensation for impacts on sea-grass beds from coastal developments[43].

8.6.5 Approaches to ensuring additionality of offsets

There are no official criteria for assessing additionality of proposed compensation measures in Sweden. However, a general rule of thumb is that conservation measures demanded by law or listed in management plans for protected areas are the responsibility of the authorities, and therefore such measures should not be accepted as compensation. But this rule may in some cases be questioned, because in reality there are insufficient funds to undertake all required management actions in protected areas.

8.6.6 The location of offsets

On-site and in-kind compensation is preferred for protected areas and nationally protected biodiversity. Similarly other compensation measures are mostly on-site and, to a slightly lesser degree, in-kind. But actual ecological requirements are not always carefully considered in the design of compensatory measures.

Voluntary municipal level compensation initiatives are more variable, and often incorporate a more flexible approach.

8.6.7 The timing of offsets with respect to impacts

There are no general requirements regarding the timing of compensation for impacts on biodiversity that is not covered by the nature directives. As a result, it is not uncommon for development permits to be given before the design of compensatory measures is finalised. Requirements regarding the duration of compensation are decided on a case-by-case basis.

8.6.8 Performance standards

There are no national level performance standards for compensation measures.

8.6.9 Monitoring and reporting requirements

Monitoring is, in theory, required and a responsibility of both the operator (ie compensation provider) and environmental authority. In practice the resources available to carry out compliance monitoring are limited and only the most important conditions in the permit are

[43] http://www.bioenv.gu.se/english/research/research-areas/Plant_Ecology/zorro/?languageId=100001&contentId=-1&disableRedirect=true&returnUrl=http%3A%2F%2Fwww.bioenv.gu.se%2Fforskning%2Fforskningsomraden%2Fekologi-och-naturvard%2Fzorro%2F

normally followed up thoroughly by the responsible authority. The quality of the operator's control and environmental reports also varies.

According to the Swedish Transport Administration[44] county Boards often include requirements for follow-up studies as part of permits for infrastructure projects. But the results from such studies are very seldom asked for, stored or analysed. Consequently, no system for learning by doing is built up, neither by the operator or the authority.

8.6.10 Contingency measures required to address possible offset failures

There are no general or formalised contingency measures, but appropriate measures may be decided on a case-by-case basis as part of the conditions in the environmental permit. The permit may stipulate the required outcomes from the compensation, but this can pose a challenge especially in dynamic habitats. The problem is distinguishing between adverse effects that are under the control of the compensation provider and other factors (eg external pollution). In such circumstances it may be difficult to come up with conditions that allow for adaptive management without creating unacceptable uncertainties for the operator.

8.6.11 The institutions involved in the offsetting and their roles

There are no specific institutional arrangements or governance related to compensation in Sweden. Compensation measures outside protected areas, and for non-protected biodiversity, are secured through general operations under the Environmental Code, which typically involve:

- NGOs or local, regional and national authorities etc. may raise a demand that certain impacts should be compensated for.
- Operators/proponents are responsible for evaluating residual impacts and proposing compensation (where applicable). This is done after consultation with the County Administrative Board.
- Environmental courts or for smaller projects, County Administrative Boards, are responsible for granting permits and exemptions and prescribing adequate conditions, including conditions regarding compensation.
- Supervisory authorities for the implementation of the compensation are the County Administrative Boards or, in some cases, municipalities.
- The SEPA has the responsibility to give guidance on environmental legislation, including provisions regarding environmental compensation.

In the case of the large compensation programme that was implemented as part of the Botniabanan railroad project (affecting a Natura 2000 site), a trust was set up to ensure long-term funding of management and monitoring. This arrangement has, however, been questioned by the government as it is not in line with public fiscal rules and will probably not be used again.

[44] Anders Sjölund Swedish Transport Administration pers. comm.

8.6.12 Measures are taken to ensure compliance with regulations and offset requirements

Compensation provisions are secured through the conditions or terms listed in the environmental resolution, or, in the case of spatial planning and urban development, in the provisions listed in the spatial plan and/or the exploitation agreement between the local authorities and the developer. The authority responsible for supervision of the operation may issue an injunction requiring the operator to comply with the conditions in the resolution (including those concerning compensation). If the operator does not comply, he may face penalties.

8.7 Offsetting achievements and lessons learnt

8.7.1 Observed problems

The main problem with compensation in Sweden outside protected areas is the absence of a clear regulatory framework where all involved know what is expected and how compensation fits into the larger picture of the mitigation hierarchy and the permitting procedure (including EIA-process). This is exacerbated by a lack of national guidance and guiding judgements on compensation from the environmental court of appeals. As a result courts and County administrative boards are not used to handling compensation issues. There are also regional differences in the application of current legislation.

Evidence for this comes from a study conducted as a master thesis at Umeå University[45] in 2012, which investigated the application of environmental compensation with a focus on the experience and attitudes among officers in the county administrations of Sweden. The study was based on qualitative interviews with county administration officers and quantitative analysis of documents. The results showed that the awareness of the legal requirement to support and apply environmental compensation varied a lot among the respondents. There was confusion about the concept of compensation and an uncertainty of when and to what level it is feasible to require environmental compensation.

8.7.2 Administrative burdens on project proponents, offset providers and authorities

At the moment the infrequent requirements for compensation probably result in very low levels of public administrative burdens. Administrative burdens may, however, be significant for developers. This may be in part due to the lack of guidance and established practice, which creates uncertainties for both developers and the public sector. There are sometimes lengthy discussions on what is to be considered appropriate compensation, and these discussions often arise late in the permitting process. This not only causes uncertainty in the planning process and project delays (eg through lengthy legal appeals) but also precludes the development of ecologically sound compensation projects, which could be integrated into the process if considered from the beginning.

8.7.3 Costs and/or economic benefits of current policies

As far as the consultees knew, no studies of the costs of providing compensation have been carried out in Sweden. Nevertheless, as compensation is quite rare in Sweden today, the costs have probably been limited. Individual project costs vary considerably according to

[45] *http://www.enetjarn.se/static/sv/311/images/Examensarbete.pdf*

circumstances but in most cases are probably a small proportion of the total development costs. However, in the case of the Botniabanan rail project, where discussions regarding compensation for impacts on the Natura 2000 site caused delays of the project, the costs were substantial. Information on the benefits of the compensation are likely to be available in the near future as a result of a five-year follow-up study.

8.7.4 The overall environmental impacts of offsetting policies and measures

It is clear that the overall impact of biodiversity and ecosystem service compensation policies in Sweden, is very low for biodiversity outside protected areas and unprotected by the nature directives. Even where some compensation measures are required, it is unlikely that NNL is frequently achieved. Although voluntary efforts may or may not individually achieve good results, they are still quite rare.

8.7.5 Expected future policy and legislative developments

There is an increasing debate on compensation and offsetting in Sweden, for example as a result of recent seminars. A recent editorial in an environmental journal argued for the development of habitat banking to more cost effectively meet the expected compensation requirements coming from the EU[46]. In addition, a guidance document on compensating for seagrass losses in the marine environment is expected in 2014 or 2015. Consequently, the existing legislation and polices governing compensation requirements may need to be reconsidered as they currently comprise a patchwork that has evolved independently over an extended period of time, with no overarching principles or goals.

A recent Official Report of a Swedish public inquiry [47] suggests that a comprehensive study should be conducted in 2014, with the aim of analyzing the legal conditions and necessary legislative changes for a potential NNL approach to compensation in Sweden. The Report highlights the need for a more consistent approach to compensation outside protected areas and lays out some basic principles concerning the mitigation hierarchy, additionality, and long term outcomes of compensation in a potential re-designed Swedish compensation / offsetting system. Consequently, although the Swedish government plans to present a bill on biodiversity in 2014, it is likely to await the results of the EU NNL initiative before possibly going ahead with national legislation.

8.8 Conclusions

Currently in Sweden, compensation requirements are relatively strong and effective for residual impacts on biodiversity (and, indirectly, associated ecosystems services) in Natura 2000 sites and some nationally protected areas, and for species subject to strict protection measures under the Habitats Directive. However, there are still some issues concerning more diffuse effects from, for example, agriculture and forestry that make it hard to achieve NNL.

[46] A. Enetjärn, S. Cole, & L. Hasselström (2013) http://miljoaktuellt.idg.se/2.1845/1.512924/debatt--ekologisk-kompensation-far-inte-bli-exploatorernas-fribiljett

[47] Official Report of a Swedish public inquiry 2013:68 Betänkande av utredningen *Synliggöra värdet av Ekosystemtjänster- Åtgärder för välfärd genom biologisk mångfald och ekosystemtjänster*

For other biodiversity compensation for residual impacts is very uncommon, mainly due to the absence of a clear regulatory framework that has a clear unambiguous requirement for offsets that aim to achieve NNL in accordance with the mitigation hierarchy and the existing permitting procedure (including EIA-process). Furthermore, this is exacerbated by a lack of national guidance and decisive rulings by the Environmental Court regarding interpretation of compensation requirements in the Environmental Code and the application of the mitigation hierarchy.

9 ANNEX 9: NO NET LOSS POLICIES AND OFFSETTING IN ENGLAND

Compiled by A.J. McConville

9.1 Consultees and sources of information used

This case study draws on the literature available on Defra's website detailing the Government's approach to the pilot offsets in England and on the strategies developed for the pilots themselves where available. We also used evidence provided to the House of Commons Environmental Audit Committee (24 October 2013) regarding biodiversity offsetting and the outcomes of a Royal Society debate (22 October 2013) on the topic.

9.2 Overview of offsetting and other key NNL policies

The UK has a relatively robust regulatory framework for biodiversity without having a formal, nation-wide offsetting scheme yet in place. Central to its conservation strategy is the network of Sites of Special Scientific Interest (SSSIs) to protect the most important sites for wildlife and geological features, and which covers 8% the country's land area[48]. Nevertheless, a large proportion of England's natural and semi-natural habitat occurs outside legally protected areas where natural environments are increasingly under threat (Treweek, 2009). Despite much of this habitat (along with its associated species) being listed as Priority Habitat[49] in the UK Biodiversity Action Plan and listed as Local Sites[50], it is afforded limited protection from development.

A number of measures already exist to protect biodiversity in the 'wider countryside'. The Countryside and Rights of Way Act (2000), updated by the Natural Environment and Rural Communities Act (2006), imposes what is known as the 'Biodiversity Duty' on certain public authorities –including local planning authorities – which requires that they must "*have regard, so far as is consistent with the proper exercise of [their] functions, to the purpose of conserving biodiversity*". This duty, along with associated requirements under the planning framework (see below) have resulted in some planning authorities seeking compensation for impacts on biodiversity, including the use of offsets (Treweek, 2009). Nevertheless, evidence for the Department of Environment, Food and Rural Affairs (Defra) suggests that its application is sporadic with biodiversity impacts often not being taken into account (Tyldesley et al, 2012).

[48] http://www.naturalengland.org.uk/ourwork/conservation/designations/sssi/

[49] Priority habitats are those identified under Section 41 of the Natural Environment and Communities Act 2006 which required the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. 56 habitats have been included on the list and are all those identified in England as requiring action under the UK Biodiversity Action Plan (UK BAP) and continue to be regarded as conservation priorities in the UK Post-2010 Biodiversity Framework.

[50] Local Sites are non-statutory areas of local importance for nature conservation that complement nationally and internationally designated geological and wildlife sites. They are designated for their scientific, educational and historical value as well as their visual qualities. Several different titles including Sites of Importance for Nature Conservation (SINCS), Sites of Nature Conservation Importance (SNCIs) and County Wildlife Sites.

In 2011, the Government in effect adopted a 'No Net Loss' (NNL) policy with its publication of the Natural Environment White Paper[51] (HM Government, 2011) - albeit without establishing a time period by which to achieve it. The White Paper sets out to "*move progressively from net biodiversity loss to net gain, by supporting healthy, well-functioning ecosystems and establishing more coherent ecological networks*." The White Paper builds on the findings of a review of England's wildlife sites and ecological network (Lawton et al, 2010), which concluded that the Government should improve the *quality* of current wildlife sites by better management; increase the *size* of existing wildlife sites; enhance *connections* between sites; create *new sites*; and *reduce pressures* on wildlife by improving the wider environment.

A central response by the Government to fulfil the requirements of the Lawton Review and to move towards net gain of biodiversity is the commitment to establish a new voluntary approach to offsetting and to test the system in pilot areas. The biodiversity offset pilots were established by the Government in 2012 in six regions of England (Devon; Doncaster; Essex; Greater Norwich; Nottinghamshire and Warwickshire, Coventry and Solihull) and their progress will be reviewed in spring 2014.

In September 2013, Defra published a Green Paper[52] for consultation on the options for an offsetting scheme in England, in which it states the Government's preference for a voluntary approach, allowing developers to opt-in to the use of offsets in order to fulfil their requirements under the planning framework (DEFRA, 2013a). The consultation period was concluded on the 7th November, and is expected to feed into a Government decision on a biodiversity offsetting scheme for the country as a whole.

9.3 NNL and offsetting policy framework and development

9.3.1 The key policies that contribute to NNL

Taking into account the requirements under the Habitats Directive (92/43/EEC), Environment Impact Assessment Directive (2011/92/EU) and Strategic Environmental Assessment Directive (2001/42/EC), the National Planning Policy Framework (NPPF) planning system provides the most important safeguards for biodiversity from development. It aims to contribute to and enhance the natural and local environment by "*minimising impacts on biodiversity and providing net gains in biodiversity where possible ... including by establishing coherent ecological networks that are more resilient to current and future pressures*" (paragraph 109). Furthermore, the system includes a provision to apply the mitigation hierarchy to developments on the basis of expected loss of biodiversity: "*if significant harm resulting from a development cannot be avoided (through locating on an alternative site with less harmful impacts), adequately mitigated, or, as a last resort compensated for, then planning permission should be refused"* (paragraph 118). This

[51] A White Paper produced by the UK Government sets out details of future policy on a particular subject and is often the basis for a Bill to be put before Parliament. The White Paper allows the Government an opportunity to gather feedback before it formally presents the policies as a Bill.

[52] Green Papers are consultation documents produced by the UK Government, normally when a government department is considering introducing a new law. The aim of the document is to allow people both inside and outside Parliament to debate the subject and give the department feedback on its suggestions.

replaced a similar requirement in Planning Policy Statement 9 (PPS9) under the previous planning system.

9.3.2 Developments in offsetting policies and legislation

The Government sees offsetting as a possible means of meeting existing biodiversity requirements under the NPPF and other planning regimes. The publication of Defra's Green Paper on biodiversity offsets (DEFRA, 2013a) and the launch of the pilot biodiversity offsets represent the most significant developments to date with respect to English offsetting policy. The Government very clearly sets out its priorities for any offsetting scheme in the Green Paper, stating that it will only introduce an offsetting scheme if it is convinced it will:

- Improve the delivery of the requirements of the planning system regarding biodiversity to ensure it is "*quicker, cheaper and more certain for developers*".
- Achieve net gain for biodiversity by ensuring the number of 'biodiversity units' (see below) lost at a development site are provided at an alternative site (ie 'no net loss'); and endeavouring to locate offsets in a way that enhances the ecological network (ie 'net gain').
- Avoid additional costs to business.

Overall, there are eight pilot offsetting schemes that have been on-going since spring 2012 over six regions, with Devon been split into three pilots: North Devon, Heart of Devon and South Devon. The schemes are led in each case by local authorities which have been tasked, as a first step, with producing biodiversity offset strategies, setting out the approaches and priorities for the scheme in their local area. Defra has deliberately limited its engagement in the delivery of the strategies in order not to prejudice the emergence of different approaches. As of October 2013, four pilots had produced completed strategies (Doncaster[53], Essex[54], Greater Norfolk[55] and Nottinghamshire[56]) while the strategy for South Devon[57] is awaiting formal adoption. At least one additional region, Somerset, has initiated its own offsetting scheme outside the pilot and has published its strategy and methodology (Somerset County Council, 2013).

9.4 Principles incorporated into offsetting policies

The principles upon which the Government has based its proposed approach to biodiversity offsetting were set out in "Biodiversity Offsetting: guiding principles for biodiversity offsetting" (DEFRA, 2011; see Box 1).

[53] http://www.doncaster.gov.uk/Images/Doncasters%20Biodiversity%20Offsetting%20Process37-99742.pdf
[54] http://www.essex.gov.uk/Environment%20Planning/Environmental-Issues/local-environment/Wildlife-and-Biodiversity/Documents/Offsetting_Strategy.pdf
[55] Available upon request.
[56] http://www.nottinghamshire.gov.uk/thecouncil/democracy/planning/biodiversityoffsetting/
[57] Available upon request

Box 1. Guiding principles for biodiversity offsetting in England

The principles that have guided Defra's proposed approach to biodiversity offsetting are that it should:

- Not change existing levels of protection for biodiversity.

- Deliver real benefits for biodiversity by:
  - seeking to improve the effectiveness of managing compensation for biodiversity loss;
  - expanding and restoring habitats, not merely protecting the extent and condition of what is already there;
  - using offsets to contribute to enhancing England's ecological network by creating more; bigger, better and joined areas for biodiversity (as discussed in *Making Space for Nature*)
  - providing additionality; ie not being used to deliver something that would have happened anyway;
  - creating habitat which lasts in perpetuity;
  - being at the bottom of the mitigation hierarchy, and requiring avoidance and mitigation of impacts to take place first.

- Be managed at the local level as far as possible:
  - within national priorities for managing England's biodiversity;
  - within a standard framework, which provides a level of consistency for all involved;
  - through partnerships at a level that makes sense spatially, such as county level, catchment or natural area;
  - with the right level of national support and guidance to build capacity where it is needed;
  - involving local communities.

- Be as simple and straightforward as possible, for developers, local authorities and others.

- Be transparent, giving clarity on how the offset calculations are derived and allowing people to see how offset resources are being used.

- Be good value for money.

Source: Defra (2011)

In its Green Paper, the Government considers a number of options where offsetting could contribute to fulfilling existing requirements under the planning regime, the potential costs of which are analysed in the Impact Assessment (DEFRA, 2013b). The options are:

- **A fully permissive system**: developers could choose to use the offsetting metric to assess their development's impacts and would be free to select the means of ensuring compensation.

- **A partially permissive system**: developers would be required to use the offsetting metric to assess their project's impacts but free to select the means of ensuring compensation.

- **A uniform system**: projects that exceed a certain threshold would be required to use the offsetting metric to assess impacts and to obtain an offset for compensation; developments below the threshold could opt-in to using offsetting. This threshold could refer to the size of the development or to the quality of the habitat being impacted (eg excluding land classed as "low distinctiveness and poor quality").

- **A Community Infrastructure Levy (CIL)[58]**: the local planning authority purchases offsets sufficient to compensate for the aggregate impact on biodiversity of developments in their area, funded by a levy built in to their charging schedule.

9.5 The scope of offsetting policies

9.5.1 Biodiversity and ecosystem coverage

The Green Paper recognises that there are scientific and legal limitations on the use of offsetting, including:

- Habitats that are impossible to recreate in a meaningful time period, such as ancient woodland or limestone pavement.
- Those habitats and species specifically protected by legislation, for instance, under the Habitats Directive.

Nevertheless, the Government envisages the offset market could be a useful tool to support compensation - when the policy tests are met - more quickly and cheaply than it currently occurs at present. For instance, for irreplaceable habitats and SSSIs, the conditions of paragraph 118 of the NPPF (see above) would have to be met; in the latter circumstance, this should only occur if it is possible to provide the same type of habitat as the SSSI affected (DEFRA, 2013a).

The Green Paper suggests that offsetting could be used in the marine environment (below mean low water mark) but do not intend to include the marine environment within the general proposals for an offsetting regime at this stage. Nevertheless, offsetting could apply in coastal zones, providing there is suitable recognition of their particular circumstances.

The system is based on habitats – rather than species – and focuses on maintaining biodiversity *per se* rather than the services that flow from biodiversity and ecosystems. This is because these services are anticipated to be highly site-specific and difficult to measure (DEFRA, 2013b).

9.5.2 Sectoral coverage

The offsetting requirements in the pilot refer to only those developments subject to consideration under the planning system (such as energy or transport infrastructure, urban expansion and industrial developments). Land use change as a consequence of farming, fishing or forestry practices are not included, nor are small-scale developments with no new physical footprint eg extensions, loft conversions (DEFRA, 2013b).

[58] The CIL system, which is already in place in England, allows councils in England and Wales to raise funds for infrastructure to support an area's development by imposing a charge per square metre of development. Before a council can begin raising cash through the levy, it must publish a table of levy charges - known as a charging schedule - so that each developer can calculate up front how much CIL it must pay for its development. These set out levy rates, variations across economic zones within council areas, different levy rates for different development classes and exemptions.

9.5.3 Levels of residual impact requiring offsets

Under the NPPF, only those developments causing "*significant harm*" that cannot be avoided through relocating or adequately mitigated require compensation through biodiversity offsets. However, no guidance is provided to define what this means in practice leading the Local Planning Authorities to set their own standards.

9.6 Offset design elements

9.6.1 Methods and metrics quantifying impacts and expected offset outcomes

Defra and Natural England have produced a technical paper on the metrics to be tested by the eight on-going biodiversity offsetting pilots in England (DEFRA and Natural England, 2012). The purpose of the metric is to establish a consistent and transparent framework for considering biodiversity impacts and to ensure that compensation put in place for residual harm from development results in quantifiable and measurable outcomes. The metric converts an assessment of overall biodiversity into 'biodiversity units'; the system aims to achieve 'no net loss' by ensuring offsets are provided in a ratio that gives (at least) one biodiversity unit for every biodiversity unit lost.

Under the metric being trialled by the pilots, the value of a given habitat is calculated in biodiversity units based on three factors:

- **Distinctiveness:** to be assessed as low, medium or high. This factor reflects the rarity of the habitat concerned (at local, regional, national and international levels) and the degree to which it supports species rarely found in other habitats.[59]

- **Habitat quality:** to be assessed as poor, moderate or good, using a standard framework. The framework adopted for the pilots is the "Higher Level Stewardship: Farm Environment Plan (FEP) Manual" (Natural England, 2010). This was selected over alternative options as the assessment is based on the condition of habitats rather than their management, and the categories are evenly spread, making it suitable for use within the matrix used for the offsetting metric (see Table 1).

- **Area:** the area of the habitat measured in hectares.

The Green Paper states that "*it has been suggested that the pilot metric can be applied in 20 minutes*". Once assessed, the value of the habitat in biodiversity units per hectare is calculated using Table 1. This score is then multiplied by the number of hectares that will be lost to obtain the value in biodiversity units that must be restored or created under an offset scheme.

[59] Further guidance to support the pilots has been provided setting out the distinctiveness rating for different habitat types, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/218680/1204-bio-offset-pilot-appendix.pdf

Table 1. Method for calculating biodiversity units of a site under the Defra metric

Value of 1 ha in biodiversity units		Habitat distinctiveness		
		Low (2)	**Medium (4)**	**High (6)**
Habitat quality	**Good (3)**	6	12	18
	Moderate (2)	4	8	12
	Poor (1)	2	4	6

Source: DEFRA and Natural England (2012)

The same system is used to calculate the value of the offset that must be provided, but three additional factors must be considered. These are:

- The **risk** associated with habitat restoration or creation - as not all activities succeed in delivering the biodiversity units anticipated.
- The **time** period between the development occurring and the offset site reaching its biodiversity unit target. This is compensated for by applying a 3.5% discount rate (as set out in the HM Treasury's Green Book (HM Treasury, 2003)), resulting in an increase in the requirement of biodiversity units to be created the longer the offset is expected to take to reach maturity.
- The **location** of the offset. The local authorities in the pilot areas are expected to develop strategies outlining where the offsets should be located in order to maximise the environmental gain. Larger offsets will be required for those that are to be located outside the area identified for offset provision (DEFRA, 2013b).

Defra has resisted calls to treat species more specifically within the metric for the pilot offsets. It gives two reasons for this:

- A guiding principle is that there are to be no changes to existing levels of protection for biodiversity: therefore species protected under European legislation are excluded from the scheme.
- The metric should be universally usable: many of the species are localised and different species would be important in different areas, requiring a significant degree of local interpretation.

Somerset Council, on the other hand, have established a species-led metric which concentrates on the requirements to maintain species' populations, on the basis that protected species and other important species in the wider countryside are more likely to be affected by development than important habitat. The metric is based on Temple et al (2010), which considers that a habitat metric alone will not produce a 'no net biodiversity loss', as is the aim of the process.

Their methodology uses data from all the Zones of Influence listed on the Somerset Priority Species List which is then partially automated within the biodiversity offsetting process. Although species-led metrics can lead to expensive surveys (see main report), Somerset state that, despite a required initial investment of research, this system does not increase overall burdens or uncertainty and can be amended to fit local purposes in different areas. The approach requires detailed information about where habitats are located and which species are likely to frequent them.

Defra encourages developers in pilot areas to make planning applications in the usual way, including avoiding and mitigating impacts on biodiversity and to compensate for biodiversity loss under planning policy. In contrast, Somerset Council considers it too late to implement biodiversity offsetting in the planning process, preferring instead to initiate biodiversity offsets at the site allocation stage of a local development plan, which is published in order to inform the prospective developer of what is required at a given site.

9.6.2 Rules regarding like-for-like compensation and trading

England encourages a system of 'trading up'; ie, trading losses in habitat of low conservation significance for gains in threatened habitats (Quetier and Lavorel, 2011). A key guiding principle of the system designed by Defra for the pilots is that it should result in a net gain for biodiversity (DEFRA, 2011; DEFRA & Natural England, 2012). The focus of offset provision is therefore on habitat restoration and creation of *priority* habitats, as identified in Section 41 of the Natural Environment and Rural Communities Act 2006. Where development takes place on habitats within the low distinctiveness band, the offset actions should result in the expansion or restoration of habitats in the medium or, preferably, higher distinctiveness bands. At no time is 'trading down' permissible.

Hedgerows – which are an important feature of the landscape in the UK– are dealt with in a separate manner within the metric. Hedgerows play a vital role in the provision of nesting sites, corridors, feeding sites and shelter belts, and therefore their contribution to biodiversity within the landscape is deemed to be far greater per unit of area than even the most biodiversity-rich habitat types (DEFRA, 2013b). For the use in the pilots, hedgerows are treated as a separate habitat type band alongside the main offset requirement; ie a development on a grassland containing hedgerows would have to offset both habitat types. The amount of hedgerow to be created as an offset will depend on the quality of the hedgerow lost.

9.6.3 Approaches to ensuring additionality of offsets

The Government has yet to establish a system to ensure additionality of offsets and will await the conclusion of the consultation period on its Green Paper. In its consultation paper, Defra expresses support for the use of habitat banking – where an offset provider undertakes habitat restoration or creation in advance of a demand in the anticipation they will be able to sell it at a later stage – as a model that the Government wants to allow. Nevertheless, it adds a number of caveats:

- The baseline must be fully understood to ensure the gain from habitat banking is properly quantified.
- The intent to generate an offset must be shown.
- Over time, a habitat bank will become an established part of the ecological network regardless of whether it has been sold as an offset. At this point, it becomes

considered part of the baseline and it will no longer be acceptable to use unsold biodiversity units as offsets.

In addition, the Green Paper raise two related questions on which it is seeking feedback:

- Whether maintaining a site in good condition should be allowed to qualify as an offset, as is the case for some species banking systems in the United States; and
- Whether biodiversity created as an incidental benefit of another regulatory or planning requirement should be qualify for offset credits (eg where a developer is installing a sustainable urban drainage system for flood risk alleviation and in doing so creates habitat with biodiversity value). This may be considered additional if there were other ways to fulfil the primary purpose of the investment (in this case, flood prevention).

The strategies of the pilots that are in the public domain do not address the issue of additionality.

9.6.4 Strategic planning of offsetting

The authorities establishing the pilots have been allowed to establish their own strategic priorities for the offset schemes in their area. This has resulted in slightly different approaches. For instance, South Devon has prioritised the design of the offsets to benefit priority habitats and two flagship species in particular: Greater Horseshoe Bat (*Rhinolophus ferrumequinum*) and Cirl Bunting (*Emberiza cirlus*). Therefore, the boundary of the pilot area (within which offset provision is to occur) is based on the habitat of these two species, covering five Local Planning Authority areas (J. Miller, pers. comm.)[60]. Essex have instead adopted the Essex Living Landscapes[61] network, which represents the best landscapes for wildlife in the county and those with the most potential to deliver biodiversity enhancements, as the intended area for offsets (Essex County Council, 2012). In North Devon, in an effort to increase uptake of offsets, the policy has been written into the North Devon Council and Torridge District Council draft local plans (Evans, 2013).

9.7 Offsetting achievements and lessons learnt

9.7.1 Observed problems

Concerns have been expressed about the ability of the metric to accurately reflect the biodiversity value of a site. One of the metric's architects, Jo Treweek of Treweek Environmental Consultants, pointed out that, as it has been adopted, the metric does not provide any indication of the important species living in the habitat (Evans, 2013). In its review of the Government's offsetting policy, the House of Commons Environmental Audit Committee (EAC) (2013) concluded that the metric was too simplistic and should be improved to "*reflect the full complexity of habitats, including particular species, local habitat*

[60] Jonny Miller, Biodiversity Offset Programme Manager, Teignbridge Council
[61] http://www.essexwt.org.uk/living-landscapes

significance, ecosystem services provided and 'ecosystem network' connectivity". It expressed concern that the metric could be applied to sites in twenty minutes, suggesting that this type of rapid assessment would be highly subjective and could easily miss the key species that use the site. The EAC were also sceptical that the current proposals had adequately demonstrated how offsetting would deliver "biodiversity gain".

Despite strong support from the Government and assurances that the scheme should not be an additional burden to businesses, the uptake of pilot offsets by developers has been disappointing, with no developments expecting to use offsets yet as part of the planning process (Evans, 2013). No Net Loss already exists as a concept within the planning system but is not being achieved in part because the option to refuse schemes on biodiversity grounds is being balanced against the need for new housing and business development (Evans, 2013).

9.7.2 Administrative burdens on project proponents, offset providers and authorities

In theory, the NPPF should already be resulting in offsetting to compensate for biodiversity losses; in practice, however, the lack of resources and trained ecologists within local authorities and the slow pace of the planning system have resulted in very limited use of this option, a conclusion shared by attendees at the Royal Society debate on biodiversity offsets[62]. In North Devon, the transaction costs have been cited as making it unfeasible to apply offsetting to very small developments; yet – according to Andy Bell of North Devon – half the land take in the region is for developments of four houses or less (Evans, 2013).

The EAC (2013) insists that, if the Government introduces an offsetting scheme, it must require local planning authorities to audit and validate assessments. The Government, it states, must allow local authorities to recoup the additional costs of this process from developers or else make the required funds available from the Treasury.

9.7.3 Costs and/or economic benefits of current policies

The Government is clear that an offsetting regime should not increase costs or burdens to developers – while simultaneously achieving net gain for biodiversity – and therefore favours a fully permissive approach. The main costs, by any offset regime, are identified as:

- Set-up costs for planning authorities establishing the offset schemes.
- Additional costs to some developers to provide compensation where they do not currently.
- Transaction costs for each offsetting scheme, on the part of the local authority and the developer.

In principle, it is hoped that an offsetting regime will reduce costs for developers in a number of ways. Firstly, the use of a unified system with a simple metric can be expected to reduce process costs, such as assessing biodiversity value. Secondly, the use of the mitigation hierarchy followed by offsetting could allow effective compensation to be

[62] http://blogs.royalsociety.org/in-verba/2013/10/31/constructive-debate-on-the-diverse-issues-of-biodiversity-offsetting/

achieved offsite (rather than adopting less effective onsite measures commonly used currently), thus freeing up developable land. Finally, the existence of an established offsetting regime may allow developments to go ahead where onsite compensation is not feasible and currently planning authorities consider offsite measures too uncertain; under the existing planning regime these circumstances would likely end in a refusal of planning permission.

There are also expected advantages of creating a larger market, which is anticipated to encourage offset providers to enter the market and drive down costs. In addition, the costs per hectare of restoring natural areas can decrease significantly as the size of the site increases due to economies of scale. These larger initiatives will only come forward if demand is high. If supply of offsets is low, developers may find it difficult to find a suitable offset to ensure compensation, thus slowing down the planning process and increasing transaction costs.

Of relevance to a Government commitment not to increase burdens on house-builders, the Impact Assessment (DEFRA, 2013b) expects around 56% of the direct costs of offsetting to fall on the residential development sector. Nevertheless, the same sector is expected to benefit should the potential business benefits of offsetting materialise – thus making the net impact unclear. The view that offsetting - and the use of an agreed national metric in particular - could speed up the planning process and reduce costs to developers was supported by a representative of the Home Builders Federation in evidence to the Environmental Audit Committee[63].

9.8 Conclusions

In its recent Natural Environment White Paper, the English Government committed to "*move from net loss of biodiversity to net gain*", establishing an important principle through out Government policy-making. A central tenet of the Government's plan to deliver this commitment is the trialling of eight biodiversity offset schemes in six regions of England, with the anticipation that it will be scaled up to the rest of the country if proven successful.

However, Government has been very clear that it will not support the implementation of an offsetting regime unless it is satisfied that it will improve the delivery of the requirements in the planning system so that the system becomes quicker, cheaper and more certain for businesses – while at the same time ensuring net gain for biodiversity. The Government is committed to honouring a promise not to increase net burdens on housing developers over the Spending Review 2010 period (ie 2011 to 2015). It is therefore questionable whether NNL can be achieved with this constraint.

In theory, the principle of implementing the mitigation hierarchy (avoid, minimise, offset) is already enshrined in the National Planning Policy Framework - where "*significant harm*" to biodiversity is expected - with local planning authorities given the power to refuse permission if these conditions are unmet. Nevertheless, evidence clearly indicates that the

[63] http://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/news/biodiversity-offsetting-evidence-1/. Available upon request.

system is not working satisfactorily for either the environment or developers, with impacts on biodiversity (other than protected habitats and species) not appropriately or consistently addressed (Tyldesley et al, 2012). Crucially, it was found that for 85% of the 46 cases reviewed residual biodiversity losses were not compensated for (Tyldesley et al, 2012). In addition, the planning regime can be slow and uncertain, meaning that homes and premises are not being built as quickly as they could be. The cumulative costs may affect the viability of projects and in some cases stop them from going ahead (DEFRA, 2013a).

The Government believes that offsetting has the potential to reduce costs to developers – while also providing net biodiversity gain – by creating clarity regarding the requirements on developers and creating a ready market which can be utilised to quickly find suitable offsets. It acknowledges that the existence of a larger offsetting market (to, for example, develop habitat banks) is particularly important in driving down costs.

Nevertheless, the Government prefers a voluntary system to allow developers to opt-in to the offsetting scheme if it suits their interests, rather than applying a mandatory approach. Currently, the eight pilots trialling this voluntary approach have developed, or are in the process of developing local biodiversity offsetting strategies. Despite this, no offsetting has yet occurred, as developers appear reluctant to commit to the scheme (Evans, 2013). It is unclear at present if this is a consequence of offsetting being considered an additional burden/cost to developers, or if simply insufficient time has been given to allow the planning process to function[64].

The idea to introduce mandatory offsetting in England appears to enjoy a wide degree of support. At a recent conference on offsetting hosted by the Royal Society, academics, RSPB (biodiversity NGO) and the Environment Bank (habitat banking brokers) all supported a mandatory system providing that it does not weaken existing safeguards including legislation to conserve protected species and habitats. This approach is also favoured by the business-led Ecosystem Markets Taskforce (2013), established by the Government, with the same caveat. A notable exception is Friends of the Earth who is opposed to the introduction of a national offsetting system on the basis that a perfectly adequately system is already in place under the planning system but poorly implemented as a consequence of the lack of capacity and expertise within local authorities – an aspect that is unlikely to change unless local authorities are provided with more funding to pay for them. They also expressed fears that the approach will, nevertheless, be used to undermine existing protection measures. The Government is expected to make a decision on its offsetting policy after the publication of this study.

Concerns remain, in particular, about the effectiveness of the metric developed by the Government, with a wide range of stakeholders suggesting that it does not adequately reflect the "*full complexity of habitats*" (Environmental Audit Committee, 2013), with many preferring a species component to be added to the metric.

It remains to be seen if the Government will continue to support offsetting if the expected benefits do not materialise early and offsetting does instead result in a net cost to

[64] http://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/news/biodiversity-offsetting-evidence-1/. Available upon request.

developers. Already there is concern amongst ecologists that the Government and/or local authorities may, with the current emphasis within Government on promoting new housing and business development, take leave of the guiding principles and apply offsetting approaches to high distinctiveness areas and/or protected areas, as almost occurred in a recent case in the south-east of England (Woodfield, 2013).

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10 ANNEX 10: BRIEF SYNOPSIS OF LESSONS LEARNED FRPOM INTERNATIONAL OFFSETTING EXPERIENCE

By Kerry ten Kate (based on a presentation to the Project Workshop on the 4th July 2013).

10.1 International offsetting experiences and implications for the EU

The international context for biodiversity offsetting is the new social compact which has been emerging over the last decade. Until this change, there was broad acceptance that development projects' social and environmental impacts should be avoided and minimized to some degree, but were an acceptable cost of the corresponding economic benefits in terms of economic growth, GDP, jobs, royalties and infrastructure. However, as familiarity with the concepts of sustainable development has grown in business, government, finance and in civil society, a new social compact has been emerging in which the economic benefits of development are expected to be accompanied by social and environmental benefits. (See variously: MMSD 2003, ICMM 2003, Creamer 2012, Fraser 2011, Boutilier and Thompson 2011, African Union, 2009, Buxton, 2012.) In the last few years, this expectation has become clearer with respect to biodiversity, as a variety of requirements and commitments to 'no net loss' (NNL) or a 'net gain' of biodiversity have emerged. (See IFC 2012, ICMM 2012, BBOP 2012a.)

Developments on NNL have advanced over the last few years on several fronts. Some 40 countries have introduced requirements (TBC 2012, Madsen et al 2011), as the members of the Equator Principles Association have espoused the revised version of IFC's Performance Standard 6 (Equator Principles, 2011), as developers and financial institutions have gained experience and published case studies of pilot projects (See, for instance, BBOP 2012c, TBC, 2012), as the international, multistakeholder Standard on Biodiversity Offsets has been published by BBOP (BBOP 2012a), as methodologies and toolkits to guide the design and implementation of biodiversity offsets have become available (See for example BBOP 2012b and ICMM 2012), and as a variety of governments, companies and international organisations have made statements and commitments on the subject. (ICMM 2012, Madsen et al 2011, Convention on Biological Diversity Conference of the Parties (COP)8: Decision VIII/17 (Private-sector engagement); COP9: Decision IX/11 (Review of implementation of Articles 20 and 21); Decision IX/18 (Protected Areas); Decision IX/26 (Promoting business engagement); COP10: Decision X/21 (Business Engagement).)

Despite these advances, there are considerable challenges to the widespread and successful implementation of NNL policies and practices. Chief among these is the lack of political will on the part of governments to mandate developers to integrate NNL into their project planning and permitting processes in an unambiguous manner. The corollary in the private sector is the limited will, in the current socioeconomic and regulatory context, to introduce corporate commitments to NNL. Other difficulties are the institutional barriers within financial institutions (such as different interests in their investment, safeguards and advisory departments) and obstacles for the NGO and scientific communities to provide the data and skills on which NNL implementation relies. Finally, the staff in all these groups lack capacity to understand, manage and implement NNL approaches fully, as do many of their consultants and advisers (BBOP & UNEP-Finance Initiative, 2010, and pers.comm in several countries and companies).

Historically, governments have sometimes approached NNL piecemeal, starting, typically, with a regulatory instrument and only putting in place the complementary information, maps, planning tools, strategies, guidance and training needed to give effect to the policy instruments in the following years. Indeed, experience from the USA, Australia, the EU, Brazil and South Africa teaches that most countries have taken two decades or more to develop the suite of policy measures, tools and information needed to support NNL policies, particularly where implementation can be through market-based systems such as conservation banking and biodiversity credits. (Pers comm. George Kelly, Wayne White, Palmer Hough , Michael Crowe). This can be illustrated by the case of Victoria, Australia, where a sophisticated but practical approach to NNL, including the use of offsets, has emerged since 1989, and is still being developed today.

- 1989 - Regulation of native vegetation clearing was introduced, in response to the realisation that some 80% of native vegetation cover had been lost on private land compared to the pre-1750 state. The regulation led to the end of broad-scale clearing of native vegetation. However offsetting was sporadic and unquantified.

- 1998 - Biodiversity mapping was brought in, with mapping of extant vegetation, modelled maps of native vegetation in the year 1750, mapping of bioregions, and mapping of the presence of threatened species. This provided a state-wide information base that supports offset design. But offsets were still not the norm.

- 2000 – The (voluntary) auction-based incentive program 'BushTender' was brought in. While this is not an offset system, it introduced site assessment and landowner agreements. This developed key techniques that are core to offsets outside the regulatory environment and allowed the state to gain experience that could then be used for offsets.

- 2002 – The Native Vegetation Management Framework policy was introduced. This clarified the basis for determining NNL (through 'like-for-like' offsets) and the metrics for offsets. However, developers found it hard to find their offsets: identifying suitable locations and landowners prepared to cooperate.

- 2007/8 – The offset market based on credit trading was introduced. This provided for third party suppliers, brokers and a credit register (Pers comm Michael Crowe).

Since 2007, the government-operated broker has conducted over 300 trades of over Aus$34 million in value. In addition, private brokers have been established. ESLink, for instance, has undertaken more than 30 trades since 2010 (Pers comm Michael Crowe). The Victorian offset system is still evolving, with 'NaturePrint[65]' under development by Victoria's Department of Environment and Primary Industries (DEPI) as an information provision service to support sound offset planning. NaturePrint is a mechanism being developed to integrate and analyse the best state-wide information about biodiversity values, threatening

[65] See http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/natureprint

processes and ecosystem function at the landscape scale, all available through DEPI's databases. The government hopes this will offer further improvements to the offsetting system by providing a consistent basis to understand the synergies and trade-offs involved in policy options and operational decisions.

The ***implications for the EU*** from lessons such as this from Victoria (and very similar lessons from other parts of Australia and from the USA and other countries) are that a sequential approach is needed to move towards NNL, and that it is unrealistic to think of it as a short-term, 'once off' policy change. The most constructive approach to take is to set out a strategy for moving towards NNL, covering core components such as policy, awareness raising and training, data generation and mapping, etc. Drawing from several of the more mature experiences around the world, it is now possible to identify some common elements of strategies for NNL. In its exploration of a NNL Initiative, the European Union may benefit from preparing a strategy that contains some or all of these elements, at least:

- **Policy/regulation:** A clear **trigger** for the requirement for developers to deliver NNL, (for instance, through Environmental Impact Assessments and/or the planning requirements). This can be a brief but unambiguous regulatory provision.

- **Policy/guidance:** To complement the regulatory requirement for NNL, government can offer guidance that clarifies the rules of the game, such as the scope of the NNL requirements; minimum and maximum thresholds; exchange rules (to operationalise the 'like for like or better' principle); metrics for loss-gain calculations; implementation options that developers face; the range of activities that are acceptable means of obtaining the 'gain' needed for offsets; guidance on the geographical aspects of offsets, such as landscape level planning, site selection and 'service areas'; the procedure for integrating the mitigation hierarchy including offsets with various planning and licensing processes (eg EIA); and how temporal issues will be dealt with, for instance through time discounting.

- **Supply side:** Regulators of offsets often concentrate on the triggers and requirements for NNL first, and do not necessarily ensure that those whom the system envisages will provide the offsets are lined up and prepared to meet the demand when it arises, creating frustration and delays for developers. Consequently, a plan for how potential suppliers will be prepared prior to offset requirements entering into force is advisable. This can cover the gain strategy (restoration versus averted risk offsets), finding and preparing suppliers, and testing the process prior to its entry into force with auctions and/or pilots.

- **Implementation:** Defining which implementation options exist for developers (for instance, permittee-led offsets in which developers implement their own offsets, or in lieu fees to government, or the use of conservation banks and biodiversity credits), setting the standards for implementing and defining whether there will be a preference for any of the implementation options (see the paragraph below about perverse incentives). Where market mechanisms are envisaged, the strategy should embrace the establishment of an offset (credit) register, management agreements, and brokers.

- **Training:** for the consultants and advisers who will apply the offset guidance and serve as assessors for government; and for offset providers as well as for the regulators themselves and for brokers.

Economics: Governments contemplating the introduction of NNL schemes, or with NNL systems in force, may find it useful to undertake cost-benefit studies to assess the economic impacts of NNL policy. This could explore which sectors in society are likely to pay the costs of an offset system (ie development sectors with an impact on biodiversity) and which sectors will benefit from a growth in jobs (eg offset assessors, offset providers and the service sector). There are many lessons to be learned from some thirty years of compensation and offsets worldwide on some of the specific aspects of biodiversity offset, one level below the importance of having of an overarching strategy. There is a broad literature on the subject of offsets and compensation.[66] By way of illustration, experience from the two principal regulatory frameworks for biodiversity offsets in the USA, namely wetland mitigation (which is analogous to offsetting in accordance with the terminology used in this report) under the Clean Water Act and species banking under the Endangered Species Act (Carroll et al 2008), reveals a number of key features that are in common with several other offset systems around the world and suggest ***implications for the EU***:

- Developers must purchase or provide habitat similar to that which they plan to convert.

    ⇒ This underlines the importance within the EU of defining ecological equivalence, service areas and metrics.

- Banks can only sell approved credits that meet agreed performance criteria over a fixed timetable.

    ⇒ The EU/Member States will need to define credits, standards, performance criteria, and consider restoration ecology timelines.

- Credits can only be used once.

    ⇒ The EU/Member States will need to establish registries and verification.

- Habitat must be conserved in perpetuity.

    ⇒ The EU/Member States will need to design the NNL-Initiative with a view to ensuring cost-benefit for suppliers, land tenure, benefit-sharing

- Price of credits includes land acquisition, rehabilitation, and endowment of a trust fund for long-term management

    ⇒ The EU/Member States will need to establish financial models, land prices and restoration costs, determine market size, trust fund mechanisms, monitoring and evaluation, and consider insurance, bonds and provisions for insolvency.

[66] See, for instance, the BBOP Library http://bbop.forest-trends.org/documents/

One of the features of NNL planning and biodiversity offsets that set them apart from other approaches to conservation and conservation finance is the quantification of residual impacts and offset gains, so as to know whether NNL has been achieved. Offset systems require metrics. There are many different approaches to offset metrics. Reviews of metrics reveal a range of approaches from simple area with 'ratios' to more detailed functional assessments. For instance, there are over 100 metrics used in the US and over 40 in Germany (BBOP 2009a and b). Despite this variety, metrics can be readily classified into just a few different approaches: area based, area x condition (which is the core of current best practice), species-based metrics based on measurement of population, and, very occasionally, economic valuation (see, for instance, BBOP 2012b, Temple et al, 2012 and ICMM 2012). There is much to learn here ***for the EU***, since it is important to pick metrics that are fit for purpose and suited to the circumstances in which they will be used, and the last few years are filled with successes and failure.

Biodiversity planning seldom takes place in a vacuum: indeed, the business case for biodiversity offsets is usually part of a broader business case for high quality risk management, covering other aspects of social and environmental management, as well as human rights, governance and ethical issues (Grigg, A and ten Kate, K. 2004). In addition, governments, the private sector and civil society are preoccupied with other sustainable development imperatives, such as climate change and the conservation and sustainable use of water resources. A key principle of biodiversity offsets is landscape level planning (see, for example, the BBOP Principles and Standard (BBOP, 2012a) and McKenney and Kiesecker et al, 2010). For instance, the third BBOP principle states 'Landscape context: A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.' This involves designing and implementing offset activities to complement and contribute to biodiversity conservation priorities identified at the landscape, eco-regional and national levels. It also involves designing and implementing offset activities for the long term, taking into consideration other likely developments (e.g., competing land use pressures) within the landscape. Taken together, the broad range of issues capturing the attention of decision-makers and the importance of regional and landscape level planning for biodiversity offsets mean that ***the EU*** will need to consider biodiversity offsets in the context of broad land-use planning for multiple landuses. There are lessons here for Europe from other jurisdictions, which are considering how to stack, layer and bundle rights associated with biodiversity, water and carbon and avoid 'double dipping' (in which landowners or sellers can sell the same activities twice to more than one buyer). Some have had to deal with how to do this after piecemeal development of different systems (relating to carbon, biodiversity, water, and social development) (see for example Ingram, 2012, Lau, 2012, Truty, 2010, Carroll et al 2008). ***Implications for the EU*** are that it may be wise to plan the NNL Initiative so as to layer carbon, biodiversity, water and perhaps livelihood 'credits' in a landscape; to support good land-use planning; to develop tools that help landowners to study opportunities and costs from provision of biodiversity credits and other ecosystem services and more traditional goods and services; and to clarify the legal issues inherent in stacking and bundling.

Regulatory frameworks for biodiversity offsets commonly offer developers a range of options as to how to fulfil their offset obligations in terms of implementation. Lessons from several countries show that it is important to consider potential unintended consequences and perverse incentives that may arise from offset frameworks. An illustrative example can be found from the USA, where developers were given three choices for how to undertake their offset obligations:

- **Permittee-responsible implementation** (in which the developer would undertake its own offset): This provided a comparatively easy option for developers, since they were obliged to submit their plans to the US Army Corps of Engineers for approval, but in practice there were no stringent ecological standards for how these plans would be implemented, often no monitoring of the results to speak of, and it was permissible for the developers to undertake the impacts prior to the offsetting.

The two other implementation options are referred to as 'third-party mitigation' (ie offsetting undertaken by an organization other than the developer), since responsibility and liability for completion are transferred to a party other than permittee.

- **Payment to in-lieu funds** (in which the developer would pay for a third party (often government) to undertake the offsetting activities on its behalf: This also proved to be a comparatively easy option for developers. Once the public agency or non-profit organization agreed to undertake the offset, the developer could obtain approval for damage before mitigation was underway. There was little oversight and few standards for this approach.

- **Mitigation banks** (referred to as habitat banks in this report),in which the developer would purchase credits from an approved bank. This approach proved to be comparatively difficult for the developer, since the conservation banks were held to strictest ecological and operating standards and consequently their costs were higher than the two approaches described above, which were not monitored and enforced to the same degree. Offsets within banks needed to be completed before credits could be sold. The approach requires conservation easements setting aside land in perpetuity and a substantial cash bond, to ensure long-term viability. (Pers.comm, George Kelly)

Unsurprisingly, in the circumstances described above, many developers undertook their own offsets or paid in lieu, and as there were inadequate standards, monitoring and enforcement, offsets were often not implemented successfully in the long term, and the NNL policy did not enjoy routine success. (Pers comm. George Kelly and Wayne White. ELI 2006, ELI 2007)

New regulations took effect on 9 June 2008 and seek to promote one standard for offsetting, whichever of the three methods of implementation described above is selected. Furthermore, there is a 'preference' for habitat banking. The more level policy playing field established by this change has increased the use of banking as an implementation method and also success in terms of NNL outcomes.

Another example of a perverse incentive can be found in Mexico, where the cost of undertaking proactive offsetting measures within the impact assessment and planning processes is higher than the cost of compensating for damage after the event (pers comm staff of Instituto Nacional de Ecologia, 2008).

The ***implication for the EU*** from examples such as these is to consider the incentives that would be created by proposed offset measures and approaches relative to one another, and to seek to avoid unintended consequences and perverse incentives.

As will be evident from the earlier ***recommendation for the EU*** and Member States to prepare a strategy for NNL and also the risks of unintended consequences, NNL systems need careful thought in order to succeed. It is often difficult for developers to navigate their way through offset systems and to satisfy their requirements in a speedy and cost effective manner without experiencing uncertainty, delay and associated costs. An important lesson from international experience is that governments cannot merely provide a basic policy framework and step back to allow organisations and citizens to implement it. Rather, government needs to provide assistance to ensure that offset policy is clear, that buyers and sellers can readily find each other, and that offset commitments are subject to high standards and can be relied upon. An example of how such assistance from government was needed can be found in Victoria, Australia, building on the illustration above about the sequential approach there to the development of the offset system. Prior to the development of Victoria's Bushbroker programme[67] , developers found offsets difficult: they reported finding the rules complex, the system inefficient, and offsets difficult to establish. This was because of the lack of information about price, demand and supply, the high transaction costs and 'red tape' associated with offsets. The BushBroker programme has helped to address these problems by finding buyers and sellers for bespoke deals, helping developers find an offset match for impacts using the State's like-for-like rules, helping landowners generate credits by permanently protecting and managing native vegetation, and by facilitating price negotiation. BushBroker also governs the final trade outcomes and Landowner Agreements, and provides security (legal certainty). (Pers Comm Michael Crowe. See www.dse.vic.gov.au)

The ***implications for the EU*** are that a strategy on NNL can include a component to provide this kind of broker service to developers and providers of offsets within the EU, avoiding some of these problems from the start of the NNL Initiative.

The start of this synopsis pointed to the proliferation of developments by governments, companies and banks in the area of NNL. However, it has also highlighted some of the constraints in broad and consistent application of the approach. Among these is a common limitation in the capacity of individuals and organisations now obliged to work on these issues to deliver NNL.

- The understanding of governments which do not yet have offset systems in place as to how these work at the national and state level is limited, as is their understanding of the time involved in development of these systems. In addition, some governments (mostly in developing and least developed countries) struggle with the regulation of planning and environmental impact assessment, let alone NNL.

[67] http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/rural-landscapes/bushbroker

- The capacity of consultants and NGOs to undertake baseline studies, risk assessments for non-offsetability, loss gain calculations and design of feasible offset activities and management plans remains limited.

- Companies sometimes fail to commission baseline work early enough or to an adequate standard. They can also struggle to coordinate internally or work adequately with joint venture partners, contractors and agents.

- Banks have limited in-house capacity to assess biodiversity risks or to screen consultants for appropriate skills if they intend to outsource some of this research.

- Biodiversity **data** are sometimes inadequate to support offset planning. Consistent, adequate data sets may not exist at the national or regional levels in countries (to serve as the basis for landscape level planning, definition of the 'exchange rules' to define 'like for like or better' and to set the benchmarks and attributes for metrics to calculate residual losses and offsets' gains). Some data sets are at a very coarse-scale which needs more refinement to support the fine-scale conservation planning needed for offsets. Furthermore, some seasonality data are missing (and project timelines are sometimes too short to enable data to be collected over years), and some taxa are poorly known and need further work (for instances, some freshwater species).

The ***implication for the EU*** is that it is almost certain that the EU and Member States will need a programme of capacity building to overcome these constraints in order for a NNL initiative to operate smoothly.

10.2 Key lessons and conclusions

This synopsis ends with a summary of some of the key lessons learned from international offset experiences and initiatives and finally some recommendations:

- Clear, consistent guidance on the mitigation hierarchy including offsets is needed for certainty and to avoid delays.

- Adequate performance monitoring and enforcement is essential.

- It is important to improve the application of the mitigation hierarchy, and not simply turn to offsets, which should be the last step and final resort in the mitigation hierarchy.

- Planners should avoid methods (particularly poor metrics) that do not deliver NNL.

- It is essential to have clear principles and standards governing offsets.

- It is advisable to keep the options for implementation open (ie allowing offsets to be implemented by developers or a range of third parties, including through conservation banking or the generation and sale of conservation credits by individual and institutional land managers), provided a consistent standard for these is met.

- It is wise to remove perverse incentives and help the parties involved in offsets (particularly buyers and sellers) to find each other.

- Governments are well advised to prepare for implementation during policy development and to put in place a multi-year strategy for moving towards NNL.

- It is vital to clarify the roles of national, state and local government.

- States should consider proportionate approaches, with more streamlined procedures and simpler baseline studies and metrics for less significant impacts on biodiversity, but full assessments and metrics for more significant impacts.

- It is important to develop good baseline data, mapping and landscape level planning.

Conclusions:

- The EU and Member States should prepare a strategy for how the NNL Initiative will be rolled out, addressing the key components of strategy laid out above in this synopsis.

- Capacity building is needed: for companies, banks, consultants, NGOs, governments.

- Safeguards & Standards: The EU and Member States should develop comparable, high quality standards for offsets, endeavouring to harmonize these with existing best practice (eg IFC PS6 and the BBOP Standard on Biodiversity Offsets) and standards that are about to be defined (eg the World Bank's revised Safeguards).

- The EU and Member States would be well served by generating more practical experience and case studies at the project level. These should be independently audited and in the public domain.

- Cost-benefit analyses for governments can help.

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11 ANNEX 11: STAKEHOLDER WORKSHOP REPORT

Policy Options for a No Net Loss Initiative

11.1 Introduction

11.1.1 The EU's 2020 biodiversity targets and the NNL initiative

The EU has a target to '*halt biodiversity and ecosystem service loss by 2020, to restore ecosystems in so far as is feasible, and to step up the EU contribution to averting global biodiversity loss'*. To support the achievement of this target (and CBD targets agreed in Nagoya in 2010) the European Commission has developed in cooperation with Member States, an EU Biodiversity Strategy to 2020, including six sub-targets and 20 supporting actions. Amongst these is Target 2, which aims to ensure that '*by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems'*.

To support Target 2, Action 7 aims to "ensure No Net Loss (NNL) of biodiversity and ecosystem services". This action consists of two complementary sub actions. Firstly, Action 7a states that "In collaboration with the Member States, the Commission will develop a methodology for assessing the impact of EU funded projects, plans and programmes on biodiversity by 2014". The focus of this current contract and workshop is on supporting the second component of the NNL framework, ***Action 7b, which states that "the Commission will carry out further work with a view to proposing by 2015 an initiative to ensure there is NNL of ecosystems and their services (e.g. through compensation or offsetting schemes).***"

The intention to ensure NNL of biodiversity and ecosystem services was reinforced in the Council conclusions of 21 June 2011, which emphasised the need to develop and implement a methodology taking into account existing impact assessment processes to assess the impact of all relevant EU-funded projects, plans and programmes on biodiversity and ecosystems. It also stressed the importance of further work to operationalise the NNL objective of the Strategy for areas and species not covered by existing EU nature legislation and of ensuring no further loss or degradation of ecosystems and their services. The conclusions also provide the following preliminary definition of the NNL concept: ***'that conservation/biodiversity losses in one geographically or otherwise defined area are balanced by a gain elsewhere provided that this principle does not entail any impairment of existing biodiversity as protected by EU nature legislation***'.

Subsequently the Council Conclusions of 19 December 2011 agreed 'that a common approach is needed for the implementation in the EU of the NNL principle and invited the Commission to address this as part of the preparation of its planned initiative on NNL by 2015, taking into account existing experience as well as the specificities of each Member State, on the basis of in-depth discussions with Member States and stakeholders regarding the clear definition, scope, operating principles and management and support instruments in the context of the Common Implementation Framework of the Strategy'.

The need for a NNL initiative is also referred to in the Resource Efficiency Roadmap, which calls for proposals to foster investments in natural capital, to seize the full growth and innovation potential of Green Infrastructure and the 'restoration economy' through a Communication on Green Infrastructure (2012) and a NNL initiative (2015).

In addition the European Parliament also adopted a resolution on 20 April 2012[68], urging the Commission to develop an effective regulatory framework based on the 'No Net Loss' initiative, taking into account the past experience of the Member States while also utilising the standards applied by the Business and Biodiversity Offsets Programme[69] (BBOP) (see Box 4.1). Importantly, the report also refers to the importance of applying such an approach to all EU habitats and species not covered by EU legislation.

It is therefore clear that the potentially broad social and economic benefits of a NNL initiative for biodiversity and ecosystem services have been widely recognised, which has resulted in a strong and clear political mandate for the Commission to develop this initiative.

To help achieve its biodiversity targets the European Commission has established a number of Working Groups under the Common Implementation Framework to obtain the views of stakeholders on key issues. Amongst these is a Working Group on NNL of Ecosystems and their Services (NNL Working Group). The objective of the Working Group is to collect views from Member State representatives, stakeholders and experts on the way forward for the NNL initiative announced for 2015, within the mandate of the 2011 December Council conclusions, taking into account all relevant policies and instruments. The aim is to support the European Commission in its preparation of a NNL initiative.

The Working Group has now completed its work and its outputs, including a paper summarising views on 'operating principles' of NNL, were published in July 2013.

11.2 The scope and objectives of this workshop

11.2.1 Objectives of the current contract on policy options for achieving NNL

To further assist with the development of the no net loss policy, the European Commission hosted this workshop, as part of a eleven-month contract being carried out by IEEP, IVM, Eftec and ICF GHK. The contract aims "***to support the Commission in developing the NNL initiative foreseen in the EU Biodiversity Strategy to 2020 by developing potential alternative options for this initiative, and analysing their main impacts.***"

In addition to organising this workshop, it has the following components:

1. Develop a business as usual scenario against which to evaluate alternative options
2. Develop policy options for implementing NNL goals
3. Analyse the impacts of policy options
4. Develop recommendations on the way forward

[68] http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/EP_resolution_april2012.pdf
[69] http://bbop.forest-trends.org/

11.2.2 The key impacts that need to be addressed

At the time of this workshop, the first component of the contract was still underway, but it was possible to reliably identify the impacts on biodiversity and ecosystem services that are most likely to be significant according to the BaU scenario to 2020. The preliminary results indicated that there is a very wide range of sources and types of impacts, and although many of these may only be low or local they all need to be addressed adequately to achieve NNL of biodiversity and ecosystem services. It is also important to point out that some small-scale environmental changes can have disproportionally high biodiversity impacts, for instance if they affect a particularly important area (such as Natura 2000 site). Furthermore, many low level impacts are commonplace, and therefore can lead to more significant cumulative impacts, such as through habitat fragmentation and wide-scale pollution.

It is also apparent that some expected sectoral activities are likely to lead to further significant residual impacts on biodiversity under the BaU scenario, and may therefore prevent the achievement of the biodiversity target unless they are addressed by new or enhanced environmental measures. These key impacts can be further summarised as:

- Site impacts (eg from the footprint of the development, and the disturbance and pollution of surrounding areas) of built developments (eg housing, industry, transport infrastructure) and extractive industries (eg coal mining, gravel extraction).

- Wide-scale pollution impacts from urban areas, transport, industry and agriculture, and in particular eutrophication of sensitive terrestrial habitats (from air-borne nitrogen deposition) and pollution of fresh and marine waters from sewage and waste-water (although declining) but also nutrient rich-run off that is increased as a result of agricultural and forestry activities.

- Expansion of forest plantations (especially where these replace or fragment semi-natural habitats, many of which are habitats of Community interest under the Habitats Directive), and intensification of forest management, which may increase in response to rising demands for energy from wood biomass.

- Agricultural improvements (eg drainage and reseeding of grasslands), specialisation (resulting in reduced landscape diversity and larger fields and farm units) and intensification (eg increased frequency of cultivations and higher use fertilisers and pesticides), particularly in eastern Europe.

- Agricultural abandonment, leading to the loss of traditionally managed semi-natural habitats such as some grasslands, heaths and pastoral woodlands (many of which are habitats of Community interest under the Habitats Directive).

- Continued high levels of commercial fishing, with direct impacts on target species, and by-catch (fish, invertebrates, birds and cetaceans) and habitat damage from bottom dredging/trawling. Although there are current CFP proposals that will ban discarding and aim to ensure all fisheries are under sustainable management to achieve a maximum sustainable yield, ongoing impacts to 2020 are highly likely.

- On-going impacts, and further spread, of invasive alien species (IAS) within the EU and the arrival of new IAS, which is exacerbated by a number of sectoral activities, most notably international transport.

Clearly, to achieve NNL of biodiversity and ecosystem services it will be necessary to develop policy measures that address all these pressures. Thus NNL measures need to cover all sectors that have significant impacts on biodiversity and ecosystem services.

It is also important to remember that NNL policy measures should follow the mitigation hierarchy, under which emphasis should be given to avoidance of significant adverse impacts at source as the first objective. This should normally be followed by efforts to identify mitigation measures to reduce or minimise impact and finally use of compensation or offsets (see Glossary in chapter 1 for definitions) to remedy unavoidable damage or loss.

The NNL policy options contract is therefore considering possible instruments that address all stages of the mitigation hierarchy. But it is mainly focusing on measures that aim to address unavoidable residual impacts (ie those that remain after avoidance, minimisation and rehabilitation measures have been taken). This is because analysis of current policy instruments indicates that most existing measures aim to avoid or reduce impacts, and the most significant policy gaps (outside the Natura 2000 network) relate to dealing with residual impacts. While there is undoubtedly scope for further progress in avoiding and minimising impacts through extension and improved implementation of the current range of policy instruments, the need for new and dedicated instruments to deal with residual impacts is also essential to achieve the NNL objective. Moreover, the recent *Biodiversity Proofing Study* assessed avoidance and minimisation measures in relation to EU funding instruments in detail and provided recommendations for improving biodiversity proofing[70]. Furthermore, the analysis and development of specific policy recommendations relating to air and water pollution, fisheries and IAS will only focus on measures that address residual impacts, such as through offsetting. This is because policy measures that aim to avoid and reduce impacts already exist (for most pollutants) or are the subject of current proposals and discussion (i.e. regarding the reform of the CFP and current proposals for an instrument on IAS).

11.2.3 Objectives of the workshop

Taking into account the overall NNL objective and priorities discussed above, the broad objective of this stakeholder workshop was to obtain ideas and feedback on key NNL policy options, including:

- sectoral coverage;
- levels of biodiversity to be addressed;
- need for mandatory versus voluntary approaches; and

[70] Biodiversity Proofing is defined in the study as a structured process of ensuring the effective application of tools to avoid or at least minimize harmful impacts of EU spending and to maximise the biodiversity benefits.

- specific policy measures and their key design components.

11.2.4 Structure of the workshop

The workshop firstly included plenary presentations that gave a brief review of the policy background and aims of the NNL policy initiative, identified key pressures on biodiversity and ecosystem services that need to be tackled to achieve NNL, identified the broad range of policies that may be used to achieve NNL and summarised lessons learnt from the implementation of NNL policy measures in the EU and elsewhere (see detailed agenda in Annex 11a).

This was followed by parallel breakout discussions on three key NNL policy topics:

Group 1: Avoiding and minimising impacts (e.g. by enhancing existing EU instruments through enforcement, guidance and capacity building)

Group 2: Offsetting residual impacts from built developments and extractive industries.

Group 3: Offsetting residual impacts from land use and management changes from agriculture and forestry.

Within each of these group discussions, consideration was also given to whether:

- suggested measures should be voluntary or mandatory; and

- measures should just address the most important ecosystem services and scarce biodiversity (eg biodiversity of EU importance as covered by the Birds and Habitats Directives, and other biodiversity that are of national importance, such as listed in National Biodiversity Strategies and Action Plans), or all biodiversity and ecosystem services.

A list of workshop participants is provided as Annex 11.b.

11.3 Avoiding and minimising built development and extractive industry impacts through enhancement of existing EU instruments

11.3.1 Background

In principle the EU and its Member States have a relatively comprehensive environmental policy and legislative framework, that should promote the identification, avoidance and reduction of impacts (especially from major built developments) on biodiversity and ecosystem services. In particular, where developments significantly affect the Natura 2000 network, risks to biodiversity should be managed through the requirements and provisions in place under the Habitats Directive (in particular under Article 6.3 and 6.4)[71].

In the wider environment major potential environmental impacts tend to be covered by the EIA and SEA Directives. The EIA Directive[72] requires a systematic assessment of the likely environmental impacts of projects in a wide range of sectors. As a result the EIA process helps ensure that project development and planning decisions take environmental impacts into account by incorporating adequate measures to avoid or reduce, and if possible, offset potential impacts from the planning stage. It may also result in the rejection of project options whose likely impacts are considered unacceptable by the competent national authorities. However, it is important to note that under the Directive the avoidance of impacts and achievement of 'no net loss' is not mandatory; merely the proper consideration of impacts. Furthermore, the provisions allow for considerable flexibility in application and interpretation at the Member State and project level. Therefore the Directive does not stimulate common use of biodiversity offsets.

The SEA Directive extends EIA procedures and principles from projects to plans and programmes. One of its strengths is that it has the potential to overcome many of the limitations of project-based EIA by providing opportunities for the conservation of biodiversity and ecosystem services to be considered as a fundamental part of strategic decision-making.

In addition to SEA and EIA requirements, in the case of the marine and water environment, there are several comprehensive and ambitious measures in place (e.g. Water Framework Directive, Marine Strategy Framework Directive and the Floods Directive) both to improve the quality of the environment and to protect biodiversity from further losses. Measures which seek to protect the environment from industrial developments are wide ranging, and some in principle afford a good level of protection and ensure that impacts are avoided and/or reduced (e.g. Mining Waste Directive, Environmental Liability Directive and the Industrial Emissions Directive).

These policy measures primarily focus on avoiding or reducing impacts, and in some cases refer to general ecosystem restoration that is not linked to specific impacts. However, Article 6.4 of the Habitats Directive requires that unavoidable residual impacts are

[71] See European Commission guidance at http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm#art6

[72] The EIA Directive has been reviewed and a Proposal to amend the EIA Directive was published in October 2012 http://ec.europa.eu/environment/eia/pdf/com_628/1_EN_ACT_part1_v7.pdf

addressed through 'compensatory measures[73]' to protect the coherence of the Natura 2000 network. The Environmental Liability Directive (ELD) also requires complete repair of 'environmental damage' to biodiversity resulting from some certain incidents, such as pollution events (but not licenced discharges etc). All species and habitats covered by the Habitats and Birds Directives must be covered by the ELD, but Member States have the option to extend it to others.

In practice the application of these existing instruments is sometimes incomplete or not as effective as it could be. For example, according to the Commission's 2009 *Report on the application and effectiveness of the EIA Directive*[74] implementation experience shows that Appropriate Assessment requirements (under the Habitats Directive) are not taken properly into account, wider biodiversity issues are overlooked (with particular shortcomings being observed with respect to agriculture and forestry[75]) and EIA procedures often fail to take into consideration cumulative impacts. Furthermore, although SEA potentially has a role to play in addressing such impacts this is not being realised in practice.

This breakout group therefore considered how impacts, especially from built developments and extractive industries, can be avoided and reduced through the enhancement of existing instruments, by for example:

- increasing implementation and enforcement of existing legislation;
- increasing capacity to support the implementation of existing instruments;
- development of guidance on the scope of the instruments and good-practice implementation;
- awareness raising; and
- other possible measures.

11.3.2 Key conclusions

The overall conclusion from the discussions was that there is significant potential to better address biodiversity and the requirement for NNL of biodiversity and ecosystem services through improved implementation and amendments to existing instruments. In particular, key summary conclusions (based on the report back to the workshop by the session rapporteur) were as follows:

- Strategic Environmental Assessment
    - The explicit mention of biodiversity in the SEA Directive is helpful, and theoretically provides a framework for more biodiversity-inclusive EIA.

[73] Which according to the terminology used here should be equivalent to offsets
[74] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0378:FIN:EN:PDF
[75] http://ec.europa.eu/environment/eia/pdf/eia_study_june_09.pdf

  - However, SEA only applies to public plans and programmes and does not apply to higher level policies (although an impact assessment by the Commission is required for EU policies). Furthermore, some Member States and/or sectors avoid SEA requirements by not producing formal plans and programmes.
  - There is no obligation to avoid harm (as with EIA) therefore SEA does not necessarily deliver better outcomes; therefore it will be important to assess its impacts during the coming 2016 evaluation.

- Environmental Impact Assessments
  - This is an important instrument, and although it has weaknesses, some are addressed through the Commission's reform proposals. Important EIA reforms that would contribute to NNL include mandatory screening, consideration of alternatives, improved qualifications of people undertaking EIAs and the explicit requirement to consider biodiversity. The group agreed that it is important that the current proposed reforms, including the reference to biodiversity, are retained and implemented.
  - As with the SEA Directive, currently the main purpose of EIA is to inform the decision making process and there is no mandatory requirement to avoid, reduce or compensate for environmental damage (unless the EIA demonstrates that damage would contravene mandatory requirements under other Directives, such as the WFD and Birds and Habitats Directives). Future reforms of EIA (and SEA) could therefore contribute to NNL considerably by incorporating a mandatory requirement to follow the mitigation hierarchy and achieve NNL. However, it was recognised that this would change the scope of the Directives, and there is no political mandate for this.
  - Another option would be to encourage Member States to link SEA/EIA explicitly to their own environmental legislation which does have mandatory environmental and/or nature conservation objectives such as for NNL (eg as in Germany).
  - There could also be clearer requirements for EIA to quantify residual impacts specifically and set out measures that would be required to achieve NNL, although this would increase the complexity and costs of the EIA process due to the need for expanded baseline assessments (including for alternatives) and detailed potential impact and offset quantification.

- Habitats Directive
  - This is considered to be an effective instrument that follows the precautionary principle and requires (under Articles 6.3 and 6.4) adherence to the mitigation hierarchy and NNL with respect to impacts on species and habitats of Community importance with Natura 2000 sites.
  - Some have claimed that it is over-demanding but actually evidence suggests otherwise, as the Directive is flexible and requires proportionate actions.
  - All agreed that no changes in the Directive should therefore be made with respect to Articles 6.3 and 6.4, but improvements in implementation are required by Member States underpinned by stronger enforcement by the

Commission. It was noted that implementation could be improved by the Commission's initiative on improving access to justice on environmental matters, and possible revision of the EU legal framework for environmental inspections.
    - The potential wider application of the Habitats Directives' concepts and measures would benefit biodiversity.

- Other Directives
    - The Water Framework Directive: has been powerful in requiring outcomes and raising awareness.
    - The Waste Framework Directive: its sectoral approach has proved effective.
    - The Environmental Liability Directive: which could be expanded to cover other species but there are current implementation problems.
- Guidance
    - There is currently no shortage of guidance on existing EU Directives etc, but clearer articulation of the NNL goal and how to achieve it in the context of these Directives might be needed.
    - Articulation of avoidance requirement possibly supported by improved information on what/ where to avoid and why.
    - The development of an NNL toolkit might be useful.

11.4 Offsetting residual impacts from built developments and extractive industries

11.4.1 Background

Biodiversity offsetting is a tool that allows adverse residual impacts of development on biodiversity (after appropriate avoidance, minimisation and onsite restoration) to be compensated by providing at least an equivalent level of measurable benefit at another location. Reviews of international offsetting experiences indicate that the main benefits of offsetting are typically:

- that it can be an important mechanism for achieving no net loss, by measuring residual biodiversity losses and requiring them to be compensated by at least equivalent gains in type and amount of biodiversity;
- that it can be an efficient economic mechanism for protecting biodiversity as it internalises the costs of biodiversity loss;
- there is significant potential for landscape-scale strategic benefits, through judicious location of the offset (e.g. to expand or link fragmented habitats) and pooling resources (in particular through habitat banking);
- increased certainty, speed, simplicity and cost-effectiveness of environmental outcomes to the potential benefit of both developers and planning authorities;
- trading up - whereby offset activities focus on higher conservation priority species and habitats than those affected by the project; and
- more effective compensation for minor and cumulative impacts, when compared to on-site mitigation alone.

However, while there are identified benefits, there are also concerns identified in the literature such as the risk that offsetting may result in a lowering of protection standards, and that offsetting measures may provide little additionality (i.e. they result in actions that would have happened anyway). It is therefore important that offsetting only occurs in accordance with the mitigation hierarchy and to a high standard. Another particular challenge is the development of metrics that can reliably capture the key components and functions of biodiversity and ecosystem services in a way that can be used to measure damage (debits) and offset outcomes (credits) – in other words ensuring that NNL has been achieved.

Taking into account existing relevant legislation (in particular under the Habitats Directive), the BBOP principles and standard for offsetting, and building on the results of the Habitat Banking workshop in 2012 (which considered broad principles and international experience), this break-out group considered policy options related to the use of offsets as an instrument for achieving NNL in the EU.

In particular it considered the following issues:

- the potential scope (eg types of developments that could be covered) and triggers for offsets;
- the need for regulation to underpin it;
- safeguards to ensure additionality;
- appropriate metrics for measuring detrimental impacts (debits) and offset outcomes (credits);
- rules concerning the need for like-for-like-or-better offsetting;
- safeguards to ensure long-term benefits;
- systems to maximise the strategic landscape-scale benefits of offsetting; and
- governance and guidance needs.

11.4.2 Key conclusions

Key summary conclusions based on the report back to the workshop by the session rapporteur were as follows:

- **Voluntary vs. Mandatory**: There was agreement (including from the three Member States present in the group) that there is a need for a mandatory approach, however it is unclear what elements exactly should be mandatory. Whilst it is clear that it has to be mandatory that residual impacts are addressed, it should not necessarily be mandatory *how* they are addressed.
    - It was noted that regulation at the national level is likely to be the best and/or most relevant level at which to introduce a mandatory requirement for offsetting.
    - Those in the group felt that there was a need for flexibility at national and local levels on how offsets are to be implemented. However, it was also noted that there needs to be some comparability and consistency across systems. How this could work – combining flexibility with consistency – is unclear. One way could be to ensure that methods have to meet certain standards or criteria, but the exact details of the methods to be used would not be specified. Although the group seemed in agreement on the need for flexibility, discussions from the floor made it clear that there was some disagreement on this and that some stakeholders felt that flexibility might not deliver the necessary benefits to the environment.
    - One element that clearly needed to be mandatory was monitoring of the offset implementation to create the necessary levels of transparency and accountability (see below).
    - The issue of ensuring that the mitigation hierarchy is properly and fully implemented was raised. It was noted that a mandatory system for offsets may internalise the mitigation hierarchy; by forcing developers to consider offsets,

and their full costs (including monitoring / enforcement), this should incentivise developers to think about avoidance and minimisation in order to reduce those costs. An example from France was highlighted, where a recent voluntary offset project identified a need for 3,000 ha of offsets. Given the scale of this need, it is unlikely to be fully implemented. It was felt that if offsetting was mandatory, it would not have been necessary for 3,000 ha of offsets, as other measures would have been taken first to reduce this figure, making it more feasible for the offsets to be implemented .

- **Scope**: It was felt that the Natura 2000 network should be outside the scope of this offsetting policy initiative, as there are already measures in place which should theoretically be dealing with residual impacts on Natura 2000 sites. Everything else however should be within scope, although there was some discussion about what kind or what size of projects and/or impacts should be covered (i.e. what kind of threshold to set, whether there should be a 'de minimus' approach, etc.).
    - It was clear that there is a need for common principles and guidance which should be applied to ensure that the scope is consistent.
    - Questions were raised about what should be considered "important" biodiversity, and more specifically, for whom the biodiversity is important.
    - The point was made that biodiversity in overseas territories should also be covered.
    - It was noted that there are important differences between biodiversity and ecosystem services, and that the appropriate levels at which these are considered may therefore also be different (e.g. EU, regional, national, local levels).

- **Triggers:** Offsets could be triggered by a number of different mechanisms, not just by the EIA (e.g. for some big projects), but also through planning requirements for smaller, cumulative impacts, through the communication of evidence and through ex post measures such as the ELD. These force the consideration of potential residual impacts early on in the process.

- **Implementation**:
    - It was clear that local and/or social benefits should not be neglected when offsetting residual impacts. However, this needs to be balanced with the possibility of using offsets to deliver more strategic (e.g. national) level benefits where the benefit to biodiversity is potentially greater. One way of doing both is through composite offsets, where compensation measures are split into different components which are delivered on different levels; local values are delivered locally, and national values can be delivered at the landscape scale. There are examples of this happening in Germany in Baden- Wuertemberg.
    - For offsets to be more effective, there could be a presumption for a bio-geographic approach on like-for-like-or-better basis. Bio-geographic regions could then be used as the 'service area', adopting a similar approach to water basins and river basin management. One exception to this could be for migratory species, which could justify an approach which extends beyond bio-geographic areas.

- There was a discussion about the need to consider multi-level governance, and to determine what would be best done at what level, and at which levels responsibility should be placed for different aspects (e.g. EU, regional, national and local level).
- It was clear that there is a need for common principles and guidance which should be applied to ensure that the approach is consistent and that results in offsets are of a comparable high standard, especially where there is flexibility in terms of what metrics should be applied.
- There is a fundamental need to put systems for monitoring in place in order to have the necessary information to support implementation, enforcement and improvement. There is also a need for enforcement mechanisms. The question was raised, however, about who would be responsible for financing these overheads; experience in other countries suggests that providers and buyers can share these costs. An option would also be to give nature conservation agencies the authority to spontaneously conduct random spot checks at any time, which could reduce costs but still ensure that the mechanism for oversight is there. Overall, it was noted that monitoring / auditing is most effective if done by an independent third party.

11.5 NNL policy options relating to land use and management impacts from agriculture and forestry

11.5.1 Background

The Common Agricultural Policy (CAP) plays a major role in supporting biodiversity and ecosystem services in the EU, primarily through funding agri-environment, Natura and forestry measures that support the maintenance (and in some cases restoration) of semi-natural habitats, within the Natura 2000 network and in the wider environment. Furthermore, CAP measures such as cross-compliance standards, other agriculture regulations (e.g. concerning fertilisers and pesticides) and the EIA Directive all help to avoid and reduce detrimental impacts on biodiversity and ecosystem services.

Despite these measures the analysis of pressures summarised above indicates that the most significant residual impacts on biodiversity and ecosystem services result from agricultural and forestry activities. Although some of these impacts may be due to inadequate or partial application of some of these measures (such as EIA) it is apparent that many agricultural activities with significant environmental impacts are insufficiently regulated to prevent biodiversity loss, such as with respect to the use of fertilisers or ploughing of semi-natural grasslands, and the general intensification of management practices in agriculturally improved habitats. Furthermore, the EU Forest Strategy and Forest Action Plan are primarily voluntary instruments and there is little evidence that these instruments have stimulated actions to conserve forests. Consequently, it is clear that even with full implementation of all existing measures there would be substantial on going residual impacts in agricultural and forest ecosystems, and therefore further measures are required for these sectors to achieve the NNL policy goal.

It is possible that the offsetting mechanisms as described above could be used to address some residual impacts from agriculture and forestry, but given the area involved and nature of the impacts (which are often low-level but extensive) it is likely that other policy mechanisms will be needed to address residual agricultural and forestry impacts. This break-out group therefore considered options for tackling residual impacts in agricultural habitats and forests, through for example:

- incorporation of NNL requirements into cross-compliance measures (e.g. requirements for farm-level NNL of certain habitats, habitat features or ecosystem services);
- adapting offsetting systems, such as through simple fee in-lieu or habitat banking systems;
- policy level measures, such as ear-marking of CAP funding to compensate for overall sectoral impacts (eg funding measures to restore semi-natural habitats); and
- use of hypothecated green taxes (eg with respect to agricultural improvements or use of environmentally damaging products) to restore lost habitats or provide payments for ecosystem services.

11.5.2 Key conclusions

The session mainly focussed on agriculture rather than forest use and achieving NNL rather than offsets specifically. Key summary conclusions that were reported back to the workshop by the session rapporteur were as follows:

- To achieve no net loss of ecosystem services in relation to agricultural and forest land use, we need to address adverse impacts in relation to:
    - land use changes;
    - intensification, where not achieved sustainably; and
    - land abandonment.

- NNL must relate to ALL ecosystem services (including food and wood, as well as environmental services), but it is the environmental services that require most attention from policy interventions because these are public goods and the market does not function efficiently to ensure their delivery.

- Focus is needed on actions at all levels of the mitigation hierarchy, however there is a lot more that can be done to reinforce existing policy mechanisms in relation to avoidance and minimisation, for example:
    - Regulations and Directives need better enforcement and control – eg cross compliance and the EIA Directive in relation to agriculture;
    - further integration of environmental requirements within the CAP (the Pillar 1 greening measures are a start and provide opportunities, but aspirations have been significantly watered down);
    - suitable support systems are required for extensive systems to avoid abandonment (eg maintaining HNV systems);
    - avoiding perverse incentives;
    - sufficient incentives targeted at the right type of activities;
    - appropriate monitoring and enforcement; and
    - increased provision of advice.

- Residual impacts will occur, which are not appropriate to address at the individual farm scale, but what scale is appropriate? Policy scale (i.e. country or region) or transboundary scale where possibilities for addressing residual impacts are not possible within the Member States (i.e intensively cultivated countries such as the Netherlands?)

- There was a strong consensus among workshop participants that it will be more feasible to address residual impacts in agriculture and forestry at the regional or policy scale than at the level of individual farm businesses. Individual impacts are often difficult to identify and measure, and individual offsets will therefore be difficult to enforce, particularly where impacts are gradual, diffuse or indirect.

- Agri-environment measures can play a key role here, since they receive substantial public funding and offer substantial potential to benefit biodiversity, potentially counterbalancing negative impacts elsewhere in the agricultural sector. However, achieving NNL would require measurable increases in biodiversity benefits equivalent to current losses. Areas for development (which may be partly facilitated through the recent CAP reforms) include:
    - a greater focus on delivering positive benefits;
    - increasing resources – considerable additional funding is needed to meet all environmental needs;
    - increasing cooperative and landscape scale action;
    - developing and promoting other innovative approaches; and

- Offsets are somewhat of an alien concept in relation to agriculture so far in the EU – although it was acknowledged that this already takes place in the US, for example.

- Questions were raised about how one could develop such a system for agriculture, with particular issues arising in relation to:
    - The focus could possibly be on major habitat change, although this may already be covered to some extent by other mechanisms (eg EIA Directive, permanent pasture requirements of cross compliance) and/or changes in land management practice (but what sort of changes and how to administer?)
    - The scale of applying offsetting to farming – does it remove responsibility for unacceptable environmental damage off the farm and possibility out of the region or even country?

- But offsets could provide agriculture with an economic opportunity - as a sector it could benefit as it has a role in offsetting residual impacts from other sectors – eg industry. This provides an opportunity to increase incomes for farmers. The positive role of agriculture and forestry in contributing to a broader NNL policy, by offsetting residual impacts elsewhere in the economy, was therefore stressed.

ANNEX 11a:

Policy Options for a No Net Loss Initiative

Stakeholder Workshop

Wednesday 3rd July 2013,
Guimard Building, Rue Guimard 10, 1040 – Bruxelles

Final Agenda

Morning Chair Laure Ledoux, European Commission)

9.30: Introduction to the No Net Loss (NNL) policy, NNL Working Group and policy options contract Laure Ledoux, European Commission

9.45: Overview of the main causes of ecosystem change and impacts on biodiversity and ecosystem services to 2020 under a business as usual scenario – i.e. the need for measures to achieve NNL (Ben Allen, IEEP)

10.05: The mitigation hierarchy and main existing policy instruments to avoid and minimise impacts (Graham Tucker, IEEP)

10.25: Measures to deal with residual impacts, including offsets and habitat banking and key considerations in their design and implementation (Matt Rayment, ICF GHK)

11.00 Break

11.30: NNL policies and offsetting lessons from experiences outside the EU (Kerry ten Kate, Forest Trends)

12.00: NNL policy and offsetting lessons from experiences within the EU (Mavourneen Conway, ICF GHK)

12.30: Lunch

1.30: Breakout groups to discuss three main topics:

- Avoiding and minimising impacts (e.g. by enhancing existing EU instruments through enforcement, guidance and capacity building). Chair: Graham Tucker (IEEP); Rapporteur: Jo Treweek (Treweek Environmental Consultants).
- Offsetting residual impacts from built developments and extractive industries. Chair: Patrick ten Brink (IEEP); Rapporteur: Mavourneen Conway (ICF GHK).
- Offsetting residual impacts from land use and management changes from agriculture and forestry. Chair: Matt Rayment (ICF GHK); Rapporteur: Kaley Hart (IEEP).

3.00: Break

Chair Francois Wakenhut, European Commission

3.30: Report back from break-out groups and plenary discussion of findings

4.30: Summing up of key conclusions (Laure Ledoux, European Commission)

4.40: Close

ANNEX 11.b: ATTENDENCE LIST

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12 ANNEX 12: OFFSETTING POLICY OPTIONS 3 AND 4 COSTING METHODOLOGY

12.1 Policy Option 3

The land-use modeling carried out for this report (presented in Annex 3) provides a high-end estimate of the total land area for which offsets would be required under Offsetting Policy Option 3. That modeling indicated the area of forest and semi-natural vegetation that would be converted to built-up area under an enhanced or full NNL policy scenario. It is unlikely that all of that area would comprise scarce biodiversity and ecosystems as defined in this report, which is why assuming all of it requires offsets is a high-end assumption for the area of land that would be impacted under this policy option. Nonetheless, that assumption along with a number of other assumptions on costs and ratios applied in an offsetting policy can be combined to reach a rough, and likely high, estimate of the recurring costs of Offsetting Policy Option 3 as € 482 mn to the public sector and € 4.337 bn to the private sector.

Table 12.1. Estimating the annual cost of offsetting the conversion of forest and semi-natural vegetation to built-up area.

	Assumption	Value	Explanation
A	Total increase in built up area in 2010-2020	405,000 Ha	Based on modeling carried out for NNL report
B	Average annual land change	40,500 Ha	A/10 = B
C	% of land change to be offset under new NNL policy	90%	Represents "additional" cost. Conway et al, 2013 (pg. 51) state that current EU legislation has required compensation for ~10% of urban area development in recent years. It is unclear what type of land was lost for this conversion. It is assumed that current legislation would apply to a larger portion of forest and (semi-)natural land lost, than to all land lost. If that is the case, than using 10% here would be an underestimate, meaning it would make the cost estimate higher than actual. Using the information at hand, however, the 10% assumption is the best estimate.
D	Risk multiplier	2	Rayment et al, 2011 indicate that an appropriate risk multiplier for restoration is 1.25 and for habitat creation is 2.25. At this stage, the balance of restoration and creation, and thus the level of risk is unclear, so we take a fairly conservative multiplier of 2.
E	Time multiplier	1.7	Rayment et al, 2011 indicate that appropriate time multipliers might be 1.4 for restoration and 2 for habitat creation; without further indication of the balance of restoration and creation needed across the EU, we apply a simple median of the two at 1.7.

F	Adjustment for biodiversity "distinctiveness"	1	Assuming all forest and semi-natural vegetation has high distinctiveness, so the pricing from Rayment et al, 2011 applies on a 1:1 basis.
G	Adjustment for biodiversity "condition"	1	No good assumption can be made, so we assume good condition, meaning that the ratio of impact to offset site is 1:1. The prices below are assumed to be for good/high condition offsets.
H	Price of offset credit	€ 35,000	Rayment et al, 2011 cited a reasonable range for land cost as GBP 20,000-25,000; plus restoration or mgmt on purchased land is estimated to be 5,000 at the high end (assuming no coastal habitat is offset). That is equivalent to approximately EUR 35,000. Evidence in Conway et al, 2013 indicates that the low end of the range for credit prices that have occurred to date in France is in the same range, at EUR 31,000. Additionally, the evidence from UK and France would provide higher prices than the EU average. As such, a rough estimate of the costs of this offset area can be obtained by applying an assumed EU average credit price of EUR 35,000.
I	Total Private Costs	€ 4.337 bn	Multiplying B through H.
J	Public Costs	€ 482 mn	Rayment et al, 2011 described that a reasonable assumption is that public costs are 10% of total costs, meaning they are 1/9 of the private costs estimated in I.

12.2 Policy Option 4

Going beyond significant impacts to scarce biodiversity and ecosystems, policy option 4 mandates offsetting for all impacts to biodiversity and ecosystems. As such, we assume that all impacts on forest and (semi-)natural vegetation will require offsetting. That means that what was a high-end estimate of area impacted under policy option 3, is now considered a reasonable actual estimate of the area impacted under policy option 4. Further, we continue to assume that the policy for offsetting such impacts would be through purchase of a high-quality habitat credit (an assumption implied in the table for policy option 3).

Additionally, we must account for impacts to less significant biodiversity and so we assume that built-up area converted from (abandoned) agricultural land will also require offsetting. The impacts on this land are on less significant/scarce biodiversity and there is likely to be ample agricultural land abandoned or with the potential to be abandoned in the future. As such, we assume these impacts are offset through management agreements and payments to owners of (abandoned) agricultural land. This additional cost is calculated in the below table.

Adding calculations from Tables A12.1 and A12.2 provides a rough, and likely high, estimate for policy option 4 of € 818 mn public sector costs and € 7.359 bn private sector costs.

Table 12.2. Estimating the annual cost of offsetting the conversion of (abandoned) agricultural land to built-up area.

	Assumption	Value	Explanation
A	Total increase in built up area in 2010-2020	1,792,800 ha	Based on modeling carried out for NNL report
B	Average annual land change	179,280 ha	A/10 = B
C	% of land change to be offset under new NNL policy	100%	Represents "additional" cost. Conway et al, 2013 (pg. 51) state that current EU legislation has required compensation for ~10% of urban area development in recent years. It is unclear what type of land was lost for this conversion. It is assumed that current legislation would mainly apply to more natural habitats, so we assume 100% of agricultural land converted to built-up area would require actions under NNL offsetting.
D	Risk multiplier	2	Rayment et al, 2011 indicate that an appropriate risk multiplier for restoration is 1.25 and for habitat creation is 2.25. At this stage, the balance of restoration and creation, and thus the level of risk is unclear, so we take a fairly conservative multiplier of 2.
E	Time multiplier	1.7	Rayment et al, 2011 indicate that appropriate time multipliers might be 1.4 for restoration and 2 for habitat creation; without further indication of the balance of restoration and creation

			needed across the EU, we apply a simple median of the two at 1.7.
F	Adjustment for biodiversity "distinctiveness"	0.5	Defra document for UK biodiversity offsets (Defra and Natural England, 2012) indicated that agricultural land has a distinctiveness 1/2 that of semi-natural habitats. Therefore we assume that one hectare of offset on agricultural land (to convert it to semi-natural habitat) would be equivalent to 2 hectares of impacted site. It must be noted that Defra explicitly states that "Discussions with stakeholders support the view that fraction multipliers are acceptable in the English situation, and that we should not enforce a minimum 1:1 ratio." If the European situation is deemed to be different, this assumption could be adjusted.
G	Adjustment for biodiversity "condition"	1	No good assumption can be made, so we assume good condition, meaning that the ratio of impact to offset site is 1:1. The prices below are assumed to be for good/high condition offsets.
H	Price of offset credit	€ 9,913.86	Based on previous IEEP work (Tucker et al, 2013) we assume the cost of converting (abandoned) agricultural land to semi-natural habitat is one-off creation/restoration cost EUR 3000/ha and ongoing maintenance cost of EUR 250/ha/year. Following the methodology of Rayment et al, 2011; the ongoing price is converted to a present value based on a 3.5% discount rate and a 100 year time frame. The one-off cost of EUR 3,000 is added to this (so possibly an overestimate of PV if the one-off costs are spread over more than the initial year). This approximates the price of a habitat credit, to allow this cost to be comparable to evidence of the one-off price of a habitat credit that is used to to estimate the costs of offsets for forest and semi-natural vegetation.
I	Total Private Costs	€ 3.021 bn	Multiplying B through H.
J	Public Costs	€ 336 mn	Rayment et al, 2011 described that a reasonable assumption is that public costs are 10% of total costs, meaning they are 1/9 of the private costs estimated in I.