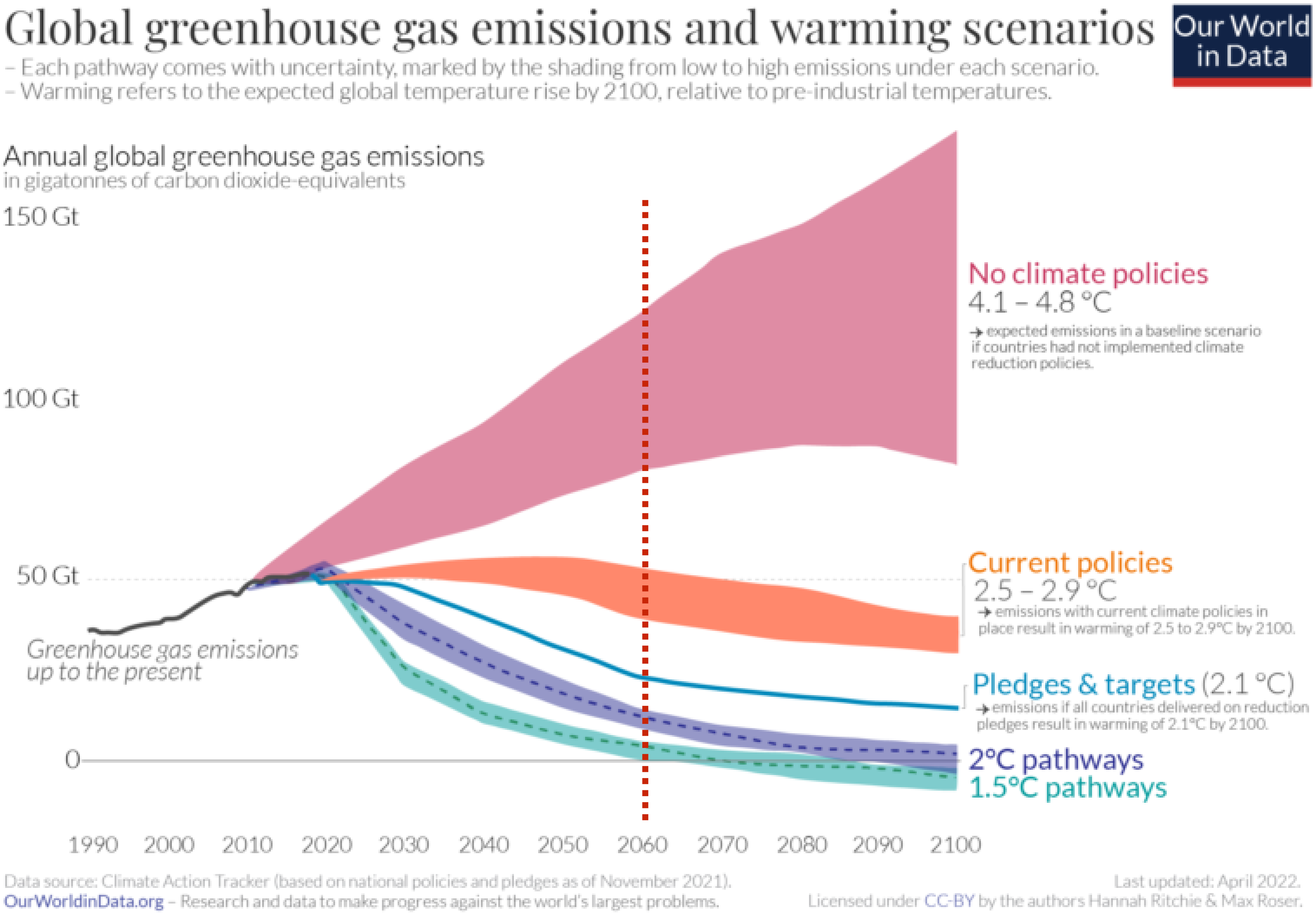
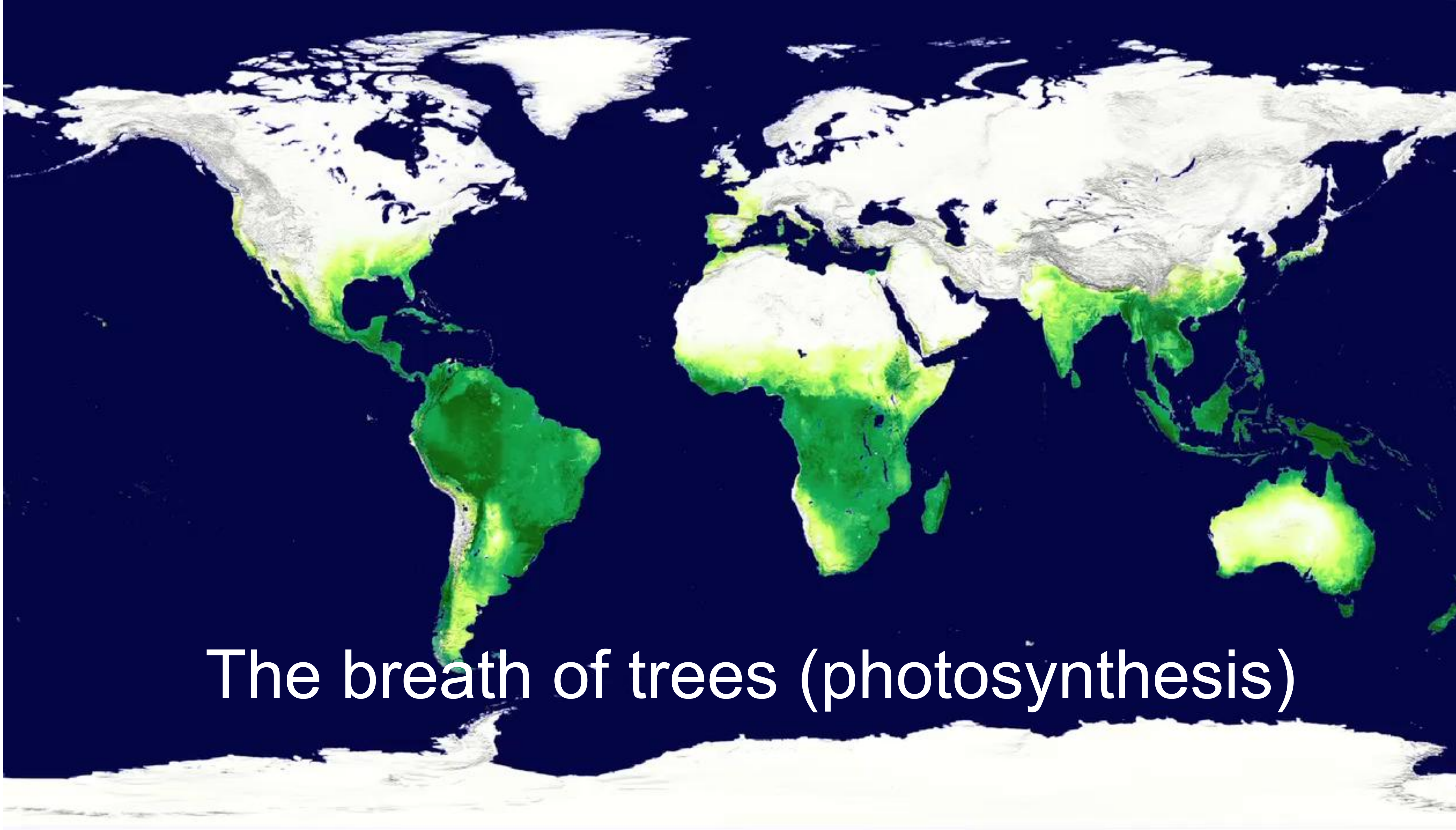
"The role of woody crops in climate change mitigation and progress in monitoring technologies"

Prof. Riccardo Valentini
University of Tuscia
Nature 4.0
ITALY


Global greenhouse gas emissions and warming scenarios
Our World in Data
– Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
– Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.
Annual global greenhouse gas emissions
in gigatonnes of carbon dioxide-equivalents
150 Gt
100 Gt
50 Gt
0
No climate policies
4.1 – 4.8 °C
→ expected emissions in a baseline scenario if countries had not implemented climate reduction policies.
Current policies
2.5 – 2.9 °C
→ emissions with current climate policies in place result in warming of 2.5 to 2.9°C by 2100.
Pledges & targets (2.1 °C)
→ emissions if all countries delivered on reduction pledges result in warming of 2.1°C by 2100.
2°C pathways
1.5°C pathways
Greenhouse gas emissions up to the present
1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
Data source: Climate Action Tracker (based on national policies and pledges as of November 2021).
OurWorldinData.org – Research and data to make progress against the world's largest problems.
Last updated: April 2022.
Licensed under CC-BY by the authors Hannah Ritchie & Max Roser.


Clean Air
Habitat for Wildlife
Water Filtration
Pollination
Soil Stability
Carbon Storage
ECOSYSTEM SERVICES


The breath of trees (photosynthesis)

GLOBAL CARBON project

Fate of anthropogenic CO_2 emissions (2013–2022)

Sources = Sinks

Sources

35.3 $GtCO_2$/yr

88%

12%

4.7 $GtCO_2$/yr

Sinks

18.9 $GtCO_2$/yr

47%

31%

12.3 $GtCO_2$/yr

26%

10.4 $GtCO_2$/yr

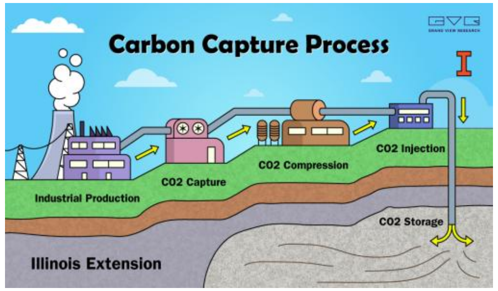
Budget Imbalance:
(the difference between estimated sources & sinks)

4%
-1.6 $GtCO_2$/yr

Source: Friedlingstein et al 2023; Global Carbon Project 2023

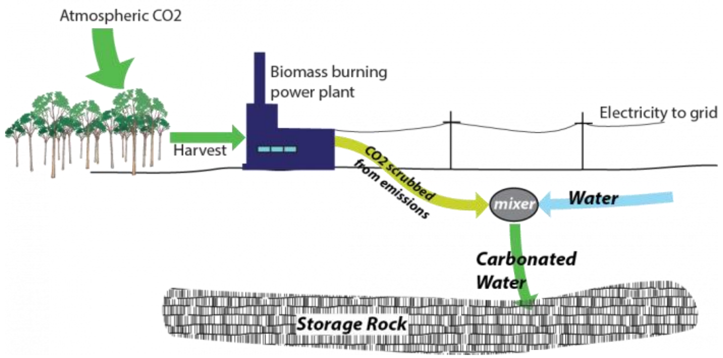
How to capture CO2 in atmosphere ?

CCS – Carbon capture storage at point



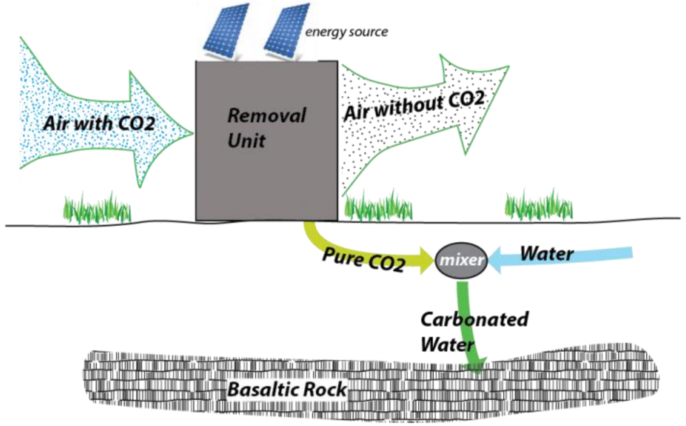
Cost 500-1000 $t CO2

BECCS— Bio-Energy with Capture and Carbon Sequestion



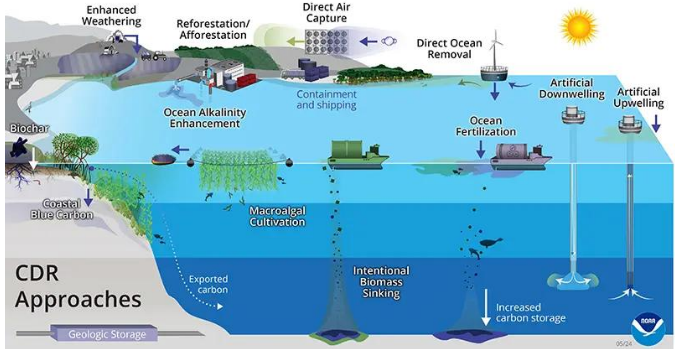
Cost 80-200 $t CO2

DACCS — Direct Air Capture and Carbon Sequestion

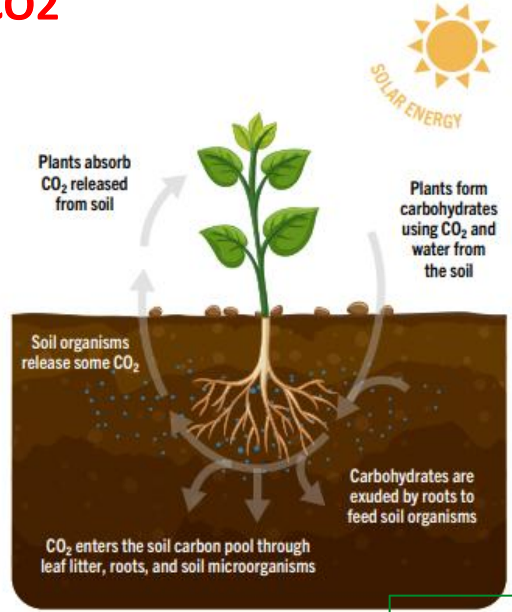


Cost 500-1000 $t CO2

OCEAN CDR– Ocean carbon capture storage



Cost 100-300 + $t CO2



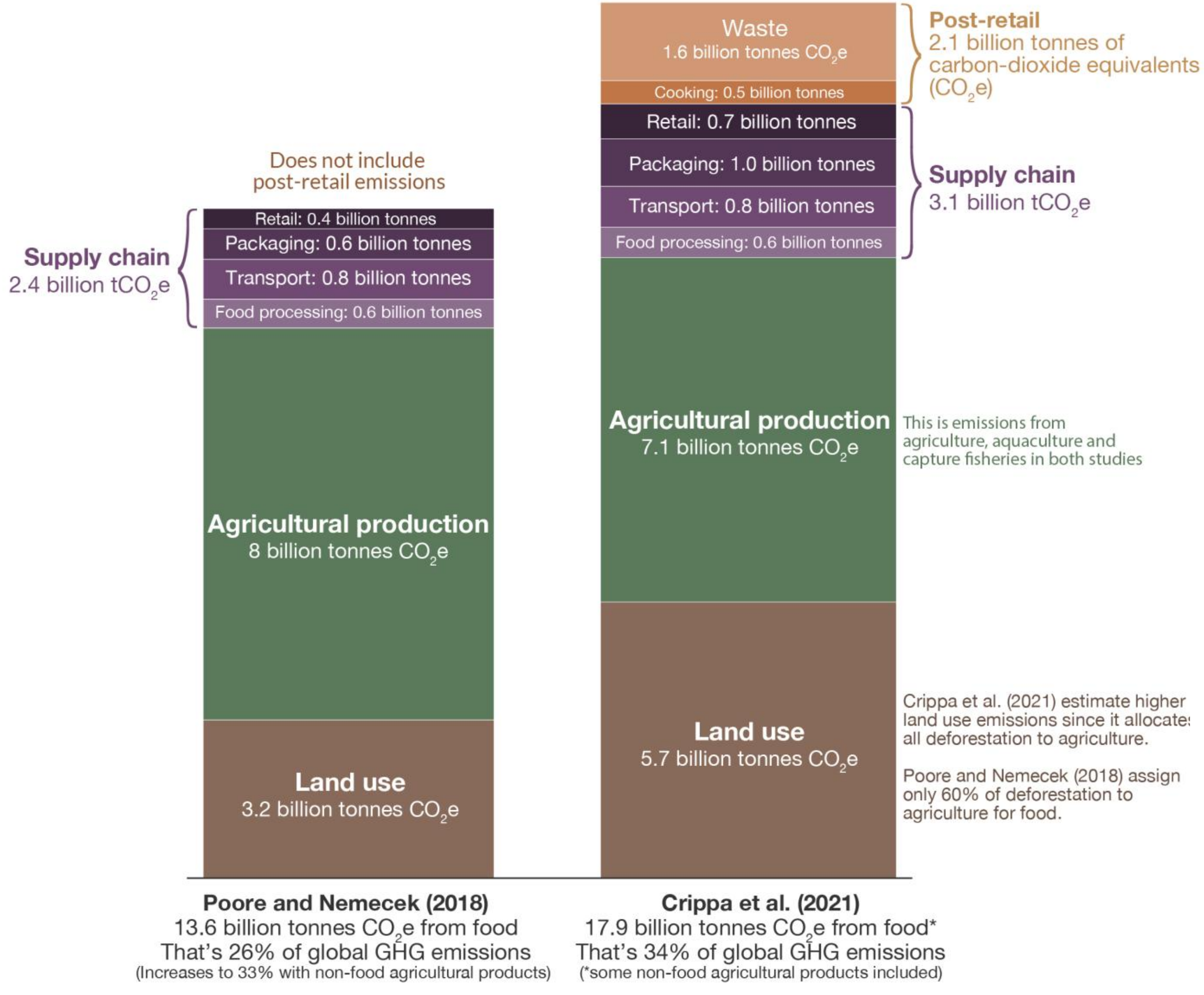
NBS - Nature based solution
Carbon Farming

Costo 15-50 $t CO2 --------> **Value on market 200-300 $t CO2**

How much of global greenhouse gas emissions come from the food system?

Our World in Data

Shown is the comparison of two leading estimates of global greenhouse gas emissions from the food system.
Most studies estimate that food and agriculture is responsible for 25% to 35% of global greenhouse gas emissions.



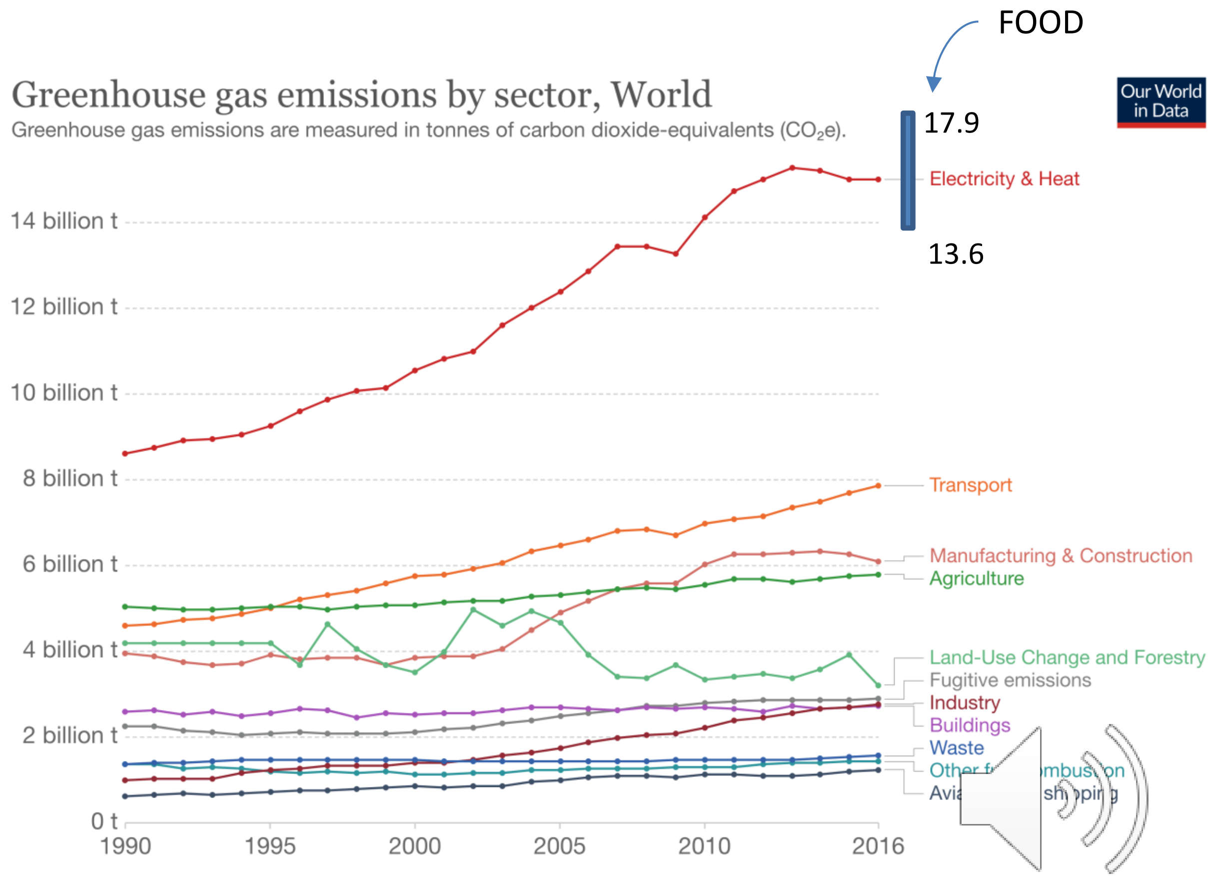
*Crippa et al. (2021) include emissions from a number of non-food agricultural products, including wool, leather, rubber, textiles and some biofuels.
Poore and Nemecek (2018) do not include non-food products in their estimate of 13.6 billion tonnes CO_2e. This may explain some of the difference.

Data sources: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*.
Crippa, M., et al. (2021) Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*.

Total 55.3 billions tons CO_2eq

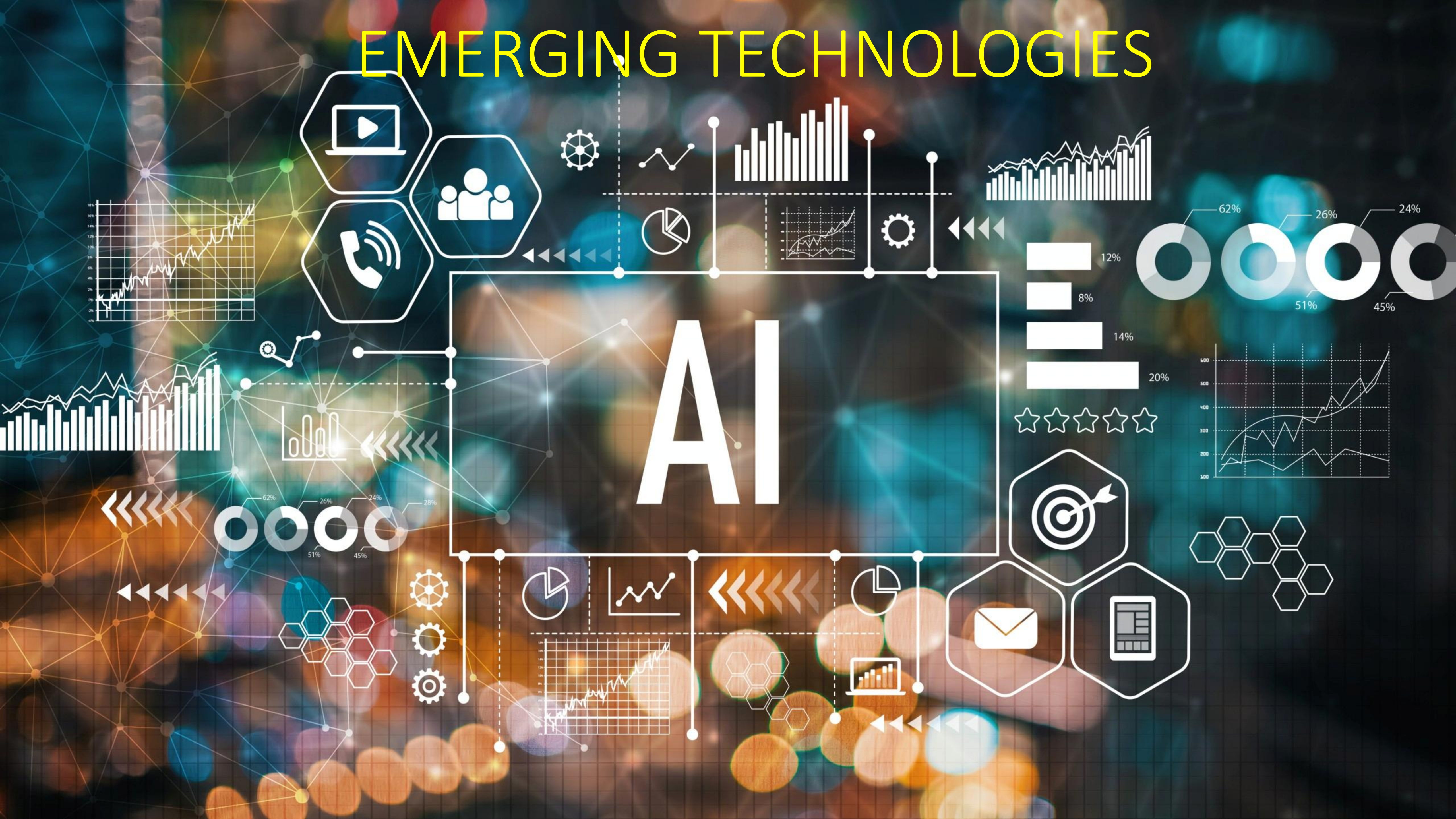
Greenhouse gas emissions by sector, World

Greenhouse gas emissions are measured in tonnes of carbon dioxide-equivalents (CO_2e).

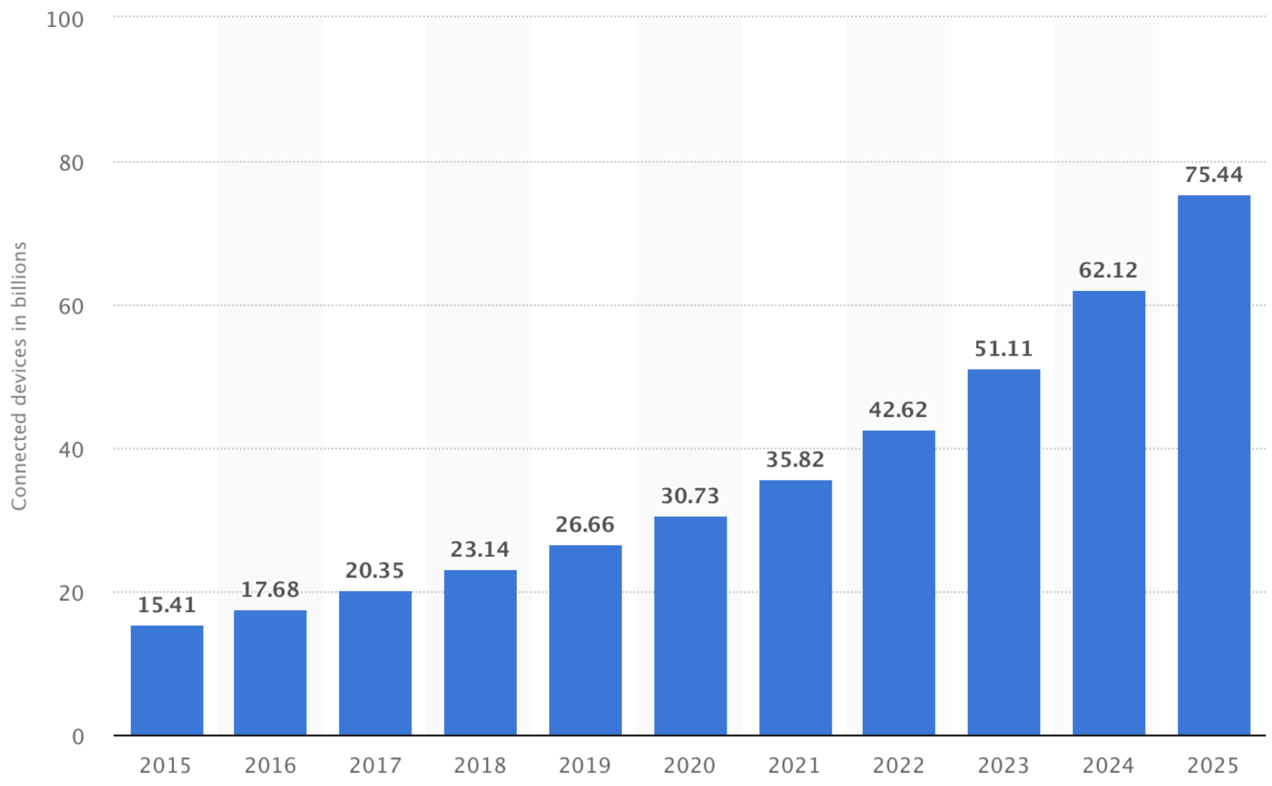


Source: CAIT Climate Data Explorer via. Climate Watch

EMERGING TECHNOLOGIES



Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions)

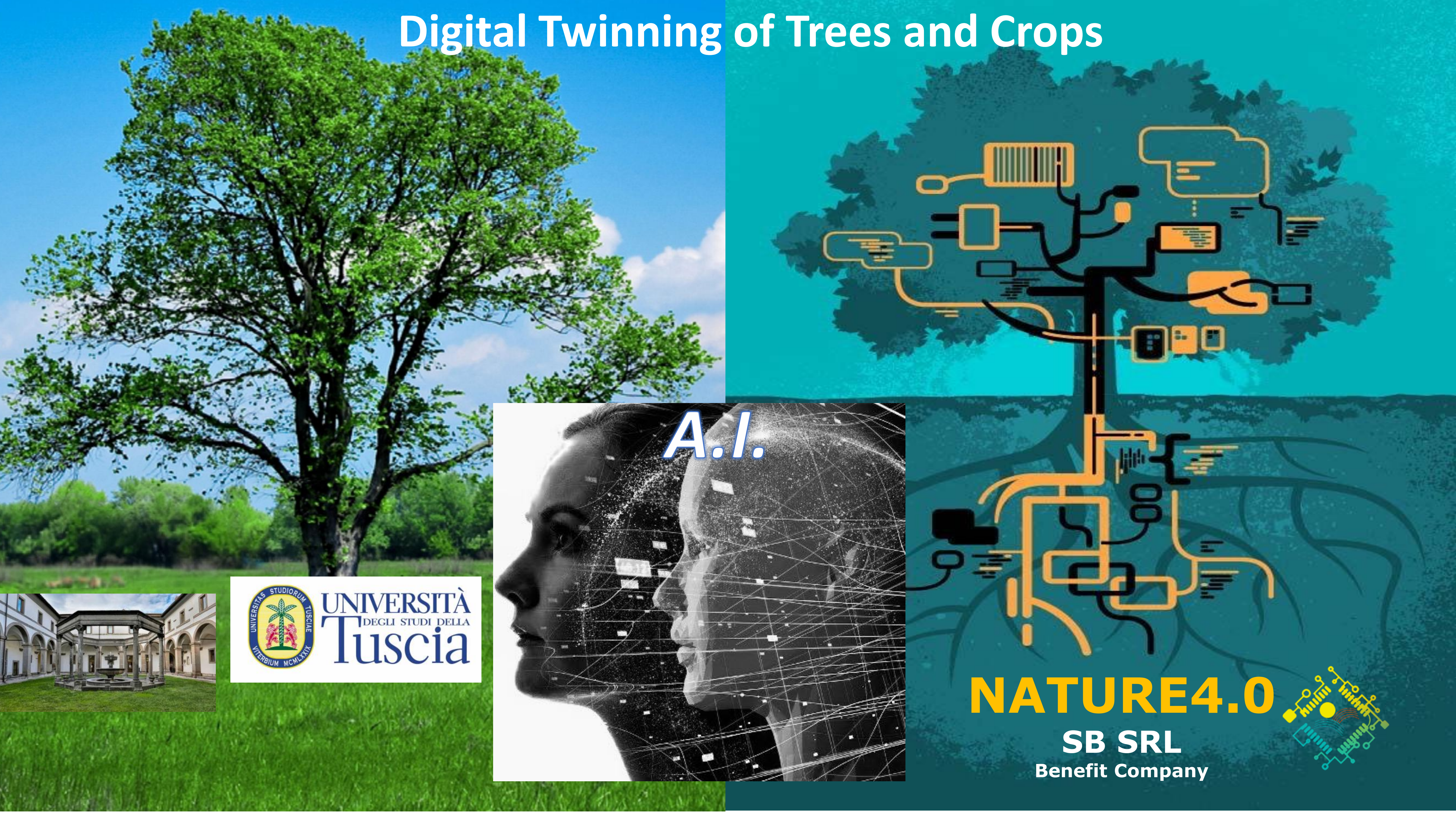


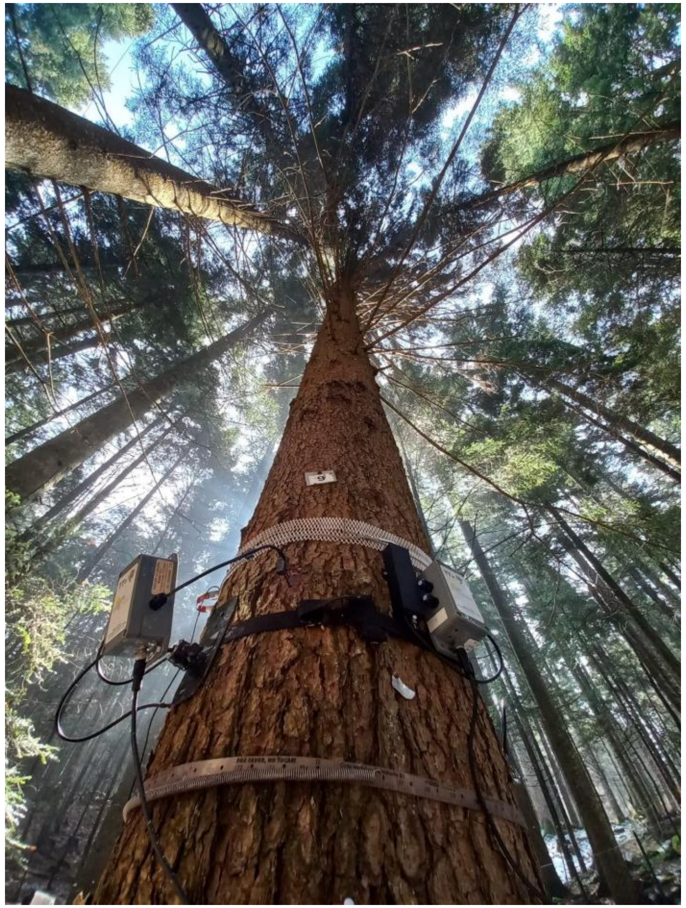
DOWNLOAD SETTINGS SHARE

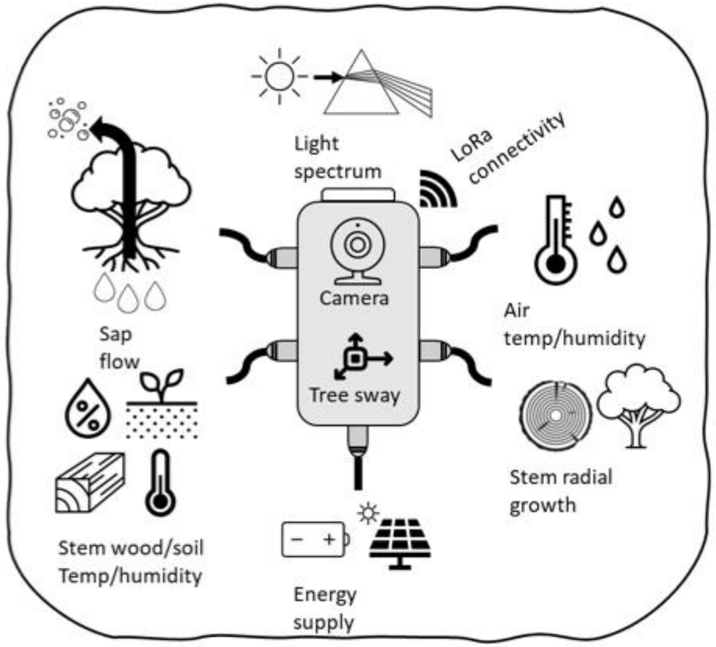
PNG PDF XLS PPT

DESCRIPTION SOURCE MORE INFORMATION

This statistic shows the number of connected devices (Internet of Things; IoT) worldwide from 2015 to 2025. For 2020, the installed base of Internet of Things devices is forecast to grow to almost 31 billion worldwide. The overall Internet of Things market is projected to be worth more than one billion U.S. dollars annually from 2017 onwards.


Digital Twinning of Trees and Crops
A.I.
UNIVERSITÀ DEGLI STUDI DELLA Tuscia
STUDIORUM UNIVERSITAS TUSCIAE VITERBIUM MCMLXXIX
NATURE4.0
SB SRL
Benefit Company

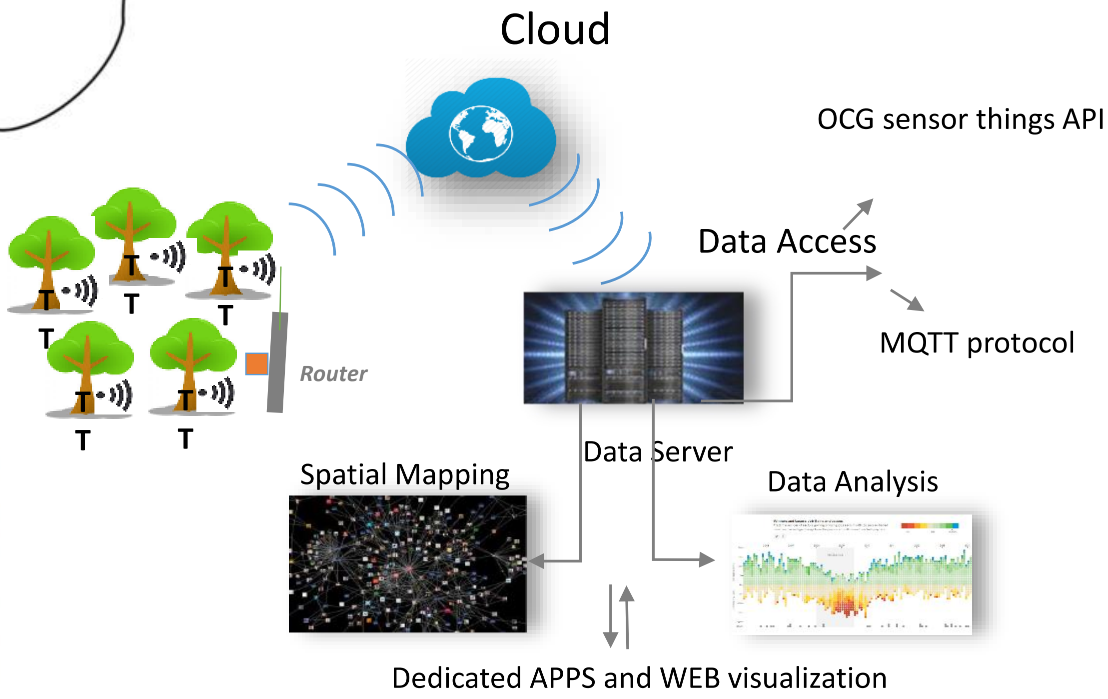


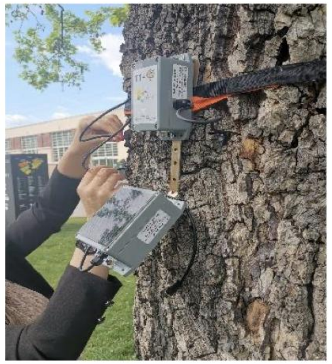


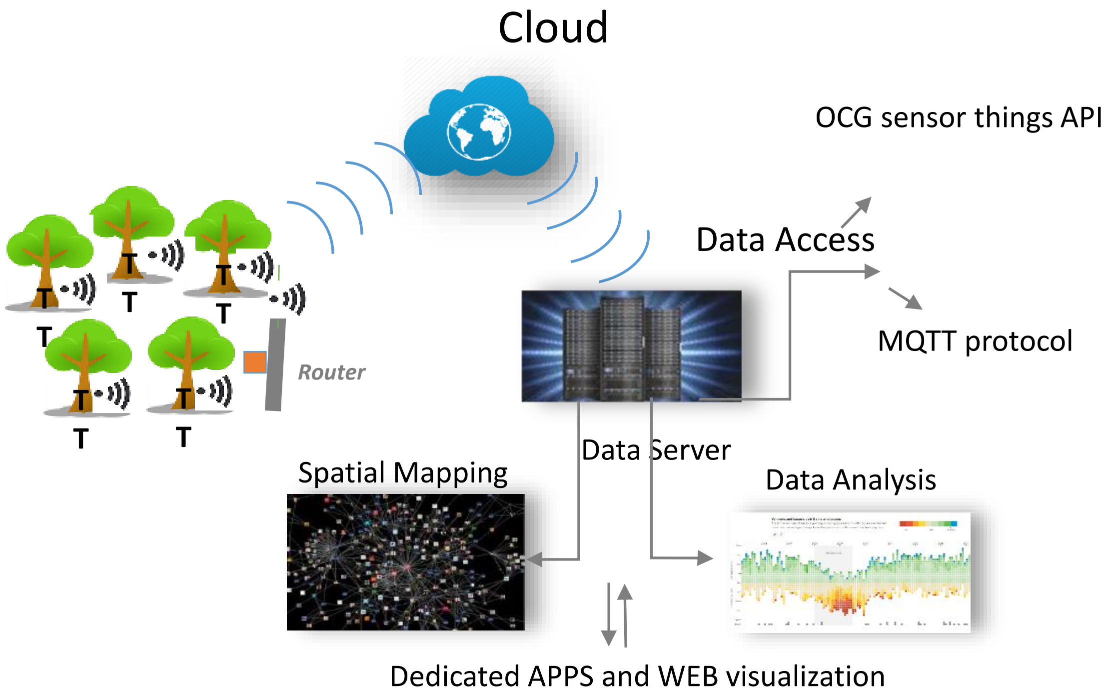
TreeTalker

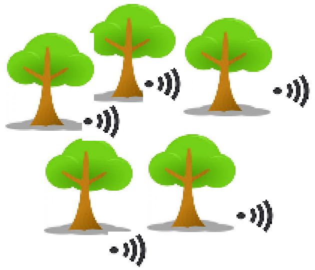
(www.nature4.org)

- Water consumption
- CO2 absorption
- Leaf color
- Tree stability





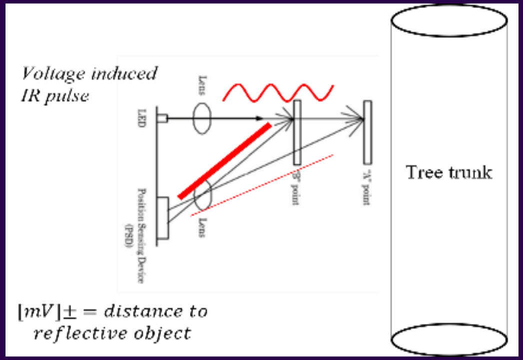

Cloud
OCG sensor things API
Data Access
MQTT protocol
T T T T T T
Router
Data Server
Spatial Mapping
Data Analysis
Dedicated APPS and WEB visualization

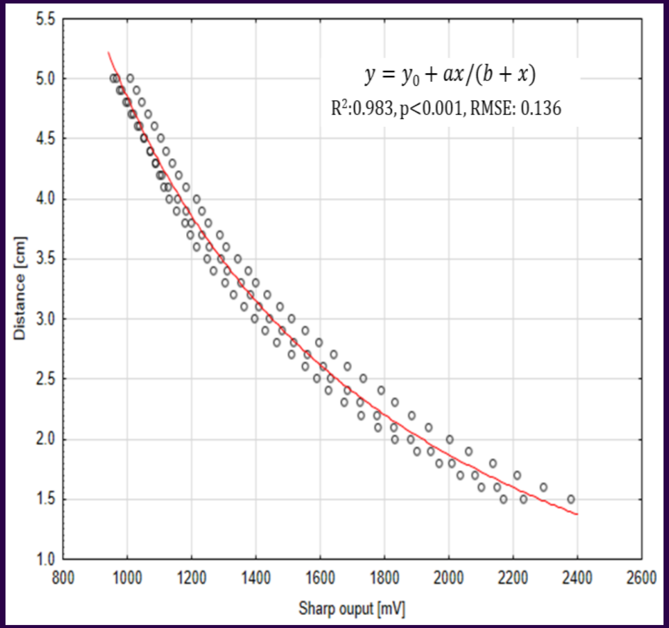


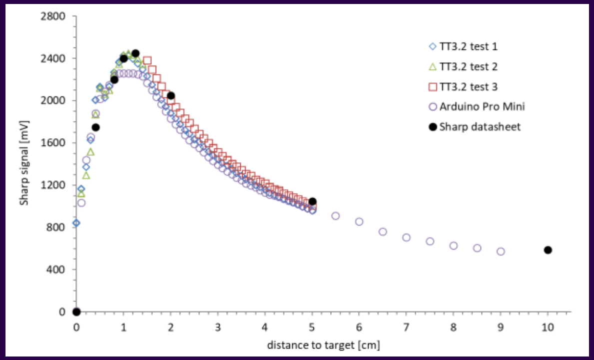
The case study of Plums in Italy

Lead by : Cooperative Monterè
Farms: Modena, Montalcino, Metaponto

APPROCCIO METODOLOGICO- LA MISURA







-Il sensore utilizzato nei nostri sistemi

Sensore di prossimità a infrarossi calibrato per estrarre un valore di distanza tra un ancoraggio fisso interno al fusto e la sua superficie - Questa distanza cambia in base alla crescita radiale del fusto

-Relazione inversa tra numero digitale e distanza.

-Utilizzando questo sensore, possiamo estrarre la variazione annuale dell'incremento radiale dello stelo.

APPROCCIO METODOLOGICO - LA RETE

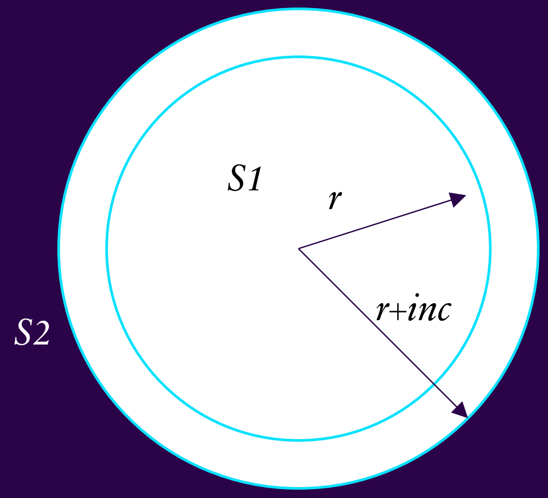
Trasmissione LoRa dal dispositivo al cloud

1. Trasmissione 4G al server dati
2. Gateway

Recupero dati server per l'elaborazione

-I dispositivi TT registrano una misura per ogni sistema ogni ora.
-Il sensore IR emette un impulso verso la superficie del bersaglio e registra la distanza dal target
-Il dispositivo registra il numero internamente al dispositivo.
-Invia un pacchetto al gateway che viene ulteriormente memorizzato.
-Invia poi il pacchetto a un server per la successiva elaborazione.

APPROCCIO METODOLOGICO - CONVERSIONE IN ASSIMILAZIONE DELLA CO2 E PRINCIPI DI SCALABILITA' ALLA PIANTAGIONE)



Annual anular increment

$S1 = \pi r^2$

$S2 = \pi(inc + r)2$

Anular Basal Area $(BA) = \pi(inc + r)^2 \; - \pi inc^2$

inc è l'incremento misurato dal sensore

Huber's stem volume approach

$$V = a \times BA \times (H)$$

Ha= 0.5

H = altezza albero in m

$$Tree\ Total\ CO2 = (Stem\ Volume \times \rho \times (BEF\ ) \times C$$

BEF(Biomass expansion factor) = 1.5(1+R)

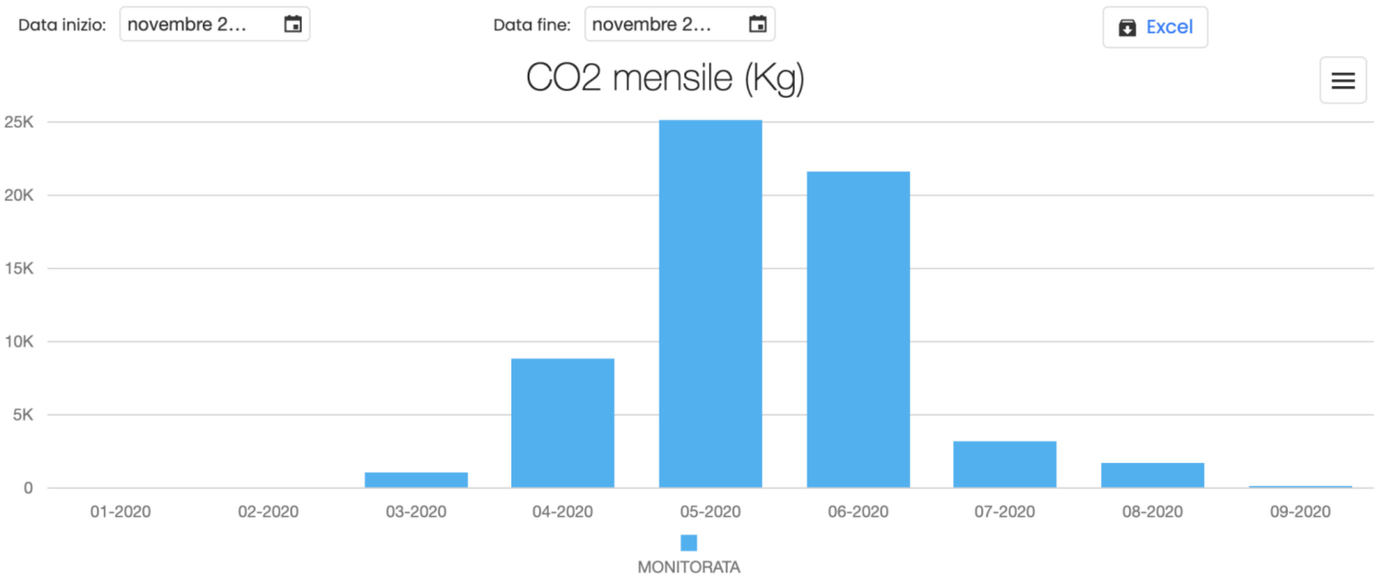
R (shoot-root ratio - espansione radicale) = 0.3

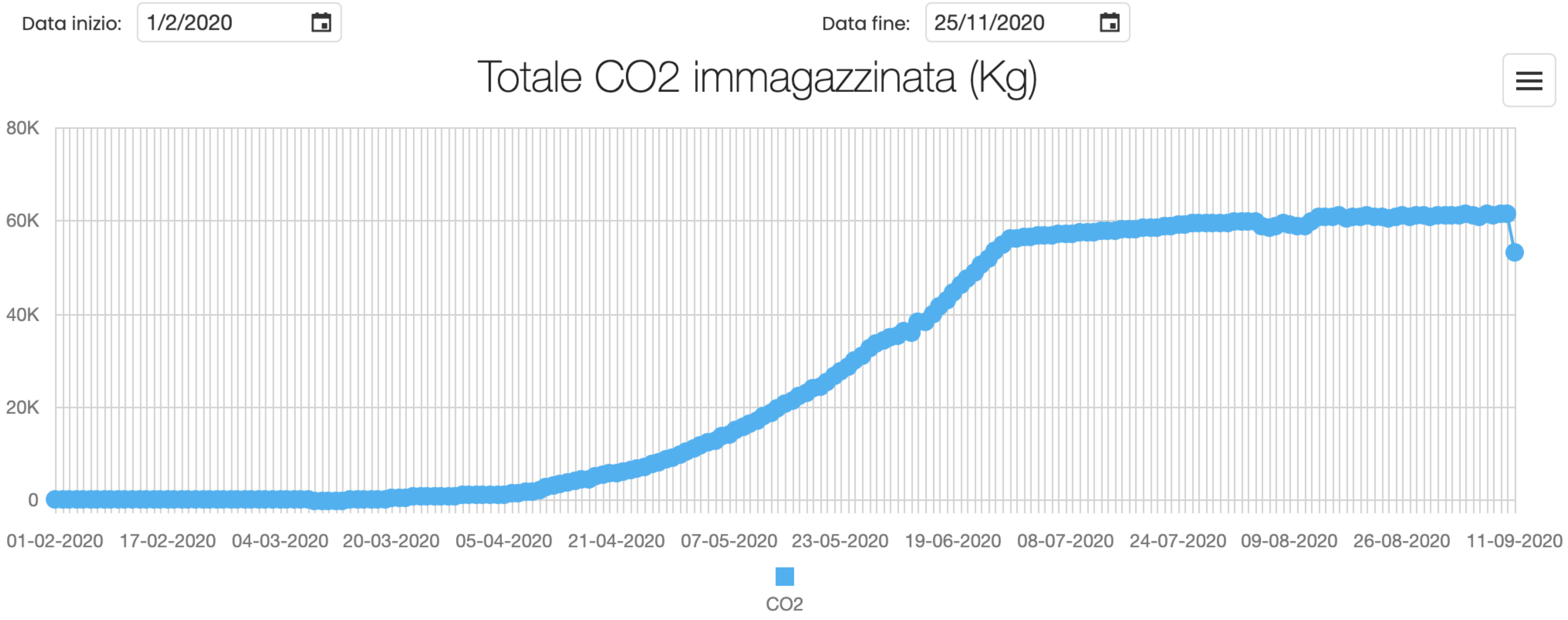
ρ(wood desnity) = 500 kg m^3

C(CO2 Kg conversion)=3.67*0.5*biomass (Kg)

BEF =

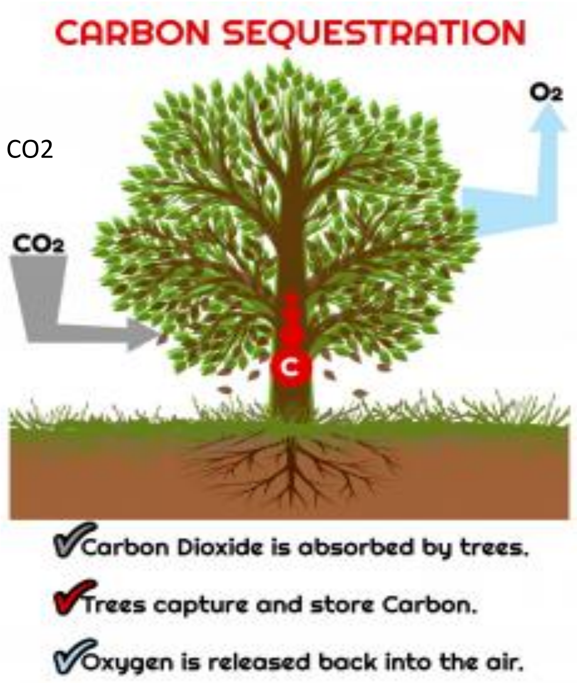
IPCC Good Practice Guidance for LULUCF chapter 3.2


Data inizio: novembre 2...
Data fine: novembre 2...
Excel
CO2 mensile (Kg)
25K
20K
15K
10K
5K
0
01-2020
02-2020
03-2020
04-2020
05-2020
06-2020
07-2020
08-2020
09-2020
MONITORATA


Data inizio: 1/2/2020
Data fine: 25/11/2020
Totale CO2 immagazzinata (Kg)
80K
60K
40K
20K
0
01-02-2020
17-02-2020
04-03-2020
20-03-2020
05-04-2020
21-04-2020
07-05-2020
23-05-2020
19-06-2020
08-07-2020
24-07-2020
09-08-2020
26-08-2020
11-09-2020
CO2

The MonteRe Plum Tree

34.19 Kg CO_2



24.86 Kg O_2

SPATIAL DISTRIBUTION BY REGION

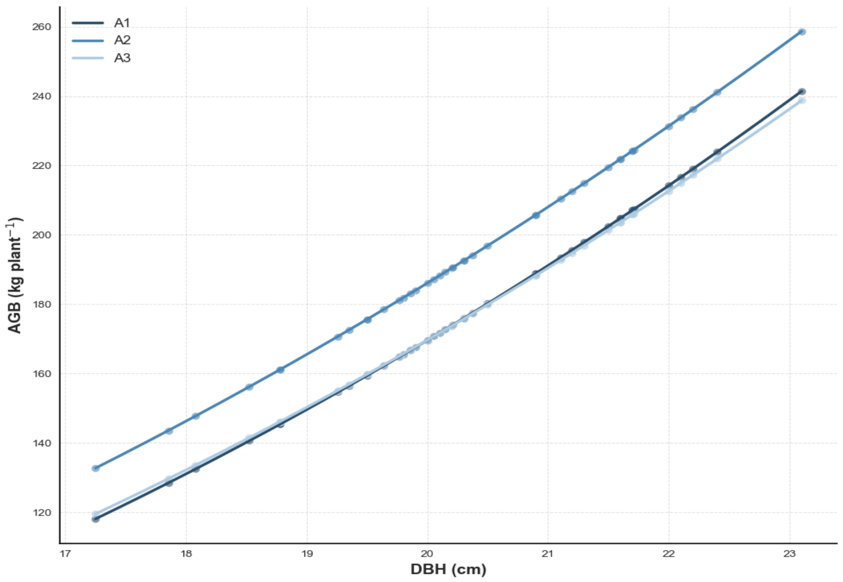
Range per ha : 7.2-10.8 t CO2

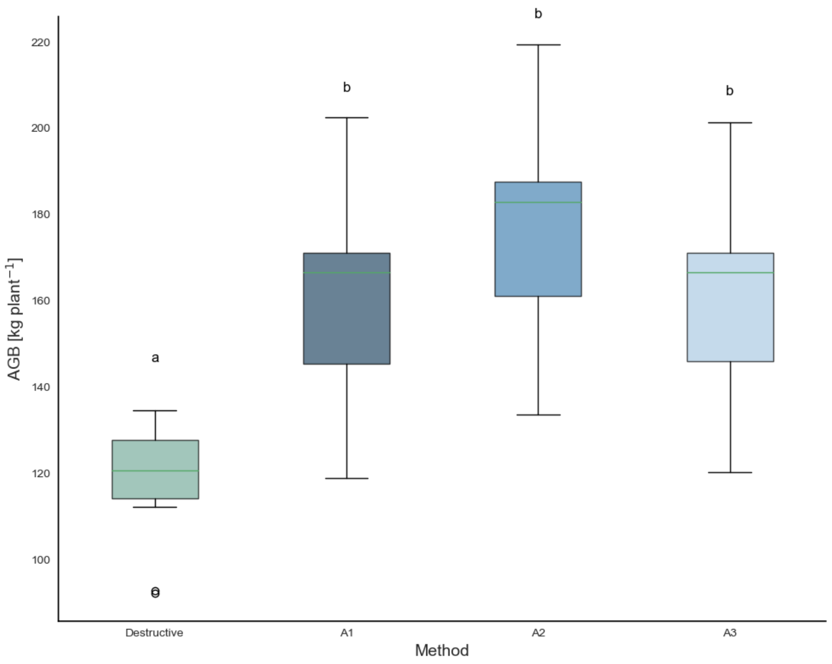
Younger trees seems to capture more carbon

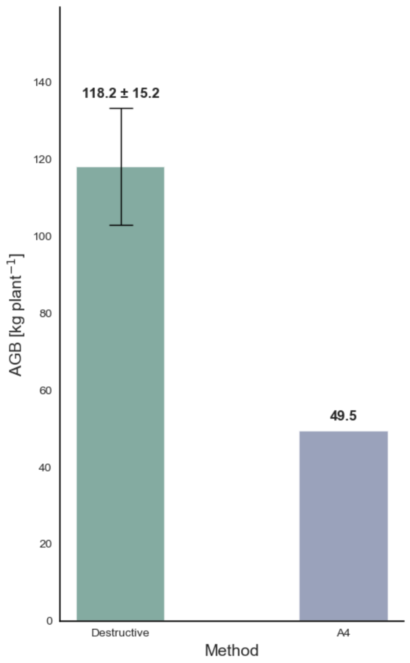
Farm	Year of establishment	Trees per ha	Total hectars	Mean per tree(Kg CO2)	Standard Error (Kg CO2)	Mean per ha (Kg CO2)	Total per farm (Kg CO2)
Mugnano	2010	308	5.298	28.13	2.4	8662.70	45894.96
Mugnano	2017	342	4.3276	31.55	4.7	10791.38	46700.79
Banfi	2012	404	9.14	19.58	2.71	7909.52	72293.00
Banfi	2017	404	9.3	23.41	2.86	9458.33	87962.42
Troiyli	2015	417	7.8	20.53	3.4	8560.10	64200.77
Troyli	2013	417	7.5	17.36	2.34	7238.41	56459.60

Uncertainty on scaling from Tree Diameter to total Biomass

- Compare the 4 allometric models :







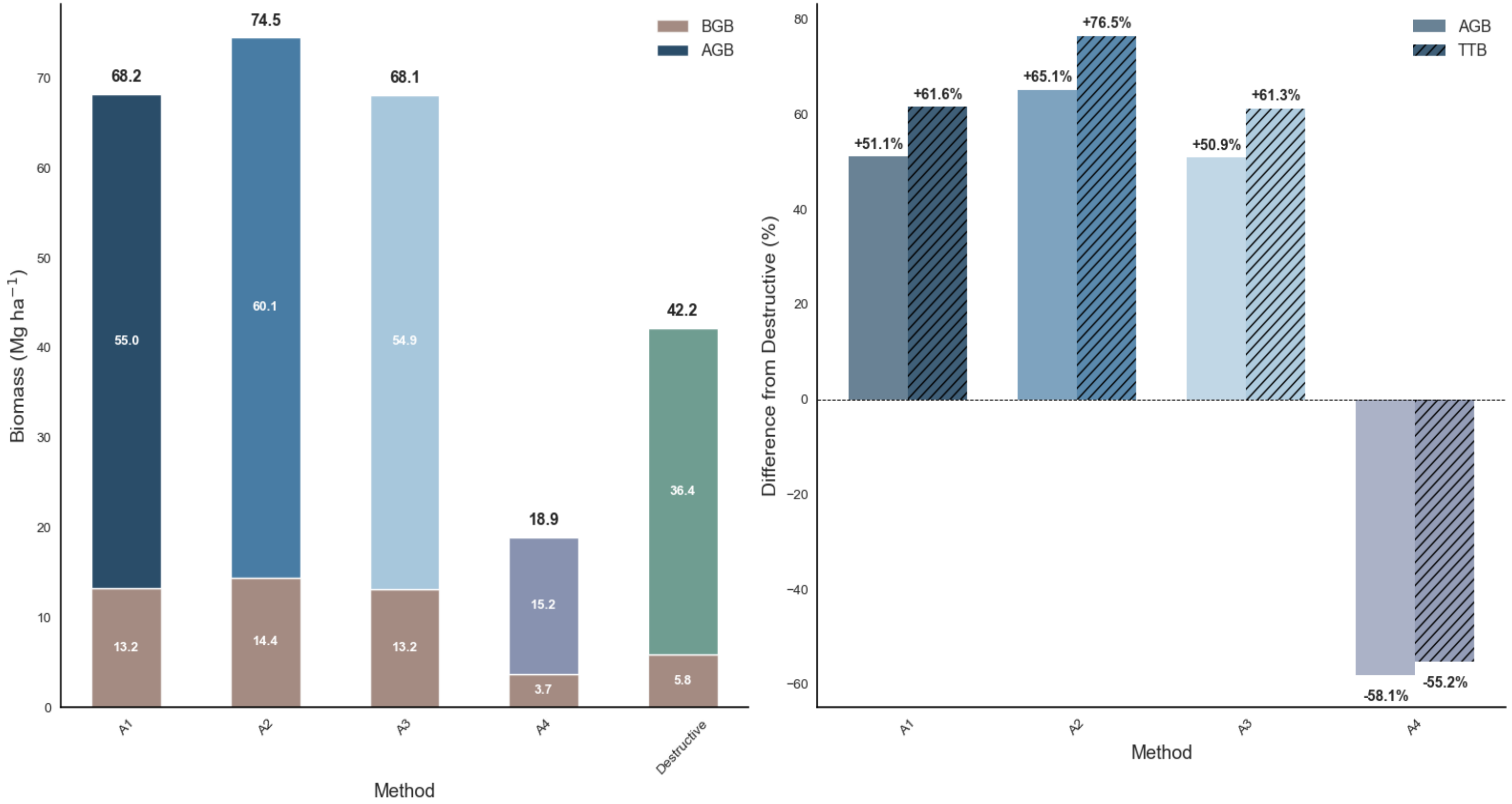
Preliminary analysis:
Fitting the 3 dbh-based allometric models to 41 field DBH data to observe trend patterns.

Comparison on the 10 destructively sampled trees: All models produce results siginificantly different from the destructive method.

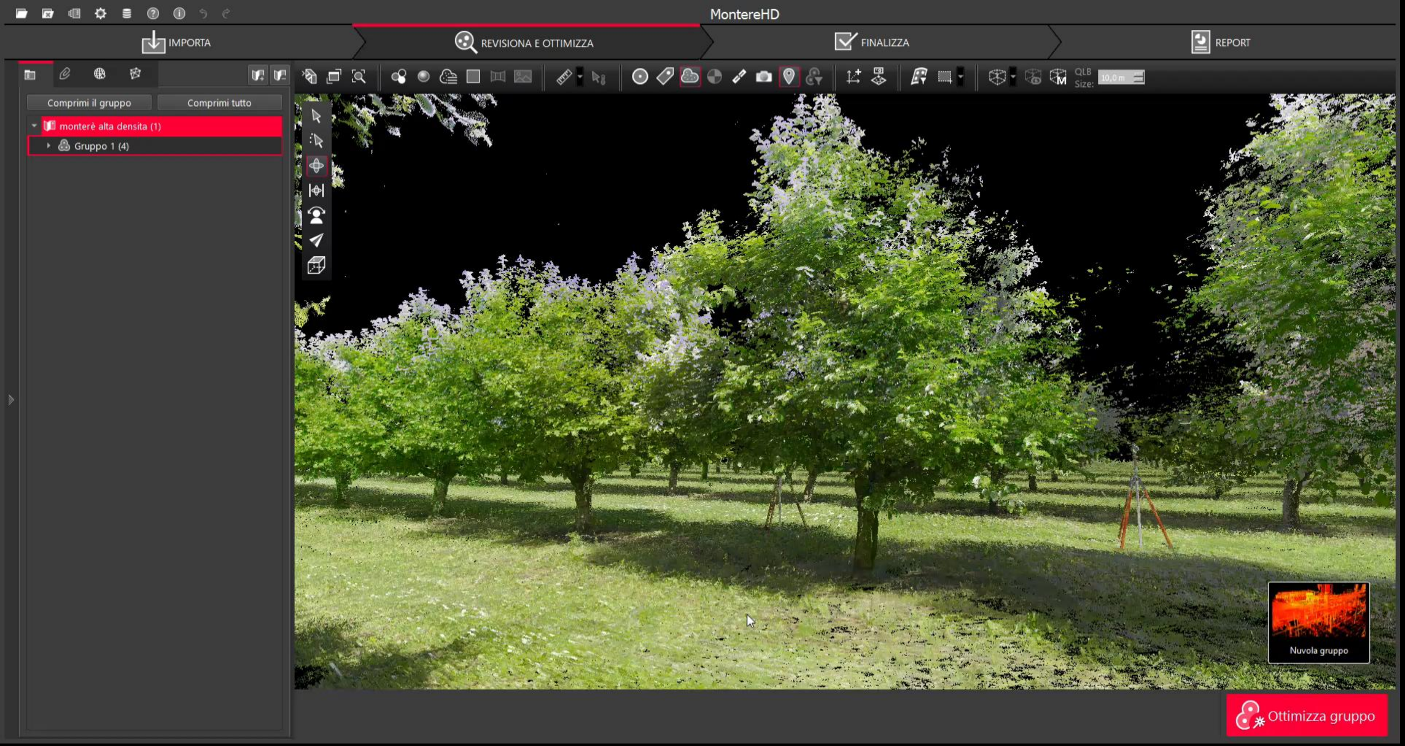
Models A1–A3 predict higher AGB than model A4 → C stock estimates are highly model-dependent, prone to over- or underestimation.

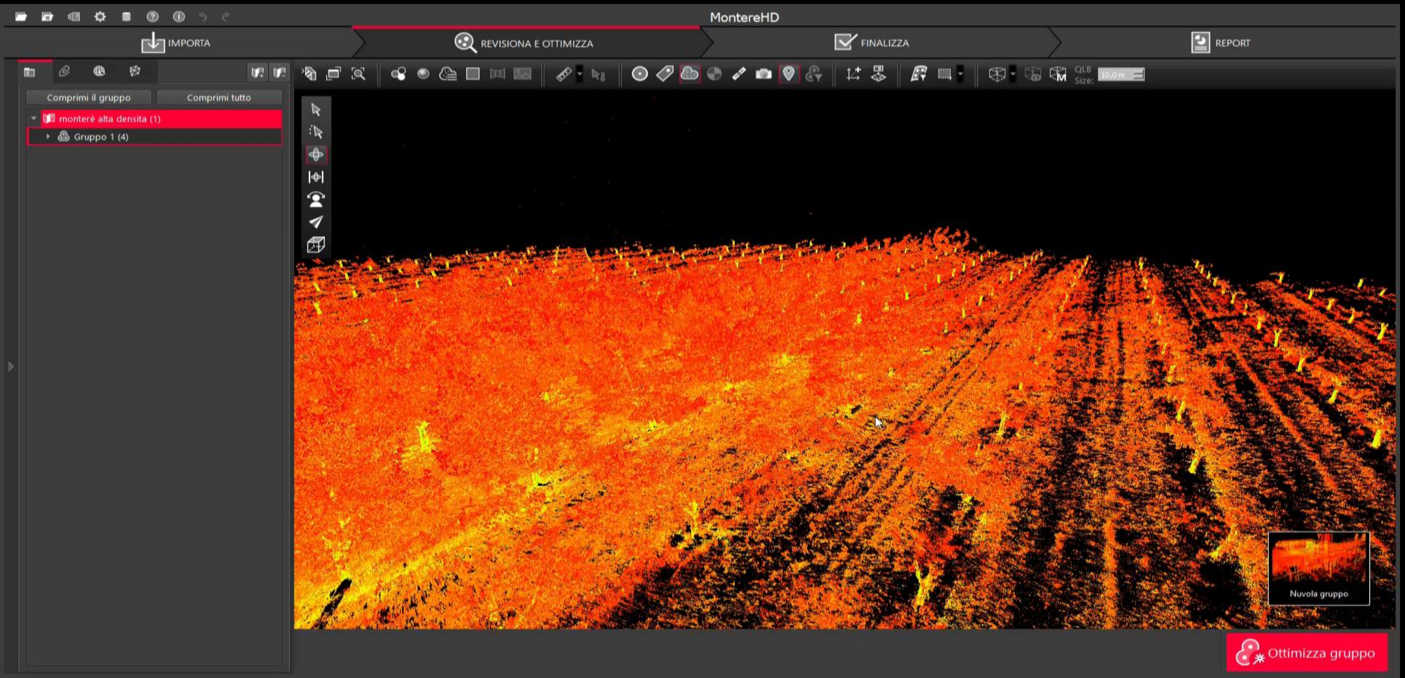
Assessing above- and below-ground biomass in a mature plum orchard in Italy

Compare models with observed values from destructive harvesting.



Models A1–A3 overestimate total CO_2 sequestration in biomass by 61% to 76% while model A4 underestimates it by 55%.

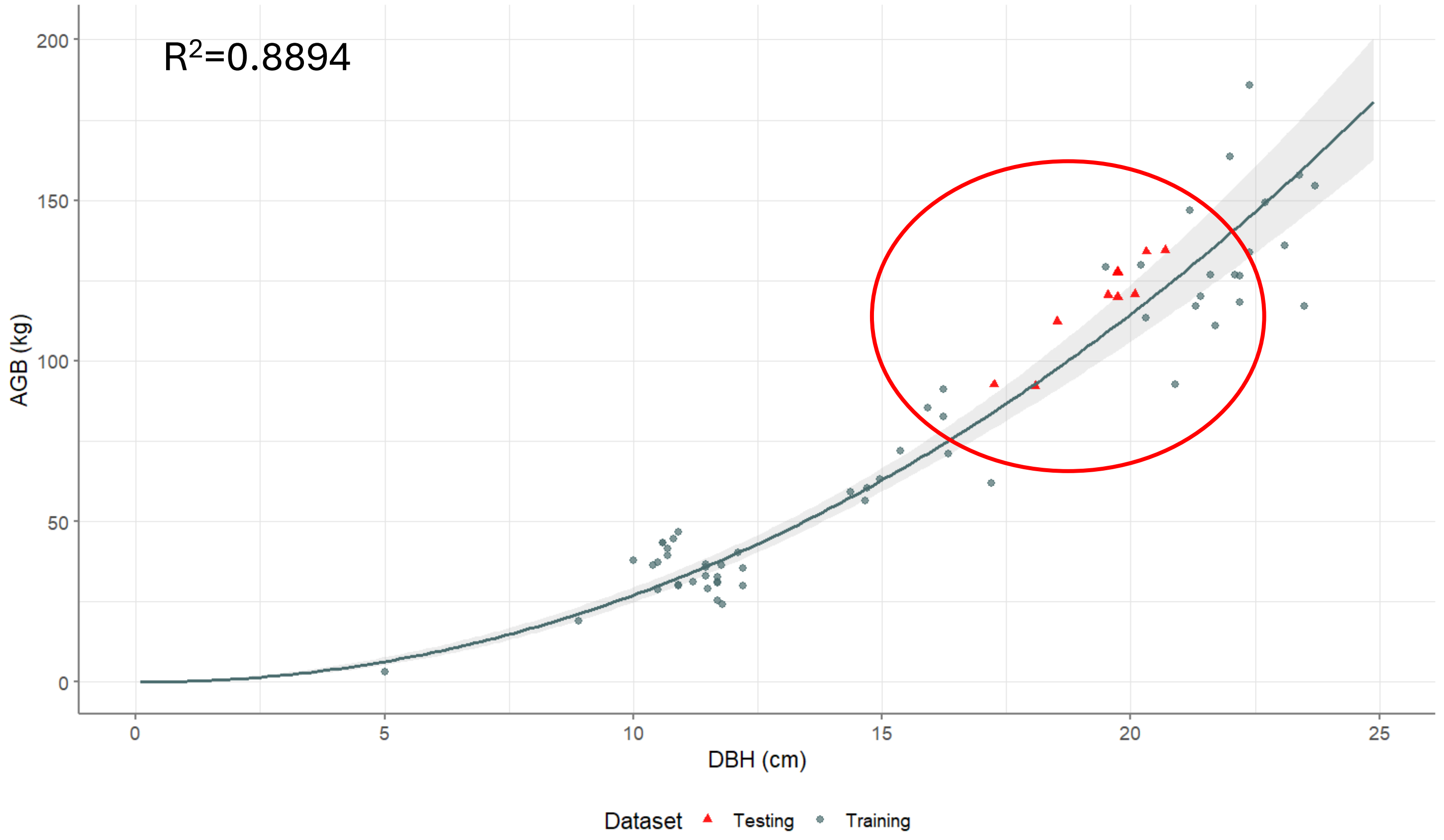




3D Analysis of Biomass and carbon accumulated in the farm

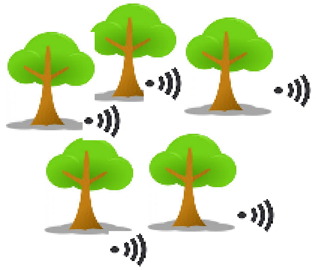
Thanks to Martina Leoni

Chapter 3: Development of non-destructive allometric models for plum trees

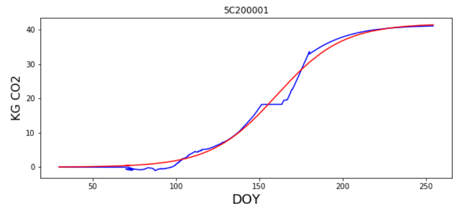


The allometric model was evaluated against destructively measured AGB, showing strong agreement.

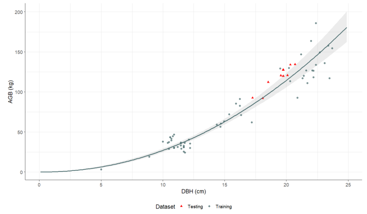
Scheme of carbon monitoring for certification



IoT sensor network (diameter monitoring)



Terrestrial Laser Scanner (Biomasss Expansion Factors)



Model fusion Extraction biomass growth

$$V = BEF \times BA \times (H)$$

CO2 conversion cofficient

$$Tree\ Total\ CO2 = (V \times \rho \times Ccoeff)$$

Upload carbon farming certification scheme

Thanks !