INRAE : Eric Ceschia, Ludovic Arnaud Christian Bockstaller, David Sheeren, Clélia Sirami, James Desaegher
IGN : Arthur Favreau, Dominique Laurent, Guillaume Marchand,
ASP : Emmanuel De Laroche, Agnieszka Tarko

NIVA
NEW IACS VISION IN ACTION

Agri-environmental monitoring for the CAP

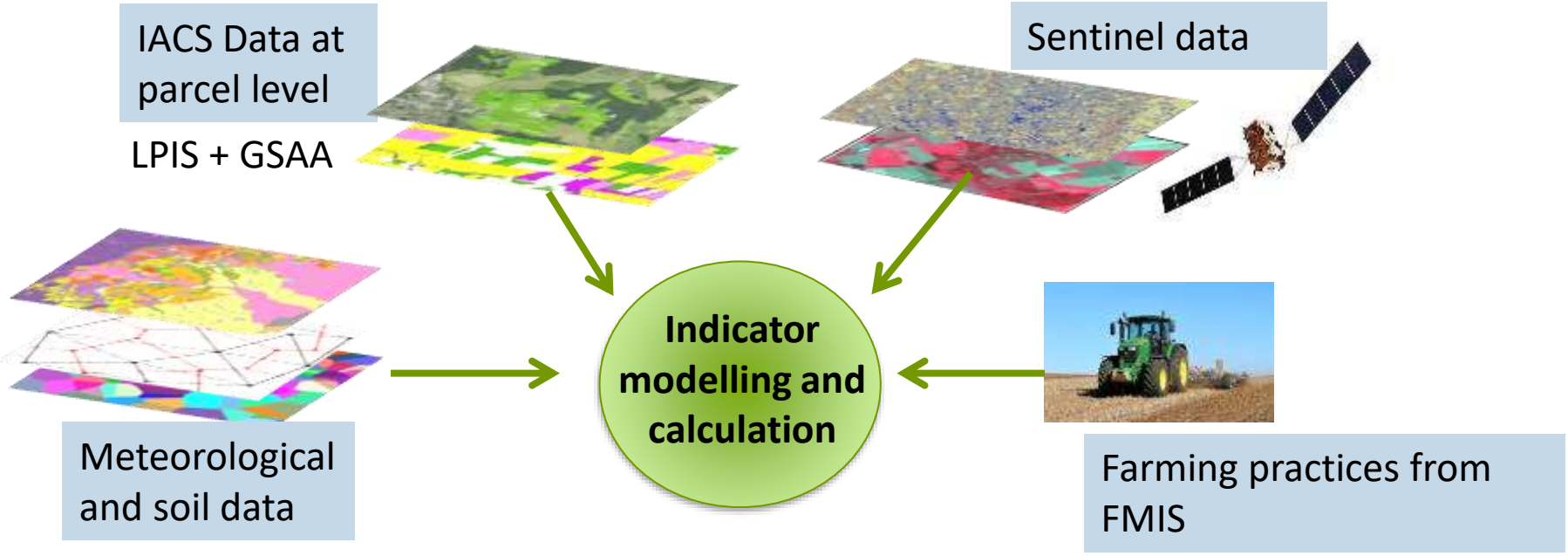
"Earth Observation services in support of agriculture and Common Agricultural Policy" event

09/02/2022

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 842009

Our objectives in NIVA

- To propose methods and calculate annual indicators in order to measure the impact of agricultural practices on the environment:
  - Based on published scientific methods & former EU projects (DiverImpact, Sensagri, Farmland)
  - Based on Sentinel 2 satellite data and other data widely available in Europe (IACS data, climate, soil maps…)



Selection of indicators

- **Discussion with the European Commission (DG Agri, Climate…) based on a preliminary selection of 13 candidate indicators**

- **Selection of 3 indicators**
  - **Carbon storage => climatic change**
  - **Nitrate Lixiviation => water quality**
  - **Biodiversity**

- **Indicators may be computed at various levels of complexity,**
  - **TIER 1 : easy to produce, operational, less accurate**
  - **TIER 2 : better result but requires farmer's data**

  } Empirical approaches

  - **TIER 3 : best results, less operational**

  } Modelling approaches

See Bockstaller et al. (2020)

NIVA - Tier 1 carbon indicator

Empirical approach ➔ most crop species except rice

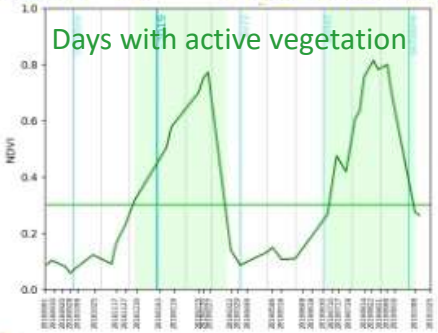
IACS (LPIS + GSAA)

(vector)

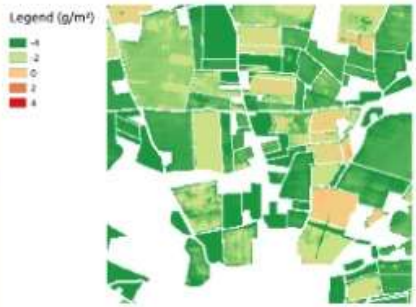
Sentinel-2 Images

(raster)

Tier 1 - Calculator

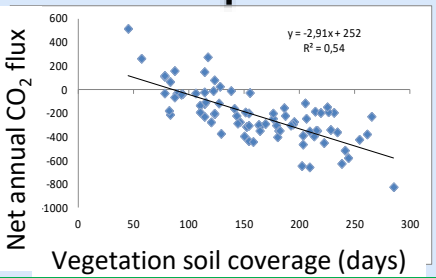


Tier 1
Net Annual CO2 Flux



(vector & raster)

Based on Ceschia et al. (2010)

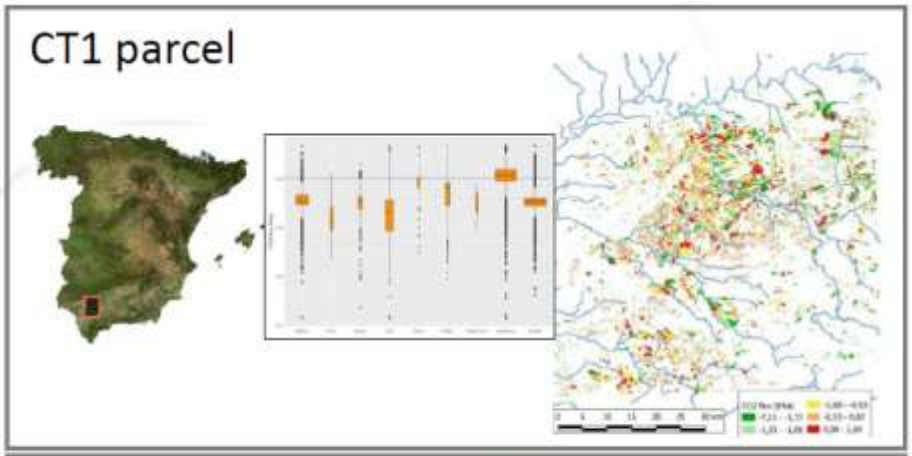


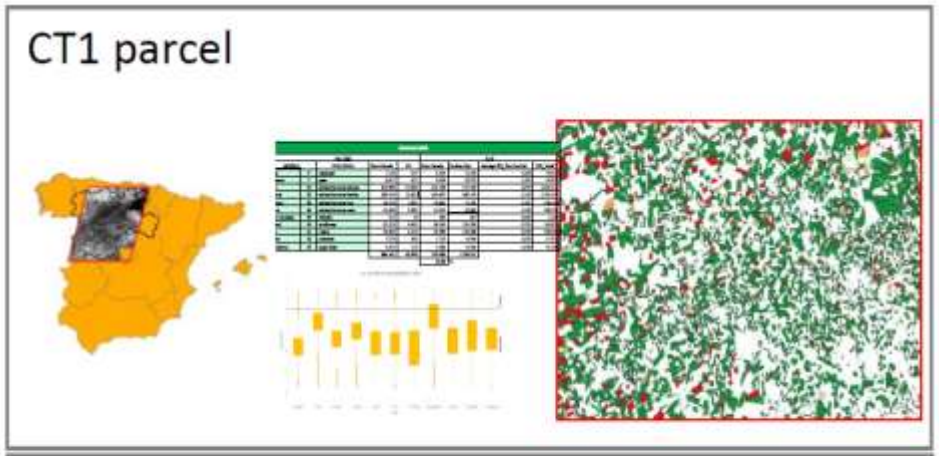
Cropland sites flux tower

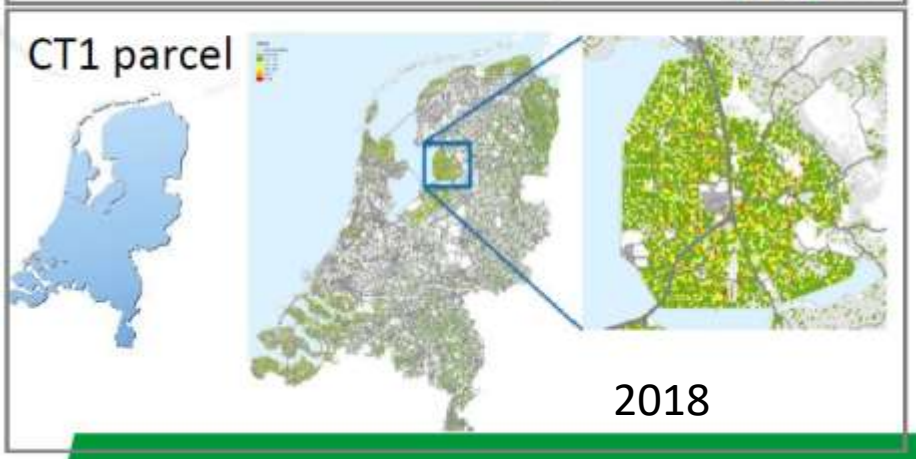
Net annual CO_2 flux depends on the total number of days with active vegetation

Carbon Tier 1 : Multi-MS testing

Open tools available at https://gitlab.com/nivaeu/uc1b_tier1_co2







Annual CO_2 fixation

Annual CO_2 losses

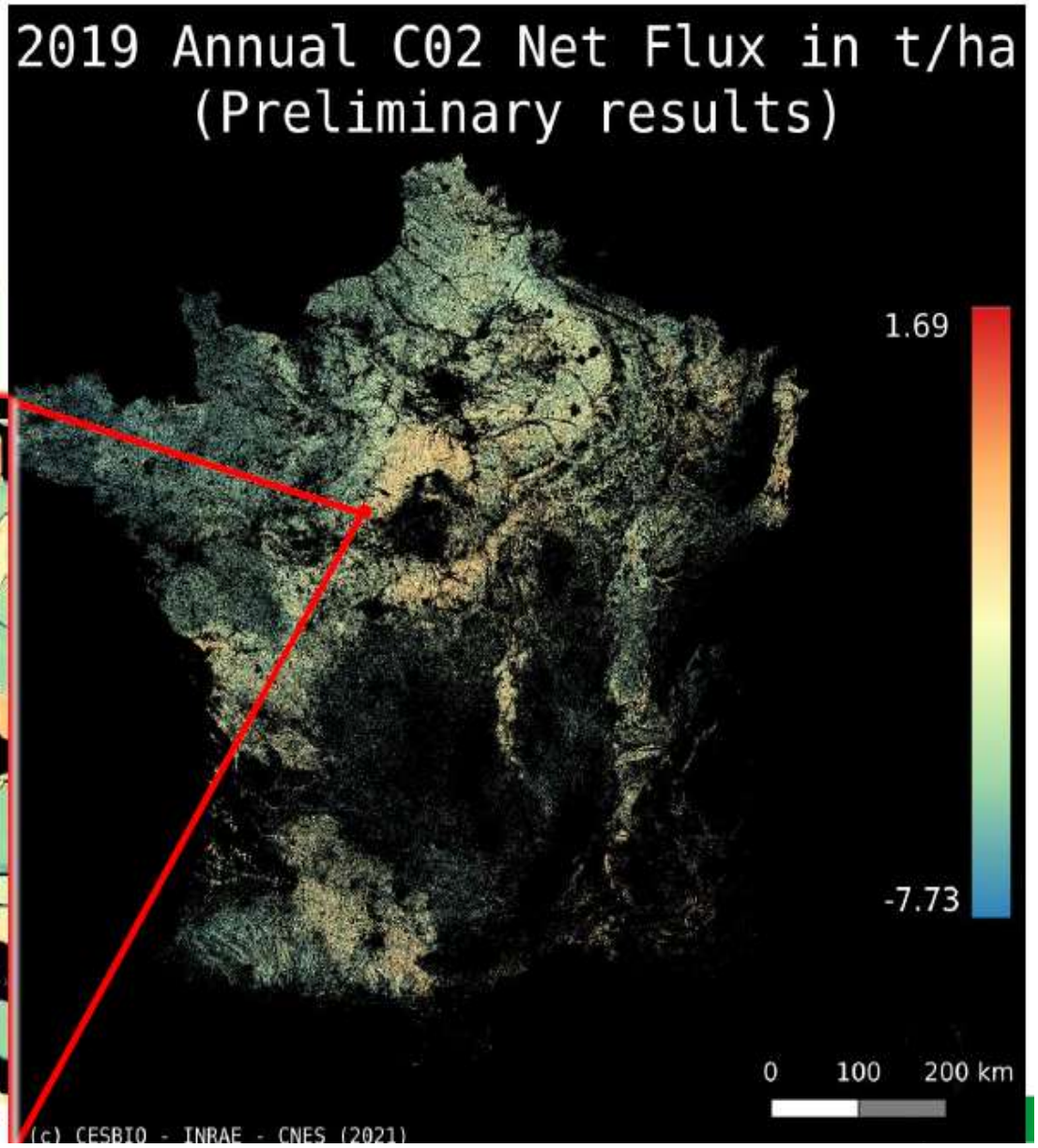
Carbon Tier 1 : National scale 10m resolution

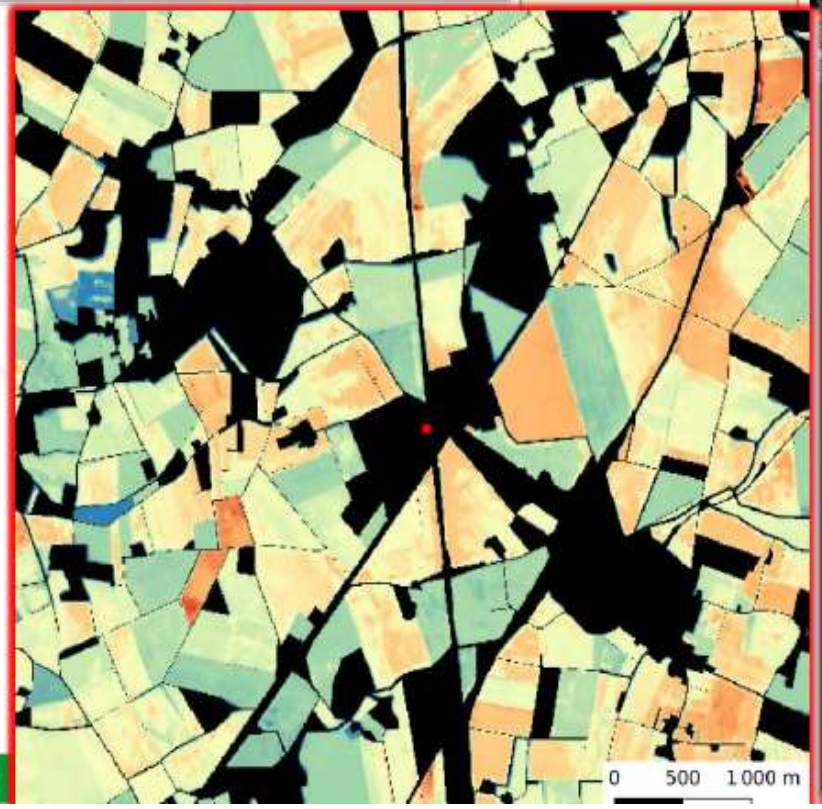
NIVA'S algorithm +
Iota2 software

With the
support of

Annual CO_2 fixation
Annual CO_2 losses

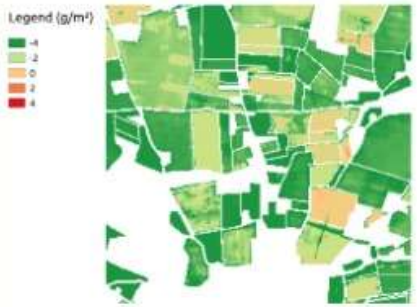
France
=
94 Sentinel-2 tiles





NIVA - Tier 2 carbon indicator

Tier 1
Net Annual CO2 flux



(vector & raster)

Empirical approach ➔ most crop species except rice

Currently tested in France in collab. with

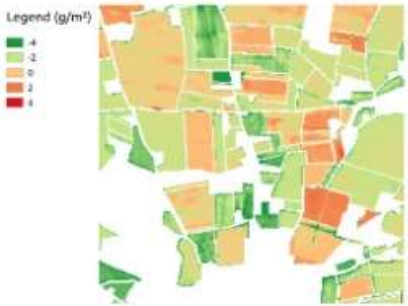
AGRO D'OC
UNION DES CETA D'OC

AGRICULTURES & TERRITOIRES
CHAMBRES D'AGRICULTURE

Tier 2 - Calculator

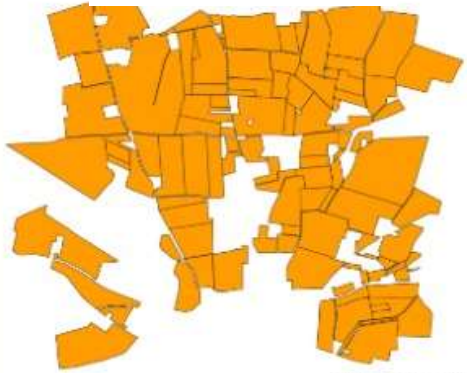
T2- Annual Carbon Budget
=
T1- Net Annual CO2 flux
+ Carbon Harvested
- Organic Amendments

Tier 2
Annual C Budget



(vector & raster)

Farmer's data



(vector)

➔main limitations is access to reliable farmer's data (check data + obtain their consent)

C budget depends on the net annual CO_2 flux (from crop cycle) and on the farmer's organic amendments and exports at harvest

NIVA - Tier 3 carbon indicator

Meteo and Soil data (csv)

LPIS (vector)

Sentinel-2 Images (raster)

LAI

Tier 3 - Calculator

AgriCarbon-EO

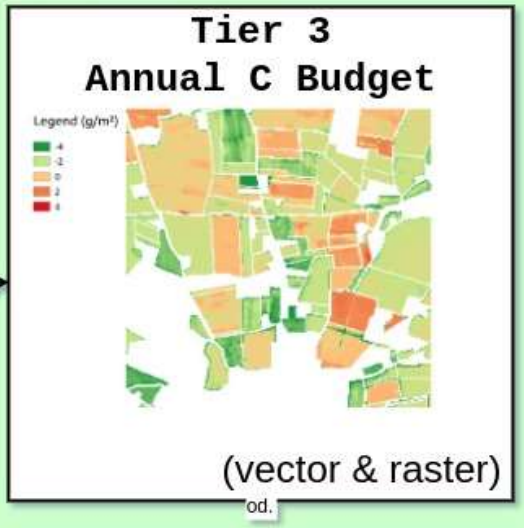
SAFY-CO2

Agro-meteo Model

Modelling approach ➔ wheat, maize, sunflower, cover crops

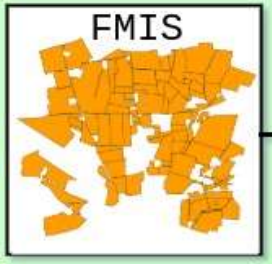
Pique et al. (2020 a & b)

Tier 3 Annual C Budget



+ yield, biomass, CO_2 fluxes

FMIS

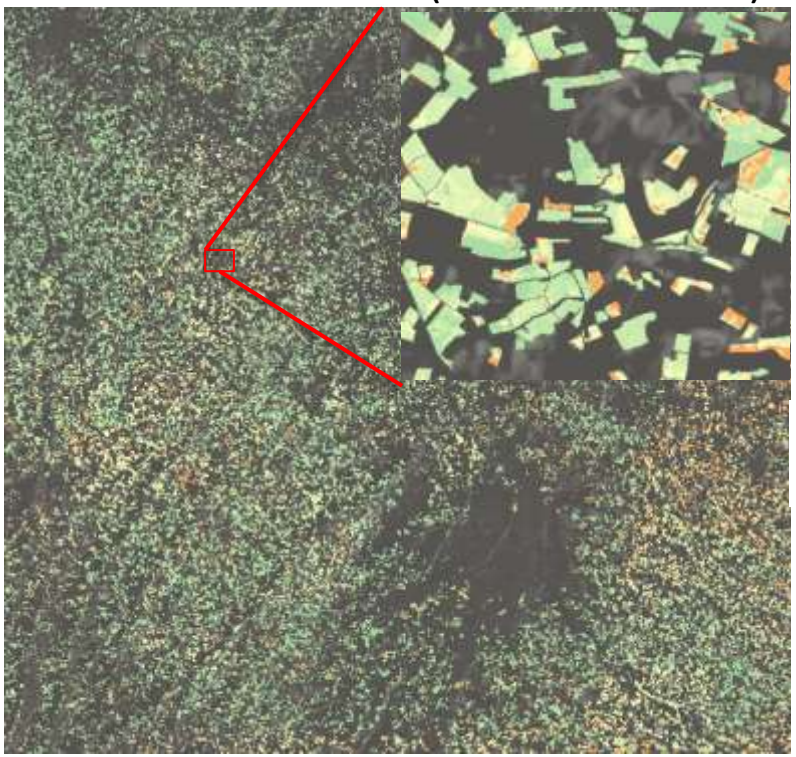


Farmer data (vector)

CO_2 flux are calculated by the model that is calibrated by LAI derived from the Sentinel-2 data, farmer's data are used to finalise the C budget calculation

Tier 3 Carbon indicator with AgriCarbon-EO

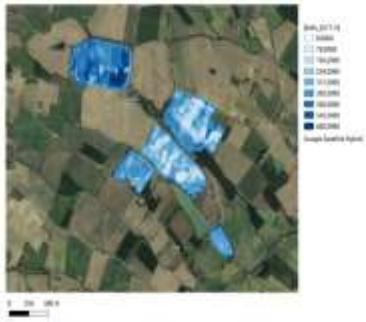
Net annual CO_2 fluxes for 2018 straw cereals in South West France (10 m resolution)



Whole Sentinel 2 Tile (31TCJ)

Cover crop biomass

Uncertainty map



10m resolution C budget map for cover crop/maize/wheat crop rotations

Villeneuve farm, Bézéril, France

CO_2 fixation / soil C storage

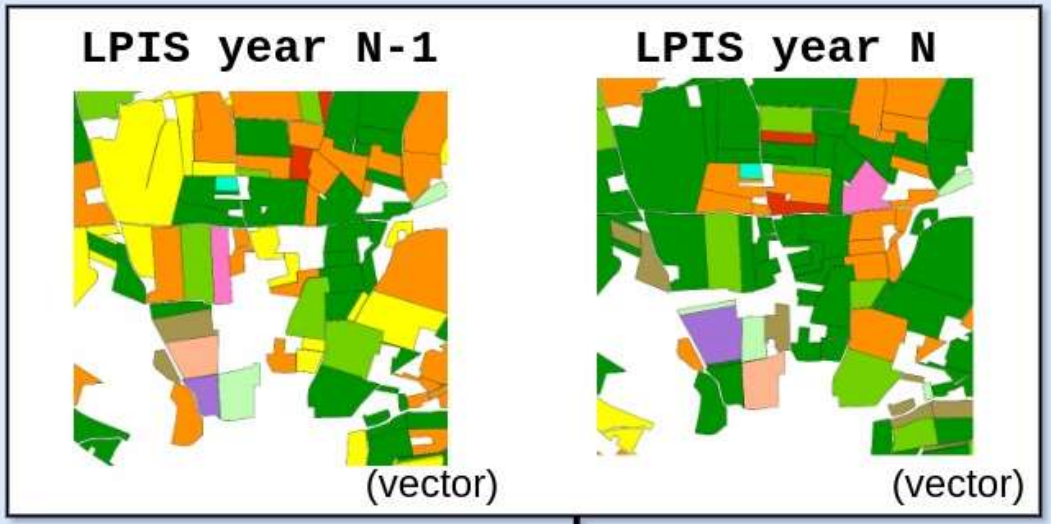
CO_2 losses / soil C loss

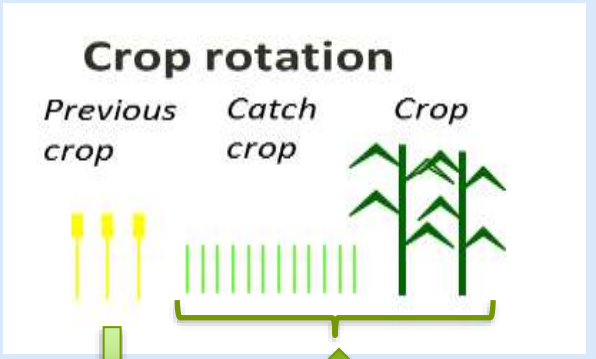
Multi-Member testing phase is starting now (plot scale)

Tier 1 Risk of Nitrate leaching

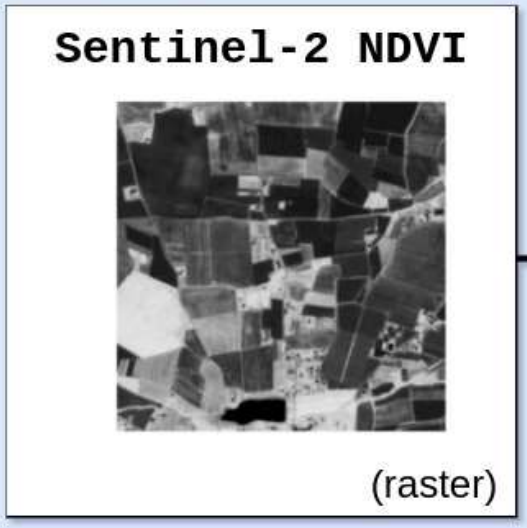
Empirical approach adapted from H2020 DiverImpacts

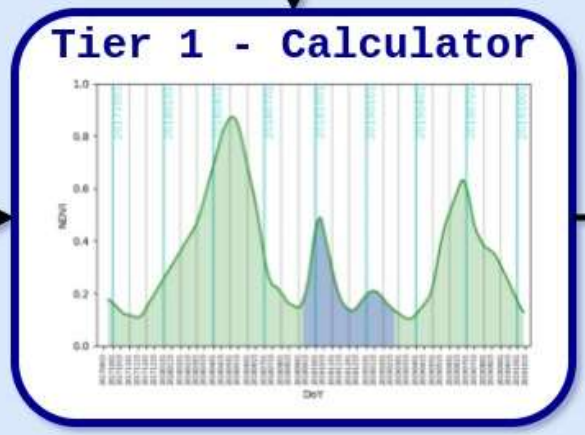
(Beaudoin et al. 2005 ; Bockstaller et al. 2015)

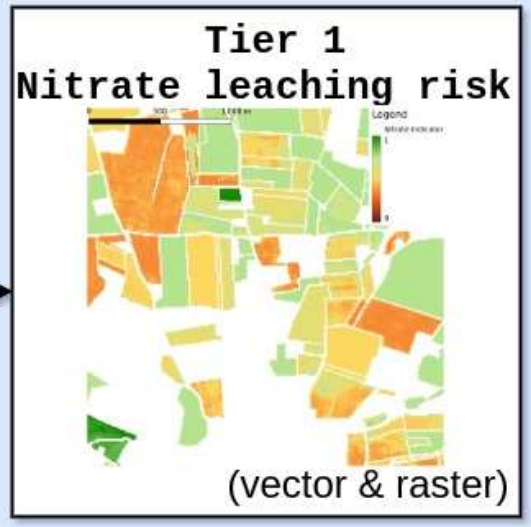




Risk = f (mineralisation - absorption)

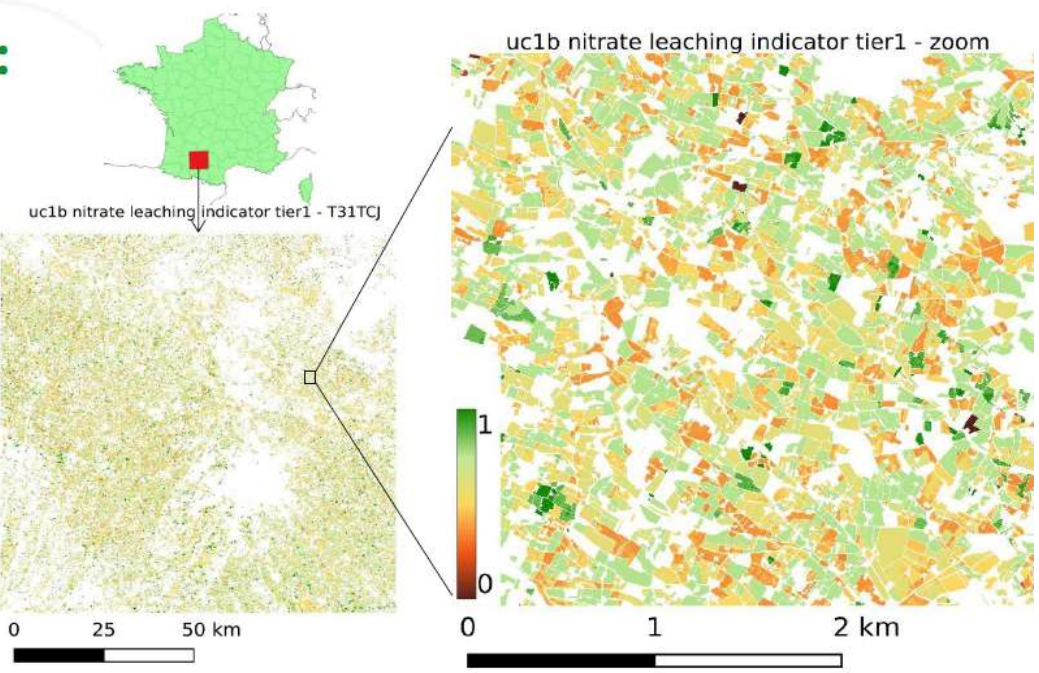




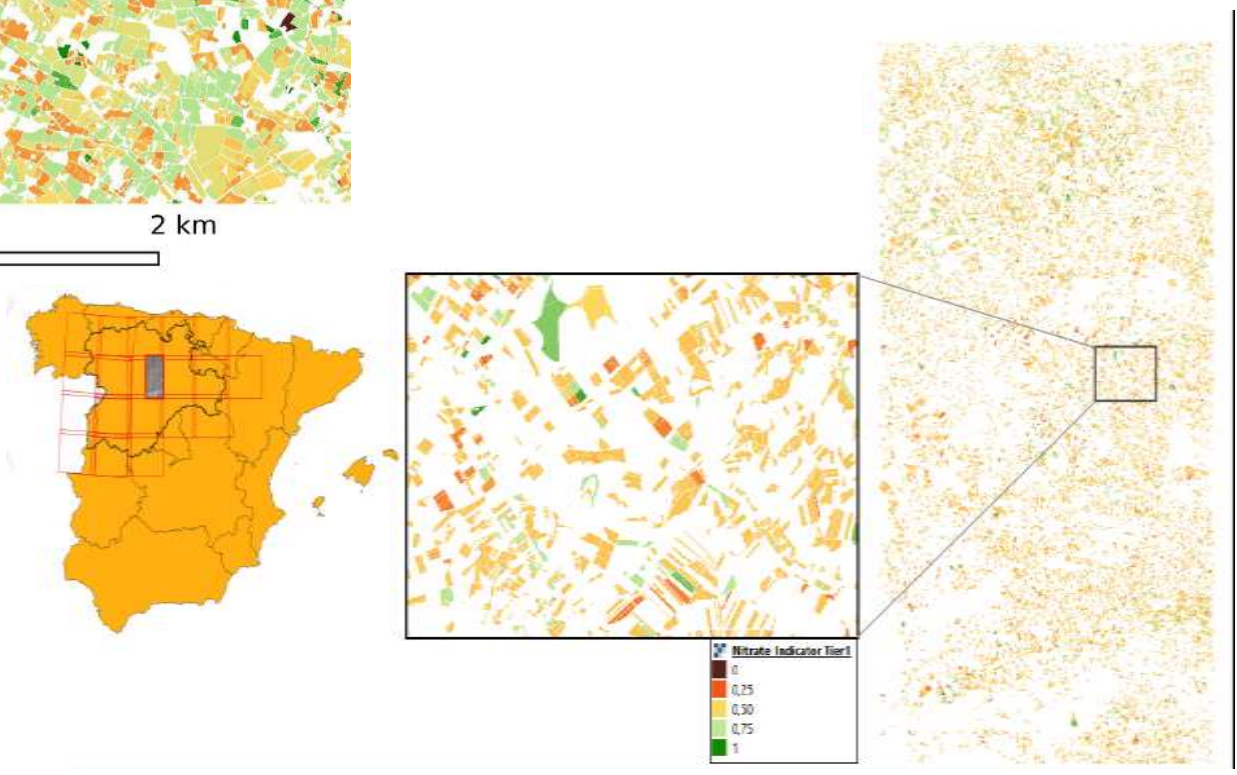


Tier 1 Risk of Nitrate leaching : : Multi-MS testing

https://gitlab.com/nivaeu/uc1b_indicators_tool



Next step ➔ national scale application



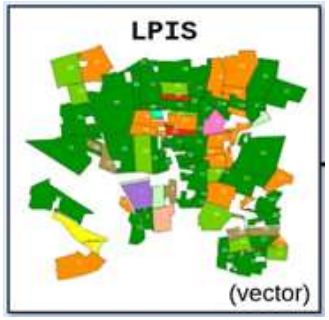
Biodiversity indicators

- Based on Sirami et al. (2019) and data of Biodiversa FarmLand project
- ➔ Landscape scale, multi-taxa, represents a biodiversity potential

TIER 1

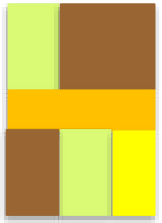
Topographic data

Semi-natural elements



Crop diversity

Parcel size



TIER 2

Organic agriculture

Agroecological infrastructures
(Perm. Grassland, Hedgerows etc.)

TIER 3

Practices

e.g. pesticides

Tier 1 Biodiversity indicator

Kilometric grid
IACS data
Semi-Natural area layer
Artificial area layer (IGN)

FarmLand data (7 regions in Europe), Land cover

Statistical model
-Significant factors
-Respective weight

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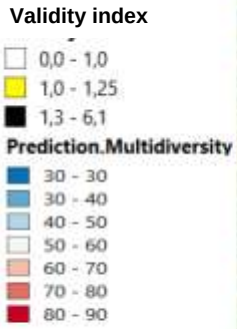
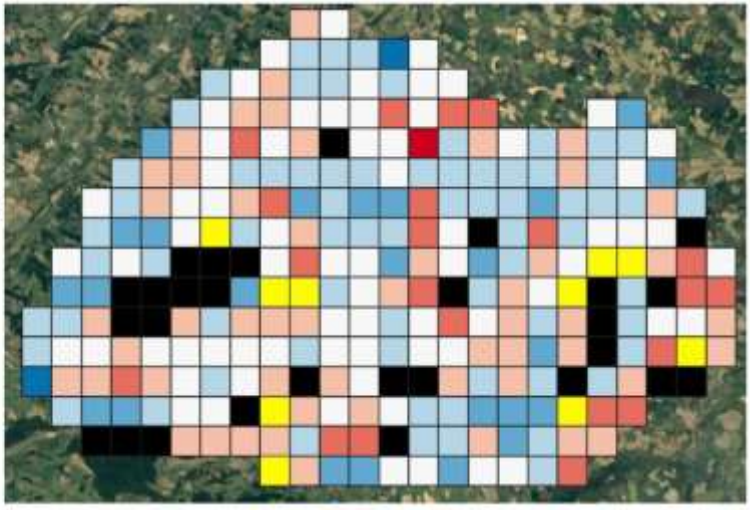
- Transparency
- Avoids threshold effects

Testing phase in France





Next is to upscale over a whole Sentinel 2 tile

Conclusions

- Based on (mainly) open data & tools, 3 indicators were produced (Carbon, Nitrate and Biodiversity) with 3 levels of complexity addressing 3 categories of environmental issues/ecosystem services calculated at pixel/plot/landscape levels,

- TIER 1: easy to implement at large scale/high resolution but lack of accuracy as do not account for some farmer's practices that may impact strongly the results (e.g. fertilisation),

- TIER 2: more accurate, technically easy to implement (e.g. API's connecting to the FMIS) but the main limitation is the access to reliable farmers data

- TIER 3 (model) offer higher levels of accuracy, may provide additional indicators (yield, biomass), but needs farmer's data and are less operational (parametrise new crops, analyse transposability…),

Access to large scale reliable data on farmer's practices needed for accurate CAP Agri-environmental monitoring ➔ initiatives such as AgDataHub, Just Connect, Join Data may solve this issue

THANKS for Your attention !

References :

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Bockstaller C., Feschet P., Angevin F., 2015. Issues in evaluating sustainability of farming systems with indicators. Oléagineux Corps gras Lipides 22.

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Ceschia E., Béziat P., Dejoux J.F., Aubinet M., Bernhofer C., Bodson B., Buchmann N., Carrara A., Cellier P, Di Tommasi P, et al., 2010. Management effects on net ecosystem carbon and GHG budgets at European crop sites. Agriculture, Ecosystems and Environment 139, 363-383.

Pique G., Fieuzal R., Al Bitar A., Veloso A., Tallec T., Brut A., Ferlicoq M., Zawilski B., Dejoux J.-F, Gibrin H., Ceschia E., 2020a. Estimation of daily CO2 fluxes and of the components of the carbon budget for winter wheat by the assimilation of Sentinel 2-like remote sensing data into a crop model. Geoderma, 376, 114428.

Pique G., Fieuzal R., Debaeke P., Al Bitar A., Tallec T, Ceschia E., 2020b. Combining high-resolution remote sensing products with a crop model to estimate carbon and water budget components: Application to sunflower. Remote Sensing, 12, 2967.

Sirami et al. 2019. Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions, Proc. Natl. Acad. Sci. USA, 116(33), pp. 16442–16447

This project has received funding from the european union's horizon 2020 research and innovation programme under grant agreement no. 842009

Carbon budgets indicators

- Calculated for each cropping year (at 10m/plot scale),
- 3 TIERS with a similar conceptual approach:

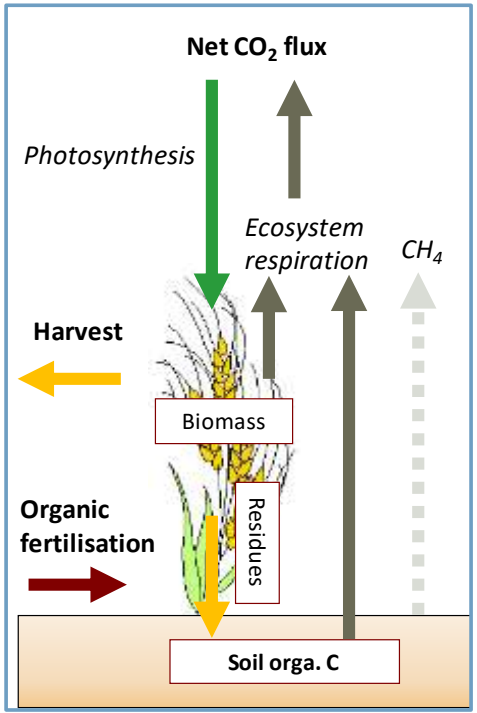
TIERs 2 & 3

C budget = Net CO_2 flux – C harvested + Organic manure

TIER 1

Farmer's data (FMIS)

Based on Smith et al. (2010)



Biodiversity indicators

- Based on Sirami et al. (2019) and data of the H2020 Farmland project
- ➔ Landscape scale, multi-taxa, represents a biodiversity potential

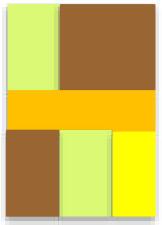
TIER 1

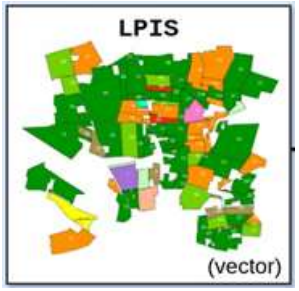
TIER 2

Semi-natural elements

Crop diversity

Parcel size





Topographic data

Grassland

Practices (bio/conventional)

Impact on

Ancillaries

Adventices

Tier 1 Biodiversity indicator

Kilometric grid
IACS data
Semi Natural Habitat layer
Artificial area layer (IGN)

Farmland data (7 regions in Europe), Land cover,

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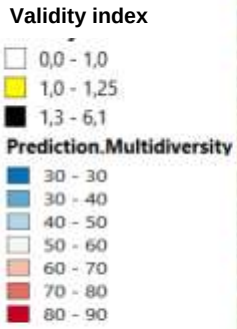

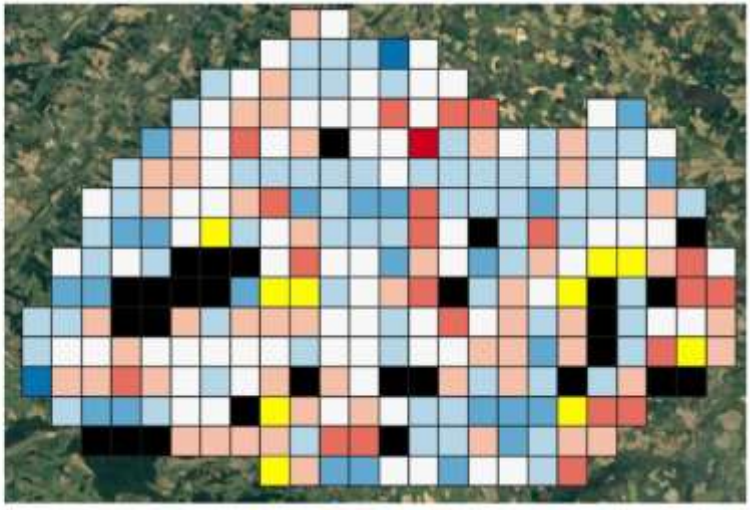

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