Office for National Statistics

Statistical bulletin

UK natural capital accounts: 2019

Estimates of the financial and societal value of natural resources to people in the UK.

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Release date:
18 October 2019

Next release:
To be announced

Correction

20 December 2019 10:25

A correction has been made to the air pollution estimates. This was due to a small error when estimating the linear interpolation between the modeled years. This has effected tables 1 and 2 and figures 23, 24, 27, 28, 29, 37 and 38. You can see the original content in the superseded version. We apologise for any inconvenience.

4 March 2020 14:00

A correction has been made to the recreation estimates. This was due to a error estimating Welsh recreation total expenditure in the modelled years and not applying the correct GDP deflator to convert to 2018 prices. This has affected Table 1, Figures 32, 34, 37 and 38, and the dataset. You can see the original content in the superseded version. We apologise for any inconvenience.

Table of contents

1 . Main points

- In 2016, with the addition of new services, the partial asset value of UK natural capital was estimated to be nearing £1 trillion (£958 billion).
- On average annually, people in Wales spend over three times longer on outdoor recreation than people in England.
- In 2018, feedstock and grazing for livestock made up 61% of UK agricultural biomass.
- The cooling shade of trees and water saved the UK £248 million by maintaining productivity and lowering air conditioning costs on hot days in 2017.
- Our model suggests around 27,500 years were saved through vegetation removing air pollution in 2017
- Renewable energy generation grew from 5% of all electricity generation in 2008 to 35% in 2018.
- In 2018, coal production was at an all-time low, 16 times less than in 1998.
- UK timber production has increased 51% between 2000 and 2018, mainly in Scotland.
- In 2016, living within 500 metres of green and blue space was estimated to be worth £78 billion to UK homes.

2 . Things you need to know about this release

This article looks at natural capital assets, the flows and values of services – terms that help us think logically about how to measure aspects of the natural world and their impact upon people. Natural capital assets are things that persist long-term, such as mountains or a fish population.

From these assets, people receive a flow of services, such as mountain hikes and fish captured for consumption. We can value the benefit to society of those services by estimating what the hikers spent to enable them to walk over the mountain or any profit from bringing the fish into the market. Applying this logic consistently across assets and services enables us to start building accounts of the UK's nature.

Where available, estimates are presented between the period 1997 to 2017 and all monetary valuations are given in 2018 prices deflated using the HM Treasury June 2019 GDP deflators. Methods for some services have been developed since the 1997 to 2015 UK Ecosystem Service Accounts. These changes reduce consistency between individual ecosystem services across reports but all figures in this report use the same methods.

It is recognised that the UK accounts remain experimental and future UK publications will be subject to methodological improvements. Ecosystem service valuations offer comparative analysis across services whereas physical flows provide information about the changes over time independent of price changes.

The services are presented by type, which include provisioning, regulatory and cultural. Types of service are defined at the beginning of each section.

Several ecosystem services are not being measured in this article, so the monetary accounts should be interpreted as a partial or minimum value of UK natural capital.

3 . Collaboration

The Office for National Statistics (ONS) natural capital accounts are produced in partnership with the Department for Environment, Food and Rural Affairs (Defra). Further details about the natural capital accounting project are also available.

4 . Overview of UK ecosystem services

This article presents 13 service accounts, containing estimates of the quantity and value of services being supplied by UK natural capital.

Table 1: UK ecosystem services asset valuation (£ million, 2018 prices)

	£	£	Percentage change	
	2016	**2017**	**2016 to 2017**	**2009 to 2016**
Provisioning Services				
Agricultural biomass	118,426	128,292	8	37
Fish capture	7,584	-	-	-
Fossil fuels	95,285	59,358	-38	-53
Minerals	5,483	6,408	17	82
Timber	8,517	8,962	5	72
Water abstraction	76,370	74,741	-2	25
Renewables generation	7,887	9,501	20	133
Regulating Services				
Carbon sequestration	103,947	105,602	2	12
Air pollutant removal	43,152	43,447	1	0
Urban cooling*	11,398	13,302	17	
Noise mitigation*	-	832	-	
Cultural Services				
Recreation	401,179	354,189	-12	1
Aesthetic (house prices)*	9,428	-	-	-16
Recreation (house prices)*	68,552	-	-	23
Total	958,040	-	-	

Source: Office for National Statistics

Notes

1. * Services marked with an asterisk are new to this publication. Back to table

2. - Signifies insufficient data in all columns rather than no change. Back to table

3. Noise mitigation asset value in 2017 has been included under UK total asset valuation in 2016. Back to table

This article uses the term “ecosystem service” throughout, which generally refers to living (biotic) components of the Earth that provide services to humanity. However, non-living (abiotic) components, such as oil and gas used for energy, are also included in this release. A summary of the main trends is presented in this article, but more information can be found in the datasets accompanying this release.

5 . Provisioning services

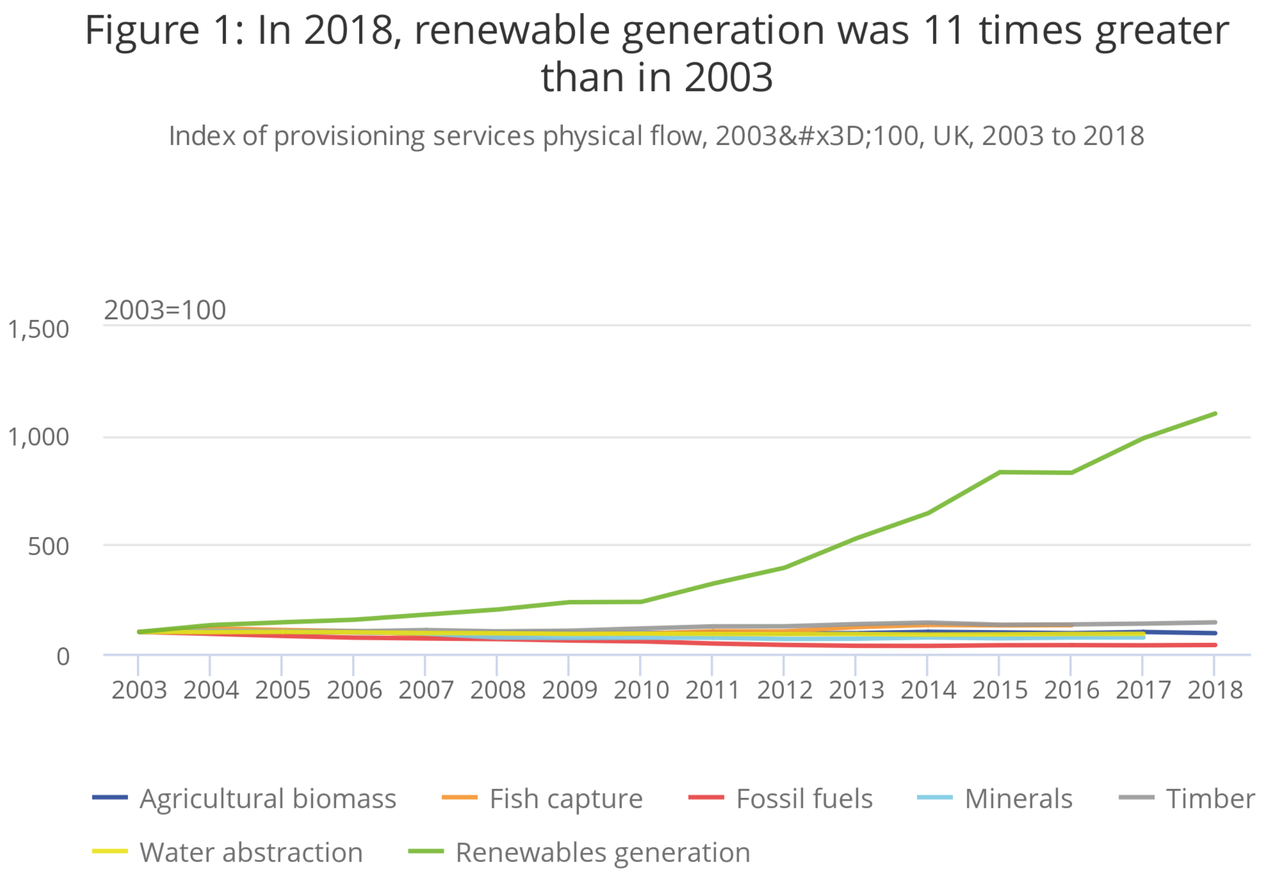
Provisioning ecosystem services create products such as food, water, and materials. They are produced by nature and consumed by society.

Provisioning services currently included in the UK natural capital accounts are:

- agricultural biomass
- fish caught
- timber
- water abstraction
- minerals
- fossil fuels
- renewable energy

Figure 1: In 2018, renewable generation was 11 times greater than in 2003

Index of provisioning services physical flow, 2003=100, UK, 2003 to 2018

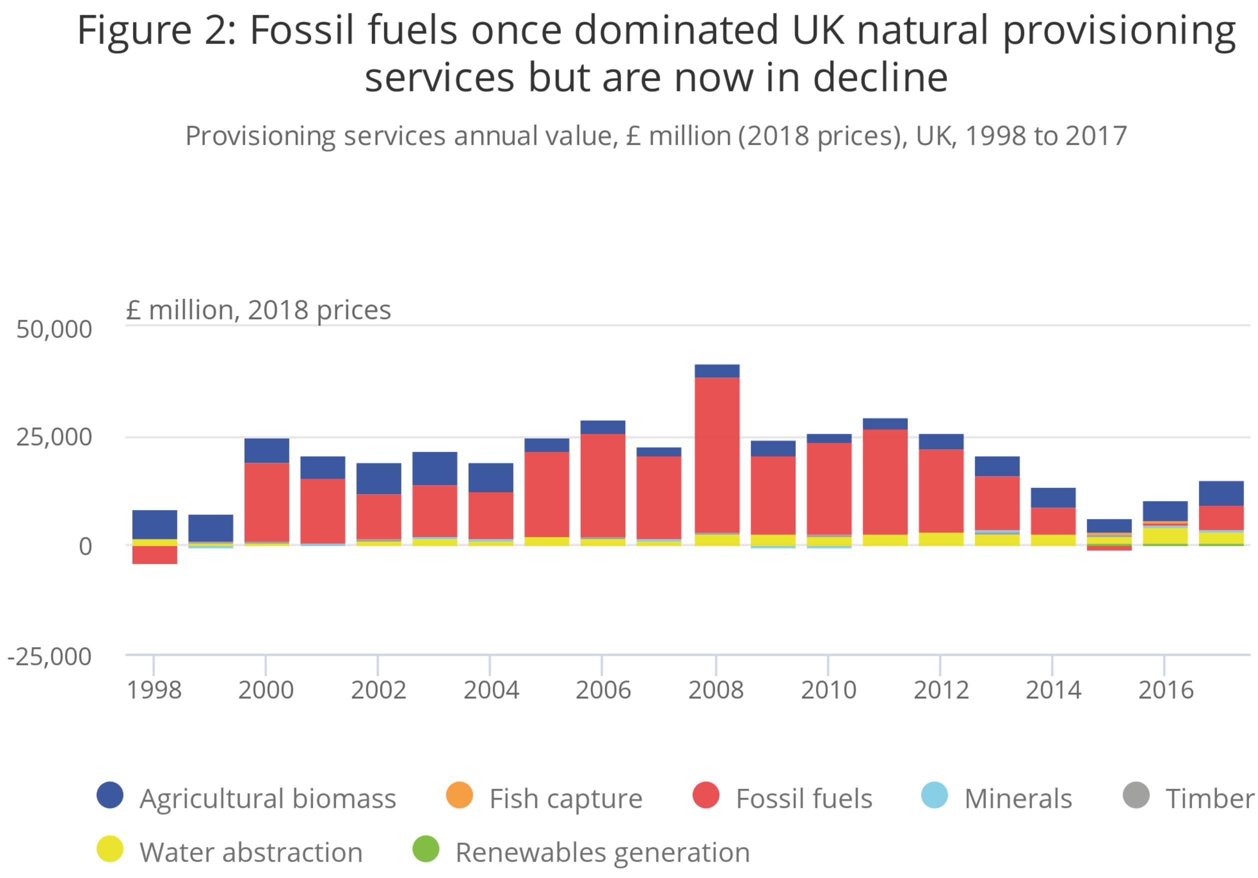


Source: Office for National Statistics –Natural Capital Index

Figure 2 shows a time series of the annual valuation for the provisioning services. The total value of provisioning services in the UK fluctuated throughout 2003 to 2016, at its highest in 2008 and lowest in 2015. Between 2011 and 2015, the total annual value for provisioning services declined. The increase in the value of fossil fuels drove the peak in 2008 and represented 85% of the provisioning service valuation, for that year. However, in 2015 fossil fuels had a negative impact on the overall annual valuation, decreasing it by 22%. The decline in the value of fossil fuels is the result of falling production, price decline, and increasing costs.

Figure 2: Fossil fuels once dominated UK natural provisioning services but are now in decline

Provisioning services annual value, £ million (2018 prices), UK, 1998 to 2017



Source: Office for National Statistics

Notes:

1. Valuations for all provisioning ecosystem services are available in 2015 and 2016 only.

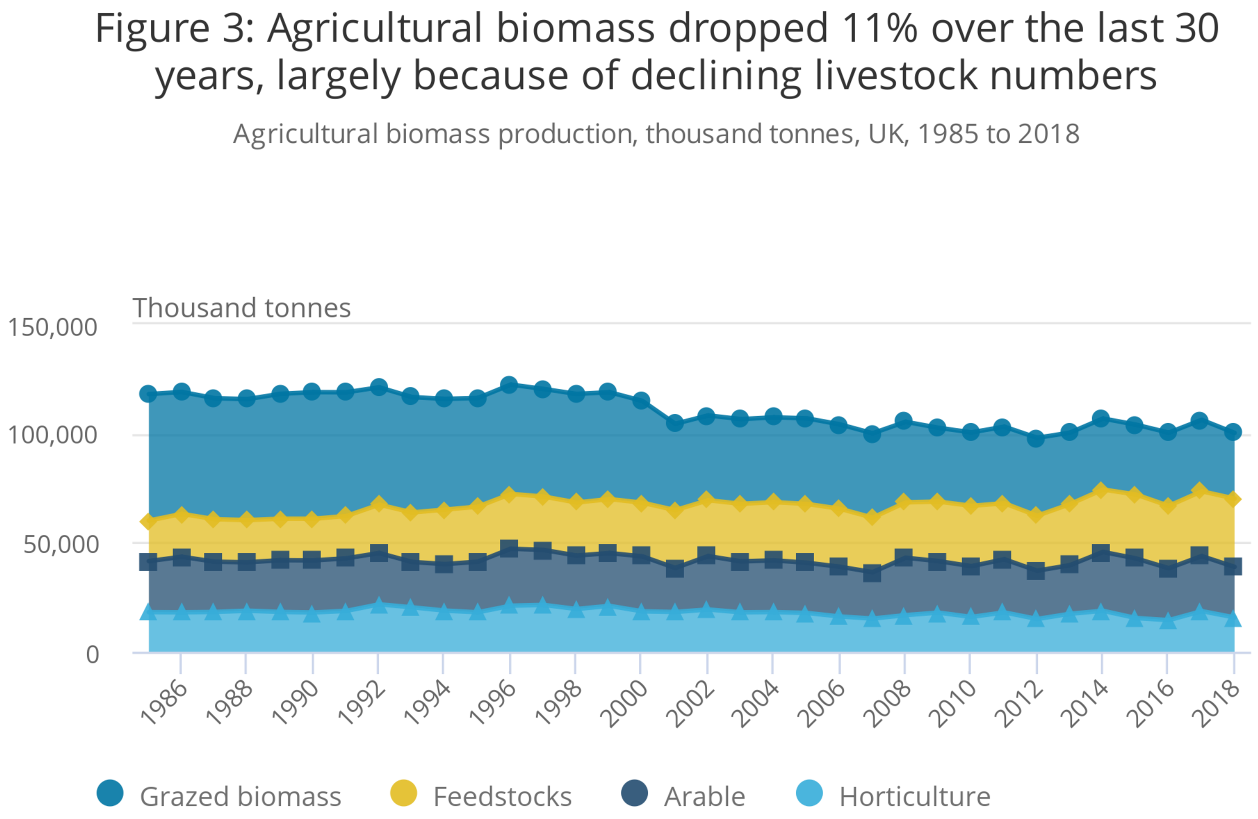
Agricultural biomass

Agricultural biomass includes the value of crops, fodder and grazing. Farmed animals are not included in these estimates as they are considered produced rather than natural assets. The food eaten by farmed animals, such as grass and feed, is included.

The 17.5 million hectares of utilised agricultural land made up 72% of total UK land area in 2018. Utilised agricultural area has declined around 5% over the last 30 years. The largest change within this period was between 2008 and 2009 where utilised agricultural land declined by 0.4 million hectares (2%). Since 2015, utilised agricultural land area has been slowly increasing.

Figure 3: Agricultural biomass dropped 11% over the last 30 years, largely because of declining livestock numbers

Agricultural biomass production, thousand tonnes, UK, 1985 to 2018



Source: Office for National Statistics and Department for Environment

Notes:

1. Arable includes: barley, wheat, oats, oilseed rape, and linseed.

2. Horticulture includes: fresh vegetables, fresh fruit, potatoes, and sugar beet.

Throughout the timeseries, meeting the feed requirements of livestock makes up the majority of agricultural biomass. On average 62% of total agricultural biomass was animal feed, being feedstocks and grazed biomass. Between 1988 and 2018, combined cattle and sheep population declined 18%, causing a 14% drop in UK-grown animal feed. While grazed biomass declined 41%, feedstocks increased 62% over this period.

With more feedstocks and fewer livestock, grazing is contributing less to feeding than in the past. In 1988, grazing made up 74% of livestock feed and in 2018 this was 51%.

Over a 30-year trend arable production has remained stable while horticulture has seen a 16% decline from 1988 to 2018. On an annual basis arable and horticulture see fluctuations, with annual increases up to 18% in 2007 and annual declines of 12% in 2000 and 2011.

Valuation of agricultural biomass provisioning

Previous UK ecosystem service accounts have provided resource rent annual valuations using the residual value approach. This is the surplus value to the agricultural industry after all costs have been considered. Estimated at an aggregate scale it may include non-agricultural aspects of farm businesses.

As part of our development, we will look at alternative measures of capturing food production value. Figure 4 compares the industry resource rent residual value approach with an aggregated whole farm income and farm rent approach.

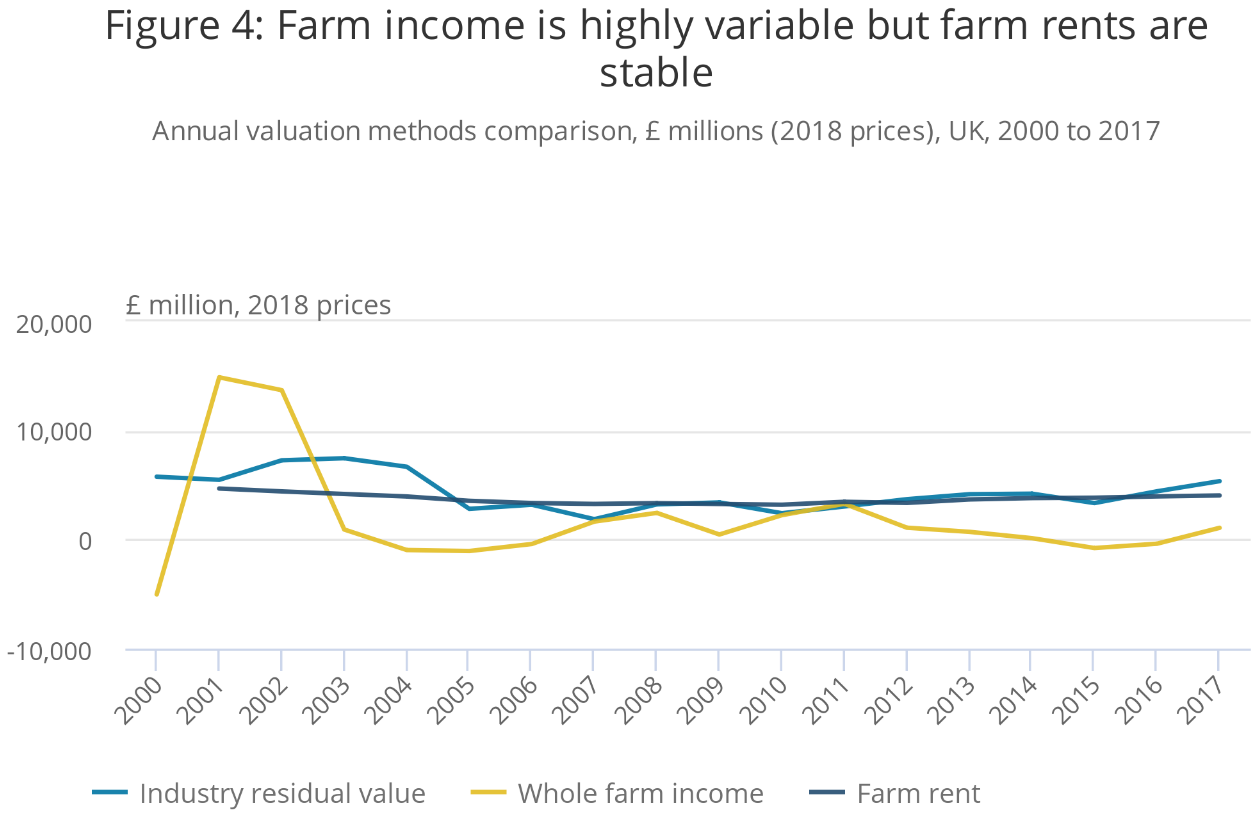
Whole farm income is the total income from agricultural production (excluding subsidies) net of costs (excluding taxes). This is like the residual value approach but calculated at a farm output level.

Farm rent is an imputed estimate of total rental costs for agricultural land.

For further details on these approaches please see the Methodology guide.

Figure 4: Farm income is highly variable but farm rents are stable

Annual valuation methods comparison, £ millions (2018 prices), UK, 2000 to 2017



Source: Office for National Statistics and Department for Environment, Food and Rural Affairs

The spike in whole farm income between 2001 and 2002 was the result of a significant drop in farming costs. The average costs for agriculture per farm fell from £137,000 to £47,000, returning to typical levels in 2003 (£147,000). This spike is not reflected in farm rents or the industry residual value. We are unsure of the specific drivers of this fluctuation but for context, 2001 was the year a foot and mouth disease outbreak occurred in Great Britain.

Farm Business Tenancy costs fell to £150 per hectare in 2006 and have since gradually increased to £227 per hectare in 2017. This has affected total farm rent.

Using the industry residual value, agricultural biomass provisioning service annual valuations show a high of £7.5 billion in 2003 and a low of £1.9 billion in 2007. In 2017 the agricultural biomass annual valuation was £5.4 billion.

Fish capture

We have been working to improve our fisheries statistics and more work is needed. We rely on a range of external sources which all involve known uncertainties. For instance, Norway and Faroese landings are excluded from this analysis. The economic data are based on UK fleet data which we also apply to foreign vessels that may face different costs and prices. In addition, UK boundaries do not perfectly align with the geographical areas of fish capture statistics. For more detail on how fish capture in UK waters is estimated, see the Marine Management Organisation Exclusive Economic Zone Analysis and associated publications.

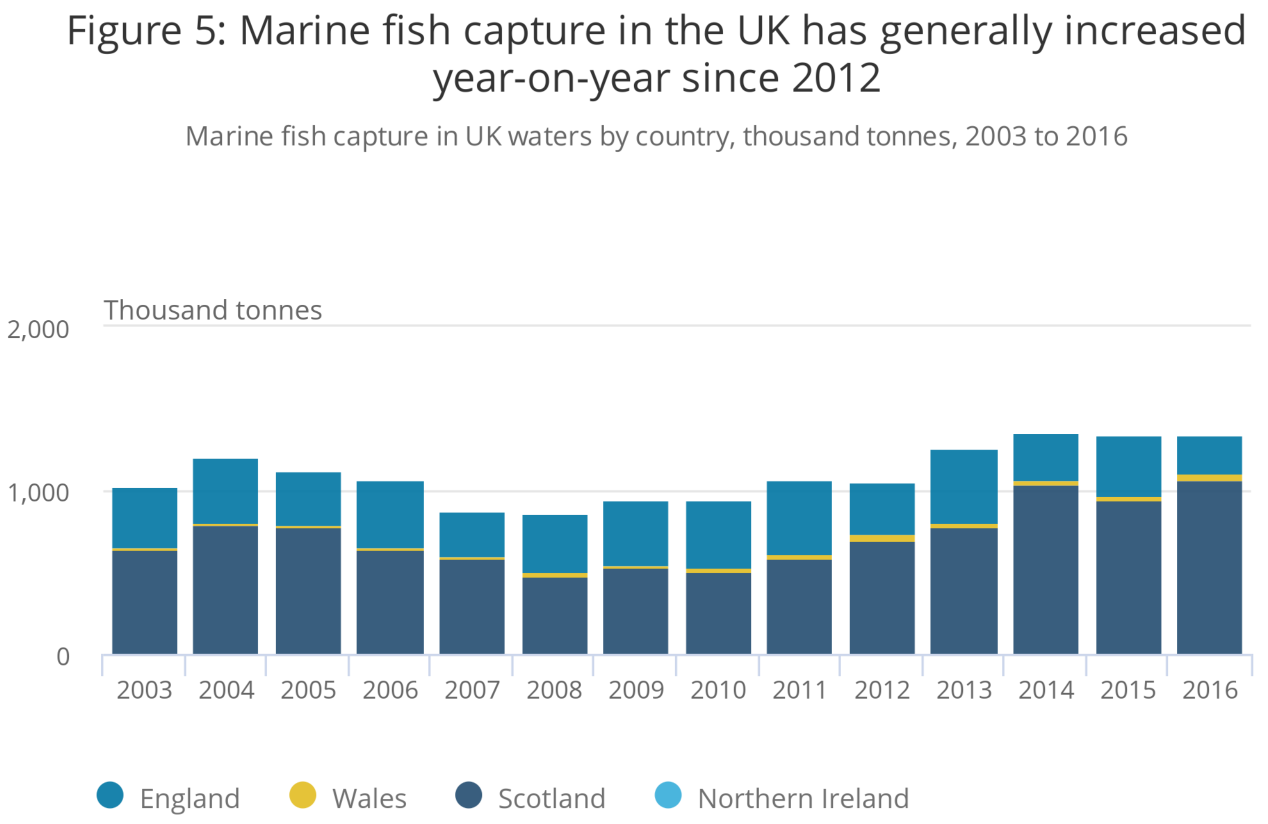
Marine fish capture in UK waters has increased nearly a third since 2003 from 1,032 thousand tonnes to 1,349 thousand tonnes in 2016.

Aquaculture or farmed fish, like farmed livestock, have been removed from estimates as farmed fish are viewed as a produced asset and not a natural asset. For more information on the method please see the Methodology guide.

Over the last three years, most of the fish capture in the UK was in Scottish waters representing on average three quarters of the total amount of fish caught (see Figure 5). According to the UK Sea Fisheries 2016 report, landings by Scottish vessels have increased significantly since 2014 as a result of greater mackerel landings.

Figure 5: Marine fish capture in the UK has generally increased year-on-year since 2012

Marine fish capture in UK waters by country, thousand tonnes, 2003 to 2016



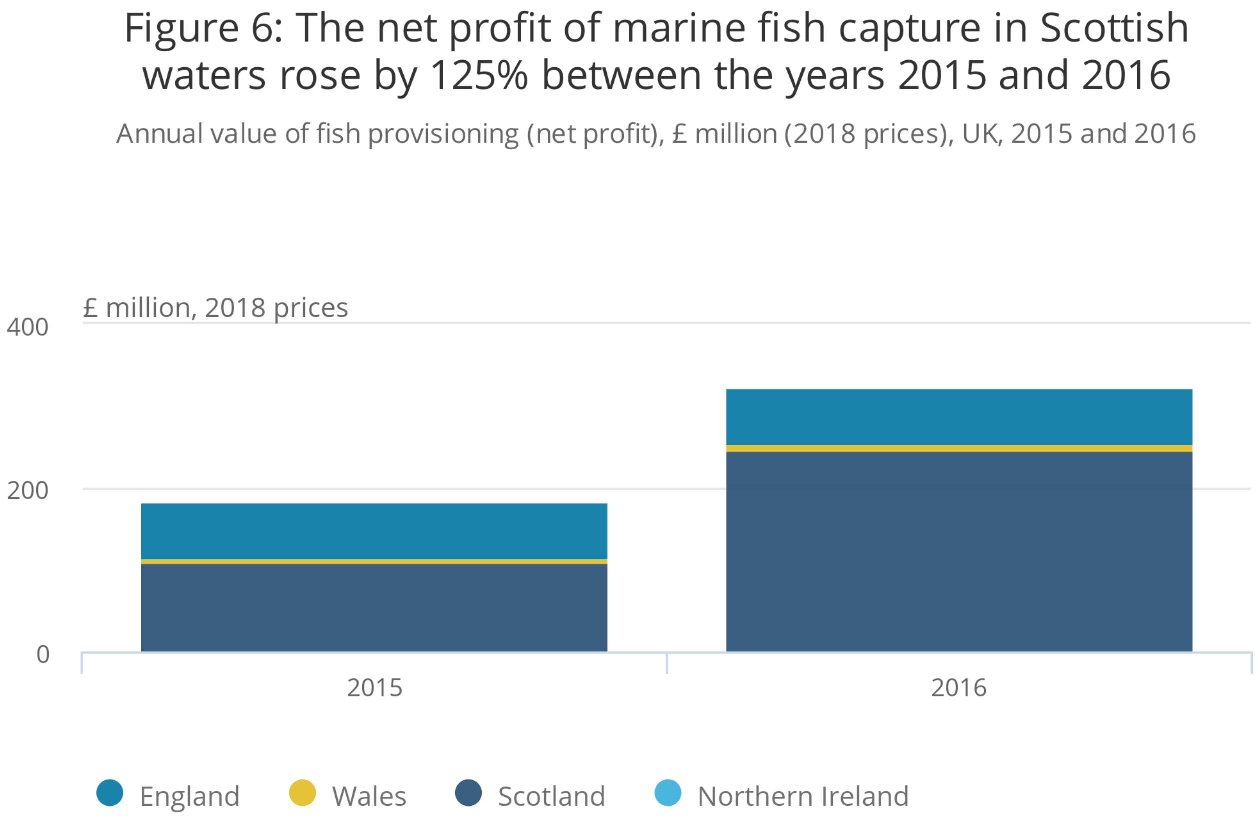
Source: Scientific, Technical and Economic Committee for Fisheries

The value of fish capture is calculated using net profit per tonne (landed) estimates, provided by Seafish, for different marine species. For more information on how we calculate the value please see the Methodology guide. We only present the years 2015 to 2016 because of a lack of price data in some of the other years.

Between 2015 and 2016, the value of marine fish capture in UK waters increased by over three quarters, from £184.1 million to £323.8 million in 2016. This was primarily caused by an increase in the value of fish capture in Scotland which increased by 125% between these years, while the value of the other countries broadly stayed stable (see Figure 6).

Figure 6: The net profit of marine fish capture in Scottish waters rose by 125% between the years 2015 and 2016

Annual value of fish provisioning (net profit), £ million (2018 prices), UK, 2015 and 2016



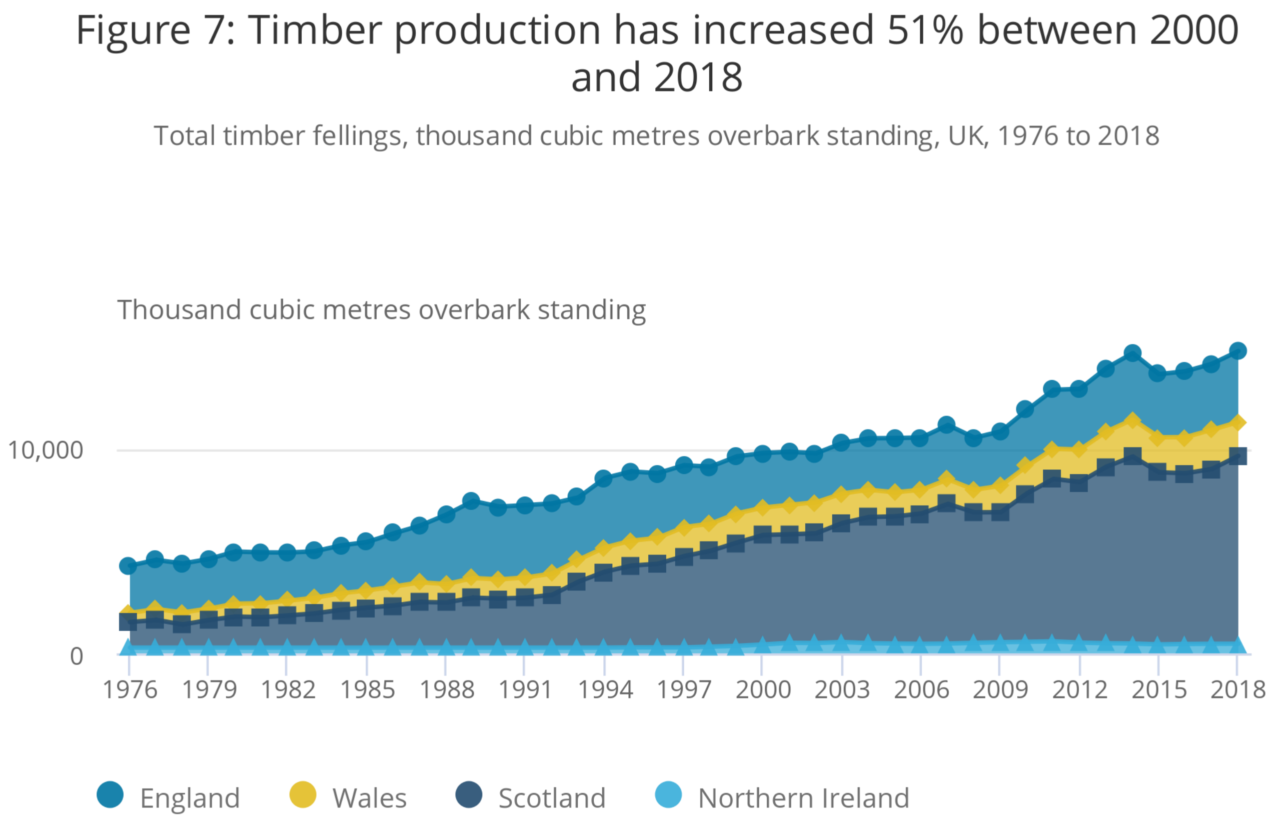
Source: Office for National Statistics

In Scottish waters, mackerel represents around a third of all species fished and the net profit of mackerel more than doubled between 2015 and 2016. According to the 2016 Scottish Sea Fisheries Statistics report, mackerel was the most valuable stock during 2016, with the average price increasing by 35% from £664 per tonne in 2015 to £895 per tonne in 2016.

Timber

Figure 7: Timber production has increased 51% between 2000 and 2018

Total timber fellings, thousand cubic metres overbark standing, UK, 1976 to 2018

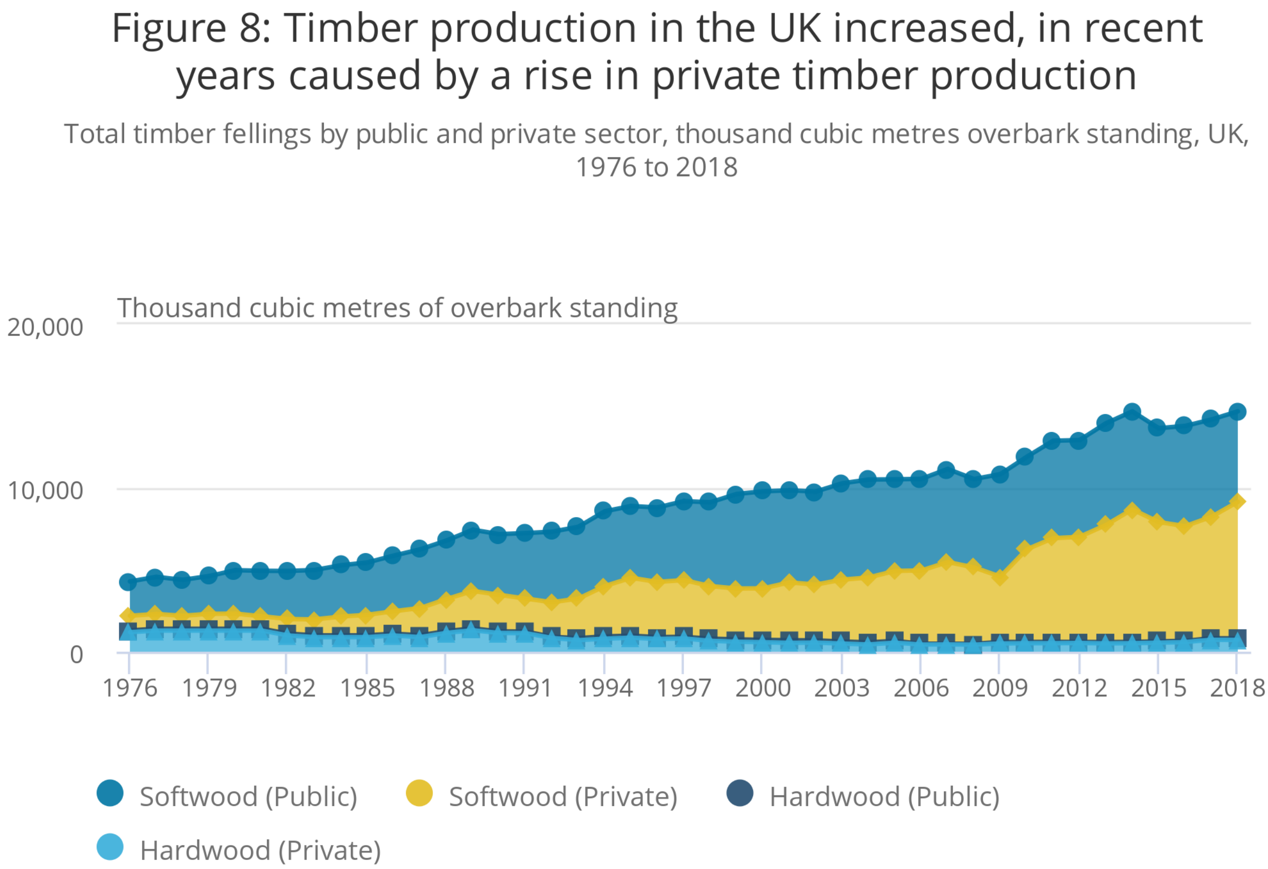


Source: Forestry Commission

As can be seen from Figure 8, Scottish production has driven the UK trend, with production increasing 316% between 1988 and 2018, and 62% of timber sourced from Scotland in 2018. Forest research data for 2018 reveals Scotland to have 45.5% of the UK's woodlands.

Figure 8: Timber production in the UK increased, in recent years caused by a rise in private timber production

Total timber fellings by public and private sector, thousand cubic metres overbark standing, UK, 1976 to 2018



Source: Forestry Commission

Notes:

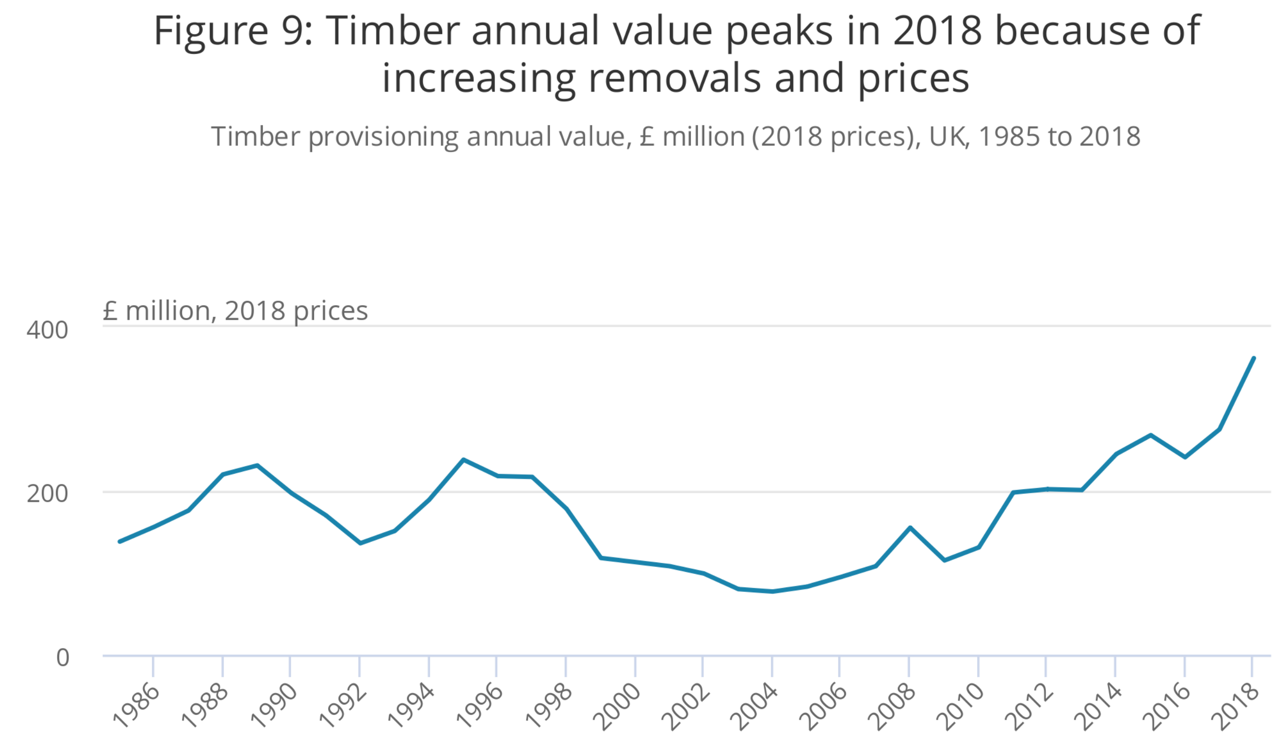
1. Hardwood - broadleaved trees such as oak, birch and beech.

2. Softwood - coniferous trees such as spruce, pine and larch.

Private sector production has driven much of the timber removals increase. Between 1988 and 2018, public sector timber production increased 53% and private sector timber production increased 192%. From 1976 to 2009, most of the timber production (56%) came from the public forestry estate. However, from 2010 to 2018 the private sector has made up the majority (56%) of timber production. The change is primarily the result of differences in the age structure and timing of timber production between woodlands on the public and private forest estates following a period of high levels of planting by the private sector in Scotland between 1970 and the late 1980s.

Figure 9: Timber annual value peaks in 2018 because of increasing removals and prices

Timber provisioning annual value, £ million (2018 prices), UK, 1985 to 2018



Source: Office for National Statistics and Forestry Commission

Timber production’s steadily increasing annual value fluctuations, shown in Figure 9, are caused by stumpage price trends. The stumpage price is the price paid per standing tree for the right to harvest timber from a given area. Prices hit a low of £5.60 per cubic metre overbark standing in 2004, and have since increased to £24.64 in 2018, driving an overall valuation time series high. Using projected timber removals over the next 100 years, the asset valuation of the timber provisioning service reached over £10 billion in 2018.

Water abstraction

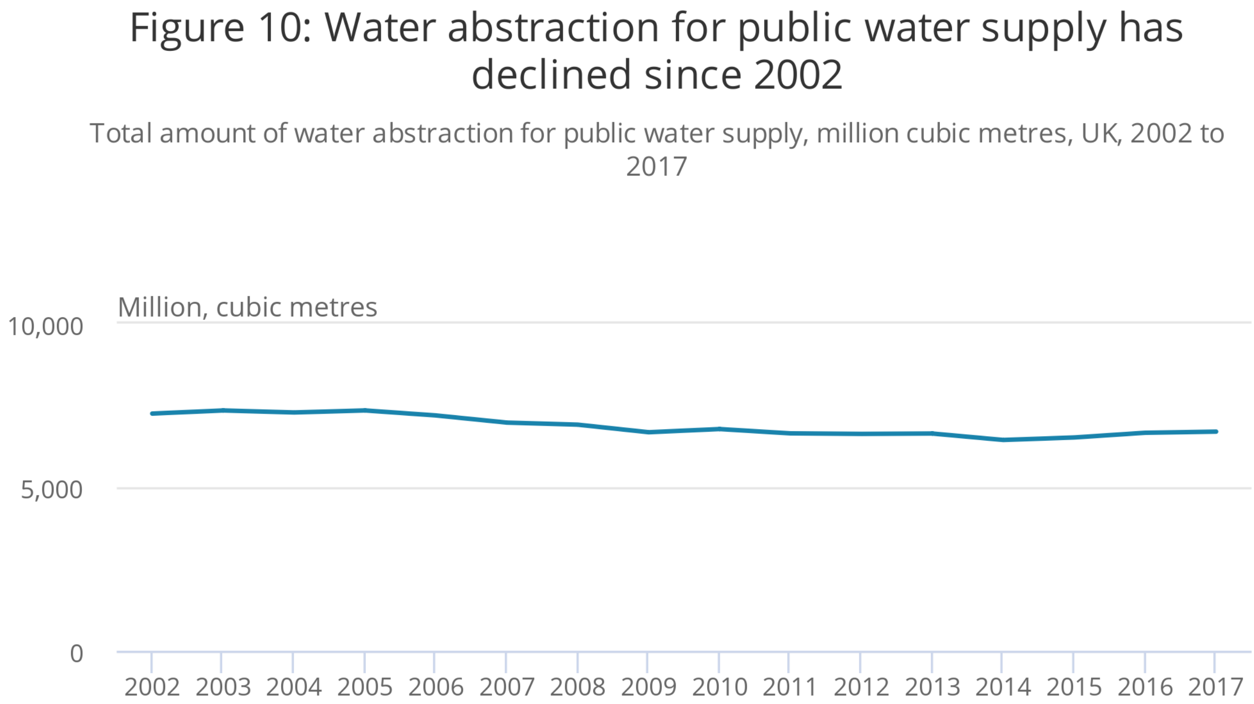
The annual value of water abstraction more than doubled from 2015 to 2016, to £3,513 million.

From 2005 to 2014, the amount of water being abstracted for public water supply declined by 12%, to 6,443 million cubic metres. A possible reason for this could be the Water Act 2003, calling for a more efficient and sustainable use of water, as well as the installation of water meters.

Since 2014, water abstraction for public water supply started to increase, rising to 6,697 million cubic metres in 2017. This was driven by increasing water abstraction in England, while water abstraction in Scotland and Wales declined.

Figure 10: Water abstraction for public water supply has declined since 2002

Total amount of water abstraction for public water supply, million cubic metres, UK, 2002 to 2017



Source: Department for Environment, Food and Rural Affairs, Natural Resources Wales, Northern Ireland Water, and Scottish Water

The annual value of water abstraction provisioning in 2017 was £2.54 billion. Currently monetary estimates are derived from information about economic activity relating to the collection, treatment and supply of water.

We are exploring alternative methods used to value water provisioning services, with the aim to look at the short-term cost and certainty, and long-term sustainability of the UK's water supply. Our aim is to capture the impact of the changing demand for water, and of climate change on the UK water supply by reporting on:

- current and projected demand and water abstraction levels
- weather forecasts and costs of ecologically excessive abstraction
- water movements by truck
- restrictions on supply

Because of population growth in England, and climate change, demand for water is forecast to continue to increase (PDF, 622.88KB), Environment Agency 2018. However, current levels of water abstraction are already unsustainable in certain regions, creating pressure on our water resources. Climate change effects are predicted to lead to increasing winter rainfall and reducing summer rainfall resulting in floods in the winter and droughts in the summer.

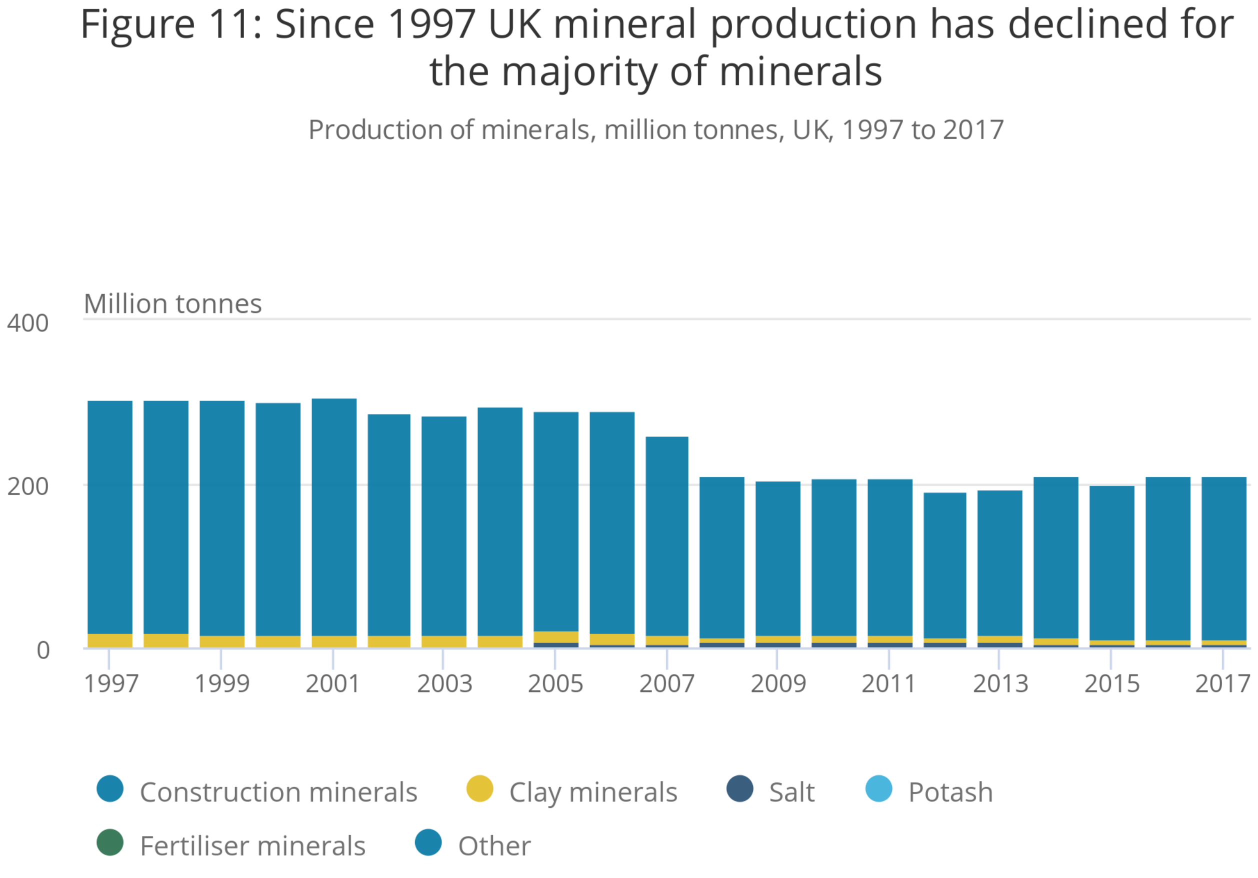
Minerals

UK minerals production generally remained stable between 1997 and 2007. After 2007, with the economic downturn, mineral production declined by 20% to 208 million tonnes in 2010. Since then production has stabilised, with 211 million tonnes produced in 2017.

While almost all minerals have shown production decline since 1997, trends have been driven by construction minerals, averaging 94% of production. In 2017, salt was the only mineral with greater production than 1997 levels, which was 128% greater. Approximately 30% of salt is used in solid form as rock salt, mostly for de-icing roads, and 70% is used in brine ([British Geological Survey](#)).

Figure 11: Since 1997 UK mineral production has declined for the majority of minerals

Production of minerals, million tonnes, UK, 1997 to 2017



Source: British Geological Survey

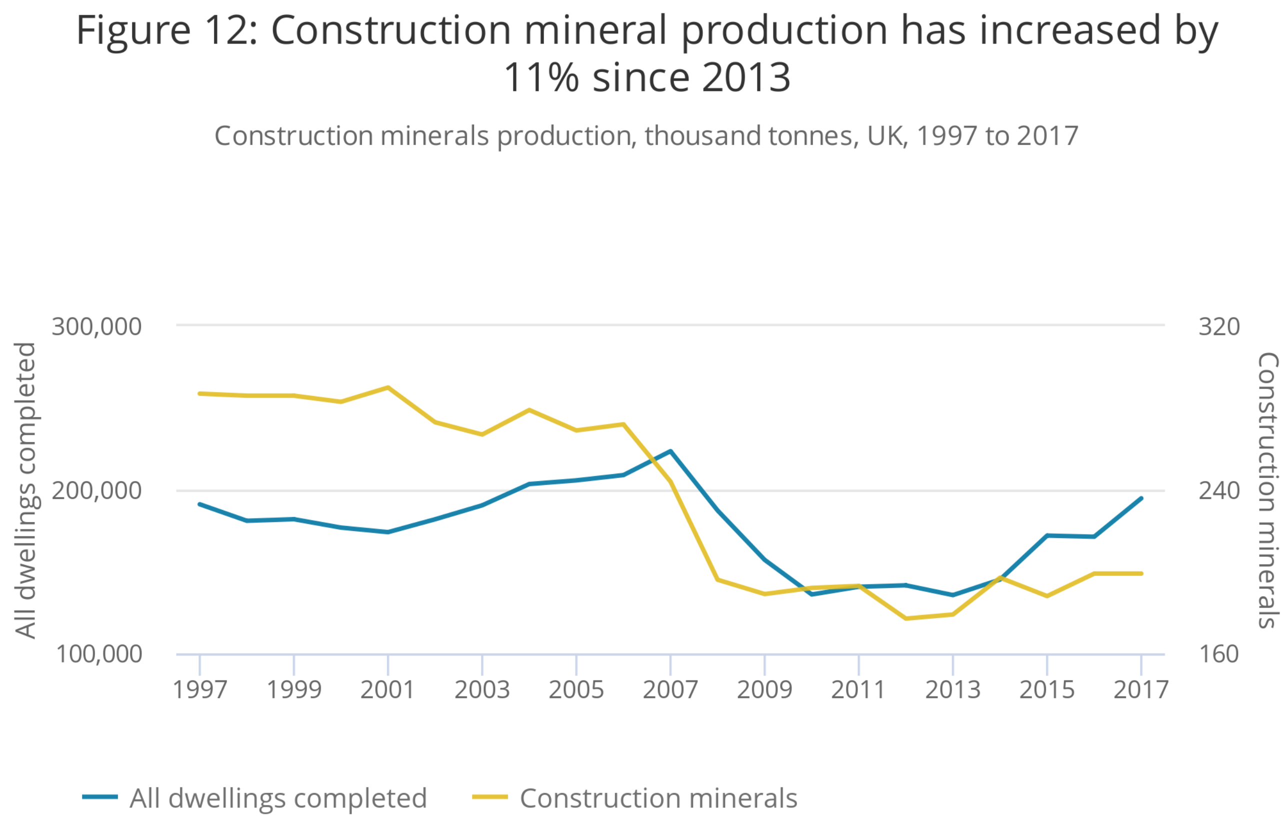
Notes:

1. Construction minerals include sand and gravel, gypsum, chalk, slate, igneous rock, limestone and dolomite, and sandstone.
2. Fertiliser minerals include barytes and fluorspar.
3. Clay minerals includes fireclay, china clay, ball clay, and clay and shale.
4. Other includes china stone and talc.
5. Mineral extraction after 2014 is estimated based on sales data.

The decline in the extraction of minerals used in the construction industry for building of houses and infrastructure corresponds with the drop in UK house building, which declined by 39% between 2007 and 2013 (Figure 12). Construction minerals production declined by 26% during the same period. Since 2013, there has been a 44% increase in house building in the UK but only an 11% increase in construction mineral production. This could be attributed to the permitted reserves not being replenished because of planning constraints (British Geological Survey). Between 2013 and 2017, UK imports of construction minerals increased by 117%.

Figure 12: Construction mineral production has increased by 11% since 2013

Construction minerals production, thousand tonnes, UK, 1997 to 2017



Source: British Geological Survey and Ministry of Housing, Communities and Local Government

Notes:

1. Construction minerals include sand and gravel, gypsum, chalk, slate, igneous rock, limestone and dolomite, and sandstone.

2. Mineral extraction after 2014 is estimated based on sales data.

Peat

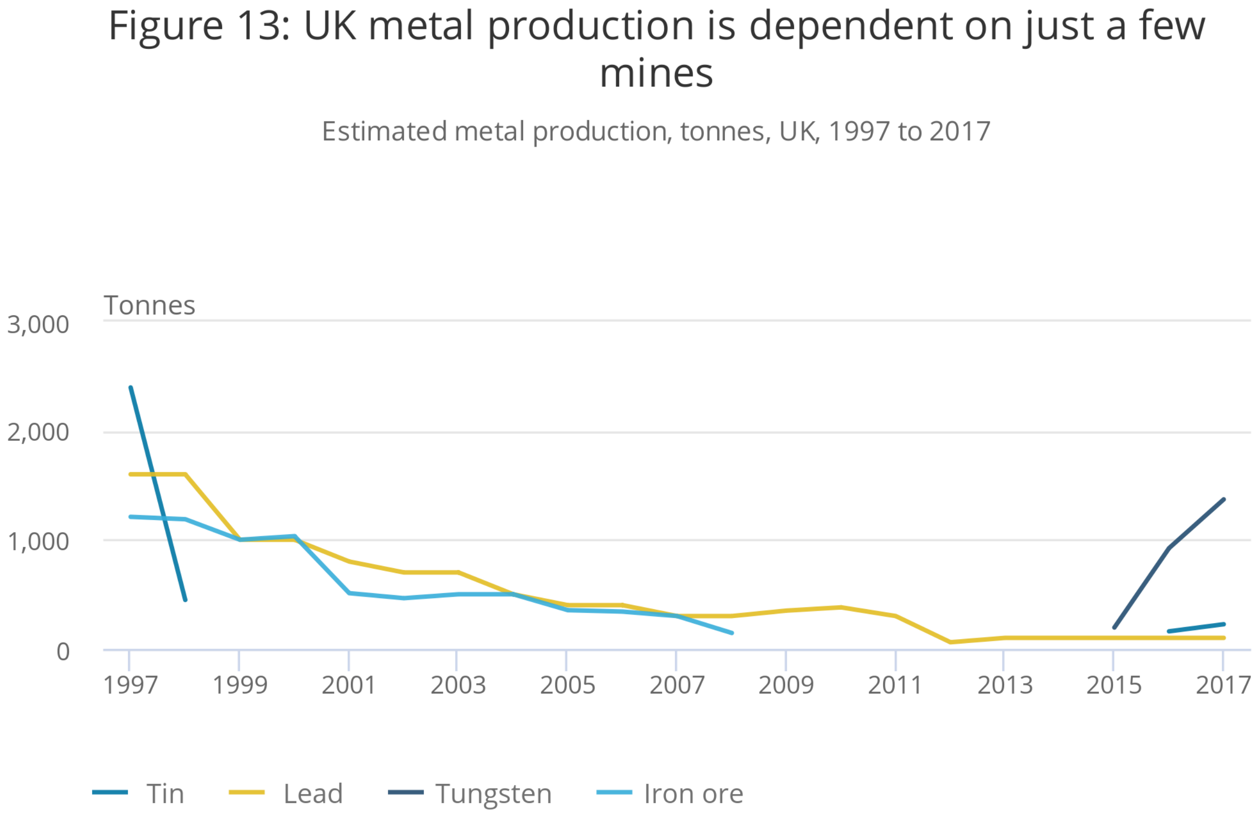
Peat extraction in the UK declined by 50.6% between the years 1997 and 2015. Peatlands can store a large amount of carbon and those that have been modified are emitting greenhouse gases. The peatlands emitting the largest amount of CO_2 are lowland peat which has been drained for farmland. These emit around 32% (7,600 kt CO_2e yr-1), grasslands emit 27% (6,300 kt CO_2e yr-1), woodland emits 20% (4,600 kt CO_2e yr-1) and semi-natural peatlands emit around 15% (3,400 kt CO_2e yr-1). For further information, please see the Peatlands Publication.

Metals

The extraction of iron ore gradually declined between 1997 and 2008 from 1,210 tonnes to 145 tonnes. Lead production has also declined from 1,600 tonnes in 1997 to 100 tonnes in 2016. Tin production ended in 1998 with the closure of Crofty tin mine in Cornwall but production has recommenced with the re-opening of the Hemerdon tin mine in south-west Devon in 2015. In 2015, the production of tungsten has recommenced in Devon.

Figure 13: UK metal production is dependent on just a few mines

Estimated metal production, tonnes, UK, 1997 to 2017

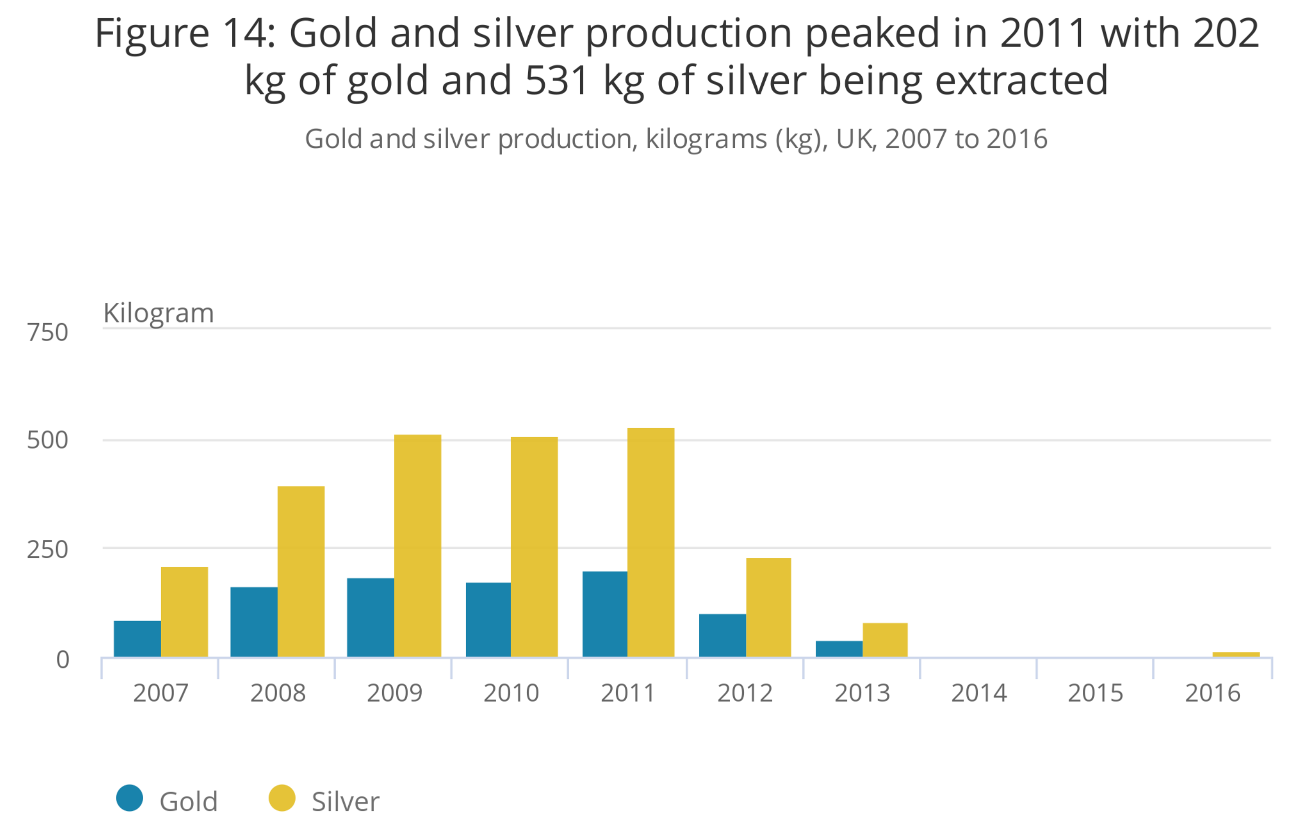


Source: British Geological Survey – Mineral Year Book and World Mineral Statistics

In 2016, new gold mines were found in Omagh and Curraghinalt, Northern Ireland and Cononish, near Tydrum, Scotland.

Figure 14: Gold and silver production peaked in 2011 with 202 kg of gold and 531 kg of silver being extracted

Gold and silver production, kilograms (kg), UK, 2007 to 2016



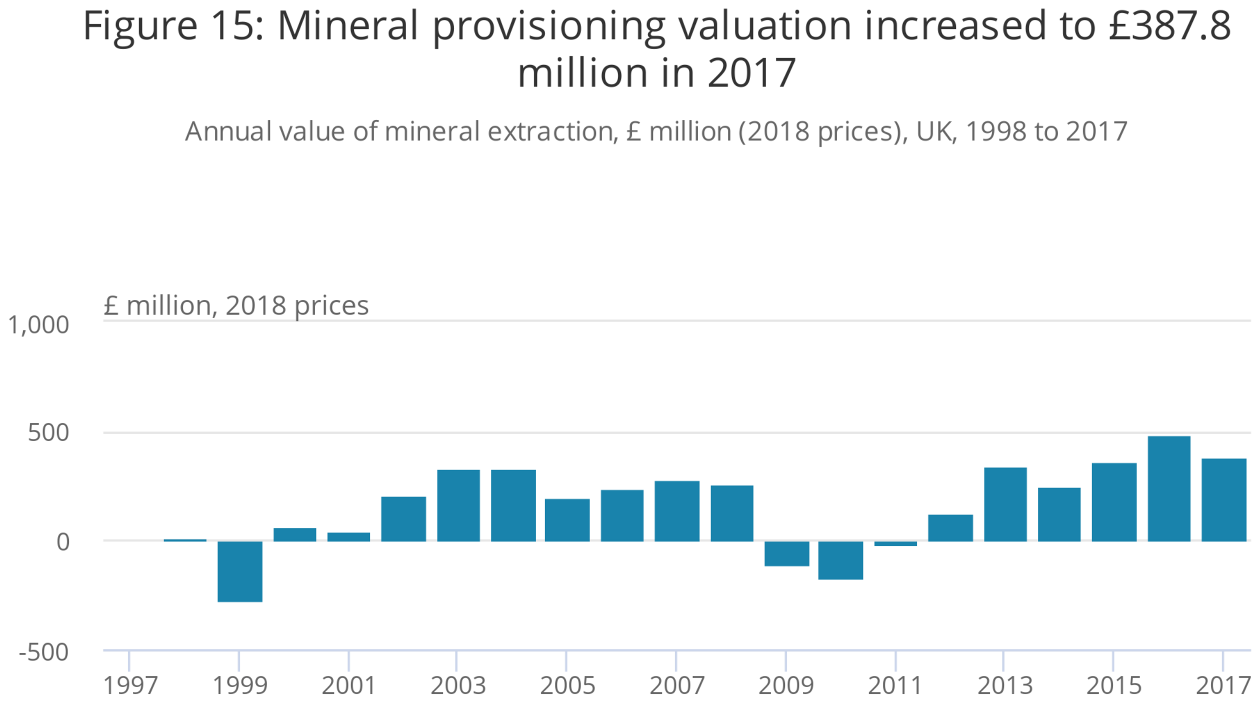
Source: British Geological Survey – Minerals Year Book and World Mineral Statistics

Valuation

Using the resource rent approach (see Methodology guide), the annual value of mineral provisioning fluctuated between the years 1998 to 2017. There are costs incurred for making use of natural resources, and before 2003 these estimated costs outweighed income from the extraction of minerals. In 2017 the annual value increased to £387.8 million.

Figure 15: Mineral provisioning valuation increased to £387.8 million in 2017

Annual value of mineral extraction, £ million (2018 prices), UK, 1998 to 2017

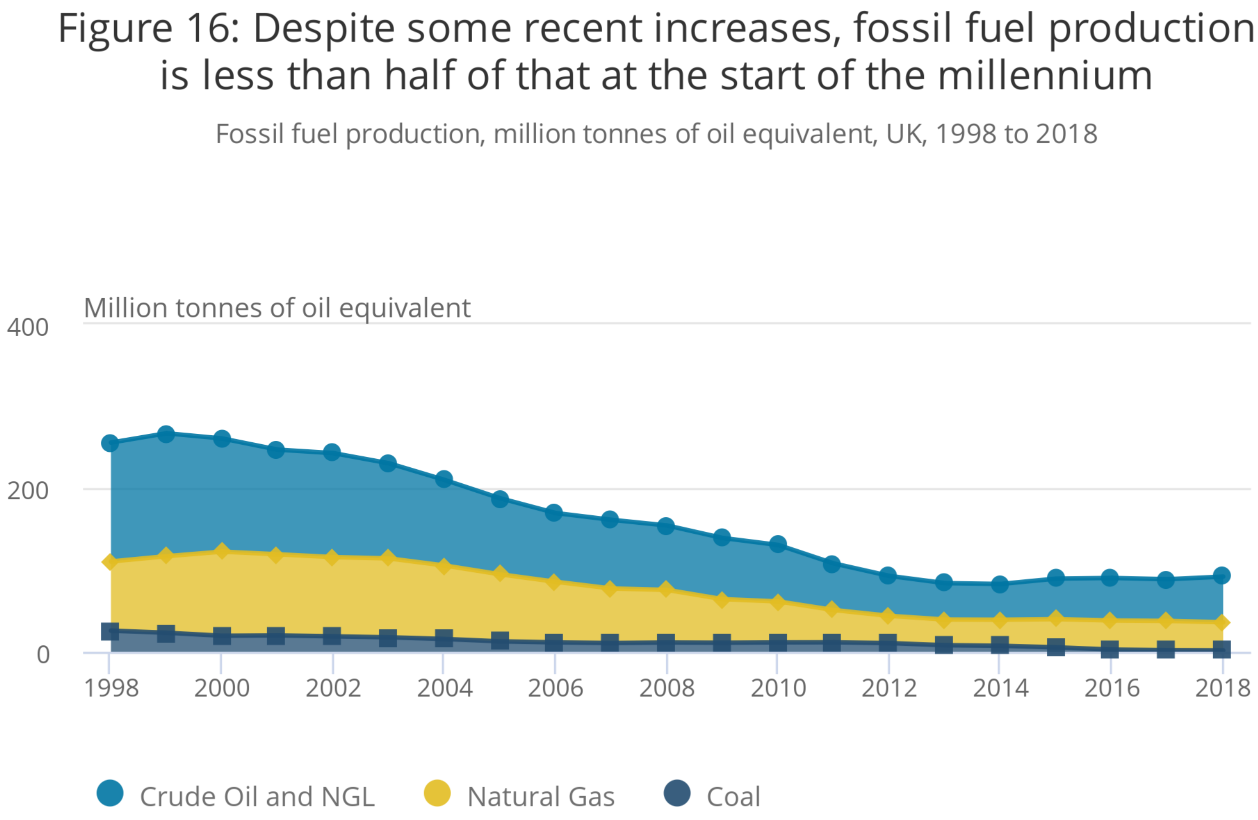


Source: Office for National Statistics

Fossil fuels

Figure 16: Despite some recent increases, fossil fuel production is less than half of that at the start of the millennium

Fossil fuel production, million tonnes of oil equivalent, UK, 1998 to 2018



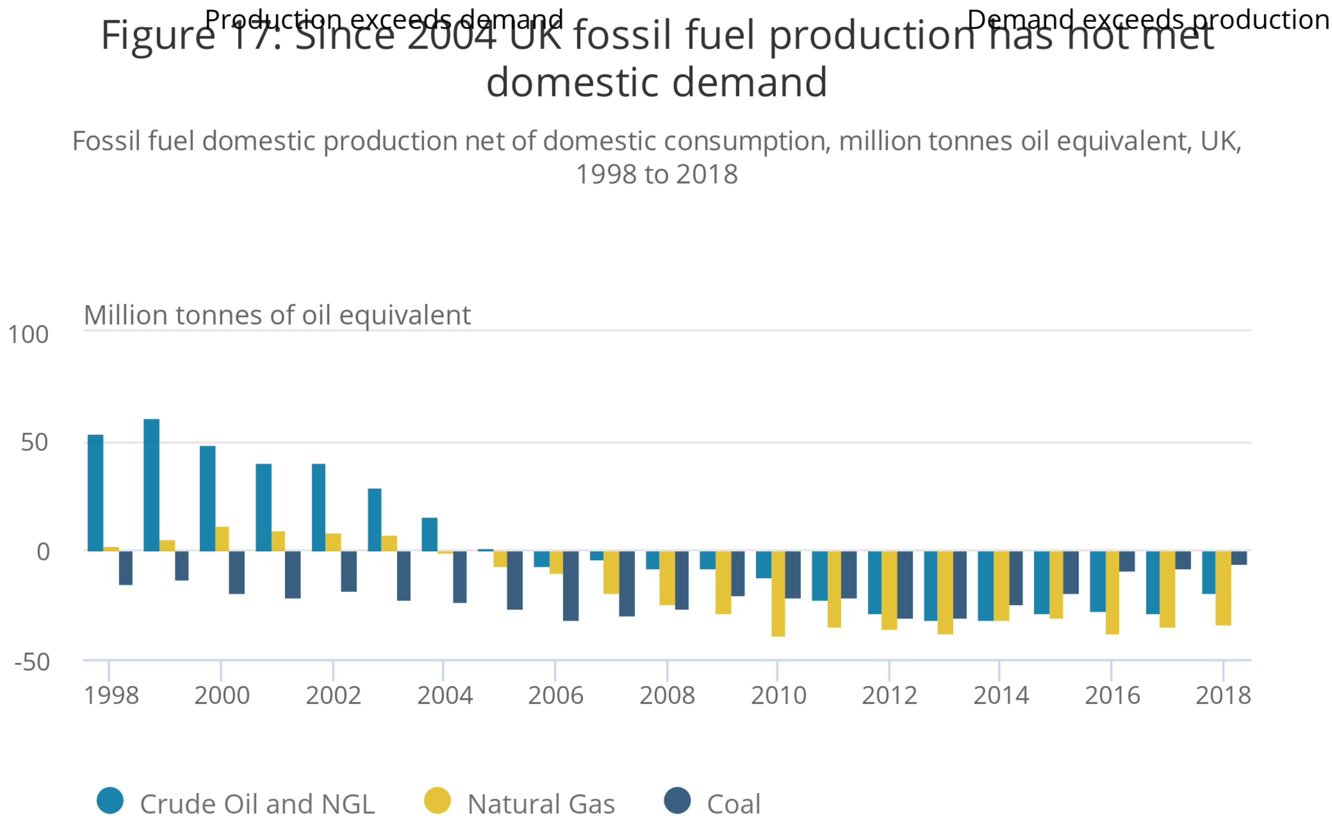
Source: Oil and Gas Authority and Department for Business, Energy and Industrial Strategy

Oil and gas production peaked around the start of the century and has gradually declined since. Oil and gas production has had some growth in recent years which may be related to lower production costs as a result of the tax relief announced in the 2015 summer budget.

With government policy to end coal-fired energy generation by 2025, coal extraction is generally being phased out across the UK. In 2018, coal production fell to an all-time low of 1.7 million tonnes of oil equivalent – about 6% of the quantity extracted 20 years earlier.

Figure 17: Since 2004 UK fossil fuel production has not met domestic demand

Fossil fuel domestic production net of domestic consumption, million tonnes oil equivalent, UK, 1998 to 2018



Source: Oil and Gas Authority and Department for Business, Energy and Industrial Strategy

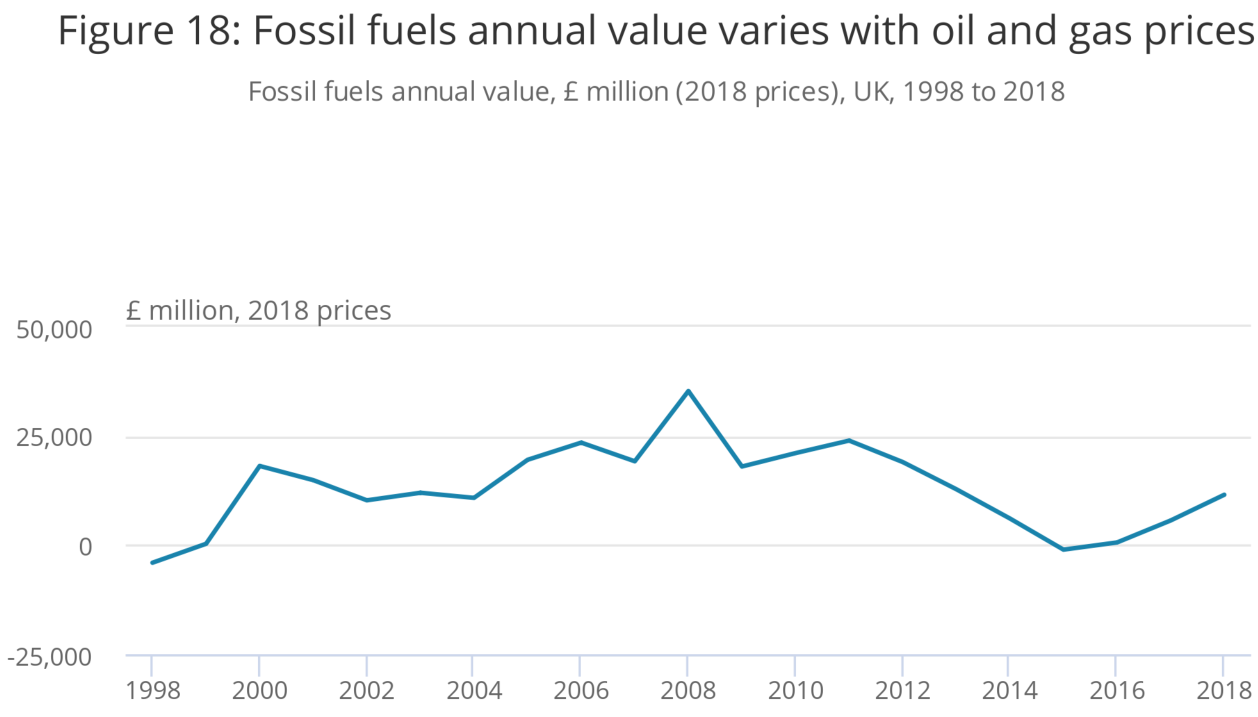
Before 2005, domestic production of oil and gas exceeded demand. During this period combined exports of primary oils, petroleum products, and natural gas was greater than imports. Driven largely by declining production, from 2005 onwards demand has exceeded domestic production and so overall imports have been greater than exports.

While demand for oil products and natural gas both fell by 18% between 1998 and 2018, oil and gas production has fallen much faster. Combined production fell by 61% from 1998 to 2018 or 62% for oil and 59% for gas.

From 1998 to 2018, domestic production of coal has not met demand, but in recent years this gap has become relatively small. Over this period domestic production has decreased by 94% and demand has decreased by 80%. In 1998, 18% of the UK’s primary energy demand came from coal, compared to 4% in 2018.

Figure 18: Fossil fuels annual value varies with oil and gas prices

Fossil fuels annual value, £ million (2018 prices), UK, 1998 to 2018



Source: Office for National Statistics

Notes:

1. Because of data limitations, 2018 values exclude valuation of coal provisioning but in recent years, coal has had little influence on overall trends.

The annual valuation of fossil fuels abiotic provisioning has varied, driven largely by oil and gas price changes and production trends. The largest year-on-year real price increases were seen from 1999 to 2000 (67% for oil and 100% for gas), which saw gas prices double, and 2007 to 2008 (41% for oil and 69% for gas). These spikes are reflected in the annual valuation. In 2018 the annual value increased to £11.52 billion because of oil and gas price increases of 24% and 31% respectively.

Consumption of UK-extracted fossil fuels has a carbon cost. This is based on the cost of the carbon removal required to meet an emission reduction target. In 2018 the carbon cost of using the fossil fuels extracted was £16.35 billion. This carbon cost was made up of £11.09 billion for oil, £4.86 billion for gas, and £0.42 billion for coal.

Renewable electricity generation

Electricity generated from renewable sources has increased dramatically over the last 10 years, with 2018 generation more than five times greater than 2008. National and international incentives, including the EU Renewable Energy Directive and Renewable Obligation (RO) target, have helped contribute towards the increase.

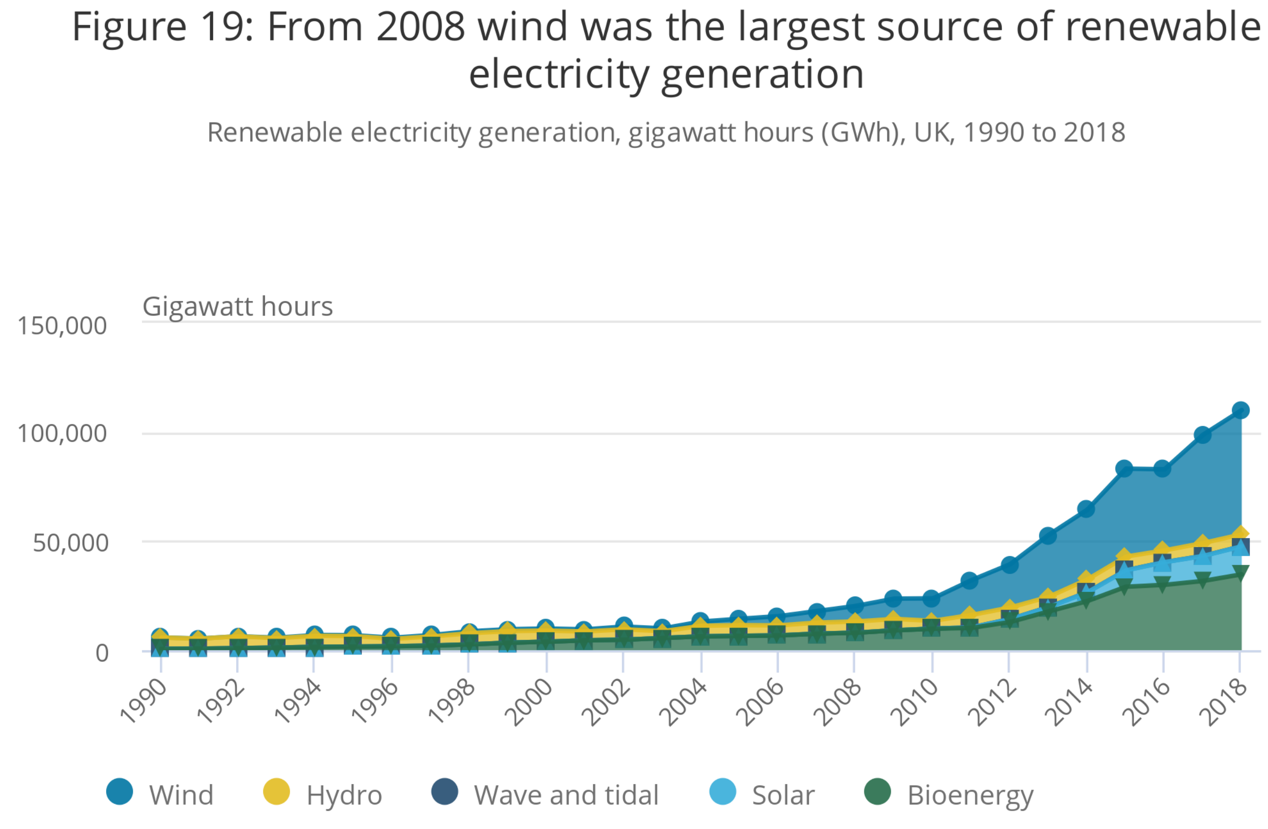
Most years have seen an increase in the total generation of renewable electricity. However, 2003 showed a 9% decline which can be attributed to a reduction in electricity generated from hydropower. This could be the result of a 28.5% reduction of rainfall in 2003. This is also reflected in the hydro generation load factor, a measure of generation efficiency using a ratio of actual to potential total generation capacity, which decreased from 34% to 23% from 2002 to 2003.

In 1998, 59% of renewable electricity generation was from hydropower. Despite hydropower generation staying relatively stable, in 2018 its share of renewable generation was 5% as other renewable generation increased. Wind, solar, and bioenergy contributed 52%, 12% and 32% respectively to the UK renewable electricity generation in 2018.

Between 2015 and 2016 there was an 8% reduction in the generation of electricity from wind. This could be attributed to the reduction of average wind speeds from 9.4 knots to 8.4 knots which more than offset the 12.8% increase in capacity. This is also reflected in the wind generation load factor, which decreased from 34% to 28%.

Figure 19: From 2008 wind was the largest source of renewable electricity generation

Renewable electricity generation, gigawatt hours (GWh), UK, 1990 to 2018



Source: Department for Business, Energy and Industrial Strategy

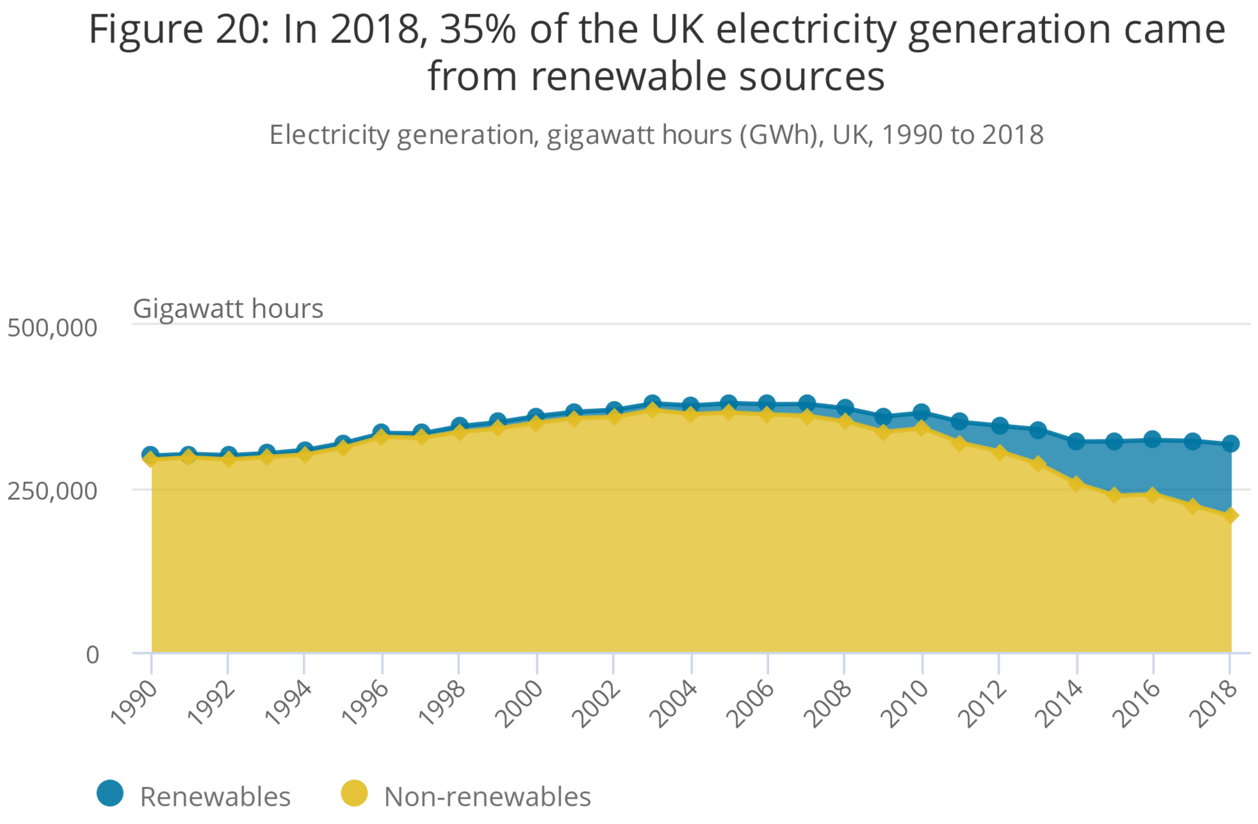
Notes:

1. Total and bioenergy excludes generation from co-firing with fossil fuels.
2. Bioenergy includes landfill and sewage gas, sewage sludge digestion, energy from biodegradable waste combustion, animal biomass, plant biomass, and anaerobic digestion.

In 2008, electricity generated from renewable sources accounted for 5% of all electricity generation. Since 2008, electricity generation from renewables has seen an average yearly increase of 19%, or around nine thousand gigawatt hours.

Figure 20: In 2018, 35% of the UK electricity generation came from renewable sources

Electricity generation, gigawatt hours (GWh), UK, 1990 to 2018



Source: Department for Business, Energy and Industrial Strategy

Notes:

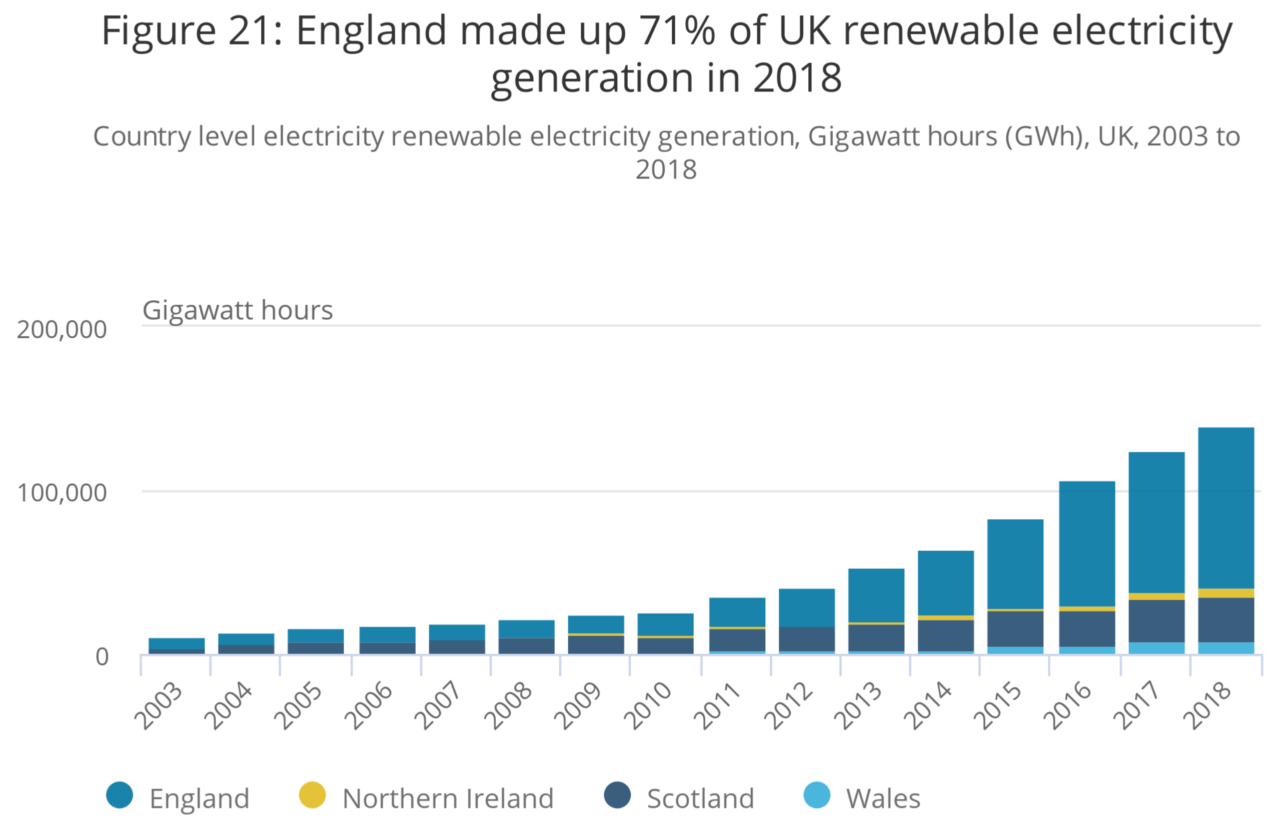
1. Renewables includes wind, hydro, solar, wave and tidal, and bioenergy.

2. Non-renewable includes coal, oil, gas, nuclear, other thermal, hydro pumped storage, and non-biodegradable waste combustion.

Over the 10 years from 2008 to 2018, England’s contribution to UK renewable electricity generation increased from 48% to 71%. Scotland’s contribution declined from 41% to 20% despite increasing generation. This is because hydropower, which is largely in Scotland, was historically the largest renewable electricity generation source in the UK. Hydropower now only accounts for approximately 4%, down from around 22% in 2008, of the UK’s electricity generated from renewables in 2018. Northern Ireland’s and Wales’ share of UK renewable generation remained around 3% and 5% respectively.

Figure 21: England made up 71% of UK renewable electricity generation in 2018

Country level electricity renewable electricity generation, Gigawatt hours (GWh), UK, 2003 to 2018



Source: Department for Business, Energy and Industrial Strategy

Notes:

1. Generation from "other sites" is not included. “Other sites” are sites that have not been attributed to a region so that data related to individual companies are not disclosed.

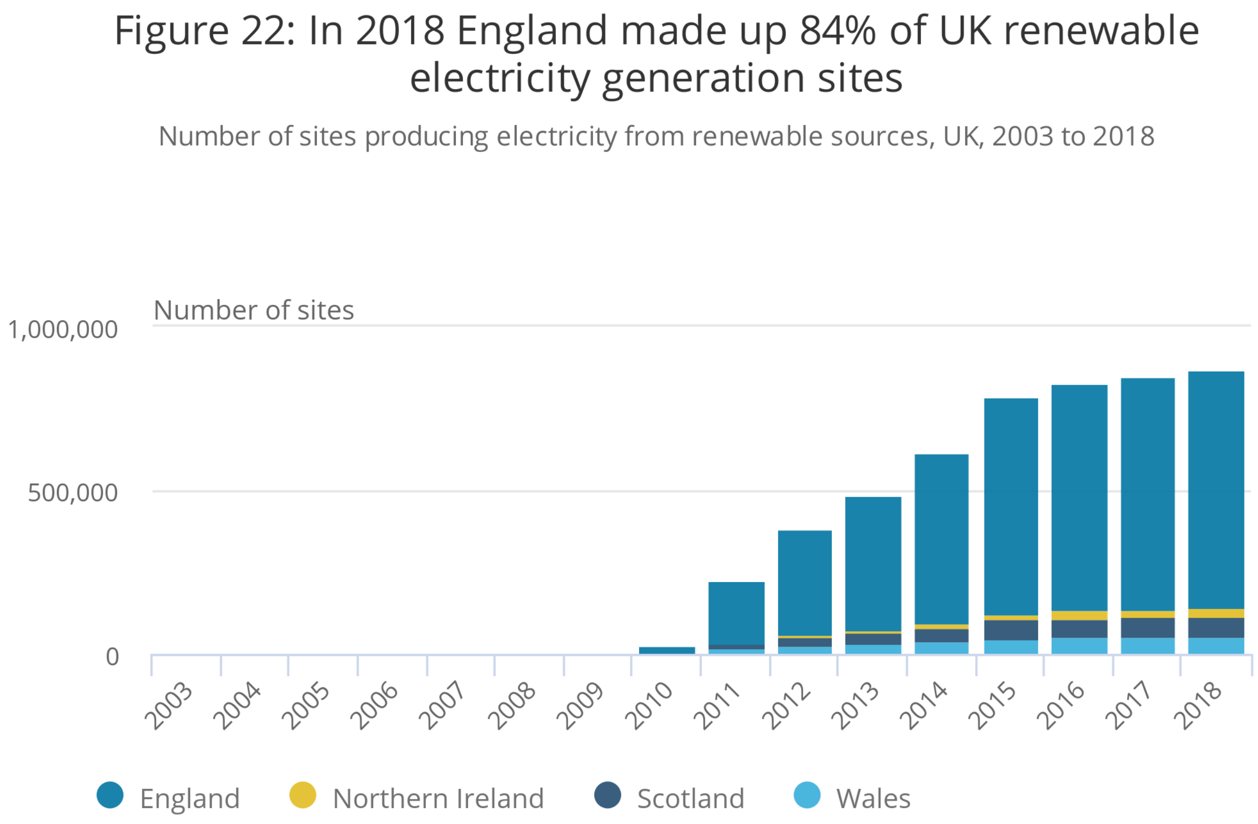
2. Data only available between 2003 and 2018.

3. Total gigawatt hours include biomass, waste and anaerobic digestion for 2016 to 2018.

In England, the number of renewable electricity generation sites increased from 3,098 in 2008 to 728,197 in 2018 as shown in Figure 22. This has largely been driven by an increase in the number of solar sites from 26,048 in 2010 to 859,151 in 2018. Despite this increase in the number of sites, solar electricity generation only accounted for 9% of electricity generated from renewables in 2018. In 2018, England held 84% of the UK renewable electricity generation sites compared to 3% in Northern Ireland, 7% in Scotland, and 6% in Wales.

Figure 22: In 2018 England made up 84% of UK renewable electricity generation sites

Number of sites producing electricity from renewable sources, UK, 2003 to 2018



Source: Department for Business, Energy and Industrial Strategy

Notes:

1. "Other sites" are sites that have not been attributed to a region so that data related to individual companies are not disclosed.

2. Total number of sites includes biomass, waste and anaerobic digestion for 2016 to 2018.

The annual value of renewable energy provisioning has increased 403% between 2008 and 2017 alongside the growth of the renewable sector. In 2017 the annual value of renewable energy provisioning was £686 million.

6 . Regulating services

As well as tangible provisioning services, natural assets provide several less visible services known as regulating services. Regulating services include cleaning the air, sequestering carbon and regulating water flows to prevent flooding.

This section presents four regulating ecosystem services:

- carbon sequestration
- air pollution removal
- noise mitigation
- urban cooling

The pollutants covered in pollution removal are:

- PM2.5
- PM10
- nitrogen dioxide (NO2)
- ground-level ozone (O3)
- ammonia (NH3)
- sulphur dioxide (SO2)

PM2.5 is a component of PM10.

Air pollution leads to respiratory diseases in humans. The risk of those diseases for a population can be estimated based on the levels of pollution and the health costs of that disease.

Both carbon sequestration and air pollution removal are carried out by vegetation. The capacity for vegetation to remove carbon sequestration and air pollution changes with the amount of vegetation.

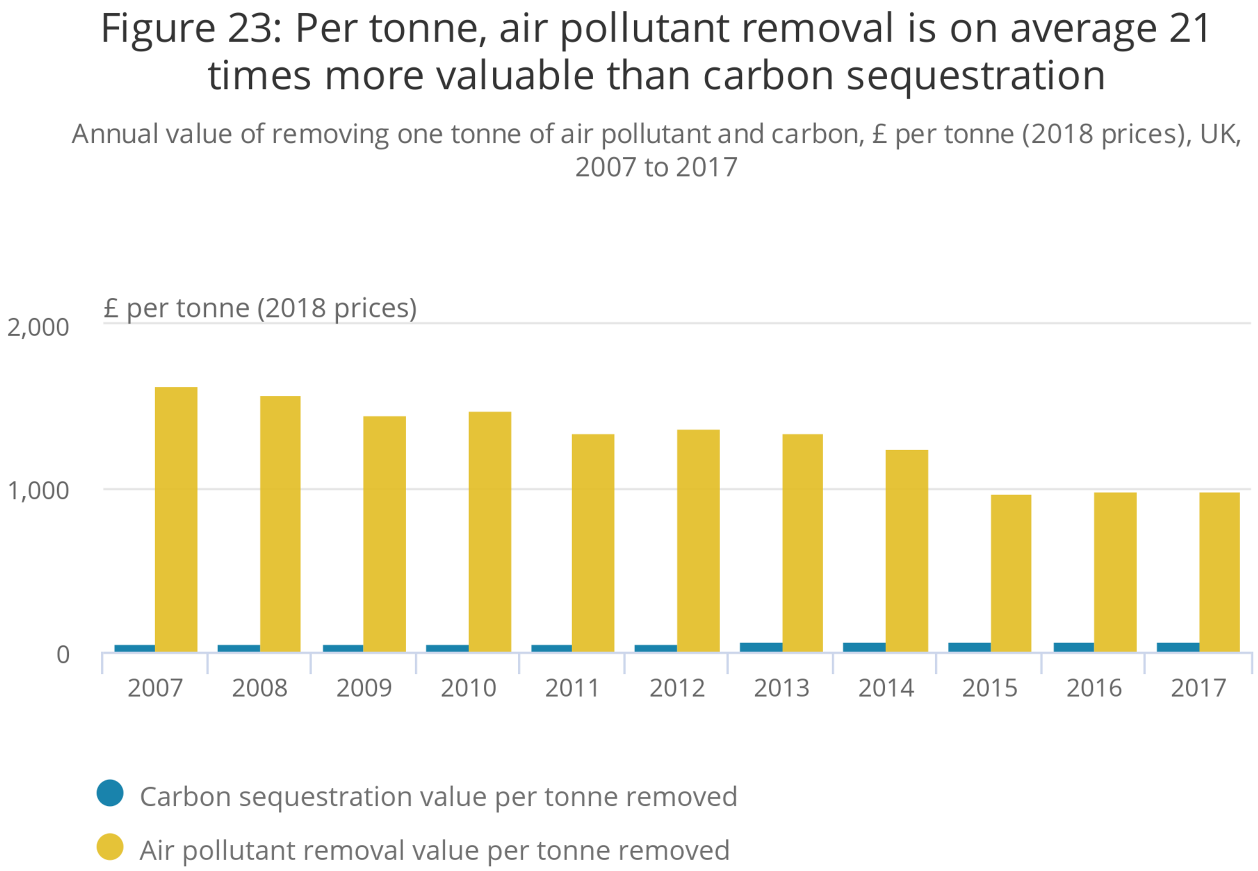
The valuation methods used differ; carbon sequestration is a removal cost, and air pollution removal is a societal cost. That is, we are measuring the value of avoiding damage (for carbon) and the value of treating existing damage (for air pollution). Air pollution removal valuation does not account for the cost of abatement, and carbon sequestration valuation does not consider the global societal impacts of carbon dioxide.

Carbon sequestration and air pollution removal are provided by a range of habitats, with woodland being the primary supplier for both. As can be seen by Figure 24, the value of carbon sequestration has generally increased annually, valued at £1.0 billion in 2017. Pollution removal annual value has fallen from over £2.0 billion in 2007 to £1.3 billion in 2017. These changes are not driven by changing conditions or the extent of vegetation; carbon prices are increasing over time while UK air pollution levels are falling.

Although the amount of carbon sequestrated is substantially more than the amount of air pollutants removed by vegetation (over 20 times more), the benefits of removing air pollutants are higher than carbon sequestration (see Figure 24). On average throughout the time series, the benefits of removing one tonne of air pollutant was about 21 times higher than carbon sequestration. This is because pollutants, predominately PM2.5, have large impacts on human health, and even a slight removal of this type of pollutant will have a large benefit to humanity. This is further explained in the Air pollution removal section.

Figure 23: Per tonne, air pollutant removal is on average 21 times more valuable than carbon sequestration

Annual value of removing one tonne of air pollutant and carbon, £ per tonne (2018 prices), UK, 2007 to 2017

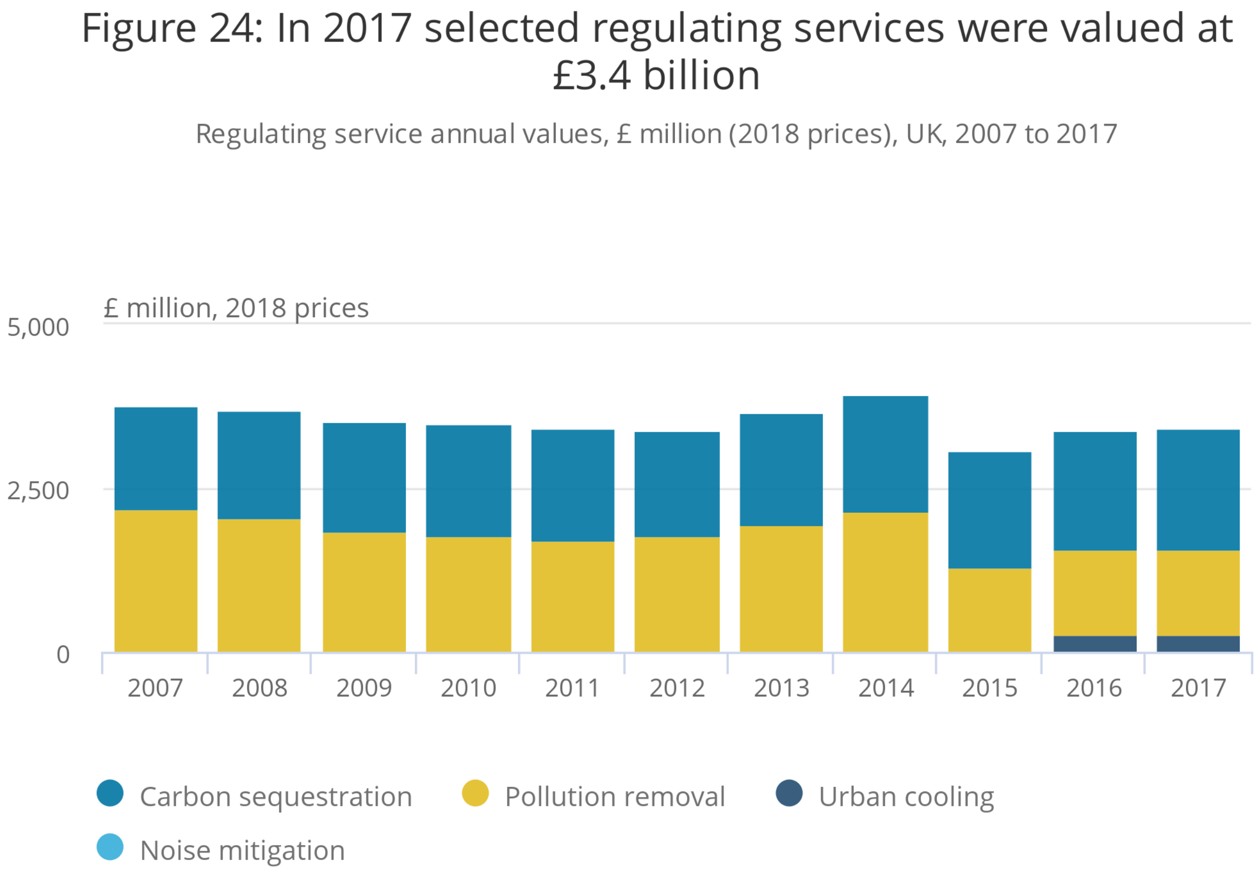


Source: Office for National Statistics, Department for Business, Energy and Industrial Strategy and Centre for Ecology and Hydrology

Urban cooling and noise mitigation are provided by the urban habitat. The data are not available for the whole time series. In 2017, urban cooling and noise mitigation accounted for 8% of the value of the selected regulating services – £263 million. In 2017, the four regulating ecosystem services were valued at £3.4 billion (Figure 24).

Figure 24: In 2017 selected regulating services were valued at £3.4 billion

Regulating service annual values, £ million (2018 prices), UK, 2007 to 2017



Source: Office for National Statistics, Department for Business, Energy and Industrial Strategy, Centre for Ecology and Hydrology, Sourced from Eftec and others (2018) and Met Office

Carbon sequestration

When using this analysis, it is important to note that we do not capture all carbon sequestration. Because of a lack of data, values related to carbon sequestration by marine ecosystems are not included in the current estimates. Furthermore, peatlands, which are a significant source of emissions, are only partially seen in the data.

A recent report by the Centre for Ecology and Hydrology for the Department for Business, Energy and Industrial Strategy, estimates that damaged peatland emissions (23 million tonnes of CO2 equivalent) negate all terrestrial sequestration in the UK. For more information on the data gaps please see the Methodology guide.

A presentation of natural capital accounts based on the impacts from nature acting naturally would include sequestration from ancient woodland but might exclude plantation forests. Emissions from damaged green spaces would not be included, as this is essentially a form of human-driven pollution, but emissions from a volcano would.

Another view of natural capital would state that all natural habitats are somewhat modified. Usually human intervention is required to capture value and so the possibility of valuing many natural services (notably renewable energy) as if they were separate from human action is impossible. Under a combined nature and human approach, greenhouse gas emissions from poorly managed peatland should be included.

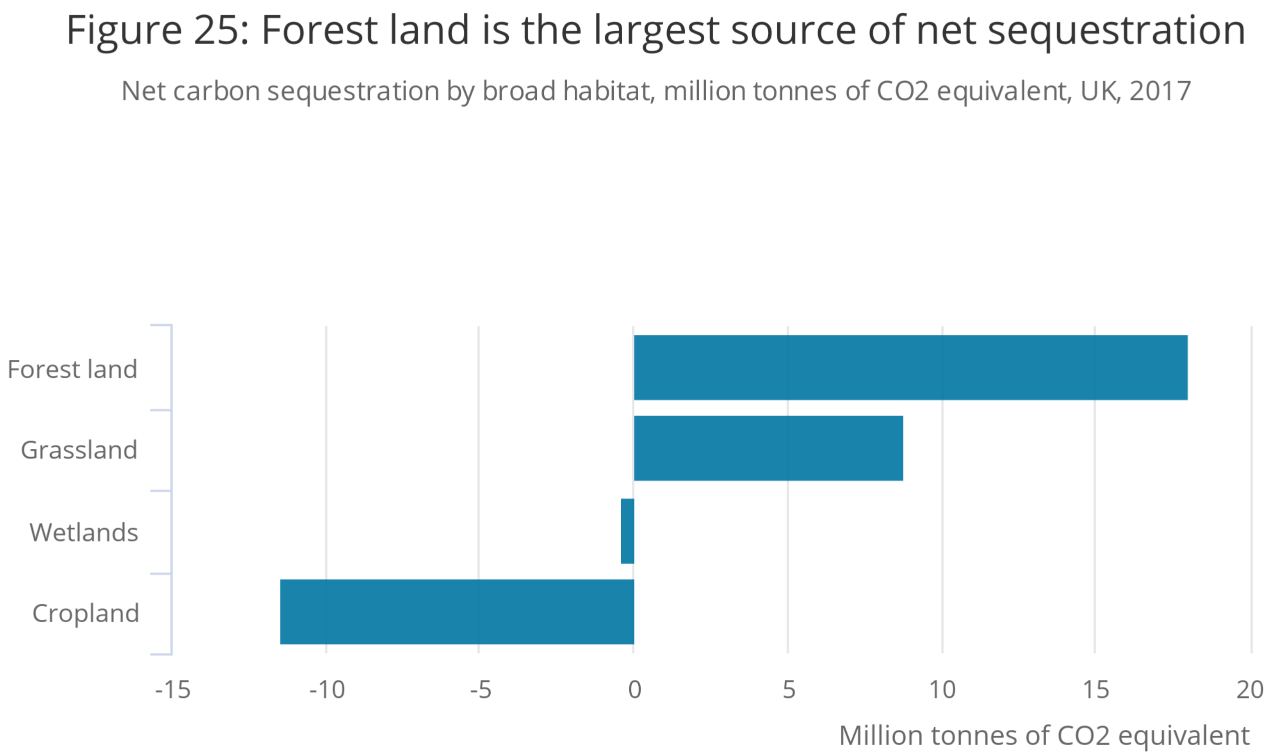
This is an area of research to consider further as our accounts develop. In this report we continue to use gross carbon sequestration as the asset value but present analysis of the net value to provide a rounded picture.

If we examined only sequestration, gross carbon sequestration of UK natural habitats was 28.0 million tonnes in 2017. This provides a service worth £1.85 billion yearly and an asset valuation of £105.6 billion. However, this excludes the emission costs related to the management of natural habitats.

In 2017, forest land removed 18.0 million tonnes of carbon, equating to a value of around £1.19 billion annually and an asset valuation of £53.9 billion. In contrast, cropland emitted 11.4 million tonnes as a result of the loss of carbon stock when converting grassland to cropland. This means UK croplands provide negative net carbon sequestration valued at negative £0.76 billion annually, with an associated negative asset value of £71.5 billion. This could be seen as a hidden cost of food production and in principle could be netted off with market-based costs such as fertiliser and fuel within the agricultural biomass account.

Figure 25: Forest land is the largest source of net sequestration

Net carbon sequestration by broad habitat, million tonnes of CO2 equivalent, UK, 2017

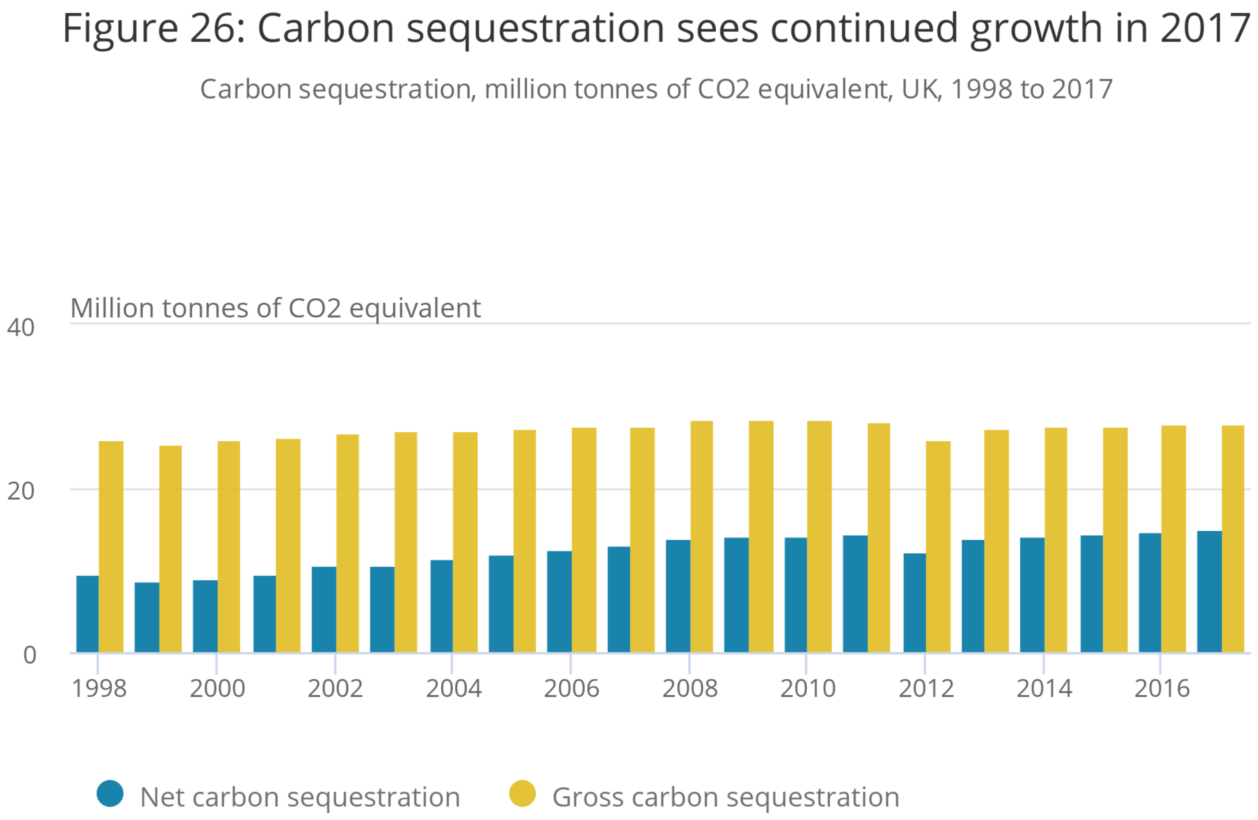


Source: Office for National Statistics and National Atmospheric Emissions Inventory (NAEI)

Overall net carbon sequestration in the UK was 15.1 million tonnes in 2017. 52% of net carbon sequestration was from England, 39% from Scotland, 5% from Wales, and 4% from Northern Ireland. Per hectare, Scotland has the greatest net carbon sequestration at 0.74 tonnes because it has the largest amount of forest cover. England is the second greatest with 0.60 tonnes per hectare, followed by Wales at 0.40 tonnes per hectare, and Northern Ireland at 0.38 tonnes per hectare.

Figure 26: Carbon sequestration sees continued growth in 2017

Carbon sequestration, million tonnes of CO2 equivalent, UK, 1998 to 2017



Source: Office for National Statistics and National Atmospheric Emissions Inventory (NAEI)

Net carbon sequestration from land use was greatest in 2017, with 14.5% more carbon removed than 10 years earlier. UK net carbon sequestration has been gradually increasing. Declining cropland emissions and increasing grassland sequestration have driven the increase. Cropland decreased by 12.2% and grassland increased by 16.4%. Meanwhile, forest land sequestration remained stable.

An increase in net carbon sequestration and carbon prices resulted in a 32.9% rise in the annual valuation from £0.75 billion to £1.00 billion from 2007 to 2017. In 2017 the asset valuation of UK net carbon sequestration from land use was £30.67 billion.

Potential sequestration

Henderson et al. (2018) estimate that a further 30 million tonnes of carbon could be sequestered per year through land use change. This would more than double current estimated natural sequestration. 15 million tonnes would come from expanding woodland by 1.2 million hectares. 10 million tonnes would be sequestered in soils following changes in agricultural processes. The other five million tonnes is driven by habitat restoration.

Air pollution removal by vegetation

In 2017, the removal of pollution by vegetation in the UK equated to a saving of £1.3 billion in health costs.

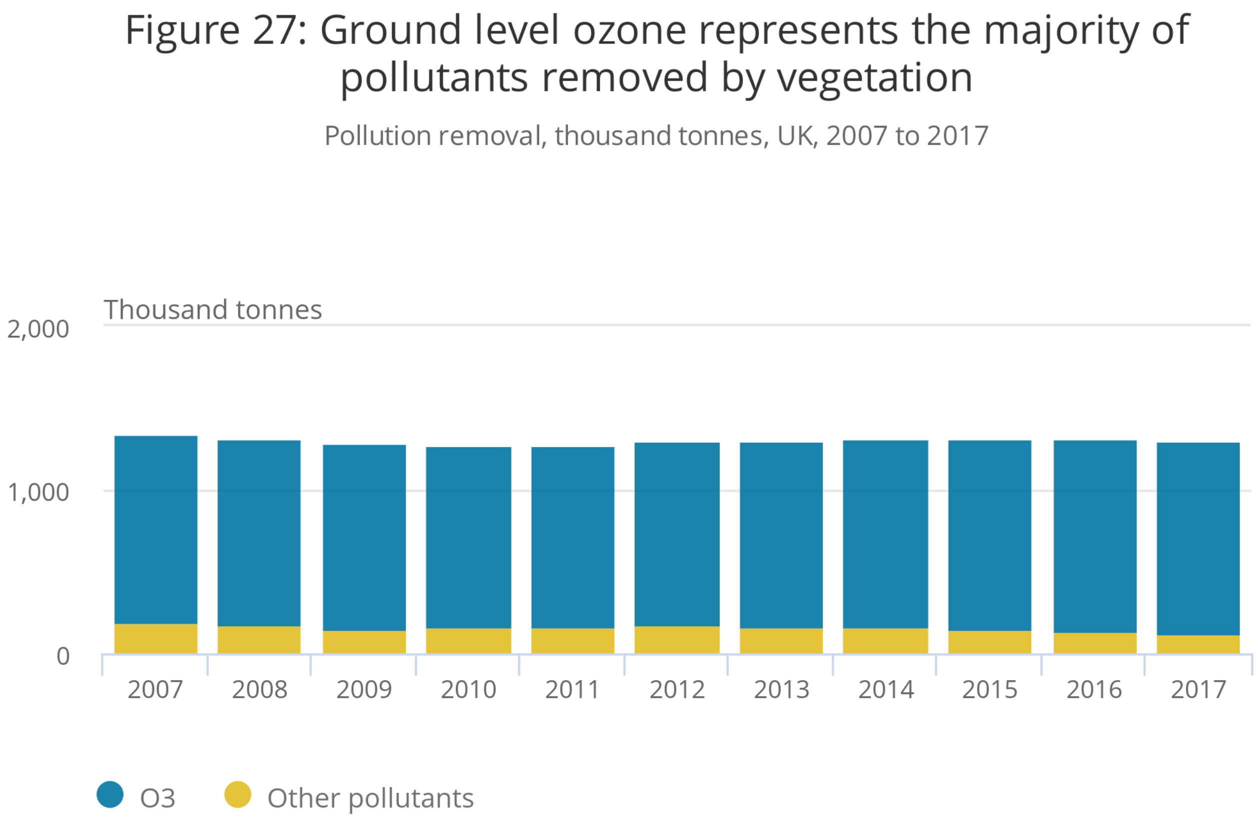
The World Health Organisation estimated that air pollution contributed to 7.6% of all deaths in 2016 worldwide. Vegetation can play a useful role in lessening this danger by removing air pollution. Polluting gases are absorbed by leaves' stomata, and particulate matter, suspended in polluted air, settles onto leaves.

This physical flow account estimates the quantity of pollutants removed from the atmosphere by vegetation such as woodland and grassland[1]. An annual time series from 2007 to 2017 is available in the datasets section on this publication.

In 2017, vegetation in the UK removed 1,301.1 thousand tonnes of PM10, SO2, NO, NH3 and O3 (excludes PM2. 5 as a subset of PM10). Ground-level ozone (O3) represented the majority of total pollution removal (90.1%) in 2017 shown in Figure 27. NH3 is the second largest pollutant removed, closely followed by PM10.

Figure 27: Ground level ozone represents the majority of pollutants removed by vegetation

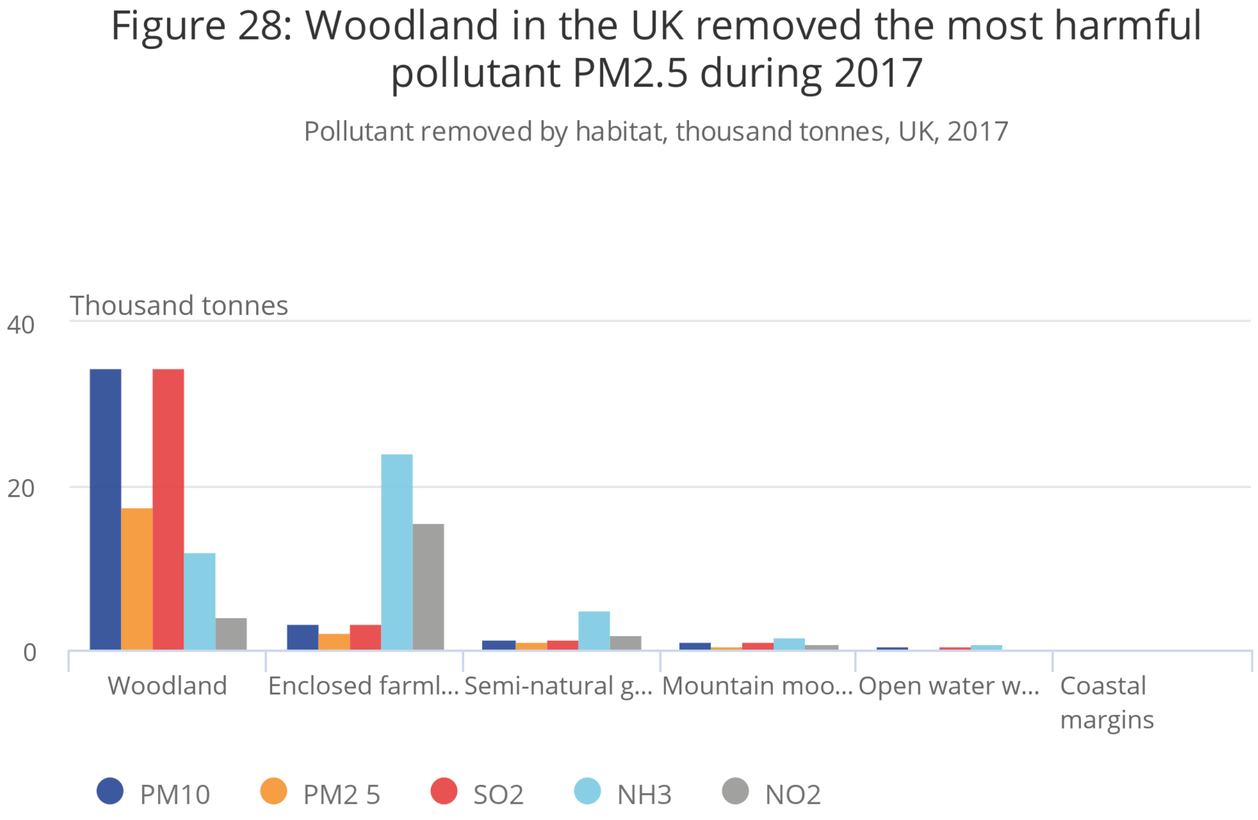
Pollution removal, thousand tonnes, UK, 2007 to 2017



Source: Office for National Statistics and Centre for Ecology and Hydrology

Figure 28: Woodland in the UK removed the most harmful pollutant PM2.5 during 2017

Pollutant removed by habitat, thousand tonnes, UK, 2017



Source: Office for National Statistics and Centre for Ecology and Hydrology

Notes:

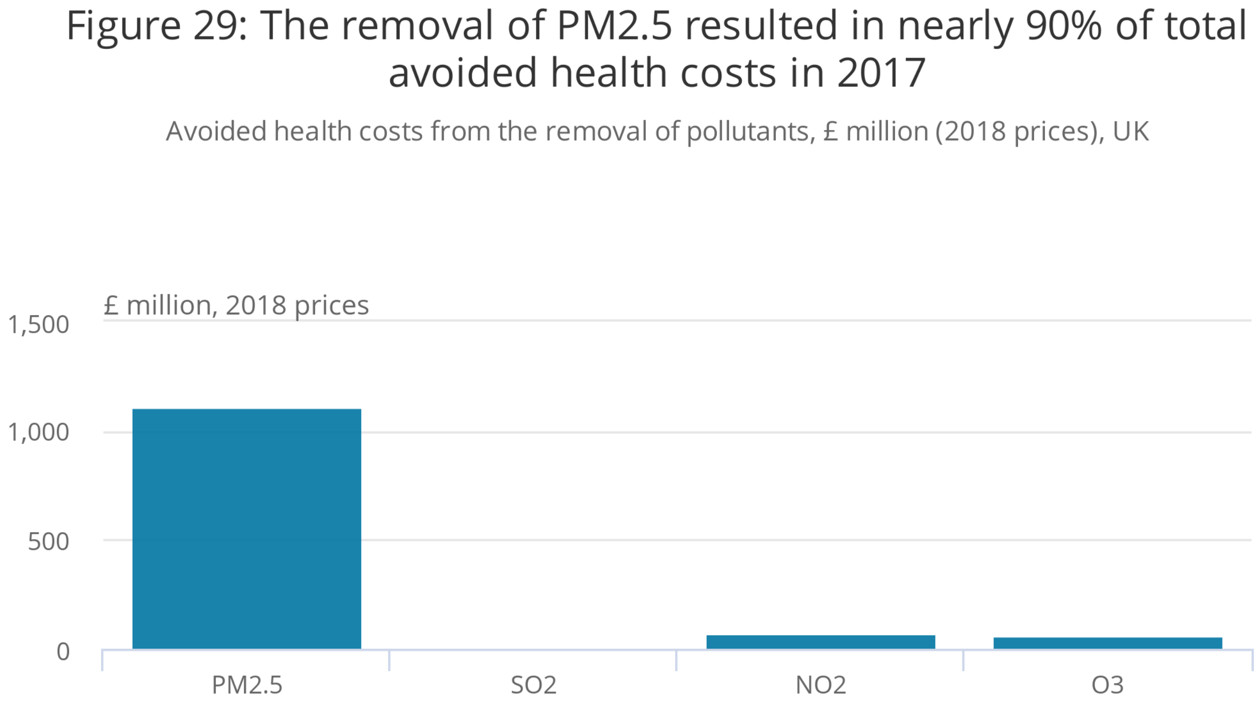
1. PM2.5 is a subset of PM10.

It is estimated that in 2017 the avoided health costs in the form of avoided deaths, avoided life years lost, fewer respiratory hospital admissions, and fewer cardiovascular hospital admissions amounted to a substantial £1.3 billion. Although the removal of PM2.5 represents only 1.7% of total pollution removed, nearly 90% of the avoided health impacts are the result of reductions in PM2.5 concentrations, removed primarily by woodland (see Figure 28). This is because PM2.5 removal accounts for 94% of the 27,500 avoided years life lost from pollution removal in 2017. When split by health impact, the greatest value comes from avoided loss of life years which equates to £1.2 billion in health savings (see Figure 29).

The most harmful pollutant is PM2.5 (fine particulate matter with a diameter of less than 2.5 micrometres, or 3% of the diameter of a human hair), which can bypass the nose and throat to penetrate deep into the lungs, leading to potentially serious health effects and healthcare costs.

Figure 29: The removal of PM2.5 resulted in nearly 90% of total avoided health costs in 2017

Avoided health costs from the removal of pollutants, £ million (2018 prices), UK



Source: Office for National Statistics and Centre for Ecology and Hydrology

Table 2: The number of avoided life years lost represents the largest benefit of air pollution removal (£1,198.8 million)

Annual value by health impact due to the removal of air pollution, £ million (2018 prices), UK, 2017

Pollutant	Avoided Impacts	Year 2017
PM2.5	Respiratory hospital admissions	4.5
	Cardiovascular hospital admissions	4.1
	Life years lost	1,127.2
SO2	Respiratory hospital admissions	0.9
NO2	Respiratory hospital admissions	0.9
	Cardiovascular hospital admissions	0.8
	Life years lost	71.6
O3	Respiratory hospital admissions	43.4
	Cardiovascular hospital admissions	6.9
	Deaths	14.5
All pollutants combined	Respiratory hospital admissions	49.7
	Cardiovascular hospital admissions	11.7
	Life years lost	1,198.8
	Deaths	14.5
	Total	1,274.7

Source: Office for National Statistics and Centre for Ecology and Hydrology

The present value long-term asset value calculated over a 100-year period with income uplift and population growth, is £43.4 billion (2018 price base).

Noise mitigation by vegetation

Noise mitigation by vegetation in UK urban areas led to a minimum saving of £15.3 million in associated health costs in 2017.

Vegetation acts as a buffer against noise pollution, in particular road traffic noise. Noise pollution causes adverse health outcomes through lack of sleep and annoyance. To inform the UK natural capital accounts, Eftec and others (2018) have developed initial estimates of the benefits of noise reduction from vegetation.

Eftec and others developed a number of estimates based on different methodologies and datasets. The flows and values presented in this section are calculated using the most conservative approach. This is because we only account for buildings within noise bands above 60 decibels (dBA) where the noise reduction effect is constrained at one dBA.[2] According to the noise action plan in urban areas published by the Department for Environment Food and Rural Areas (Defra), four million people were in agglomerations where road traffic was above 60 dBA. An example of sound that produces 60dBA is normal speech. These are considered minimum values, but further work is needed to develop more refined and robust estimates.

Table 3 provides estimates of the physical flow of the service. The total number of buildings in UK urban areas benefiting from a reduction in noise was 167,000. Out of the countries, England reported the largest number of buildings benefiting from noise reduction.

Table 3: 167,000 buildings benefited from noise reduction due to UK urban vegetation
Number of buildings where road noise levels are mitigated by natural capital in the UK, 2017

Noise band in noise metric by decibel[1]	Number of buildings benefiting from noise mitigation by urban vegetation[2] (rounded to the nearest thousand)				
	England	Scotland[3]	Wales	Northern Ireland	UK
more than=80	-	-	-	-	-
75.0-79.9	1,000	-	-	-	
70.0-74.9	8,000	-	1,000	-	
65.0-69.9	36,000	1,000	3,000	1,000	
60.0-64.9	98,000	6,000	8,000	4,000	
Total	143,000	7,000	12,000	5,000	167,000

Source: Eftec and Others

Notes

1. 5 dBA bands applied along with guidance in Defra's noise pollution: economic analysis published in 2014. Back to table

2. Urban vegetation includes large woodlands (greater than 3,000m2) and smaller woodlands (less than 3,000 m2), but not very small woodlands (less than 200m2). Back to table

3. Number of dwellings receiving mitigation in Scotland is likely to be lower than the estimates for the other countries because Eftec and others 2018 used the Lden noise metric rather than the LA1018 metric which was not available for Scotland. Back to table

The total annual value of noise reduction in the UK was £15.3 million in avoided loss of quality-adjusted life years (QALY) during 2017. To calculate this, Eftec and others used economic valuation guidance and a transport noise modelling tool developed by Defra which provide marginal values for changes in noise (decibels) associated with road, rail and aviation[3].

The monetary values are given as British pounds per household for changes in decibel levels from the baseline in relation to the following impacts: amenity values from noise, sleep disturbance and annoyance. For each of the values the “central scenario” is applied. This assumes a QALY value of £60,000, with a disability weight applied for each disability associated with traffic noise.

For more information on the method please see the Extending noise regulation estimates study by Defra Valuations based on quality-adjusted life years are economic welfare values based on willingness to pay studies.

Table 4: Noise mitigation from natural capital led to a £15.3 million saving in avoided loss of quality-adjusted years associated with a loss of amenity and adverse health outcomes
Monetary flow accounts for the noise mitigation of urban natural capital, £ thousands (2018 prices), UK, 2017

Noise band[1]	**Annual value of noise mitigation of 1dBA (£ thousand per year)**				
	England	**Scotland**	**Wales**	**Northern Ireland**	**UK**
Greater than or equal to 80	1	-	-	-	1
75.0-79.9	148	-	11	2	161
70.0-74.9	1,104	8	106	56	1,274
65.0-69.9	4,026	124	313	141	4,604
60.0-64.9	7,778	481	672	324	9,255
Total	13,057	613	1,102	523	15,295

Source: Eftec and others (2018)

Notes

1. Five dBA bands applied along with guidance in Defra's noise pollution: economic analysis published in 2014. Back to table

The asset value for noise reduction in the UK, based on the estimated flow of future benefits over 100 years was worth £833 million. Present values are calculated as the discounted flow of future value over 100 years, using a variable discount rate as suggested by HM Treasury's Green Book Guidance (2018) for health impacts: 1.5% for 0 to 30 years, 1.29% for 31 to 75 years, and 1.07% for 76 to 100 years.

A number of assumptions have been taken into account in estimating the future flow of value from noise mitigation by urban vegetation. For example, population has been held constant and the impact of electric cars has not been considered. For more information on all the assumptions and method please see the scoping study by Eftec and others (2018).

Table 5: The asset value for noise regulation in England was estimated to be worth £710 million
Asset value of ecosystem service from noise mitigation, £ million (2018 prices), UK, 2017

Noise band[1]	**Annual value of noise mitigation of 1dBA (£ million per year)**				
	England	**Scotland**	**Wales**	**Northern Ireland**	**UK**
Greater than or equal to 80	-	-	-	-	-
75.0-79.9	8	-	1	-	9
70.0-74.9	60	-	6	3	69
65.0-69.9	219	7	17	8	251
60.0-64.9	423	26	37	18	504
Total	710	33	61	29	833

Source: Eftec and others (2018)

Urban cooling

Green and blue space in Great Britain's city regions reduced the air temperature leading to a saving of £248 million in avoided labour producing and air conditioning costs during 2017.

Green and blue space (rivers, lakes, canals) can cool urban environments which benefits the economy by mitigating labour productivity loss and reducing the use of artificial cooling (air conditioning).

Eftec and others (2018) estimated the cooling benefit provided by natural capital in urban environments for 11 city regions[4] in the UK. Eftec and others (2018) calculate the overall benefit by applying cooling effects discovered in academic literature (Table 6) to the urban area within the cooled areas beside green or blue spaces.

Table 6: Width of buffers and temperature differentials applied for urban blue and greenspace

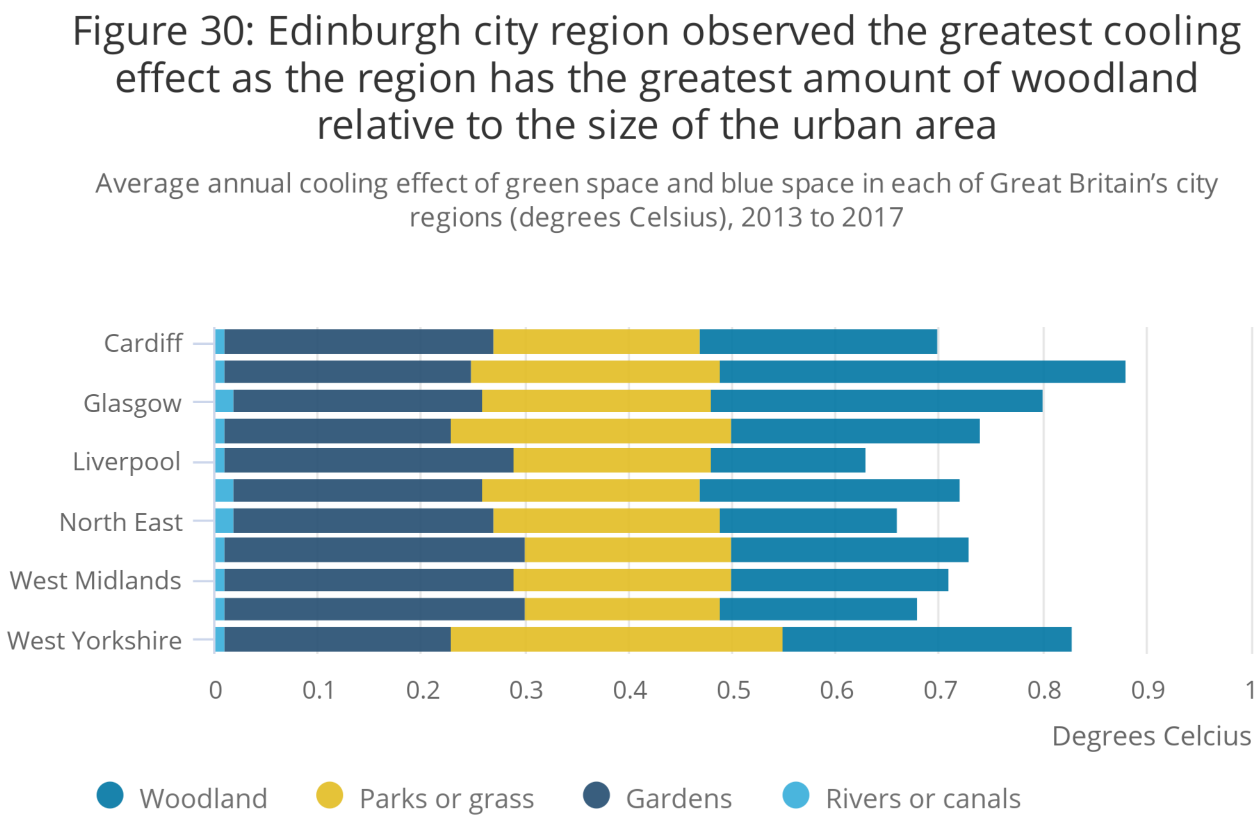
	Width of buffer to apply (m)	**Temperature differential (degree Celsius)**	
Asset		**Green/blue infrastructure**	**Buffer**
Urban blue space			
Rivers, canals (greater than 25m wide)	30	-1.4	-0.8
Lakes, ponds, reservoirs (less than 700m2)	30	-0.1	-0.057
Urban green space			
Woodland (greater than 200m2 less than 30,000m2)	0	-3.5	n/a
Woodland (greater than 30,000 m2)	100	-3.5	-0.52
Open parks and grassland (greater than 200 m2)	0	-0.95	n/a
Contiguous gardens (greater than 200 m2)	0	-0.95	n/a

Source: Eftec and others (2018)

As can be seen from Figure 30, the aggregate cooling effect varies between 0.63 and 0.88 degrees Celsius, with green space providing a greater cooling effect than blue space.

Figure 30: Edinburgh city region observed the greatest cooling effect as the region has the greatest amount of woodland relative to the size of the urban area

Average annual cooling effect of green space and blue space in each of Great Britain's city regions (degrees Celsius), 2013 to 2017



Source: Eftec and others (2018)

It should be noted that the cooling effects may be conservative because the simplistic approach to physical account modelling leads to an underestimation of the cooling effect of blue space features. Furthermore, the approach does not account for the locally felt cooling effects such as shading by street trees. For more information on all caveats please see the scoping study by Eftec and others 2018.

The cooling effect is valued through the estimated cost savings from air conditioning and the benefit from improved labour productivity. The benefit from improved labour productivity makes up most of the value, with avoided air conditioning energy costs only accounting for a small fraction. For more information on the method please see the Methodology guide and the scoping study.

Table 7 shows the total annual value of labour productivity savings and avoided air conditioning energy costs across the 11 city regions. From Table 7, the cities in the south, that is London and Cardiff city regions, experienced the greatest benefits from urban cooling, with the London city region having the largest amount in avoided costs of £207.8 million in 2017 (84% of the total). This is because London has the biggest economy as well as the greatest number of hot days (7.42 days out of a total of 25.71 hot days in 2017). “Hot days” throughout this section refers to any days equal to or between 28 degree Celsius and 35 degree Celsius.

Between 2016 and 2017, the total annual value across all 11 cities regions declined slightly from £278.8 million in 2016 to £247.8 million in 2017, despite having five more hot days overall (see Table 7). This is because the London city region, the largest economy in this study, saw a reduction in avoided costs due to fewer hot days. Also, there were no hot days in both the Edinburgh and Glasgow city regions, so no values were assigned to these regions.

The Cardiff city region had the biggest increase in the annual value of the cooling effect between the years 2016 and 2017 because the city region experienced the largest rise in the number of hot days.

Table 7: The total annual value of cooling from green and blue space in 2017 was valued at £247.8 million
Total annual value of cooling from green space and blue space in city regions, £ thousand (2018 prices), Great Britain, 2016 and 2017

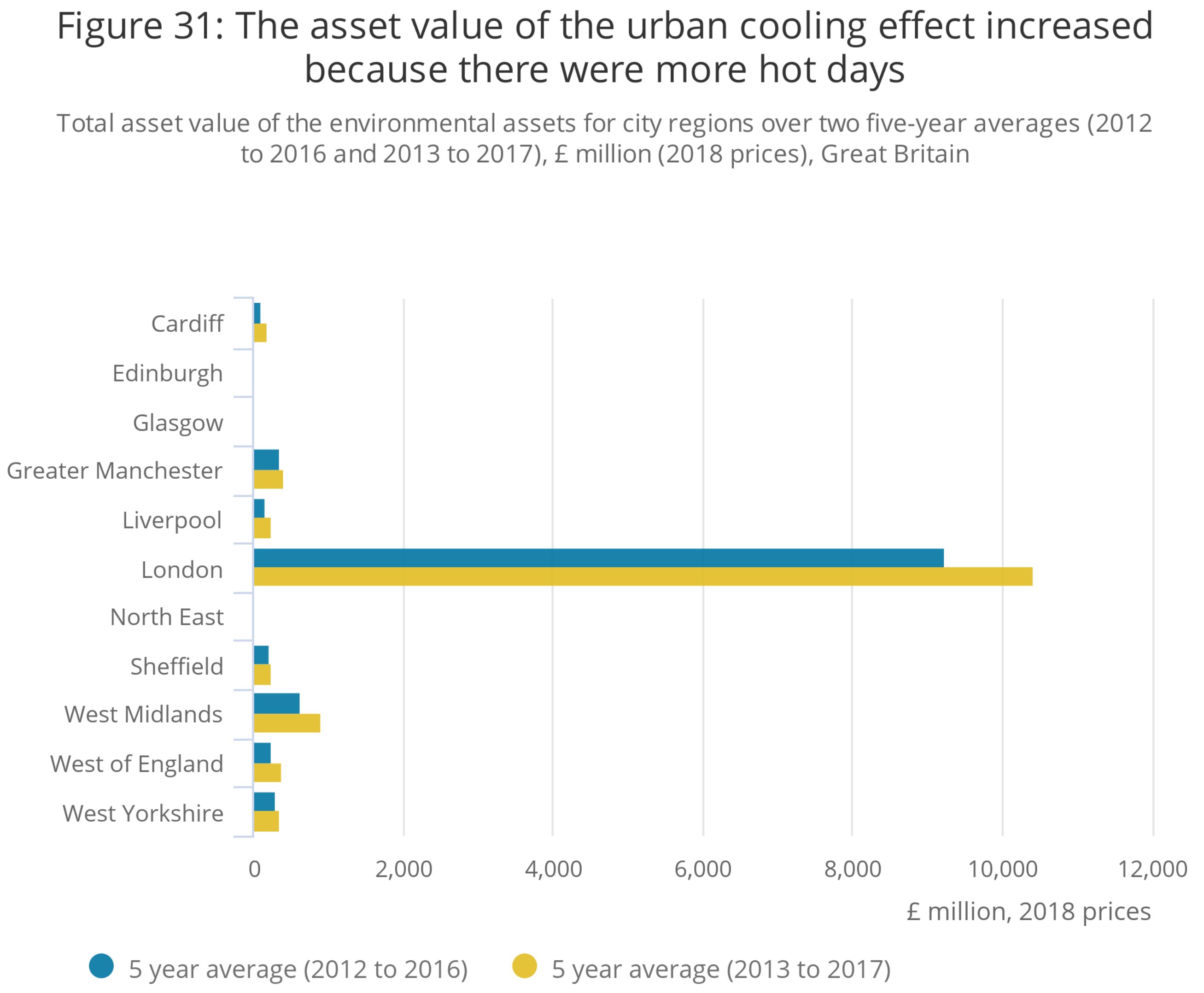
City Region	**2016**		**2017**	
	Avoided costs (£)	**Number of hot days**	**Avoided costs (£)**	**Number of hot days**
Cardiff	3,370	1.3	5,260	3.1
Edinburgh	230	0.2	-	0
Glasgow	330	0.2	-	0
Greater Manchester	7,820	1	1,440	0.9
Liverpool	4,230	1	860	2.2
London	237,050	8.2	207,830	7.4
North East	350	0.4	40	0
Sheffield	3,460	2.4	3,180	1.9
West Midlands	12,640	2.8	16,080	4.6
West of England	4,650	1.6	11,370	4.6
West Yorkshire	4,710	1.1	1,770	1
Total	278,840	20.2	247,830	25.7

Source: Eftec and others (2018) and Met office

Figure 31 presents the environmental asset value for each city region. These asset values are calculated using the average number of hot days over the last five years in 2016 and 2017. The total asset value between the two years increased by 17% from £11.4 billion to £13.3 billion. This is because between the 2012 to 2016 and 2013 to 2017 five-year averages, the number of hot days increased by seven days. Again, the London city region saw the largest amount of avoided labour productivity costs and air conditioning costs.

Figure 31: The asset value of the urban cooling effect increased because there were more hot days

Total asset value of the environmental assets for city regions over two five-year averages (2012 to 2016 and 2013 to 2017), £ million (2018 prices), Great Britain



Source: Eftec and others (2018) and Met Office

As shown in Table 8, an increase in woodland by one percentage point in all city regions (relative to the urban area) could lead to a saving in labour productivity of at least £9.3 million. There are clear benefits of increasing woodland areas in city areas. These numbers are calculated using the five-year hot day average (2013 to 2017). We would expect to see increases in this value as climate change progresses.

Table 8: A rise in one percentage point of woodland relative to the urban area can lead to an overall saving in labour productivity by at least £9.3 million

Avoided productivity losses by city region based on an average hot day between 2013 to 2017, £ (2018 prices), Great Britain

City Region	Avoided labour productivity costs (£)
Cardiff	115,500
Edinburgh	4,500
Glasgow	5,200
Greater Manchester	196,800
Liverpool	91,900
London	7,784,300
North East	9,000
Sheffield	131,400
West Midlands	589,100
West of England	261,700
West Yorkshire	137,200
Total	9,326,500

Source: Eftec and others (2018), Met Office and Office for National Statistics

Notes for : Regulating services

1. Please be aware that the data are different to data published in March 2018, because of a mistaken chemical conversion. The values will also be higher after an update in the damage costs (PDF, 1.1MB) by Defra.
2. The method uses Ordnance Survey (OS) Master Map to identify sufficiently large areas of urban woodland, based on a coarse spatial resolution, which provide the service. Alongside this method, Eftec and others provide alternative estimates of the service based on the nationwide extrapolation of finer resolution tree cover data in Manchester. This latter method is considered to overestimate the service and be subject to substantial uncertainty, so the OS Master Map method is preferred. For more details, please see Eftec and others (2018).
3. Rail and Aviation are not yet included in our noise mitigation estimates.
4. Eftec and others (2018) created a set of regions which comprised the main eleven city regions in Great Britain. Some city regions encompass large urban conglomerations, for example, Greater Manchester city region, while others include considerable rural areas as well, for example, North East city region. All spatial calculations were made within these boundaries. For a map of the city regions please see page 21 in the scoping study.

7 . Cultural services

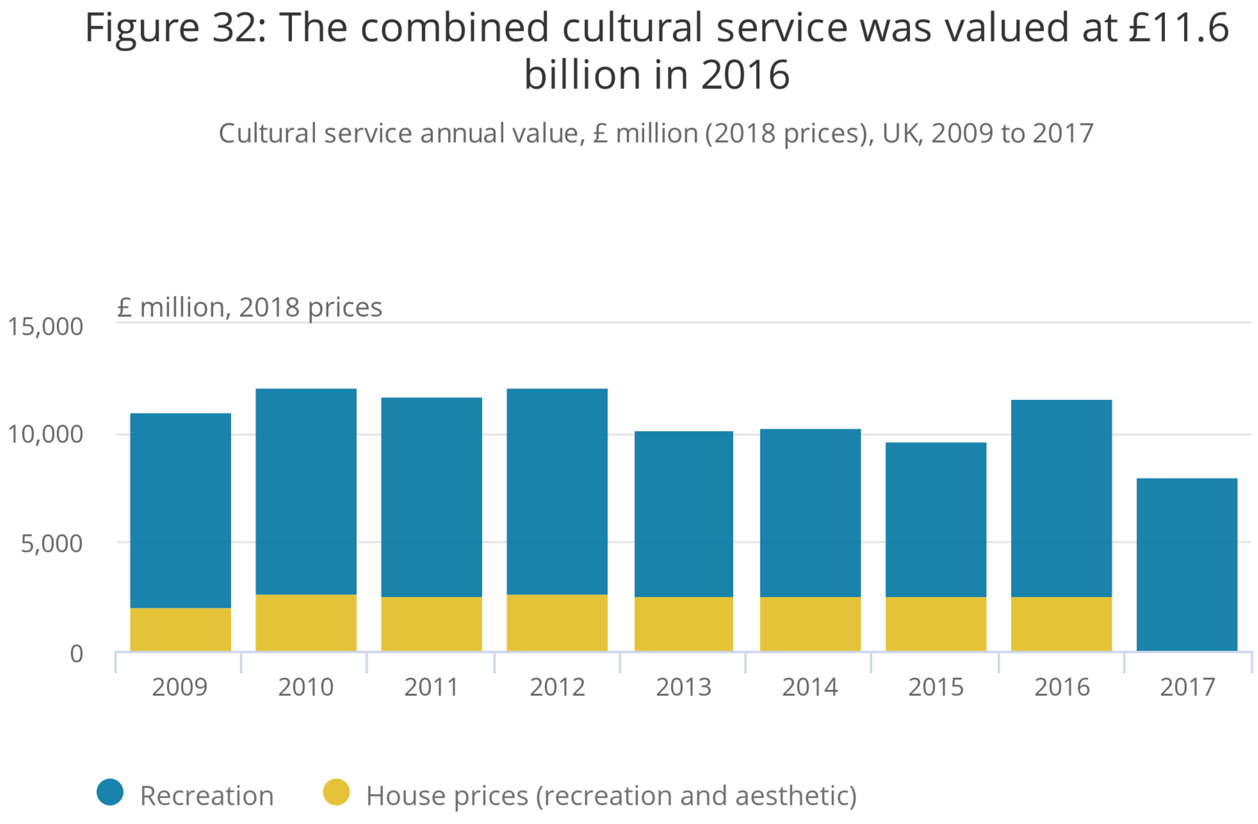
This section presents some of the cultural services that nature provides to humanity such as recreation.

Here we present estimates for the recreational and aesthetic benefits. Recreation is by far the largest service, by value, that we currently measure with an average of about £8.5 billion across the time series (2009 to 2017).

As well as measuring recreation by looking at surveys we also capture recreational values in the housing market by looking at the willingness to pay for living close to green and blue spaces (see Figure 32). However, a lack of significant data means we were unable to split the additional housing value into recreational and aesthetic benefits. Therefore, the estimates provided in Figure 32 show the combined recreational and aesthetic values found in house prices. We do know that the recreational element in the house prices makes up a large proportion of the total benefit of the housing stock – largely because more houses are close to outdoor spaces than have views of nature.

Figure 32: The combined cultural service was valued at £11.6 billion in 2016

Cultural service annual value, £ million (2018 prices), UK, 2009 to 2017



Source: Monitor of Engagement with the Natural Environment (MENE) survey, The Welsh Outdoor Recreation Survey, Scotland's People and Nature Survey and Office for National Statistics

We have also looked at how nature helps science, however, this work is only in its development phase as will be explained in the Estimates of science section.

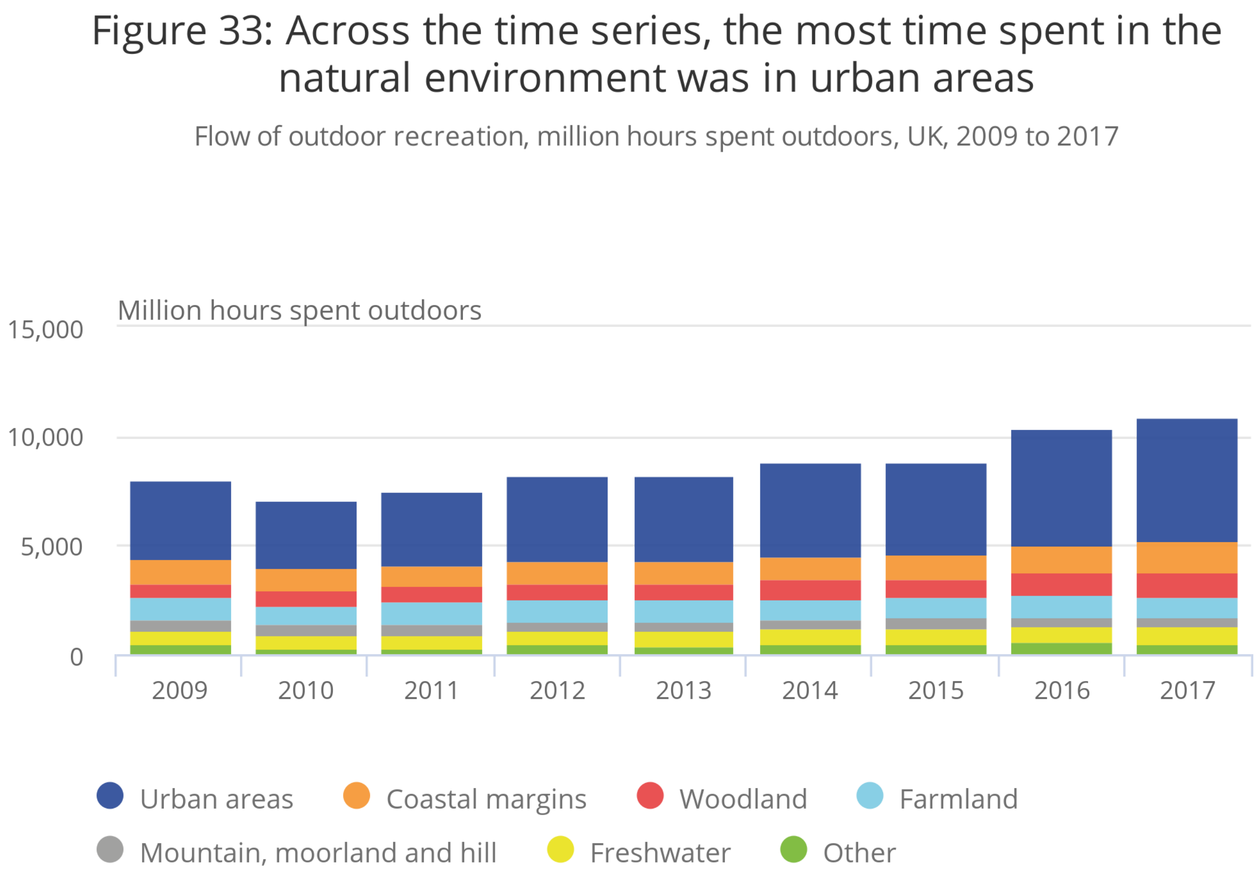
Recreation

Estimates of outdoor recreation refers to people aged 16 years and over and excludes overnight and tourist visits.

In the UK, around 11 billion hours were spent in the natural environment in 2017. This cultural service was valued at a substantial £8 billion. Since 2009, the amount of time spent in the natural environment has gradually increased over time (see Figure 33). With more people living in and visiting urban habitats, on average 48% of time spent on outdoor recreation was in urban areas, for example parks and allotments.

Figure 33: Across the time series, the most time spent in the natural environment was in urban areas

Flow of outdoor recreation, million hours spent outdoors, UK, 2009 to 2017



Source: Monitor of Engagement with the Natural Environment Survey, The Welsh Outdoor Recreation Survey, Scotland's People and Nature Survey

Overall the average length of an outdoor recreation visit in the UK was two hours and 10 minutes. As 48 minutes of this time was spent on travel to and from the visit destination, one hour and 22 minutes was spent at the visit destination. For some visitors travel time could be considered part of the enjoyment from nature, which may be reflected in the choice of travel method or route chosen. For others it may represent a willingness to pay or a cost of accessing outdoor recreation.

Between 2009 and 2017, overall time spent on outdoor recreation visits increased by 41%. This was driven largely by a 1.2 billion (33%) increase in visitor numbers, while average time spent per visit increased by seven minutes (6%). Visitor numbers increased from 3.7 billion to 4.9 billion between 2009 and 2017.

While people visited urban areas most (55% of visits), they tended to spend less time on these visits than outdoor recreation in other habitats. The average visit to outdoor urban areas lasted one hour and 52 minutes, the shortest visit length of all habitats. The longest visits were to mountain and moorland habitats, at three hours and 15 minutes, shortly followed by trips to the coast, at three hours and 12 minutes.

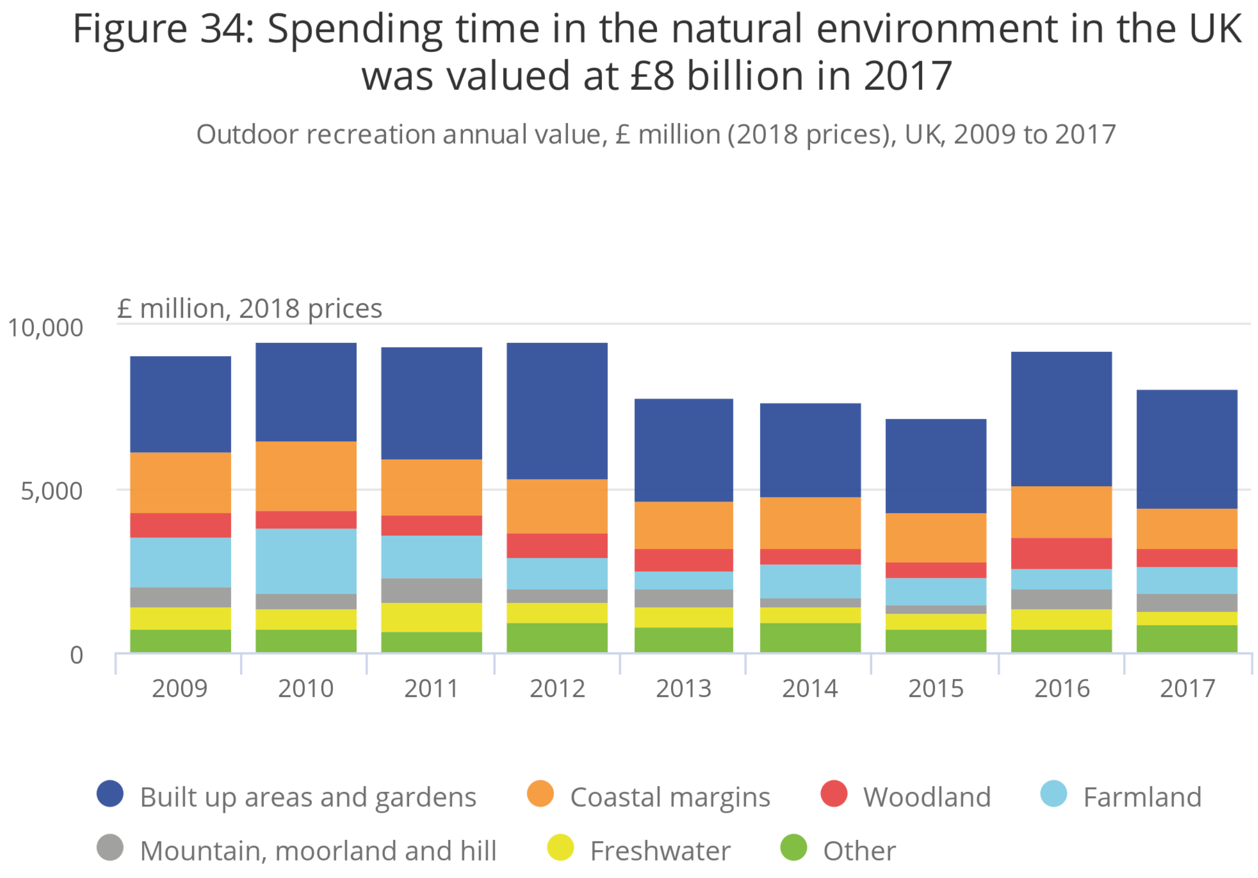
English visits represented 72% of overall UK time spent in the natural environment. This is unsurprising as England represents the majority of the UK population (84% of the population aged 16 years and over). However, in comparison to the rest of the UK, on average people in England spent the least amount of time on outdoor recreation, at 143 hours per person annually. Annual time spent per person was highest in Wales, at 498 hours per person. In Scotland on average people spent 204 hours on outdoor recreation annually.

While time spent in the natural environment has increased over the time series, the annual value of this service fluctuated between a high of approximately £9.5 billion in 2010 to a low of approximately £7.1 billion in 2015. Recreational visits in nature are valued based on expenditure per trip (that is, fuel, public transport costs, admission costs and parking fees). For more information on how we calculate the annual value please see the Methodology guide.

The total expenditure for recreation in the UK, in natural habitats, equated to around £8 billion in 2017. This amount has decreased by a little under £1 billion since 2009, and the number of visits in the UK has increased by over one billion during the same period. This may suggest that people are choosing cheaper outdoor activities. The average spend per outdoor recreation visit was £2.18 in 2017.

Figure 34: Spending time in the natural environment in the UK was valued at £8 billion in 2017

Outdoor recreation annual value, £ million (2018 prices), UK, 2009 to 2017



Source: Monitor of Engagement with the Natural Environment Survey, The Welsh Outdoor Recreation Survey, Scotland's People and Nature Survey

While on average urban areas represented 55% of visits and 48% of time spent, they only made up 39% of expenditure . This is because expenditure per visit was lowest in urban areas, at £1.56, slightly lower than visits to woodland areas at £1.59. In contrast visitors to the coast spent an average of £4.83 on outdoor recreation, the highest of any habitat followed by visits to mountains (£3.68).

Visits to coastal were cheaper in Wales and Scotland than the UK average. Compared with the UK average, people in Wales and Scotland respectively spent £1.81 and £1.37 less on visits to the coast. This is partly because of the population’s proximity to this habitat, with lower travel times and reduced expenditure on travel.

Even though people in Wales had the largest annual expenditure per person (£229) , they had the lowest expenditure per visit, at £0.76 below the UK average (£2.18). This is because on average people in Wales took 88 more visits per year than the UK average. In England annual expenditure on outdoor recreation was £161 per person. The lowest expenditure per person was in Scotland, at £144 annually.

The asset value of UK outdoor recreation, which looks at the annual benefit over a 100-year time scale taking into account population growth and discounting, was valued at £354 billion in 2017 (see Methodology guide for more information on how we calculate the asset value).

Recreation and aesthetic value in house prices

Living within 500 metres of publicly accessible green and blue spaces added on average £2,800 to property prices in urban areas.

The hedonic pricing approach analyses the variables that affect house prices, including the willingness to pay for living close to green and blue spaces as mentioned in Section 7. This approach can be used to measure the value of the "free trips" to spaces within 500 metres.

The model has been significantly updated since the previous urban publication to improve accuracy, with extra variables having been added such as the rating of the nearest school and travel to work areas. Please note that throughout this section when referring to "green spaces" this is publicly accessible green space [1].

Other environmental variables which may affect house prices are also included such as air pollution and noise pollution. For more information on all the variables included in the model and the type of model used please see the Methodology guide.

To work out the value of living near to urban green and blue spaces, we estimate the difference between the predicted house price based on real data and the predicted house price if there were no green or blue spaces [2]. The estimated effect of living within 500 metres of green or blue spaces was £2813.8 on average in 2016 (see Table 9), which is about 1.2% of the average property price in our sample. In 2016, there were 27.7 million residential properties in the UK. To work out the total stock value for green and blue spaces we multiply this by the average annual value – £2813.8 – to get £78.0 billion. We can also the split the total stock value to look at the separate recreational and aesthetic values (see Table 9).

The recreational services are measured by the distance to and area of blue and green spaces while the aesthetic services are captured by the view over green or blue spaces. For example, in 2016 the recreational benefit of living within 500 metres of green or blue space was estimated to be worth £68.6 billion, while the aesthetic benefit was valued at £9.4 billion.

Table 9: In 2016, the total stock value of living within 500 metres of green and blue space was estimated to be £78.0 billion

Value of cultural services capitalised into property prices, 2018 prices, UK, 2009 to 2016

Year	Average value (£)	95% CI lower bound	95% CI upper bound	Average value (%)	Stock value (£billion)	Aesthetic value (£billion)	Recreational value (£billion)	N properties (million)
2009	2,519.30	2,260.10	3,132.90	1.05%	66.84	11.24	55.59	26.5
2010	3,274.80	2,965.10	3,647.50	1.36%	87.42	10.84	76.59	26.7
2011	3,295.80	3,070.20	3,806.80	1.33%	88.51	9.68	78.83	26.9
2012	3,427.00	2,997.90	3,725.40	1.37%	92.56	10.59	81.97	27
2013	3,313.50	3,004.40	3,731.50	1.30%	89.96	11.27	78.7	27.2
2014	3,249.00	2,877.90	3,590.10	1.29%	88.72	10.89	77.82	27.3
2015	2,814.00	2,484.90	3,145.40	1.21%	77.38	9.66	67.72	27.5
2016	2,813.80	2,401.50	3,089.00	1.19%	77.98	9.43	68.55	27.7

Source: Office for National Statistics

For annual values, we can present an imputed rental value of living within 500 metres of green or blue space shown in Table 10. This is calculated by using the percentage increase in house prices caused by living within 500 metres of green or blue space and using this to take a percentage of the imputed annual rental estimates published by the Office for National Statistics (ONS).

Since 2010, the annual value has generally fallen year on year (with the exception of a slight pickup in 2014). However, the annual value has not dropped as much because of the number of properties increasing from 2009 to 2016. In 2016, the imputed rent for living within 500 metres of green or blue space for all properties in the UK was estimated to be £2.5 billion.

Table 10: In 2016 the imputed rent of living within 500 metres of green and blue space is estimated to be £2.5 billion

Imputed rental benefit from green and blue space, £ million (2018 prices), UK, 2009 to 2016

	Total (£ million)
2009	2,057.20
2010	2,642.30
2011	2,557.80
2012	2,682.30
2013	2,584.60
2014	2,610.30
2015	2,541.30
2016	2,534.50

Source: Office for National Statistics

Table 11 presents the average effect of living within 500 metres of green and blue spaces on house prices in different travel to work areas (TTWA). We report both the absolute effect and the effect relative to the average property price in the area. Out of the 30 most sampled TTWAs[3], Slough and Heathrow had the greatest average effect (£7097.1) of living within 500 metres of green and blue spaces. Liverpool had the greatest average value percentage increase relative to the houses in that area.

For a full list of all the TTWA please see the Methodology guide.

Table 11: Slough and Heathrow reported the greatest increase in the average value of properties within 500 metres of green and blue space

Average effect of green and blue space on property price by TTWA

Travel-to-work area	Average value (£)	Average value of property price (%)	N validation set	Avg. Distance to Blue Spaces	Avg. Distance green space
London	4,045.0	1.0	43,971.0	406.9	225.3
Birmingham	2,478.5	1.3	14,529.0	342.3	267.3
Manchester	4,469.1	2.5	14,161.0	282.2	219.4
Slough and Heathrow	7,097.1	1.8	8,497.0	316.2	238
Nottingham	2,643.6	1.5	7,775.0	407.9	255.3
Leeds	3,714.4	1.9	7,401.0	428.1	242.8
Bristol	3,868.3	1.6	7,047.0	345.9	206.7
Sheffield	1,943.7	1.2	6,372.0	422.8	246.6
Luton	3,977.6	1.2	6,220.0	495	245.5
Liverpool	3,999.1	2.5	5,702.0	430.4	223.2
Leicester	2,205.9	1.2	5,576.0	308.7	282.5
Cardiff	4,213.5	2.1	4,916.0	289.8	258.5
Newcastle	4,550.4	2.5	4,866.0	527.2	202.3
Medway	2,923.5	1.3	4,858.0	576.6	282.7
Guildford and Aldershot	5,152.6	1.3	4,772.0	305.1	242.6
Portsmouth	2,714.4	1.1	4,482.0	350.5	281.8
Norwich	1,255.2	0.6	4,351.0	411.7	291.4
Warrington and Wigan	2,584.1	1.7	4,175.0	273.7	268.2
Plymouth	862.3	0.4	3,953.0	377.1	295.1
Wolverhampton and Walsall	881.2	0.5	3,763.0	365	286.3
Chelmsford	4,722.0	1.5	3,649.0	286.4	293.9
Milton Keynes	3,107.2	1.3	3,637.0	311	278
Southampton	3,440.2	1.3	3,591.0	348.6	293.3
Reading	3,497.5	1.0	3,579.0	371.4	282.5
High Wycombe and Aylesbury	3,720.0	1.1	3,377.0	396.3	293.1
Cambridge	6,030.2	1.9	2,986.0	320.6	243.6
Ipswich	3,082.4	1.4	2,981.0	408.8	260.7
Lincoln	1,873.4	1.1	2,924.0	357.2	318.2
Derby	2,164.4	1.2	2,918.0	397.2	255.2
Hull	1,927.5	1.4	2,832.0	370	289.6

Source: Office for National Statistics

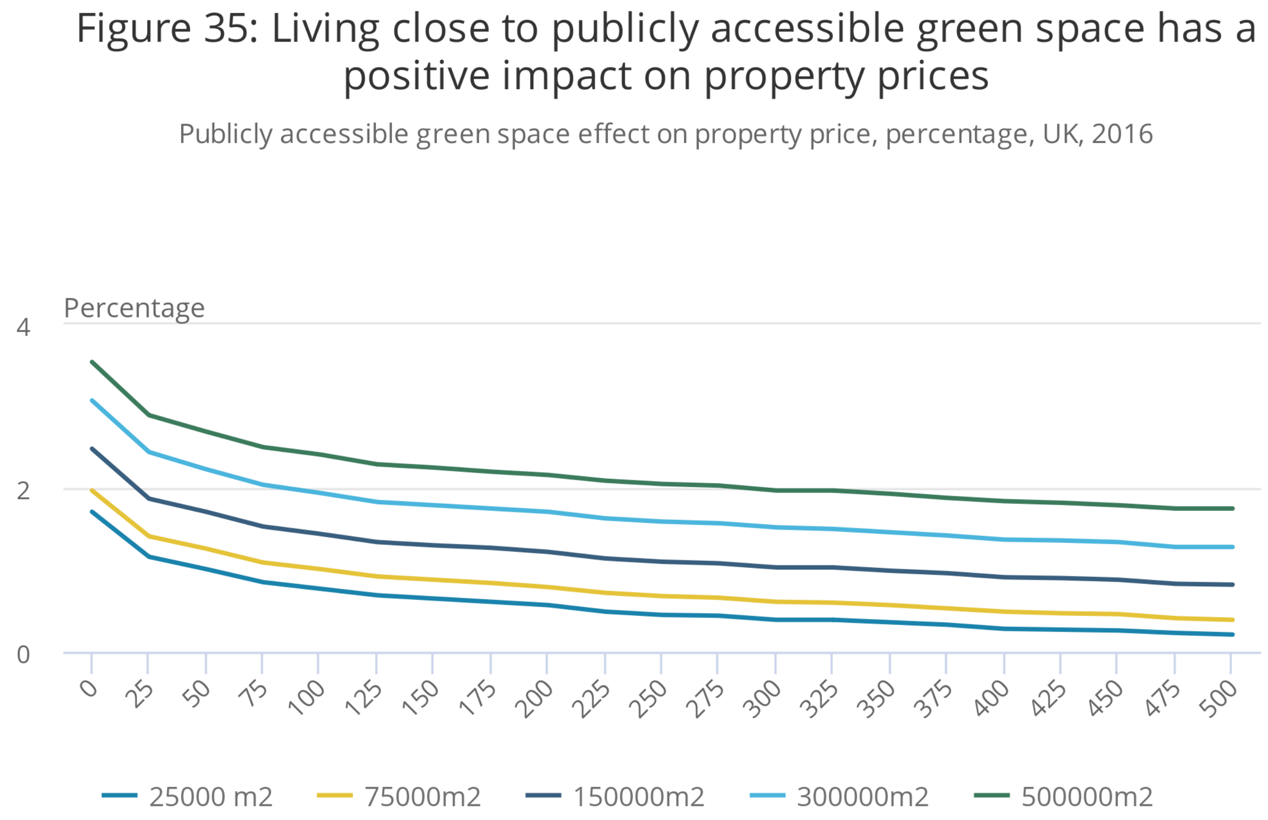
Notes

1. Estimates for the largest 30 TTWA in our validation sample. Back to table

As well as looking at the annual figures, we can also estimate the joint effect of distance and area of green space on house prices. Figure 35 shows that the effect of a green space on property prices is greatest for properties within 50 metres. That is, a property close to a large green space increased by an average of 3.5% (£8,664) compared to only 0.2% for a property 500 metres from a small area.

Figure 35: Living close to publicly accessible green space has a positive impact on property prices

Publicly accessible green space effect on property price, percentage, UK, 2016

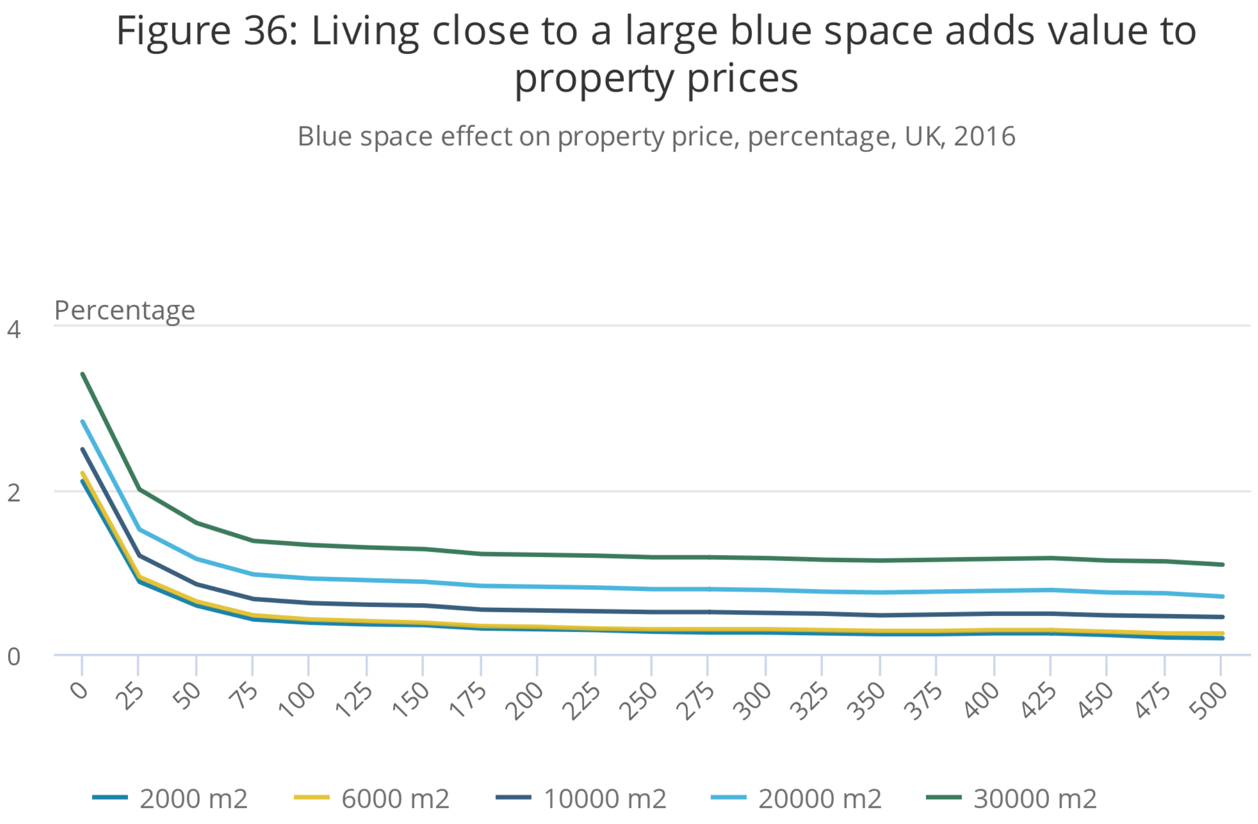


Source: Office for National Statistics

We can do the same for blue spaces and the results are similar, properties close to large blue spaces (30,000 square metres) are on average 3.4% (£8,398) more expensive than comparable properties with little access to blue spaces. However, the effects of proximity to blue space diminish faster than the effect of proximity to green space.

Figure 36: Living close to a large blue space adds value to property prices

Blue space effect on property price, percentage, UK, 2016



Source: Office for National Statistics

Scientific research

We are developing UK estimates on the value of environmental scientific research, itself an ecosystem cultural service. The Common International Classification of Ecosystem Services (CICES)[4] is an internationally agreed set of Ecosystem Services. CICES defines environmental science as the "characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge".

This can also be extended to "abiotic characteristics of nature that enable intellectual interactions", for example, water, sunlight and soil. It might be easier to think of it as, "what scientific examination of nature can teach us".

One way of estimating the value of environmental scientific research is through estimating the value of research grants awarded. Data on publicly funded research grants was sourced from the UK Research and Innovation (UKRI) gateway. In our initial work we have attempted to establish which studies investigate the UK environment by searching project titles and abstracts for relevant keywords.

Our preliminary work on developing a partial UK estimate focused upon identifying scientific research associated with UK Woodland, and Mountain, moorland and heathland (MMH), using keywords such as: "woodland", "tree", "timber" and "forest"; and "mountain", "moorland", "bog", "peatland", "peat", "heather", "heather grassland" and "inland rock" respectively. We then manually sifted the resulting list of studies. Future work might hope to produce full UK estimates for other areas of natural capital, while also assigning a typology for nature-based research, such as "protective" or "exploitative".

Research grant amounts were divided by project length to provide an estimate for cost per day. This was then multiplied by the amount of days a project operated during each year, to calculate estimates of how much was spent on UK Woodland (Table 13) and MMH research (Table 12) every year between 2006 and 2024, as of 25 September 2019. It is worth noting that we only include allocated spend. Projections of future spending are likely to increase as more grants are won.

Because of data uncertainties, unlike all other monetary figures in this publication, values reported under scientific research are nominal.

Table 12: Estimates of amount spent (£, current prices) on publicly funded research on UK mountains, moorlands and heathland (as of 25 September 2019)

Year	Amount spent on publicly funded research (£)
2006	13,238.98
2007	216,864.16
2008	761,810.42
2009	631,560.07
2010	551,303.65
2011	412,416.33
2012	591,497.09
2013	478,667.65
2014	340,760.67
2015	301,777.82
2016	140,785.20
2017	533,060.73
2018	938,721.37
2019	567,294.45
2020	180,553.86
2021	142,461.14
2022	142,461.14
2023	142,461.14
2024	106,553.13

Source: Office for National Statistics

Table 13: Estimates of amount spent (£, current prices) on publicly funded research on UK woodland (as of 25 September 2019)

Year	Amount spent on publicly funded research (£)
2006	-
2007	18,430.42
2008	27,532.79
2009	77,056.19
2010	179,002.06
2011	201,441.27
2012	278,787.47
2013	411,154.75
2014	1,565,989.76
2015	2,309,950.16
2016	2,437,794.10
2017	2,121,302.20
2018	1,221,581.41
2019	2,014,649.92
2020	2,288,004.70
2021	1,812,408.45
2022	923,589.87
2023	640,704.68
2024	465,238.80

Source: Office for National Statistics

These values cover only a small subset of what might be considered environmental science. Woodlands, and Mountains, moorlands and heath present areas where a keyword search is less likely to include studies which we would prefer to exclude and so have been our initial focus. We are reporting project funding of a little over £2 million in 2018 whereas the total budget of the UK Natural Environment Research Council (NERC), "Science budget" was £502 million in 2017 to 18 (PDF, 1.71MB). NERC is not the only funding source for environmental research.

Limitations

The decision to include or exclude a study from our estimates represents a value judgement, particularly when observing for criteria such as whether any scientific fieldwork took place within the UK's natural environment or not.

Other limitations arise from our data source. Use of the UK Gateway source risks excluding studies from abroad which focus upon UK ecosystems. It also focuses upon publicly funded studies, because of the difficulties associated with accessing data on privately funded studies. These preliminary estimates of science and research for UK Woodland and MMH remain highly experimental.

We welcome suggestions to further develop our work in this area.

Notes for: Cultural services

1. Any green space that has a specific function in its use, for example, public parks or gardens, playing fields, golf courses, allotments. These spaces contain natural land cover and can also include some blue space, for example, a park that has a lake within it.

2. We set areas and view of green and blue spaces to zero and distance to 500 metres.

3. We removed all houses in the data in Scotland because we were unable to link them to any school data. As such, any results we have obtained would have also excluded Scotland.

4. Developed from European Environment Agency (EEA) work on environmental accounting.

8 . Asset valuation

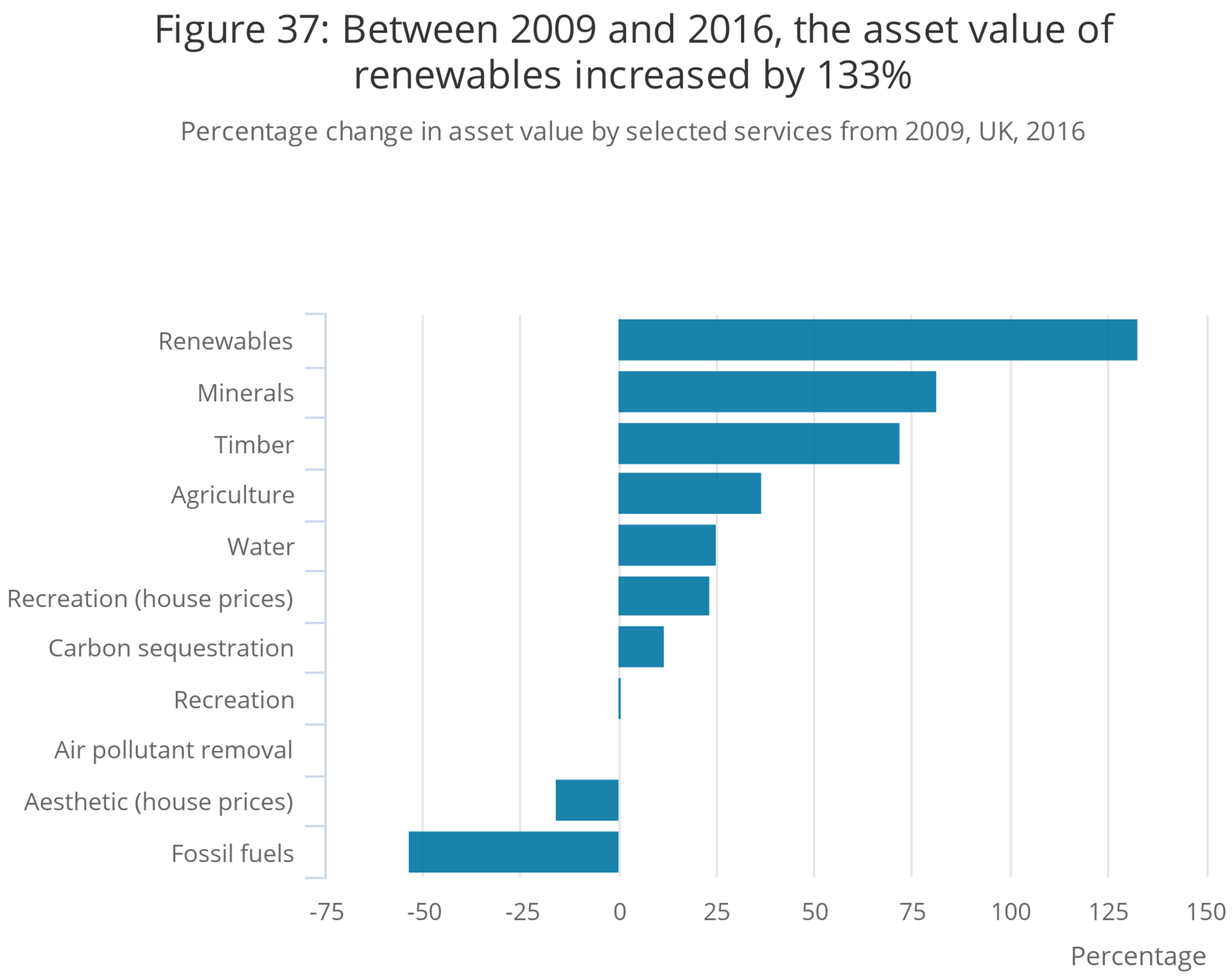
The asset values are estimated by capitalising the annual flow of services from the natural resource that are expected to take place over a projected period. This period is known as the asset life. The annual environmental service flows provide the basis for the projected flows. This method, known as net present valuation (NPV), is explained in more detail in the Methodology guide.

Some environmental services presented in this article are produced from renewable resources whose stock is not exhausted over time, for example, woodland delivering carbon sequestration. For renewable resources, a 100-year asset life has been assumed. The non-renewable abiotic resources presented in this article are minerals, and fossil fuels, where an asset life of 25 years has been assumed.

Figure 37 presents the percentage change in UK natural capital asset values between 2009 to 2016 by selected services. Between the years 2009 and 2016, the asset value of renewables increased by 133%. That is, the asset value for renewable energy more than doubled during this period. In contrast, the asset value of fossil fuels has more than halved in this time period.

Figure 37: Between 2009 and 2016, the asset value of renewables increased by 133%

Percentage change in asset value by selected services from 2009, UK, 2016



Source: Office for National Statistics

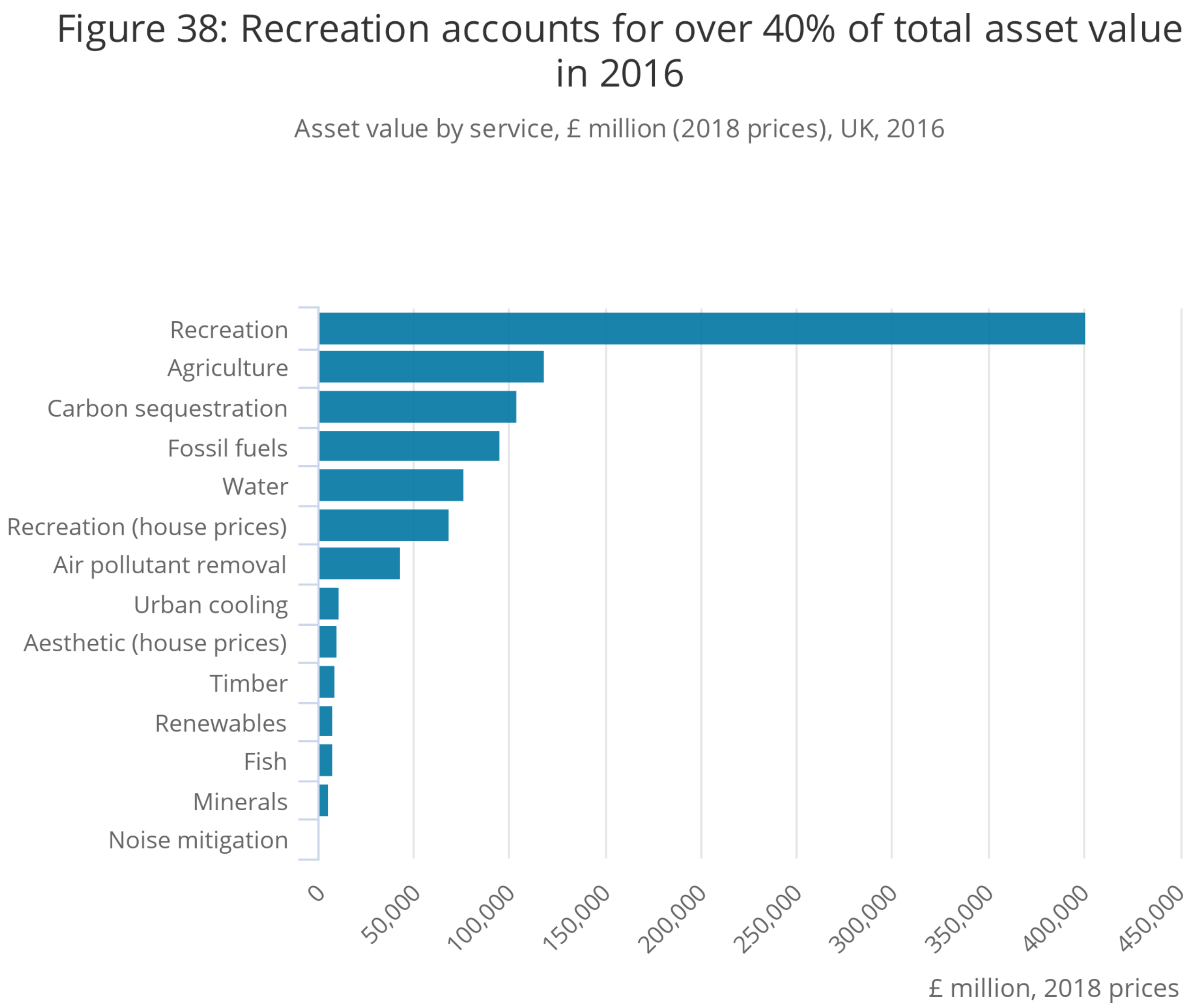
Notes:

1. Excluding the comparison of asset values for fish capture, urban cooling and noise mitigation, due to data limitations.

Despite the asset value of recreation growing by only 1% between 2009 and 2016, this cultural service still made up a large proportion of the asset value of natural capital in the UK, forming 41.9% of the total UK asset value in 2016 (see Figure 38). The overall asset value of non-material services not directly captured in gross domestic product (GDP) (that is, regulating services and cultural services) represented 66.6% of the UK's natural capital asset value in 2016.

Figure 38: Recreation accounts for over 40% of total asset value in 2016

Asset value by service, £ million (2018 prices), UK, 2016



Source: Office for National Statistics

Notes:

1. Noise mitigation asset value for 2017 is included.

The total asset value of the UK's natural capital is estimated to be £958 billion, in 2016. This figure includes the 2017 asset value for noise mitigation.

9 . Quality and methodology

The methodology used to develop these estimates remains under development; the estimates reported in this article are experimental and should be interpreted in this context. Experimental Statistics are those that are in the testing phase, are not yet fully developed and have not been submitted for assessment to the UK Statistics Authority. Experimental Statistics are published to involve customers and stakeholders in their development and as a means of building in quality at an early stage.

UK Natural Capital Accounts methodology guide: October 2019 provides a detailed summary of the methodology used to develop the Natural Capital Ecosystem Service Accounts. It summaries the broad approach to valuation and the overarching assumptions made, as well as giving a more detailed description of the methods used to value the individual components of natural capital and physical and monetary data sources.

We have used a wide variety of sources for estimates of UK natural capital, which have been compiled in line with the guidelines recommended by the United Nations (UN) System of Environmental-Economic Accounting Central Framework and System of Environmental-Economic Accounting Experimental Ecosystem Accounting principles, which are in turn part of the wider framework of the system of national accounts.

As the UN guidance is still under development, the Office for National Statistics (ONS) and the Department for Environment, Food and Rural Affairs (Defra) published a summary of the principles underlying the accounts.

We welcome discussion regarding any of the approaches presented.