<table>
<tr><td>Short title</td><td>ICF KPI 10: Value of ecosystem services generated / protected as a result of ICF support.</td></tr>
<tr><td>Type of indicator</td><td>Annual, £/year (flow of services from hectares protected in any given year):
Reporting of this KPI relies on a figure being produced for KPI 8.</td></tr>
<tr><td>Key reporting requirements</td><td>Below is a list of key reporting requirements to keep in mind when making your returns. Further details are available in the text below:

<table>
<tr><th>Requirement</th><th>Summary</th></tr>
<tr><td>Available for reporting?</td><td>Yes</td></tr>
<tr><td>Methodology changes?</td><td>Yes</td></tr>
<tr><td>Units</td><td>£/year</td></tr>
<tr><td>Attribution</td><td>Pro rata share of public funding</td></tr>
<tr><td>Disaggregation to be reported in results templates</td><td>Projects operating across multiple locations should disaggregate the value of benefits by location.</td></tr>
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</td></tr>
<tr><td>Technical Definition / Methodological summary</td><td>Ecosystem services are the benefits we derive from the natural environment, as assessed through the framework established in the Millennium Ecosystem Assessment (2005). They are grouped into 4 categories: provisioning (e.g. providing a source of food, fuel and fibre), regulating (e.g. influencing the flow or quality of water, regulating the climate), cultural (e.g. aesthetic benefits) and supporting services (e.g. nutrient cycling). See the ‘additional comments’ section for a full explanation of ecosystem service categories.

A high-level indicator measuring the value of ecosystem services generated or preserved by investments on the ICF has been developed based on the measurement and location of hectares of forest / habitat protected and restored (therefore using as inputs data already generated for KPI 8 – the hectares indicator). This is combined with data on the per-hectare value of each service provided on a hectare of habitat – eg. the value of air quality maintenance offered by a hectare of rainforest in Costa Rica. Going through this process for as many ecosystem services as possible using the data available will provide a wider indicative estimate of the value protected and/or delivered, which provides benefits on a local, national, and global level.

The broad methodology below disaggregates between the value of carbon and non-carbon ecosystem services, and outlines separate methods for reaching each figure. The reason for this is that HMG has a robust existing methodology for valuing carbon through the use of the BEIS International Carbon Price Series. This methodological approach does not exist for non-carbon ecosystem services.

This indicator is measured in gross terms, to reflect that the aim of this KPI is to capture the wider ecosystem benefits supported by the ICF portfolio.

<u>A: Carbon Ecosystem Services</u>

For carbon ecosystem services, the method used depends on whether the hectares in question have been protected versus restored – protecting an existing carbon stock will entail a different level of carbon from the restoration of carbon in degraded or new forest.

For carbon stock through forest protection:</td></tr>
</table>

	Step A1a: Derive an estimate for per-hectare carbon stock for the project area – if data is not available from the project, generic figures are provided by IPCC[1], though this will increase the uncertainty around the value. **Step A2a:** As carbon stock is considered a present value (eg. not a flow of services), it must be converted to a flow. The method recommended for this is to divide the carbon stock protected equally across 20 years, the assumed lifetime of benefits. **Step A3a:** Multiply the carbon stock protected in Year 1 by the carbon price for that year, using the BEIS International Carbon Price Series. **Step A4a:** Multiply p/ha value by number of hectares protected. **For carbon sequestration through restoration:** **Step A1b:** Derive an estimate for p/ha carbon sequestration based on project data. If project-level data is not available, use IPCC values for the relevant forest type/biome. **Step A2b:** Multiply the carbon sequestration levels by the carbon price for that year, using the BEIS International Carbon Price Series. **Step A3b:** Multiply p/ha value by number of hectares restored. **B: Non-Carbon Ecosystem Services** For non-carbon ecosystem services, the following outlines the 5 steps to take to transform hectare data into the value of ecosystem services protected/generated, recognising that this is a high-level approach that is primarily suitable for order-of-magnitude estimates at a more aggregate level. **Step B1:** Form an estimate of the proportion of habitat types within the area under consideration. This can be drawn from ecological literature or estimated using program knowledge of the local area. For an example of this, see the Worked Example section. **Step B2:** Use value transfer based on the Economics of Ecosystems and Biodiversity (TEEB) Ecosystem Services Value (ESV) database (developed in 2010) to form an order-of-magnitude estimate of the value of services per hectare per year provided by an ecosystem broadly representative of the area under consideration. The ESV database holds 1310 data points on the value of 22 different ecosystem services across 10 habitat types. 582 have been peer-reviewed as being of sufficiently robust to use in value transfer from one location to another. The values have been updated to 2018 £ figures, and will be updated annually to reflect inflation. **Step B3 (Optional):** Derive values for ecosystem services specific to the location under consideration, if available. • This is the most resource-intensive step of the process, and the level of time committed to this step will be dependent on the analytical capacity of ICF programme teams. • We are looking to significantly reduce the analytical resource necessary for this step through an update to the ESV database – this will ensure that all robust location-specific ecosystem service values are available to ICF analysts in a single searchable database. **Step B4:** Derive a monetary value for the ecosystem services generated by the likely alternative land use without the ICF to ensure additional benefits are captured.

[1] IPCC, (2006), *IPCC guidelines for national greenhouse gas inventories*. Chapter 4: Forest Land.

	• This step assumes that the non-monetised/able ecosystem benefits generated by the alternative land-use are negligible. **Step B5:** Multiply the per-ha value by hectare figures provided by KPI 8 to reach an overall order-of-magnitude estimate for KPI 10. The values of carbon and non-carbon ecosystem services are then added together to give a total value for the flow of ecosystem services from hectares protected or restored through ICF support. We envisage this method being utilised by HMG ICF analysts, with input (most likely on Steps B1 and B4) from project partners and country offices. Further information on how to approach the reporting of this indicator is provided through in the Worked Example section. As mentioned above, it is likely that in the event of an update to the ESV database, Step 3 would be a much less resource-intensive undertaking, as it would simply involve a search of the ESV database for values specific to the location under consideration. The ESV database could also be updated on an annual basis with new peer-reviewed location-specific estimates for ecosystem service values – this would allow reporting of the KPI to potentially be undertaken by project leads. **Until the ESV database is updated, Step 3 should be skipped unless analytical capacity allows.** This indicator will be generated based on the data already requested of programme managers e.g. annual estimate of the number of hectares maintained at their baseline level and/or any improvements in the quality of forests in the intervention countries as a direct result of the programme under review etc. As with other indicators programmes will be encouraged to report against indicators over time so this indicator would be updated with this reporting over time. As this method relies on KPI 8 data as an input, the risks of leakage and non-permanence (where impacts are not sustained beyond the program lifetime) will have already been accounted for. As such, leakage and non-permanence <u>should not be considered</u> when deriving a value for the total ecosystem services generated or protected.
Rationale	The TEEB study (2009)[2] presented estimates that humanity globally loses ecosystem services with a capital value of $2tr-$4.5tr each year as a result of deforestation alone. As the benefits of the natural environment tend to be delivered for free, they are often neglected in decisions, especially where the parties who benefit from the environmental services are not those who benefit from the action which removes them e.g. deforestation by non-local companies – they will take the benefit from the sale of timber and future use of the land, but do not compensate populations living locally for reduced access to products from the forest, or increased flood risk. The TEEB study also highlights the role of forests in the income of rural poor, suggesting that (based on analysis across India, Indonesia and Brazil) between 47% and 89% of the effective income of the rural poor is delivered for free by nature, implying significant real losses are likely for such groups when deforestation occurs without work on alternative livelihoods. While we are looking to update this dataset

[2] http://doc.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Synthesis%20report/TEEB%20Synthesis%20Report%202010.pdf

	with new valuation figures for ecosystem services in different habitats and biomes, we have no reason to believe that the role of forests has changed substantially for the rural poor in the developing world. Whilst the "Forest Dependent People" indicator (ICF KPI 3) focuses on this livelihood issue specifically, valuing ecosystem services attempts to capture more broadly the value of the range of benefits (forest) ecosystem provide to society for free. It will not ascribe these to particular population, where the benefit falls will depend on local topography, climate, land ownership etc. KPI 10's main aim is to identify the wider benefits. Many non-carbon ecosystem services have a more local benefit than reduced CO_2 emissions. This indicator reveals, to an extent, the more local benefits of forest protection, and therefore is relevant to the impact of the ICF on people within the countries where money is spent. It will also reveal the wider benefit of protecting biodiversity and natural habitats, as global public goods which support the generation of ecosystem services.
Country office role	To be agreed but it could involve validation of the results reported by project managers. Country offices could also assist with assumptions for the business as usual scenario i.e. in the absence of the ICF
Data sources	TEEB Ecosystem Services Valuation (ESV) Database – 1310 data points on the value of ecosystem services across the world, disaggregated across 10 biomes and 45 ecosystems. 582 of these have been cleared for use in value transfer by peer review. Database with all values updated to 2018 price levels currently available on request from moray.fraser@defra.gov.uk. An overview of biome-level ecosystem service values for 10 biomes is available at https://www.sciencedirect.com/science/article/pii/S2212041612000101 Further location-specific data not captured by the TEEB database is available in caches such as the Environmental Valuation Reference Inventory, the WAVES Knowledge Center and peer-reviewed journals. This data, when resources allow, would be derived and utilised by ICF analysts until a point where the TEEB database is updated to a high-quality standard.
Reporting organisation	Indicator reported by HMG
Data included	The results would estimate the value of ecosystem services generated by ICF spend. From year to year, it is likely that the ecosystem service valuation data on which the method relies is likely to improve, as more study results are added to the TEEB valuation database. As such, values for each service, as well as the total economic value of a hectare of protected or restored habitat, should be re-appraised during each reporting year. This is not expected to be a capacity-intensive exercise, as median values for each service in each habitat will be easily convertible from the database.
Formula/Data calculation (including attribution rule)	Attribution rates will already have been applied to the figure reported for KPI 8. As such, no further attribution rates would be applied. Reported value = (Per-hectare value of service) x (number of hectares of forest protected or generated through ICF support)
Worked example	A case study of the method in practice has been undertaken on the Cerrado biome, an area in Brazil where two ICF projects are currently in operation.

This habitat encompasses 204.5m hectares, covering 21.3% of Brazil's territory. It is the 2nd largest biome in South America and is acknowledged as one of the world's biodiversity hotspots, with over 4400 endemic plant species. The biome is vital for Brazil's long-term sustainability in areas as diverse as agriculture, energy, water security and climate regulation. Despite this, it has been heavily affected by the spread of agriculture across the region since the 1960s, with just 47% of the biome retaining its natural vegetation in 2010. Habitat loss in in the region continues at 0.6% a year.

Method

Step A – Carbon Ecosystem Services

This case study assumes that the counterfactual would be that the natural habitat would be converted to agriculture, with an assumed minimal carbon stock.

Step A1

Estimates for the carbon sequestered annually by Cerrado natural habitat range from 1.2TC/ha[3] to 6.2TC/ha[4], with a median of 3.7TC/h – this converts to 13.55TCO_2e/ha.

Step A2

Using the BEIS International carbon Price for 2018 of £52 produces a per-hectare median estimate for carbon sequestration by Cerrado natural habitat of £705 (13.55T x £52).

Step B – Non-carbon Ecosystem Services

Step B1

To apply the data held in the ESV database to the Cerrado, first we estimate the habitat composition of an **average** hectare of Cerrado in its natural state. Based on relevant ecological literature[5], we make the assumption that this composition is 72% grassland, 24% grassland/forest transition (with the assumption of a 50/50 split), and 4% tropical forest.

- We used tropical forest as the ESV forest indicator as it was most relevant to the tropical *dry* forest found in the Cerrado biome. However, there is not enough data available in the ESV database to differentiate between dry and moist tropical forest at this time, though they are likely to generate a sizably different set of ecosystem services.

Step B2

To calculate an estimated figure for the value of each ecosystem service within our generic habitat, we use the median values provided by the TEEB database[6]. Median is used to increase robustness, as the effect of outliers does not skew the results. A simple formula is used in the case of the Cerrado:

[3] Abreu, R. C. R. et al. (2017) "The biodiversity cost of carbon sequestration in tropical savanna"
[4] Teixiera do Vale, A. and Felfili, J. M. (2005) "Dry Biomass Distribution in Cerrado *Sensu Stricto* Site in Central Brazil"
[5] Cardoso Da Silva, Bates (2002) - "Biogeographic Patterns and Conservation in the South American Cerrado: A Tropical Savanna Hotspot"
[6] TEEB: Ecosystem Service Value Database; https://www.es-partnership.org/services/data-knowledge-sharing/ecosystem-service-valuation-database/

$$0.72(\alpha) + 0.24((\alpha+ \beta)/2) + 0.04 (\beta),$$

where α represents the grassland ecosystem service median value and β represents the tropical forest ecosystem service median value. This formula enables us to create an indicative baseline estimate of ecosystem service values for a hectare of the Cerrado.

Step B3

To increase the accuracy of our ES value estimate, we find a number of location-specific figures for the value of individual ecosystem services provided by the Cerrado and aggregate them. This is the most time-intensive step in the process. As such, the time committed to Step 3 will be dependent on the analytical capacity available. Results are shown in Column 2 of the table below.
Cerrado-specific metrics are available for the following services:

- Food – the per-ha value of pequi (*caryocar brasiliense*) harvest[7, 5].
- Climate regulation – the value of carbon sequestered annually on average by a hectare of Cerrado[8,9].
- Water flow regulation – the evapotranspiration services offered by Cerrado vegetation[5]
- Natural hazard regulation – erosion prevention values for Cerrado soils[10]
- Genetic diversity – the value of plant diversity in an area of the Cerrado[11]

Step B4:

The value of the standing forest is now compared to the counterfactual, ie the economic value obtained from deforesting the land for an alternative land-use. The most financially valuable alternative land-use is double-cropping soybean/corn agriculture – one crop is harvested after six months and immediately replaced with another crop, so the land is productive on a year-round basis. Analysis of the ecosystem services provided are sourced through relevant literature[12].

Step B5
This step is dependent on estimates being produced for KPI 8. Ecometrica's analysis of an ICF project in the Cerrado estimated 784 hectares have so far been protected from deforestation through ICF support. This is the figure we combine with a per-hectare value to produce an estimate of KPI 10.

Results

Table 1 shows the resulting values using this method. The groups and subgroups of services reflect the approach proposed in the UK National Ecosystem Assessment[13]. The dashes in the table reflect areas where data is not currently available.

Table 1: Value of Ecosystem Services in the Cerrado Biome
(All figures are in £/ha/year at 2016 price levels)

[7]Zardo, R. N. and Henriques, R. P. B. "Growth and fruit production of the tree *Caryocar brasiliense* in the Cerrado of central Brazil", 2011.
[8] Abreu, R. C. R. et al. (2017) "The biodiversity cost of carbon sequestration in tropical savanna"
[9] Teixiera do Vale, A. and Felfili, J. M. (2005) "Dry Biomass Distribution in Cerrado *Sensu Stricto* Site in Central Brazil"
[10] TEEB for Business Brazil, Final Report (2014)
[11] Resende, F. M., Fernandes, G.W and Coelho, M. S. - "Economic valuation of plant diversity storage service provided by rupestrian grassland ecosystems", 2013.
[12]TEEB for Business Brazil, Final Report (2014)
[13] UK National Ecosystem Assessment (2011) UNEP-WCMC, Cambridge.

Ecosystem Services	Generic Cerrado-type Habitat	Cerrado-Specific	Final Generic/Specific Cerrado
Provisioning services	1137	129	**418**
Food	848	129	**129**
Resources*	248	-	**248**
Freshwater	41	-	**41**
Regulating and Habitat Services	1282	1450	**1508**
Climate regulation	278	705	**705**
Air quality	2	-	**2**
Water flow regulation	46	17	**17**
Natural hazard regulation	2	79	**79**
Waste treatment	54	-	**54**
Genetic diversity**	899	649	**649**
Disease & pest regulation	2	-	**2**
Social & Cultural Services	51	-	**51**
Aesthetic	31	-	**31**
Recreation & Tourism	20	-	**20**
Cognitive benefits***		-	
Total Economic Value	2470	1579	**1977**

** Resources includes TEEB sub-groups of raw materials, genetic resources, medicinal resources and ornamental resources*
***Genetic diversity figure includes TEEB sub-groups of nursery services, genetic diversity and biological control*
**** Cognitive benefits figure includes TEEB sub-groups of inspiration, spiritual experience and cognitive development*

We have used location-specific figures for ecosystem services where available. In the 'Final Generic/Specific Cerrado' column:

= Generic Cerrado-type habitat figure used

= Cerrado-Specific figure used

As Table 1 highlights, the climate regulation and genetic diversity services provided by the Cerrado are particularly valuable. However, we remain unable to value services such as air quality which potentially have a high value.
The sizable discrepancy between generic habitat and specific Cerrado estimates for the value of climate regulation are likely to be linked to the different methodologies utilised by different researchers and nations in the valuation of a tonne of C02. Another issue is the use of differing time frames and discount rates when converting a stock of carbon to a flow.

Our central estimate of the total economic value of an average hectare of natural Cerrado vegetation is estimated at being in the region of £1980.

Sensitivity Analysis

For sensitivity analysis we have taken the lower and upper bounds of each value used in the final column of Table 1. The results are shown in Table 2.

Table 2: Sensitivity Analysis of Ecosystem Service Values for the Cerrado Biome

(All figures are in £/ha/year at 2016 price levels)

	Median value	Lower bound	Upper bound	Number of Sources
Provisioning services	**418.0**	**267.9**	**666.7**	-
Food	129.0	59.2	198.8	-
Resources	247.7	207.3	336.9	24
Freshwater	41.3	1.4	131.0	6
Regulating & Habitat Services	**1506.8**	**616.7**	**2393.7**	-
Climate Regulation	704.5	226.9	1182.1	2
Air Quality	1.6	1.6	1.6	1
Water flow regulation	17	7.4	22.3	-
Hazard Regulation	79	45.1	112.9	-
Waste treatment	54.2	9.2	99.3	6
Genetic Diversity	649.0	325.0	974.0	-
Disease & Pest Regulation	1.5	1.5	1.5	1
Social & Cultural Services	**51.5**	**2.4**	**1739.5**	-
Aesthetic	31.2	0.7	419.6	5
Recreation & Tourism	20.3	1.4	1096.4	24
Cognitive Benefits	0	0	0	-
Total Economic Value	**1976.3**	**886.7**	**4576.4**	**-**

The above table shows an overall range for TEV of a hectare of natural Cerrado habitat of -55% to +132%. This sizable range reflects the small amount of data currently available. The high upper bound is a result of using median values as opposed to the mean.

To produce a total estimate of KPI 10 for the Cerrado project, our per hectare value of ecosystem services protected or generated (£1976/ha) is multiplied the number of hectares where deforestation has been avoided by the project in the reporting year (764ha in 2016). This produces a KPI 10 value for the Cerrado project for the year 2016 in the region of £1,510,000, with a range of £283,000 to £3,103,000.

These findings reflect the basis of the economic case for conservation, and provide us with a simple and robust monitoring metric for KPI 10 in the Cerrado biome.

Most recent baseline	There is no current baseline (this would be calculated within the indicator – i.e. the value of ecosystem services in the absence of the ICF as the counterfactual). However the TEEB interim report did highlight the global magnitude of the ecosystem

	service losses associated with current levels of deforestation at $2tr - $4.5tr p.a. (capital value).
Good performance	Protecting forests of high value to people should highlight the benefits of natural capital protection at the local as well as the global level, a high number could help show the benefits of the ICF (and forest protection more generally) to country partners.
Return format	Monetary value of ecosystem services generated or protected
Data dis-aggregation	Data will be disaggregated by: - Country - Habitat type
Data availability	Will be assessed as the transfer function is developed, however we know the approach is feasible as it has been done before for the TEEB study.
Time period/ lag	Assuming applied offsite, the value of the indicator could be updated as and when update to the input data (specifically KPI 8) are available (eg. studies are undertaken to value ecosystem services in the specific area under consideration).
Quality assurance measures	The work by researchers in this area will need to be well peer reviewed, as value transfer remains to an extent on the academic frontier. If reporting officers have any concerns about the quality of data or any points that they think ICF analysts should be made aware of, then please note this in the ICF (and DRF) results templates. Any comments can usually be added into the free text columns on the far right of each template. Further guidance should be available in the commissioning note.
Data issues	Valuation of ecosystem services is a complex field (especially at large geographical scales due to the differences in p/ha service provision across a landscape), therefore it is likely that this indicator will only be able to provide information on the order of magnitude of ecosystem service benefits provided at the level of the ICF as a whole. A discussion of the issues around large scale assessments of ecosystem service values will be published in the TEEB Quantitative Assessment (forthcoming). A key issue is that having a single transfer function, assumes we can identify the variables which will affect both the ecological functioning of an ecosystem and the value of the services it provides and use these to adjust and transfer values from existing studies. This of course relies on the both the quality and quantity of studies available, and implies as more work is carried out, the way in which such assessments are carried out may develop and evolve. **In future, we would like to improve this indicator by:** A clear next step for improving the rigour of our estimates is to update the TEEB ESV database to include location-specific ecosystem service values published more recently than 2008 (when the database was first published). This will increase both the ability of ICF analysts to find robust ES values for a specific location and also the accuracy of estimates for a generic habitat. This is especially pertinent when we account for the huge number of valuation studies that have been published between 2008 and the present. Currently this method does not account for differences in the value of ecosystem services generated based on surrounding land-use, proximity / density of human

	population / infrastructure, relative wealth of population, habitat quality. This is an issue which we will be looking to address in due course. It also does not differentiate between different levels of degradation, and how this impacts the provision of services by an area of natural habitat. Further debate is recommended on the relationship between the condition of the natural stock and the level of ecosystem services provided by that stock - with a focus on whether the service/degradation relationship is linear or exponential.
Additional comments	**Ecosystem service categories**[14] *Provisioning* Food Water Resources (medicinal, raw materials) *Regulating* Air quality maintenance Climate regulation Natural hazard regulation Waste-water treatment Erosion prevention Disease and pest regulation *Supporting* Genetic diversity maintenance Pollination* *Cultural* Tourism Education and cognitive development Recreation Aesthetic appreciation *Not considered a *final* ecosystem service. Only final services are valued to avoid double-counting of benefits.
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[14] http://www.teebweb.org/resources/ecosystem-services/