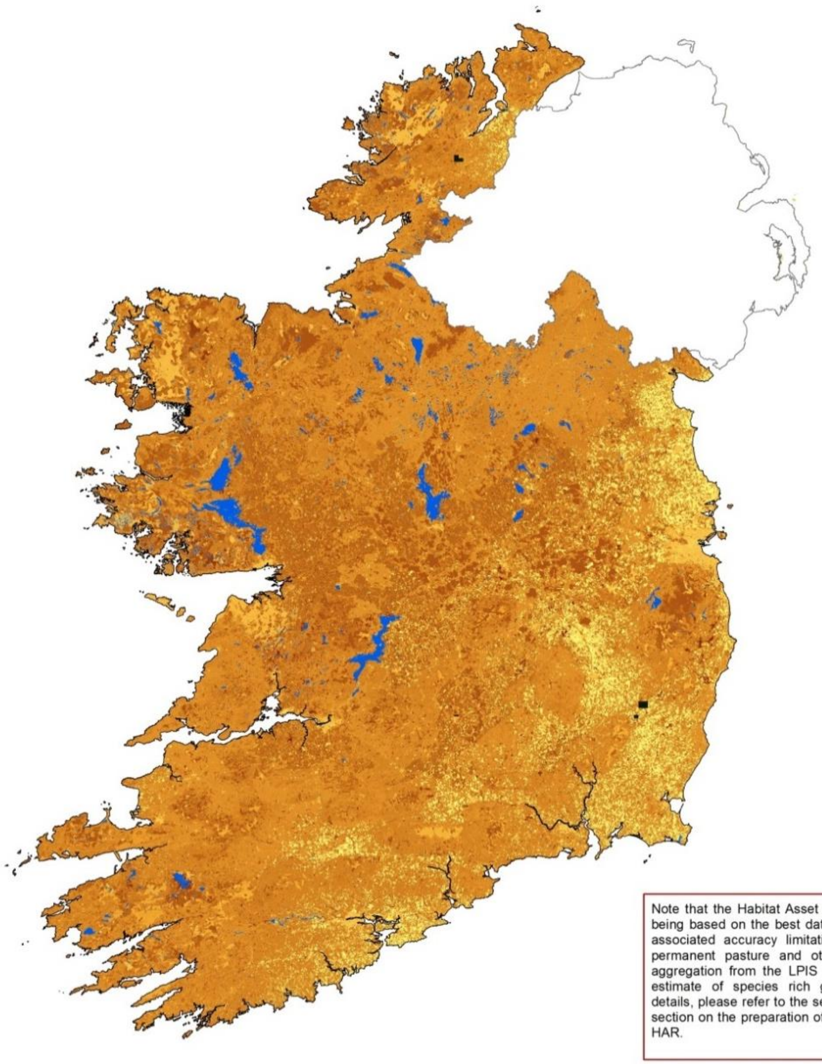
An Roinn
Ealaíon, Oidhreachta agus Gaeltachta
Department of
Arts, Heritage and the Gaeltacht

Vegetation carbon: Indicator document - Ecosystem Service Modelling & Rule-base development

Vegetation Carbon

Ecosystem service: **Regulation of greenhouse gases (carbon)**

29/03/2016



Note that the Habitat Asset Register (HAR) has, whilst being based on the best data currently available, some associated accuracy limitations, particularly regarding permanent pasture and other information based on aggregation from the LPIS information and an under-estimate of species rich grassland and heath. For details, please refer to the section on data gaps and the section on the preparation of LPIS data for usage in the HAR.

Legend

Higher contribution to carbon sequestration

Moderate contribution to carbon sequestration

Lower contribution to carbon sequestration

Freshwater

Compromised data in urban input

How to interpret the map:
The darkest colours represent areas where there is more carbon storage in the vegetation. Lighter colours represent areas of land where vegetated carbon is removed from the land each year.

Ecosystem service:
Climate change (regulation) - storage of carbon within vegetation.

What the service is:
Atmospheric carbon is sequestrated by and stored in vegetation through the process of photosynthesis, resulting in vegetative growth. The more biomass present in the vegetation the more carbon that is stored, with mature woodland of higher importance and grasslands and bare ground providing a lesser amount of carbon storage.

Why it is important:
Terrestrial ecosystems such as woodlands help to mitigate climate change by binding carbon within its biomass, thereby reducing greenhouse gas concentrations.

How the map was created:
Data analysis identified areas of significant carbon storage within vegetation. Information derived from existing habitat and land management data. This included a habitat map derived from Corine, FIPS Forest 07 and Forest 12 and NPWS (Article 17, National Survey of Native Woodlands 2003-2008; and Ancient and Long-established Woodland Inventory 2010) datasets. Vegetation is valued high to low according to both its above and below ground likely sequestration of carbon.
The map should be interpreted as showing the best information using the data currently available.

Valuation Example

Ecosystem Service Typology	Significant effects	Data used	Example attributes	Indicative scoring
Vegetation carbon resource: how much carbon is stored in the vegetation	Biomass present	Habitats	Woody species	high
			Bare ground	low
	Biomass removal	Management	Ancient woodland	high
			High intensity agriculture	low

0 10 20 30 40 50
Kilometres

N

Cartography by Environment Systems Ltd, May 2016.
Ordnance Survey Ireland Licence No EN 0059216

Contains data prepared by the Environmental Protection Agency based on Ordnance Survey Ireland information.
For full list of datasets used for this map, please refer to the final project report.

Indicator	CICES classification
VEGETATION CARBON STORAGE Vegetation carbon (Regulation of greenhouse gases (carbon))	**Section**: Regulation & Maintenance **Class:** Global climate regulation by reduction of greenhouse gas concentrations Filtration / sequestration / storage / accumulation by micro-organisms, algae, plants, and animals **CICES IE Sub-class:** Areas important for emissions reduction
Scale	**CICES Cascade Level** [1]
Strategic/National/~~Regional/Local~~	~~Structure/Function/~~Service/~~Benefit/Value~~

[1] Potschin, M. and R. Haines-Young (2016): Frameworks for ecosystem assessments. In: Potschin, M., Haines-Young, R., Fish, R. and Turner, R.K. (eds) Routledge Handbook of Ecosystem Services. Routledge, London and New York, pp 125-143.

What the service is

This is an important ecosystem service as it can help mitigate climate change by storing CO_2 and preventing its release into the atmosphere. Atmospheric carbon is sequestrated by, and stored in vegetation through the process of photosynthesis, resulting in vegetative growth. The more biomass present in the vegetation the more carbon that is stored, with mature woodland providing higher storage, grasslands providing little, and bare ground providing none.

Service indicator(s) mapped

This is an important ecosystem service as it can help mitigate climate change by storing CO_2 and preventing its release.

Vegetation carbon storage occurs in living plant biomass both above-ground in the form of stems, trunks, leaves and branches, and below-ground in the form of roots and rhizomes. This is a temporary form of carbon storage. As the vegetation dies back the plant material is broken down by decomposer organisms, releasing carbon back into the soil and atmosphere. Plants which generate the largest living biomass, and have the longest lifespan, store the highest levels of carbon.

Datasets used	Dataset requirement [2]
Habitat Asset Register [3]	Essential
Teagasc Soil	Beneficial
Conservation Designations	Beneficial

[2] 'Essential' datasets are needed to map the service, whilst 'beneficial' datasets will increase model accuracy but are not necessary requirements for mapping.

[3] The Habitat Asset Register only contains habitats suitable for national scale mapping; for details, please refer to the project report.

How the map was created

Information was derived from existing habitat and land management data. This includes the Habitat Asset Register for Ireland. Vegetation has been valued high to low according to both its above ground and below ground likely sequestration of carbon. In addition to habitat data, the effects of soil and conservation designations were considered.

Scoring

Significant Effects	Datasets used	Example attributes	Indicative scoring [4]
Level of biomass within habitat, longevity of species.	Habitat Asset Register	Woodland	High
		Raised Bog – Marginal Ecotope	Medium
		Coniferous woodland - Felled	Low
Effect of soil type on plant growth and longevity.	Teagasc Soil	None	High
		None	Medium
		AminSW, GQz	Low
Areas under conservation likely to have less vegetation removed through management	Conservation Designations	None	High
		None	Medium
		Area under designation	Low

[4] The indicative scoring in this table gives overview-type information on how the individual data layers were incorporated into the ES maps. For full scoring, please refer to the spreadsheet containing the full rules-base.

Data gaps associated with this map during the pilot project

Habitat cover as an indicator for vegetation carbon storage could be enhanced by the addition of nationwide condition data of semi-natural habitats. Direct measurements of biomass cover and density e.g. ancient woodlands with diverse understorey and ground flora will contain more vegetation carbon than semi-mature plantation woodland with no understorey.

NOTE – Whilst the Habitat Asset Register (HAR) is based on the best data currently available, it does contain some inherent limitations due to the manner in which LPIS categorises permanent pasture. This may lead to an underestimation of semi-natural grassland and heaths. For details, please refer to the section on data gaps and the section on the preparation of LPIS data for usage in the HAR.

Scientific framework for modelling 'vegetated carbon storage'

Overview:	Atmospheric carbon is sequestrated by, and is stored in, vegetation through the process of osmosis and plant growth (FAO, 2001). There is good supporting evidence regarding the role of soils and habitats in vegetation carbon storage and the role of above and below ground processes. The most relevant material is summarised here.
Soil	Vegetation carbon storage is influenced by soil type, with properties such as soil texture, depth, organic matter/nutrient content as well as the context of the soil in the landscape affecting the type of vegetation likely to be present (Brady and Weil, 2002; Dominati et al., 2010). Additionally, human management of soil has a strong influence on vegetation carbon storage by altering the type of vegetation found in an area (Foley et al., 2005). This is of particular relevance when modifications of the soil (e.g. drainage or fertiliser input) promote growth of plants that would not naturally be sustained by the soil type present (Foley et al., 2005; Holman, 2009; McCracken et al., 2011). While vegetation is linked to broad groups of soil type (as discussed below), association between vegetation and subdivisions of soil type is low (Rankin et al., 2007). For example, mature woodland can even develop on quite shallow and wet soils.

Soil (cont.)	Good information regarding soil composition, particle size, pore spaces, and peat content in Ireland have been recorded by Teagasc (Teagasc Soils Guide [5]; Teagasc, 2007).

[5] http://gis.teagasc.ie/soils/soilguide.php

Habitat and land use	The more biomass that is present in the vegetation layer, the more carbon is stored in the vegetation. Habitat type is a key determinant of vegetation carbon storage. As plant material, particularly woody tissue, contains up to 50% carbon (FAO, 2001; Thomas and Martin, 2012), a high biomass within the habitat is associated with large quantities of vegetation carbon. Consequently, on a per area basis, woodlands are the main contributor to vegetation carbon storage in temperate climates (Milne and Brown, 1997; Quine et al., 2011; Alsonso et al., 2012), with most carbon being stored in the trunks (Hagon et al., 2013). To assess the rate of carbon uptake, the age of the forest is important, as uptake is highest during the full-vigour phase (Quine et al., 2011; Alsonso et al., 2012) before levelling out in mature forests (Broadmeadow and Matthews, 2003). Most of the carbon stored in grasslands is in the soils (Bullock et al., 2011; Alonso et al., 2012; Hagon et al., 2013). Habitats managed for arable and horticultural crops store the least carbon in their vegetation (Milne and Brown, 1997; Alonso et al., 2012). An important difference between agriculturally managed and natural systems is that, in natural systems, part of the above ground biomass will be incorporated into the soil carbon store as plant litter (Melillo et al., 1989; Angers and Caron, 1998; Rasse et al., 2005). For example in heathlands, during the growth phase biomass increases, which leads to a net gain in vegetation carbon. However, after a certain time, between 18 and 27 years in Calluna vulgaris dominated heath, vegetation biomass (and carbon with it) levels out, as gain from growing plants and loss from dying plants balance out. During this time, however, stocks in the soil could keep increasing due to plant litter (Kopittke et al., 2013).

Habitat and land use (cont.)	Wetlands are considered a terrestrial carbon sink (Billett et al., 2010; Kayranli et al., 2010; Bain et al., 2011), but store the majority of the carbon in the underlying soils rather than in the vegetation (Ostle et al., 2009; Bain et al., 2011). A diverse community of soil invertebrates, particularly earthworms, can have a positive impact on soil structure by creating pores of various sizes that enable easy root penetration and increase oxygen content and water holding capacity (Brussaard, 1997; Wall and Moore, 1999; Lavelle et al., 2006). In habitats where this is the case, below ground species richness can have a positive impact on the maximum biomass that can be sustained above ground (Brussaard, 1997; Wall and Moore, 1999) and, hence, affect vegetation carbon.

Supporting Evidence: References

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