Water Footprinting and other Agricultural SaaS Solutions

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is an end-to-end environmental software-as-a-service (SaaS) provider that is recognized as one of the world's top Sustainability brands.

We have unrivalled experience in helping businesses and governments identify risks and opportunities by combining satellite earth observation data with local information and business intelligence on the award-winning Ecometrica Platform.

Ecometrica brings together recognized experts in environmental and sustainability accounting, and our software supports all aspects of sustainability planning, operations and reporting.

Our data and software services are available worldwide through our offices in London, Boston, Edinburgh and Montreal.

Content

- Benefits of SaaS
- Waterfoot Printing
- Land Use and Land Use Change (LULUC)
- Soil Moisture Change
- Water Risk and Drought Vulnerability

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Benefits of SaaS

- No tedious spreadsheet calculations
- Increased accuracy
- Accessibility
- Cloud based - No software installation
- Automatic updates on a timely basis
- Increased data analysis and results
- No maintenance cost
- No capital expenses

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Water Footprint SaaS

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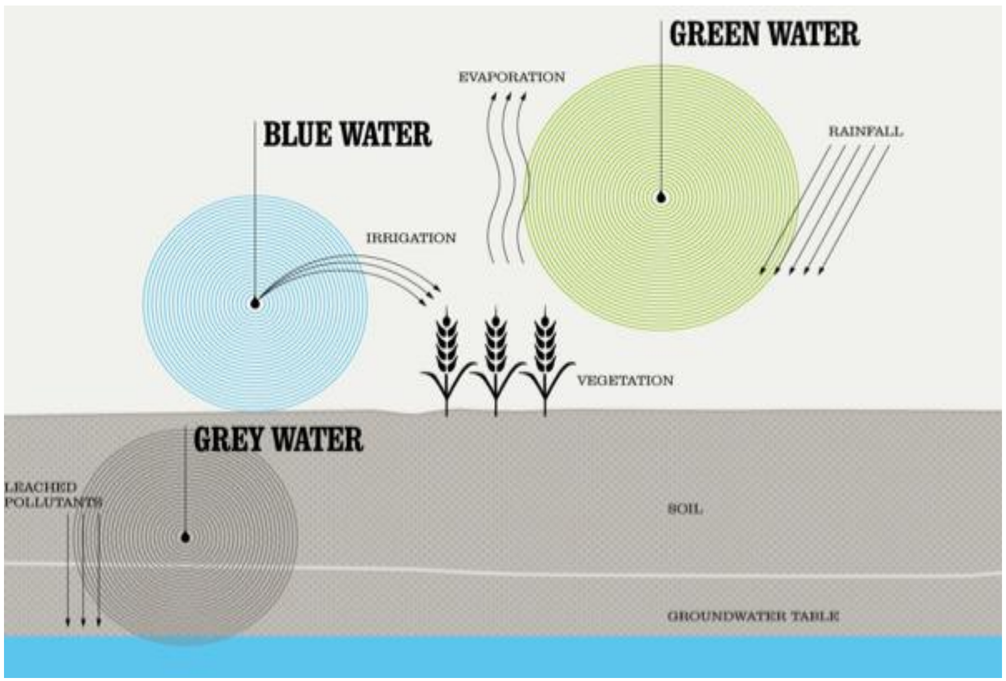
Fraser MacDonald – The Data Lab

Water footprinting Methodology

The Water Footprint Assessment Manual (Hoekstra A.Y., et al. 2011)
Grey Water Footprint Accounting (Franke N.A., et al. 2013)



What is a water footprint?

The water footprint measures the amount of water used to produce each of the goods and services we use. It can be measured for a single process, such as growing rice, for a product, such as a pair of jeans, for the fuel we put in our car, or for an entire multi-national company. The water footprint can also tell us how much water is being consumed by a particular country – or globally – in a specific river basin or from an aquifer.

Source: http://waterfootprint.org

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Water footprinting Calculations

$$WF_{proc,green} = GreenWaterEvaporation + GreenWaterIncorporation$$

[volume/time]

$$WF_{proc,green} = \frac{CWU_{green}}{Y} \quad \text{[volume/mass]}$$

$$CWU_{green} = 10 \times \sum_{d=1}^{lgp} ET_{green} \quad \text{[volume/area]}$$

$$WF_{proc,blue} = BlueWaterEvaporation + BlueWaterIncorporation + LostReturnflow \quad \text{[volume/time]}$$

$$WF_{proc,blue} = \frac{CWU_{blue}}{Y} \quad \text{[volume/mass]}$$

$$CWU_{blue} = 10 \times \sum_{d=1}^{lgp} ET_{blue} \quad \text{[volume/area]}$$

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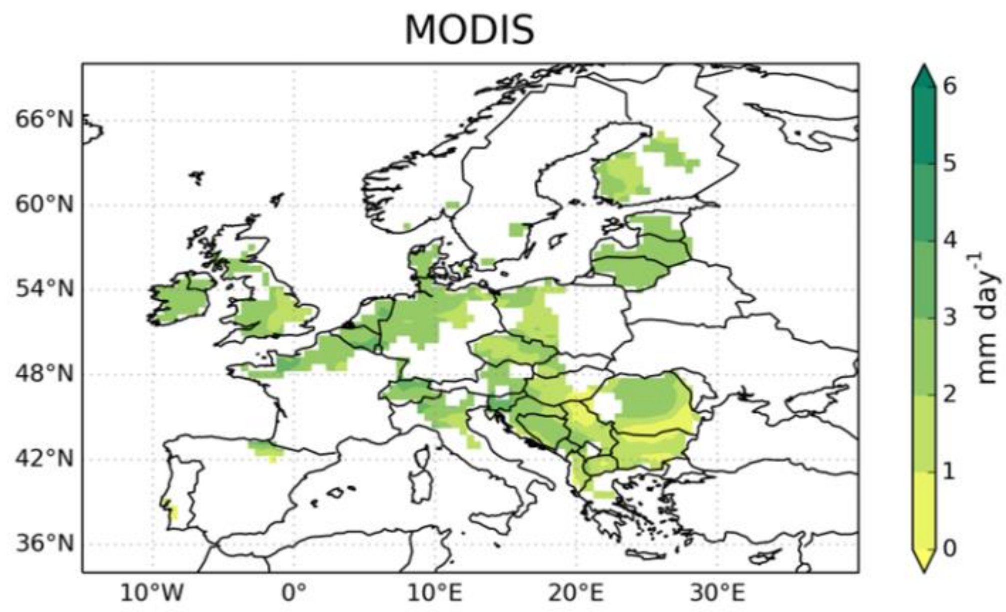
Green and Blue water footprint

Green and Blue water consumption are mapped based on the available climate and rainfall models as well as models determining the required amount of water to grow a certain crop.

- Modelling Evapotranspiration (ET) (ET = WF_{Green})
- Evaluate model at regional & global scales
  - Data sets used: FLUXNET-MTE, GLEAM, MODIS
- Precipitation maps
- $WF_{Blue} = ET_{max\ yield} - Precipitation$



Water footprinting Calculations

$$WF_{proc,grey} = \frac{L}{c_{max} - c_{nat}} \qquad \text{[volume/time]}$$

$$WF_{proc,grey} = \frac{(\alpha \times AR)/(c_{\max} - c_{nat})}{Y} \qquad \text{[volume/mass]}$$

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Grey water factors

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α

Category		Factor	Pesticide	Metal	Nitrogen	Phosphorus	Data collection
Chemical properties		*Contaminant factor K_{oc} (L/kg)*	√				User/Database
		Contaminant factor K_d (L/kg)		√			User/Database
		Persistence half time (leaching)	√				User/Database
		Persistence half time (run-off)	√				User/Database
Environ mental factors	*Atmospheric*	*N-deposition*			√		Mapping
	Soil	*Texture leaching*	√	√	√		Mapping
		Texture run-off	√		√	√	Mapping
		Erosion potential		√		√	Mapping
		Natural drainage (leaching)			√		Mapping
		Natural drainage (run-off)			√		Mapping
		Organic Matter content	√				Mapping
		P-content				√	Mapping
	Climate	*Rain Intensity*	√			√	Mapping
		Precipitation (mm)	√		√		Mapping
Agricultural practice		*Management practice*	√		√	√	User
		Artificial drainage (run-off)		√			Mapping
		Application rate (kg/ha)			√	√	User
		Plant uptake (crop yield)			√	√	User
		N-fixation (kg/ha)			√		User

Grey water footprint

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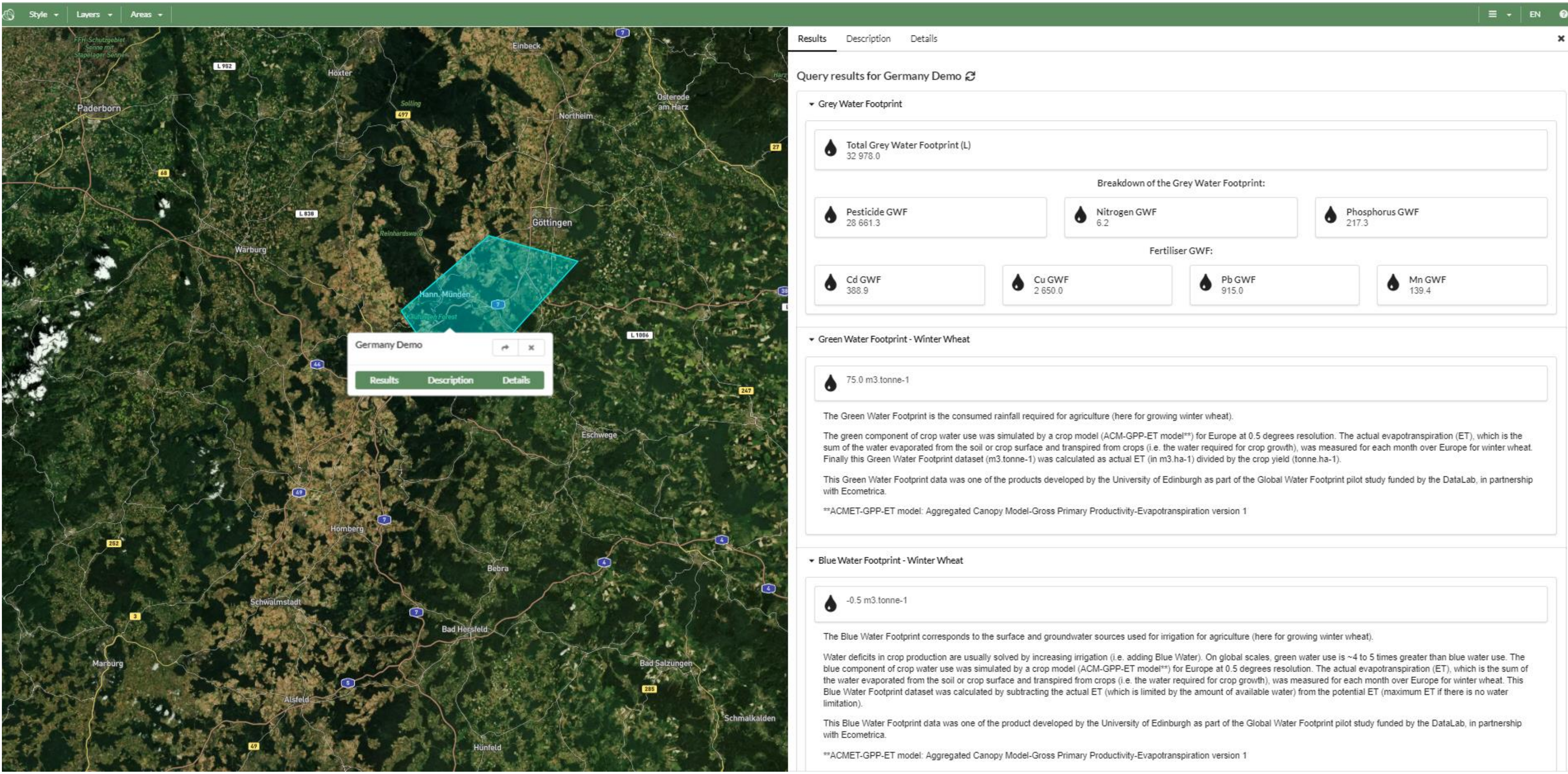
Grey water consumption is calculated based on mapped and submitted impact factors and the Grey Water Model by Franke et al. (2013)

- $GWF=(\alpha * Appl)/(c_{max}-c_{nat})$
  - α – Grey water factors weighted intensity
  - Appl – Application of chemical – user
  - c_{max} – Maximal contamination – maps
  - c_{nat} – Natural contamination – maps

Grey water is the amount of water necessary to assimilate contaminated water (A.Y. Hoekstra, 2012)

Göttingen area - Germany



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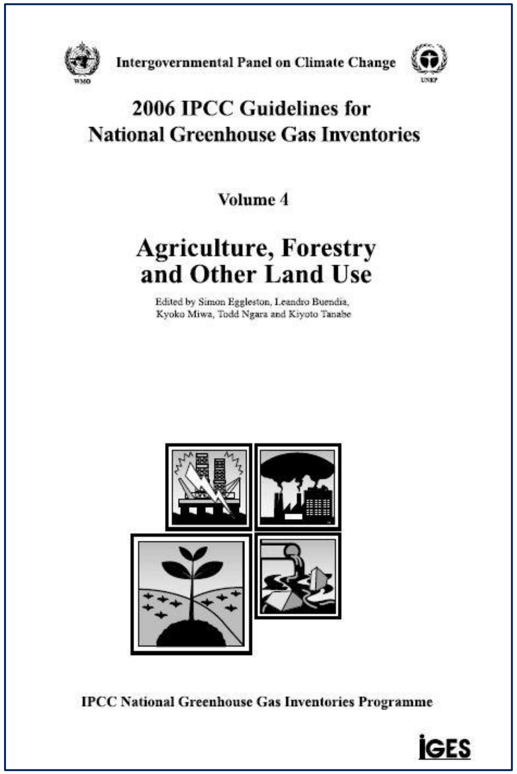
Calculating emissions from Land Use and Land Use Change (LULUC)


Intergovernmental Panel on Climate Change

2006 IPCC Guidelines for National Greenhouse Gas Inventories

Volume 4

Agriculture, Forestry and Other Land Use

Edited by Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara and Kiyoto Tanabe

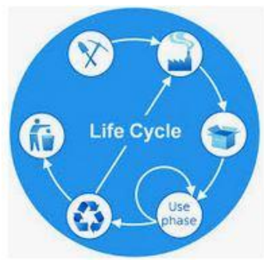
IPCC National Greenhouse Gas Inventories Programme

IGES

Why calculate emissions from land use and land use change?

- *Reporting requirement for countries obligated to submit a National Greenhouse Gas Inventory (Annex I party to the UNFCCC)*
- *LCA of land-based products (e.g. biofuels, crops, meat)*
- *Understand impact of deforestation and other primary vegetation loss*

United Nations Climate Change



Current calculation method

- Guidance, methods, calculation steps and default emission factors provided in Volume 4 (AFOLU) of the IPCC guidelines
- Considers (i) changes in carbon stock in biomass, dead wood, litter and soils
  (ii) GHG emissions due to land management activities (fire, fertiliser, livestock, flooding)
- Requires background reading and understanding, multiple worksheets and complicated calculation steps
- Specific emission factors may need time consuming research

EQUATION 2.8
ANNUAL CHANGE IN CARBON STOCKS IN BIOMASS IN LAND REMAINING IN THE SAME LAND-USE CATEGORY (STOCK-DIFFERENCE METHOD)

$$\Delta C_B = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)} \qquad (a)$$

where

$$C = \sum_{i,j} \{A_{i,j} \bullet V_{i,j} \bullet BCEF_{S_{i,j}} \bullet (1 + R_{i,j}) \bullet CF_{i,j}\} \qquad (b)$$

Sector		Agriculture, Forestry and Other Land Use						
Category		Forest Land Remaining Forest Land: Annual increase in carbon stocks in biomass (includes above-ground and below-ground biomass)						
Category code		3B1a						
Sheet		1 of 4						
Equation		Equation 2.2	Equation 2.9	Equation 2.10			Equation 2.9	
Land-use category		Subcategories for reporting year	Area of Forest Land Remaining Forest Land	Average annual above-ground biomass growth	Ratio of below-ground biomass to above-ground biomass	Average annual biomass growth above- and below-ground	Carbon fraction of dry matter	Annual increase in biomass carbon stocks due to biomass growth
Initial land use	Land use during reporting year		(ha)	(tonnes dm ha^{-1} yr^{-1})	[tonnes bg dm (tonne ag dm)$^{-1}$]	(tonnes dm ha^{-1} yr^{-1})	[tonnes C (tonne dm)$^{-1}$]	(tonnes C yr^{-1})
			National statistics or international data sources	Tables 4.9, 4.10 and 4.12	zero (0) or Table 4.4	$G_{TOTAL} = GW * (1+R)$	0.5 or Table 4.3	$\Delta C_G = A * G_{TOTAL} * CF$
			A	G_W	R	G_{TOTAL}	CF	ΔC_G
FL	FL	(a)						
		(b)						
		(c)						
Total								

TABLE 4.13 BASIC WOOD DENSITY (D) OF TROPICAL TREE SPECIES (OVEN-DRY TONNES (MOIST M^3))
1 = Baker *et al.*, 2004b; 2 = Barbosa and Fearnside, 2004; 3 = CTFT, 1989; 4 = Fearnside, 1997; 5 = Reyes *et al.*, 1992

Species	Density	Continent	Reference
Adina cordifolia	0.58-0.59	Asia	5
Aegle marmelo	0.75	Asia	5
Afzelia bipidensis	0.67-0.79	Africa	3
Agathis sp.	0.44	Asia	5
Aglaia llanosiana	0.89	Asia	5
Agonandra brasiliensis	0.74	Americas	4
Aidia ochroleuca	0.78	Africa	5
Alangium longiflorum	0.65	Asia	5
Albizia sp.	0.52	Americas	5
Albizzia amara	0.70	Asia	5
Albizzia falcataria	0.25	Asia	5
Alcornea sp.	0.34	Americas	5
Aldina heterophylla	0.73	Americas	4
Aleurites trisperma	0.43	Asia	5
Alexa grandiflora	0.59	Americas	4
Alexa imperatricis	0.52	Americas	4
Allophyllus africanus	0.45	Africa	5

TABLE 4.13 BASIC WOOD DENSITY (D) OF TROPICAL TREE SPECIES (OVEN-DRY TONNES (MOIST M^3))
1 = Baker *et al.*, 2004b; 2 = Barbosa and Fearnside, 2004; 3 = CTFT, 1989; 4 = Fearnside, 1997; 5 = Reyes *et al.*, 1992

Species	Density	Continent	Reference
Aspidosperma macrocarpon	0.67	Americas	1
Aspidosperma obscurinervium	0.86	Americas	4
Astronium gracile	0.73	Americas	4
Astronium graveolens	0.75	Americas	4
Astronium lecointei	0.73	Americas	5
Astronium ulei	0.71	Americas	4
Astronium urundeuva	1.21	Americas	4
Aucoumea klaineana	0.31-0.48	Africa	3
Autranella congolensis	0.78	Africa	5
Azadirachta sp.	0.52	Asia	5
Bagassa guianensis	0.69	Americas	4
Baillonella toxisperma	0.70	Africa	3
Balanites aegyptiaca	0.63	Africa	5
Balanocarpus sp.	0.76	Asia	5
Banara guianensis	0.61	Americas	5

LULUC Analysis Steps on the Ecometrica Platform

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Step 1: Add a 'test' area with available sequential land use maps to the Ecometrica platform (Marques de Comillas, Chiapas, Mexico)

Step 2: Perform additional analysis to re-classify original datasets into the 6 IPCC categories (Forest Land, Cropland, Grassland, Wetlands, Settlements, Other Land)

Step 3: Determine the areas of land covered by each category, and land areas converted from one category to another between two periods

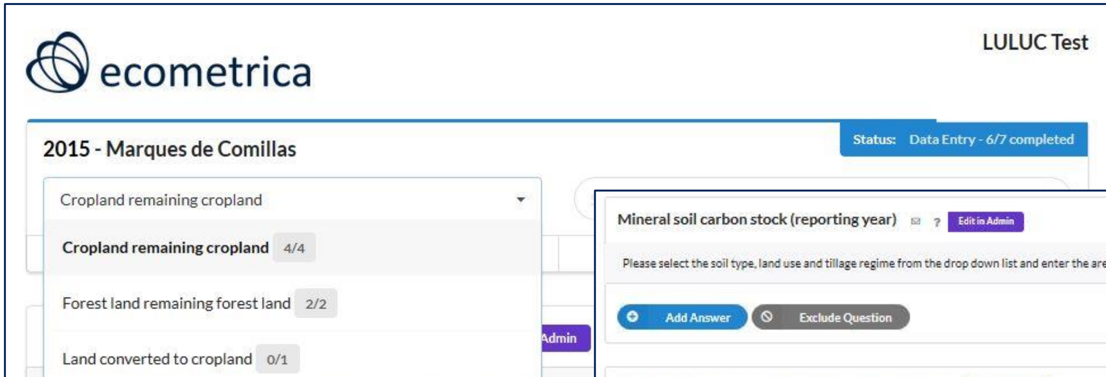
Step 4: Input the area data to the calculation steps

Step 5: Select appropriate activities which will automatically select the proper emissions factors (IPCC defaults and regionally specific factors)

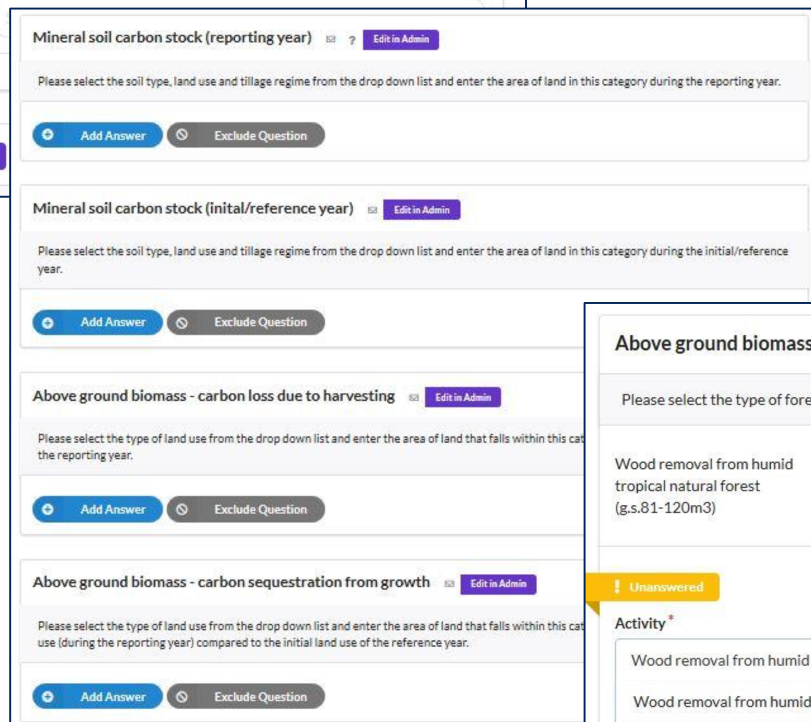
Step 6: Calculate emissions automatically on the platform according to the IPCC Volume 4 (AFOLU)

Step 7: Display results on the Ecometrica platform

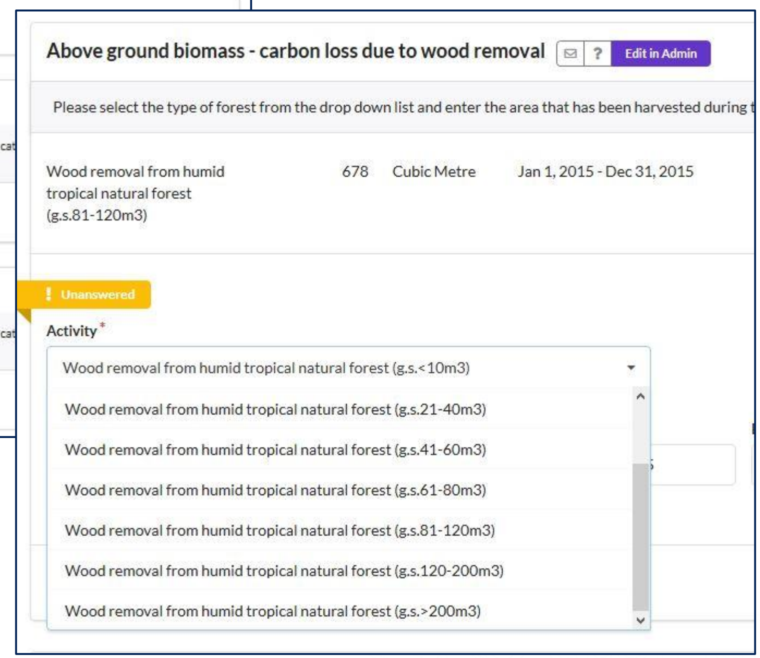
LULUC questions and activities



Select the IPCC land conversion category



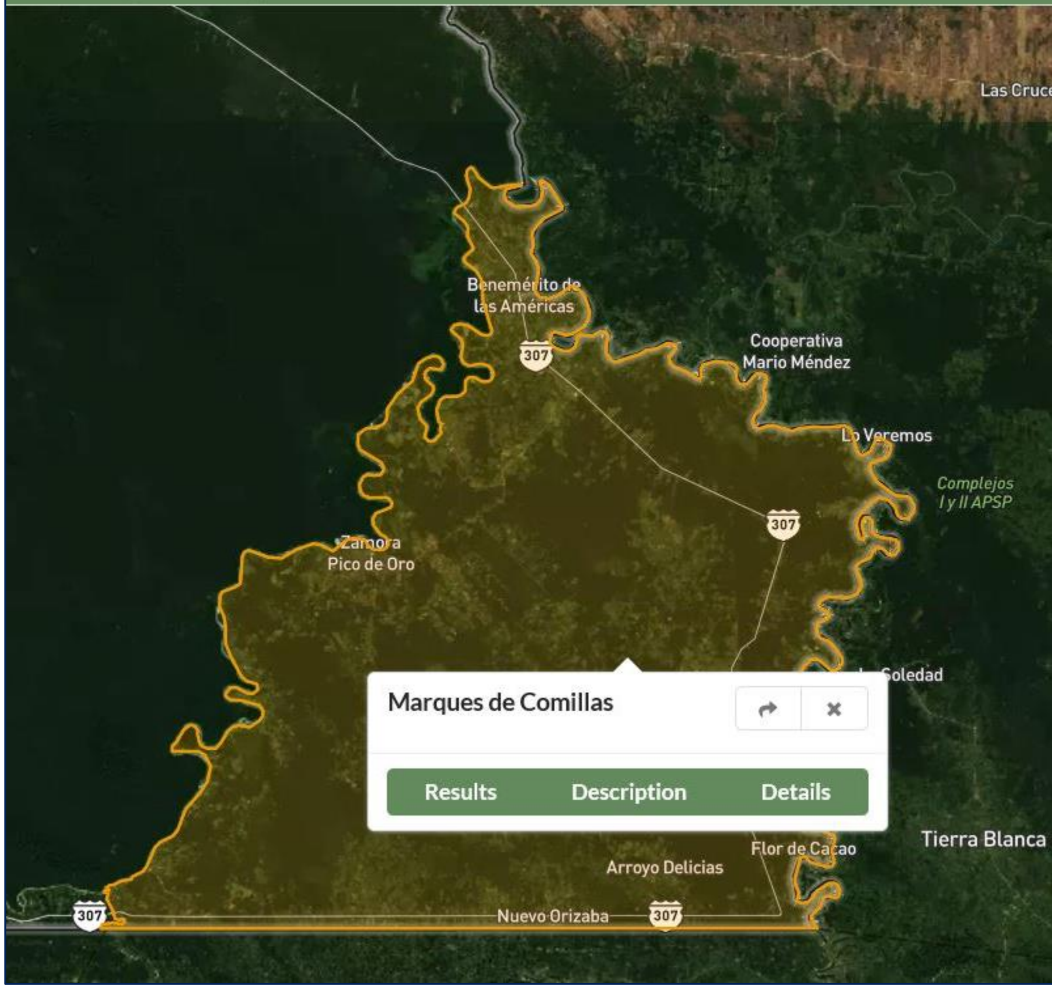
Questions relating to relevant changes in carbon stock for that category are added



Multiple options ‘activities’ available under each question, each activity links to a geographically relevant emission factor

Marques de Comillas

Layers ▾ | Areas ▾



Results | Description | Details

Land Use Change	Area [ha]
CC (cropland remaining cropland)	117 928.744865
WW (wetland remaining wetland)	1 979.858618
GG (grassland remaining grassland)	7 177.266342
SS (settlements raiming settlements)	2 226.783238
LN (land converted to forest: cropland to natural veg.)	1 233.368263
LC (land converted to cropland: grassland to cropland)	1 608.844267
LG (land converted to grassland: cropland to grassland)	2 591.802242
NN (remaining natural veg.)	8 275.669595
LC (land converted to cropland: natural veg. to cropland)	1 070.378493
LW (land converted to wetland: cropland to wetland)	210.115981
LG (land converted to grassland: natural veg. to grassland)	548.225640

Results

Forest land remaining forest land » Above ground biomass - carbon loss due to wood removal

Answer Date	Scope	Activity	Value	Frequency	Location
2015	Scope 1	Wood removal from humid tropical natural forest (g.s.81-120m3)	678 m3	Non-Extrapolated	Chiapas

CO_2

Coefficient	Value	Unit	Uncertainty
Data Value	678	m3	±5%
Carbon loss from wood removal, humid tropical, natural forest, growing stock level 80-120 m3 derived from IPCC 2006 & FCPF 2016 Locations: Mexico Factor Dates: From Jan. 1, 2000	-3527.04	$kgCO_2/m3$	±50%
Total	-2,391,333	$kgCO_2$	±50.2%

GWP Source	GWP	tCO_2	tCO_2e
Fifth Assessment Report (without climate feedback)	1	-2,391	0

Total Emissions

GWP Source	tCO_2e
Fifth Assessment Report (without climate feedback)	0

Forest land remaining forest land » Above ground biomass - carbon sequestration from growth (forest land)

Answer Date	Scope	Activity	Value	Frequency	Location
2015	Scope 1	Tropical moist deciduous forest (natural)	4,535 ha	Non-Extrapolated	Chiapas

CO_2

Coefficient	Value	Unit	Uncertainty
Data Value	4,535	ha	±5%
Tropical moist deciduous forest (natural), biomass carbon stock increase derived from IPCC 2006 & FCPF 2016 Locations: Mexico Factor Dates: From Jan. 1, 2000	10559.999999999998	$kgCO_2/ha$	±50%
Total	47,889,600	$kgCO_2$	±50.2%

GWP Source	GWP	tCO_2	tCO_2e
Fifth Assessment Report (without climate feedback)	1	47,890	47,890

Calculations happen automatically

Assessment Results » 2015 Assessment » Results » LULUC Test

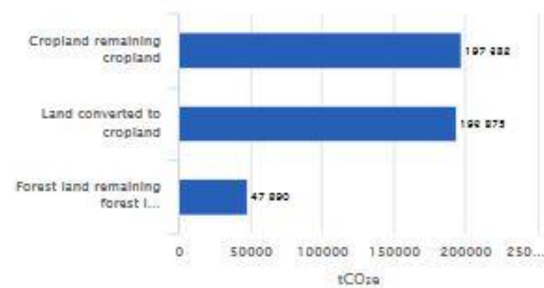
GHG - | Sustainability - | Trends & Targets | Downloads & Data

Carbon sequestered : 439,146 tCO_2e   **Carbon lost: 972,035 tCO_2e**

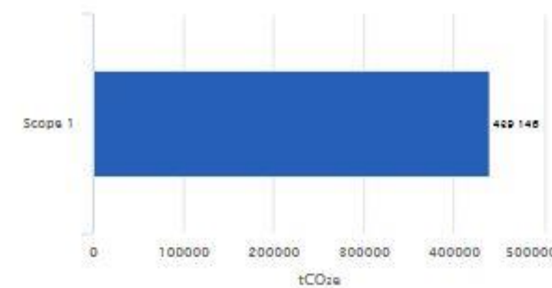
Net overall carbon stock change: -532,889 tCO_2e

Geographic Summary by Question

Summary by Question Group

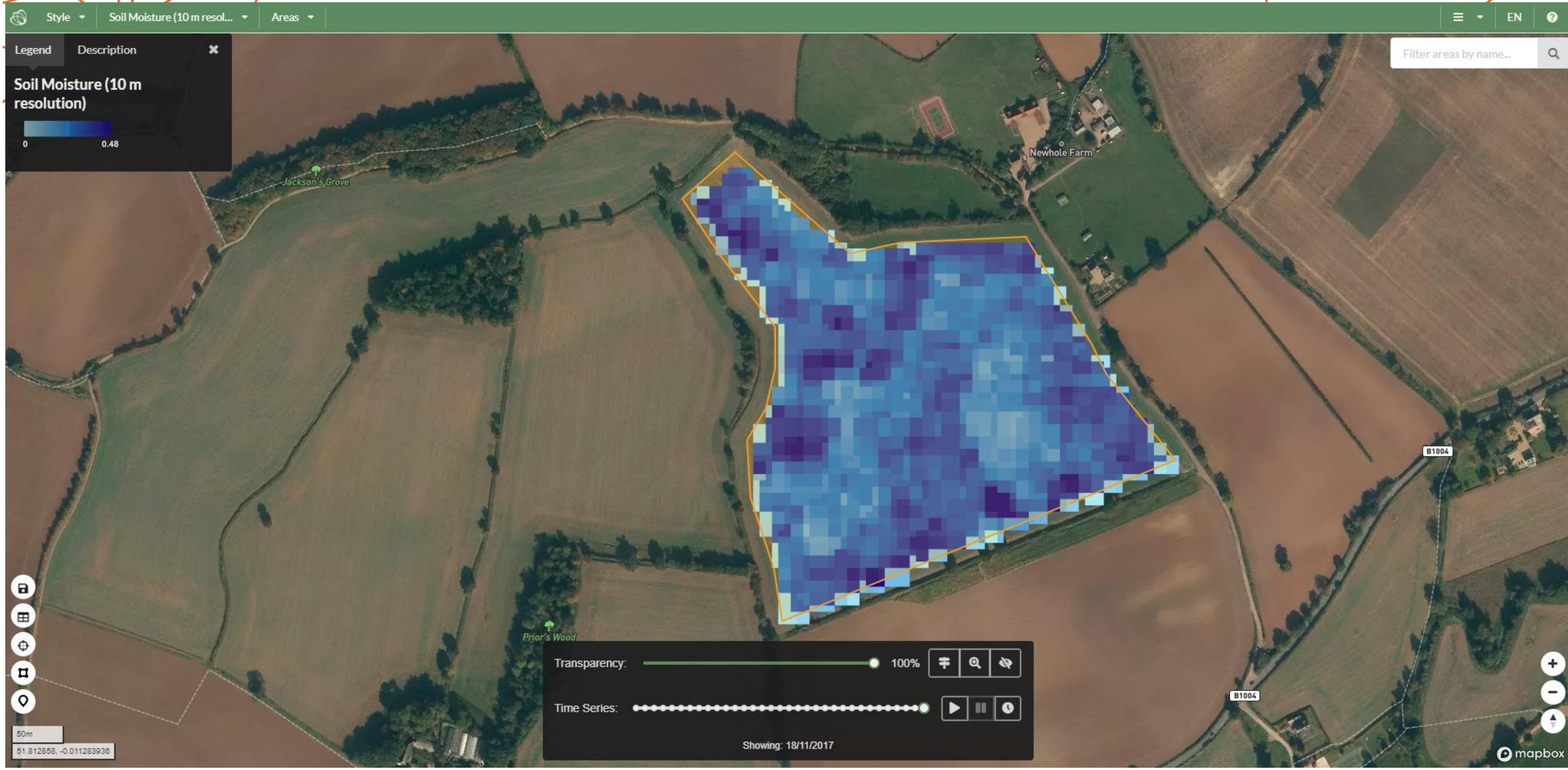


Summary by Scope



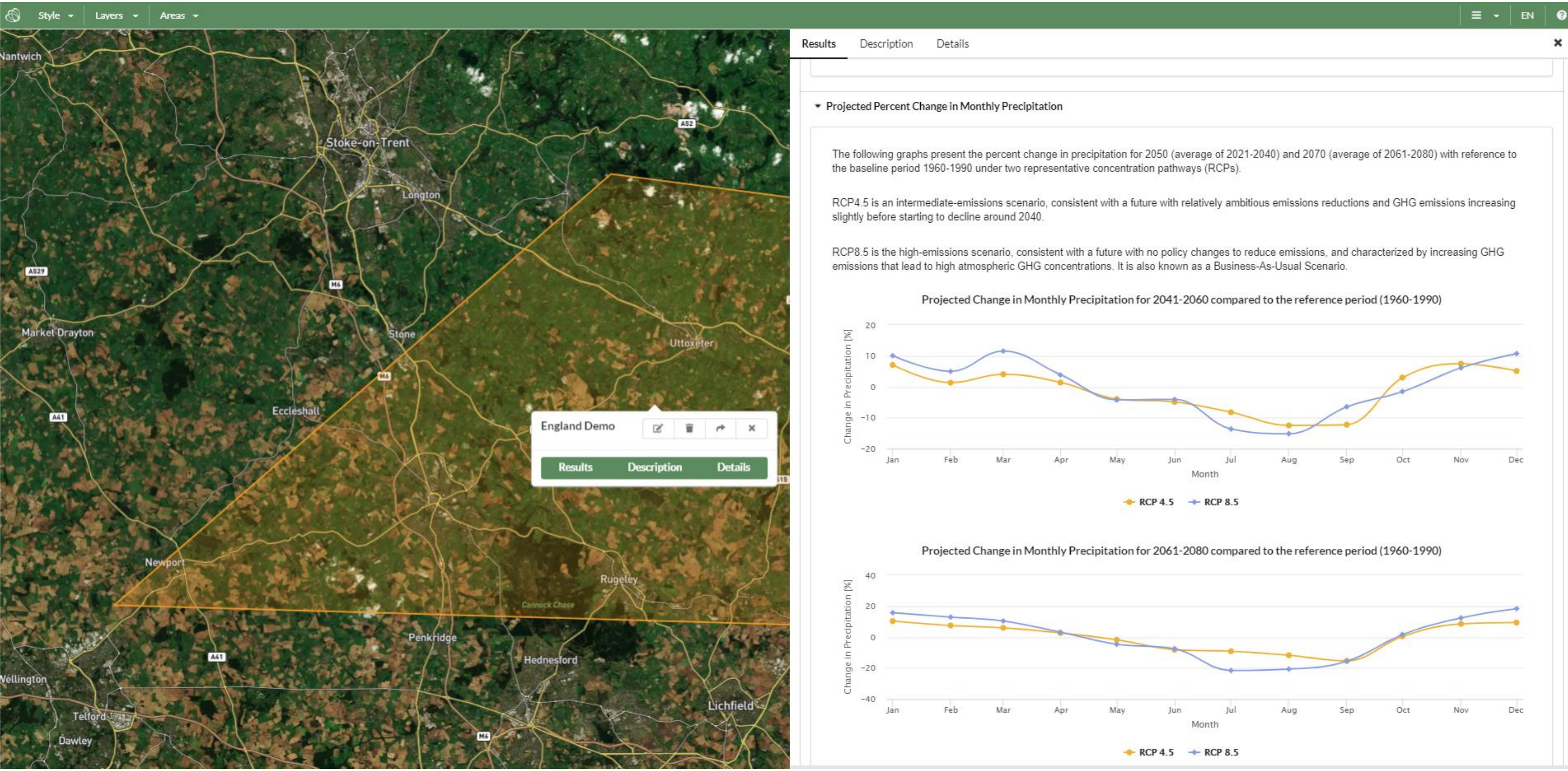
Carbon sequestration, loss and net change shown for all categories

Soil Moisture Change



https://soil-moisture.rothamsted-ac.ourecosystem.com/interface/

Precipitation Projections



Thank you

Questions

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