BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Seville
22-24/05/23

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

GOBIERNO DE ESPAÑA — MINISTERIO DE CIENCIA E INNOVACIÓN

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Istituto sull'Inquinamento Atmosferico
Consiglio Nazionale delle Ricerche

23/5/2023, *Designing a Biodiversity-Aware Vegetation Monitoring System for Post-Fire Recovery Transition in the Alta Murgia National Park*. Emanuele Costanzo

Designing a Biodiversity-Aware Vegetation Monitoring System for Post-Fire Recovery Transition in the Alta Murgia National Park

Emanuele Costanzo[1], Rocco Labadessa[2], Sabino Maggi[2], Giuseppe Pappagallo[3], Cristina Tarantino[2], Saverio Vicario[2]
[1]LifeWatch ERIC c/o CNR IIA , Bari, Italy, [2]CNR IIA , Bari, Italy, [3]CNR IRSA, Bari, Italy

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Post-fire vegetation recovery in a Mediterranean ecosystem

Post-fire vegetation recovery in a Mediterranean ecosystem is a complex process depending on several factors, such as:

- severity of the fire
- type of vegetation burned
- post-fire environmental conditions

The latter include:

- soil erosion;
- presence of invasive species;
- local climate changes;
- repeated fires.

Following a fire event, long-term changes can occur in the vegetation and ecology of an area, leading to a change in the overall structure of the ecosystem.

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

A model for a biodiversity-aware vegetation monitoring system for post-fire recovery transition

- The system should be able to remotely detect changes in vegetation cover and composition.
- Select appropriate sensors, such as remote sensing data from satellites and ground-based sensors
- Develop data analysis algorithms that can be trained on labelled data to classify different vegetation types and detect changes over time.
- Incorporate biodiversity metrics such as species richness, Shannon diversity index, and evenness index
- Visualisation and communication of results to managers and stakeholders

A combination of remote sensing data, ground-based sensors, machine learning algorithms, and biodiversity metrics will provide a comprehensive understanding of the recovery process and its impact on biodiversity.

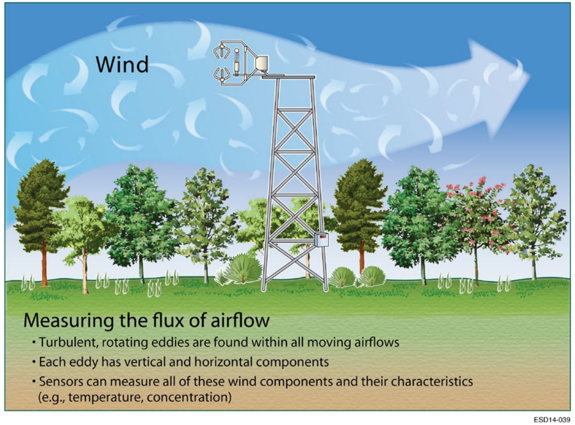
GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Eddy covariance measuring system

The eddy covariance is a technique used to measure the exchange of gases (such as carbon dioxide, water vapor, and methane) and energy (such as sensible and latent heat) between the Earth's surface and the atmosphere.

An eddy covariance measurement system typically consists of several components:

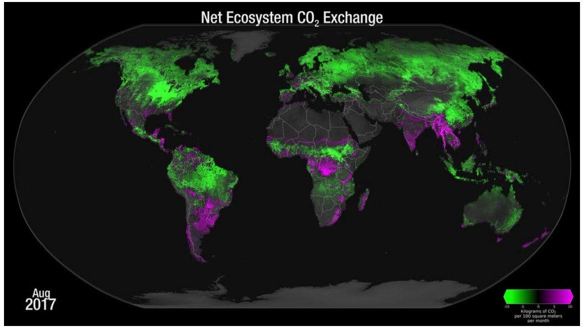
- an instrument to measure the 3D wind speed (usually a sonic anemometer), which provides information on the turbulent fluctuations in the atmosphere
- an instrument to measure the concentration of the gas of interest (such as a CO_2 analyser), which provides information on the amount of the gas being exchanged between the surface and the atmosphere
- a data logger to collect and process the data from the sonic anemometer and the gas analyser
- a software tool to calculate the eddy covariance flux, i.e., the rate of exchange of the gas or energy between the surface and the atmosphere.



Eddy covariance measuring system: direct measure of NEE

The net ecosystem exchange, **NEE**, represents the net CO_2 exchange with the atmosphere, used to study the effects of climate change, land use change, and other disturbances on the carbon cycle. Can be measured using the eddy covariance method.

- NEE is the difference between the amount of CO_2 taken up by photosynthesis by plants (gross primary production or **GPP**) and the amount of CO_2 released back to the atmosphere through plant respiration and other ecosystem processes (ecosystem respiration or **ER**), NEE = ER - GPP
- If GPP > ER, indicating that the ecosystem is a **net sink** for atmospheric CO_2
- If ER > GPP, indicating that the ecosystem is a **net source** of atmospheric CO_2



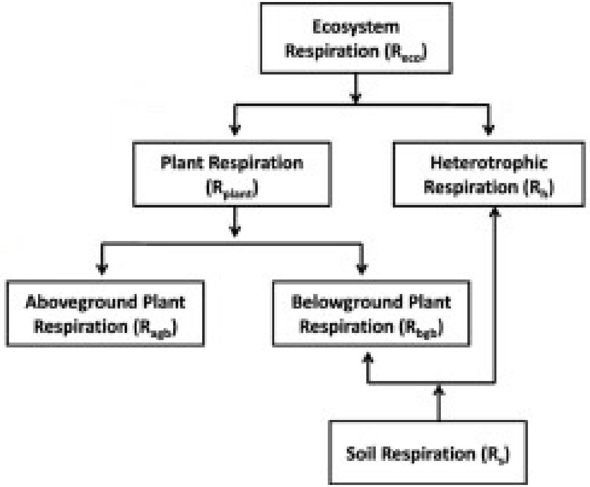
NASA Carbon Monitoring System's estimate of the Net Ecosystem Exchange of Carbon Dioxide (green is a negative value, pink is a positive value)

Eddy covariance measuring system: indirect measure of ER

Ecosystem respiration (ER) is the process by which living organisms release carbon dioxide (CO_2) into the atmosphere through cellular respiration. It is an important component of the carbon cycle and plays a crucial role in regulating the Earth's climate.

ER can be estimated by overnight CO_2 exchange from eddy covariance extrapolated to diurnal temperature. However, this is likely to be an underestimate.

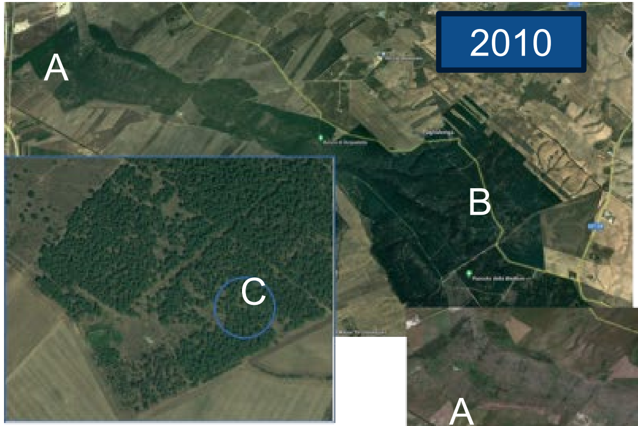
ER can also be measured directly using chambers or other techniques, although it is much more difficult to achieve a good spatial coverage.



GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

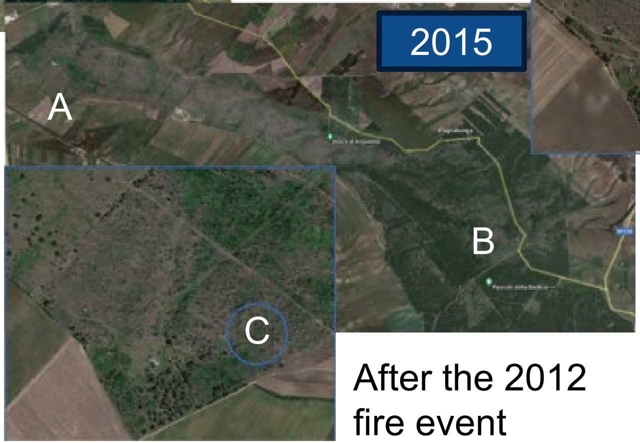
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Acquatetta Forest



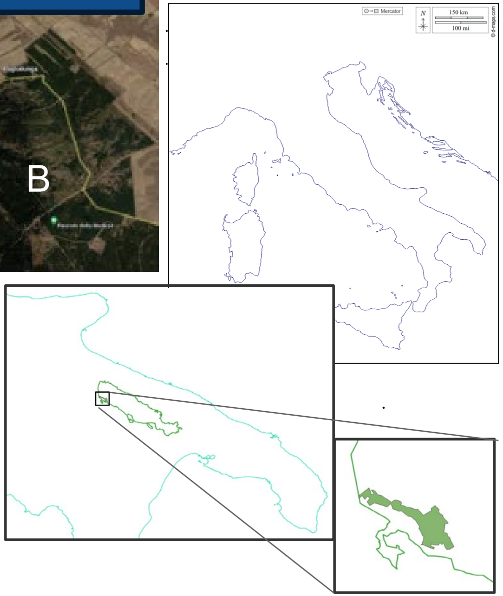
Before the 2012 fire event

a. area with conifers
b. area with conifers and deciduous trees
c. candidate site for the installation of the EC tower



After the 2012 fire event

After the July 2020 fire event

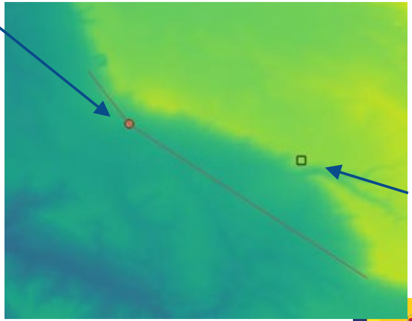


GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Eddy covariance implementation in the Acquatetta Forest

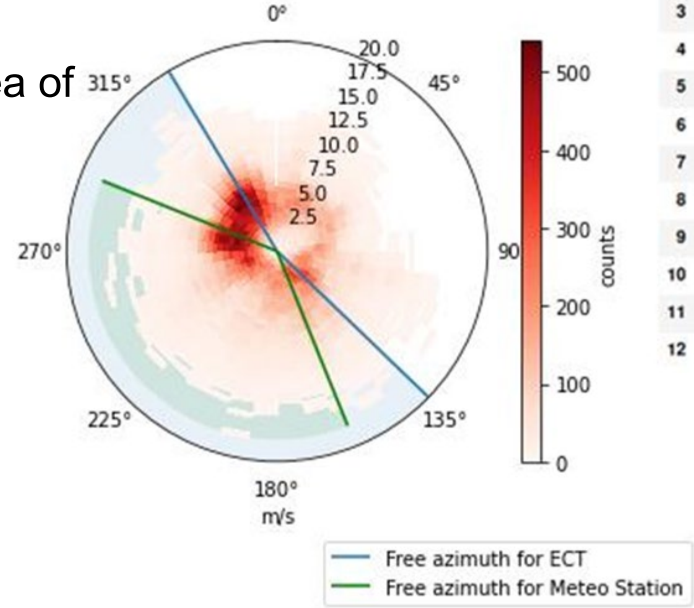
- Requires a homogeneous wind field. Wind coming from a steep slope must be avoided.
- A candidate site was identified in a burned area of the forest, in a flat position (~5°) and with available meteorological data from a nearby weather station (3.5 km).

Candidate site



DTM showing: highland, steep slope, low valley

Meteo station



	2020	2021	2022
1	NaN	0.771358	0.562444
2	NaN	0.608576	0.616551
3	NaN	0.556230	0.492682
4	NaN	0.667440	0.698977
5	NaN	0.806793	0.574860
6	NaN	0.595448	0.726291
7	NaN	0.713450	0.645748
8	NaN	0.691427	0.793305
9	NaN	0.607798	0.650371
10	NaN	0.591093	0.688924
11	NaN	0.658084	0.608507
12	1.0	0.659487	0.594467

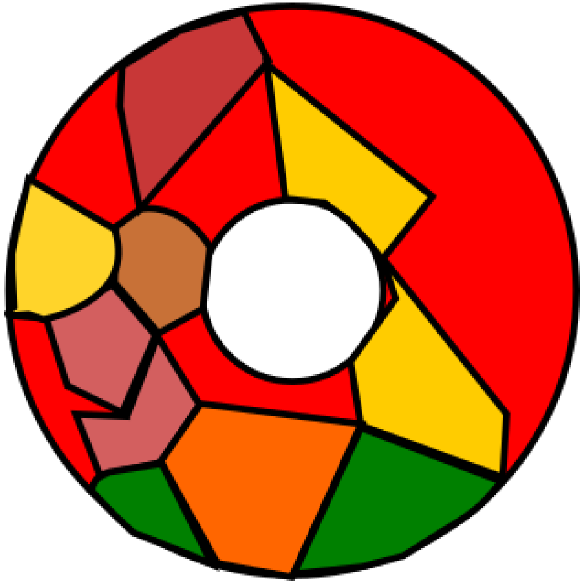
Percentage of wind in sector without highland effect

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Vegetation biodiversity monitoring

- A vegetation survey within the potential annual footprint of the tower, will identify patches of homogeneous vegetation and assess the diversity within them.
- The vegetation survey will be both drone- and man-based.
- For each patch, vegetation structure (e.g., height, cover) and plant community patterns (e.g., richness, diversity, functional diversity) will be measured.
- These structure attributes will be used to inform the spatialisation of the footprint, given their influence on turbulence.

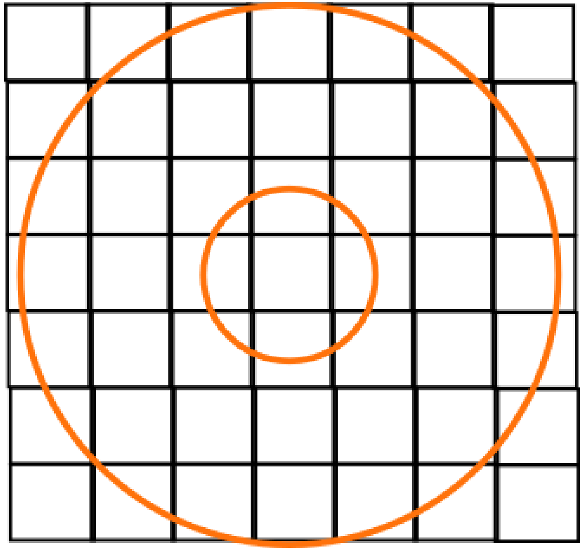


V. Giannico. et al., Contributions of landscape heterogeneity within the footprint of eddy-covariance towers to flux measurements. Agricultural and Forest Meteorology 260–261 (2018) pp. 144–153.

Spatialization of flux footprint

Integrating different sources of information

- Based on the footprint estimate (shown in orange), a 10 m x 10 m grid is constructed using the pixel grid of Sentinel-2 stacks.
- Sentinel-2 (10 m resolution, 2-day frequency) vegetation index time series will monitor total pigment and chlorophyll phenology.
- Phenocam vegetation index time series will help calibrate Sentinel-2 data.
- Prisma hyperspectral time series (30 m, monthly frequency) will target other pigments (e.g., Anthocyanins or Zea/Violaxanthin ratio) and sun-induced fluorescence data.
- A small network of sensors within the station footprint will measure soil moisture and canopy temperature.

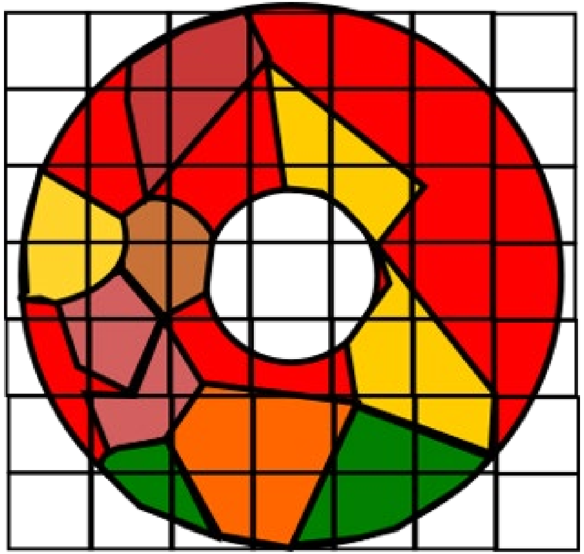


GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Biodiversity partitioning of EC flux

Integration of biodiversity spatial distribution with flux spatial partitioning

- *In situ* measurements of vegetation patches with a flux chamber.
- Calibration of the remote sensing primary productivity model.
- Validation of the EC flux spatial partitioning.
- Assessing the contribution of EC flux budget to the different vegetation patches across seasons and years.



Sharing methodology using LifeWatch VRE

Main inputs for VRE

- eddy covariance (format: EddyPro software output)
- shapefile of vegetation patch with as attribute the relevant feature for analysis
- stack of Sentinel-2 data
- biodiversity surveys (format: Darwin Core)

Optional input

- hyperspectral data
- spatial meteorological data

Implement flux spatialization in open-source code and perform assignment to vegetation patches.

Test robustness of the implementation.

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Seville
22-24/05/23

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

GOBIERNO DE ESPAÑA | MINISTERIO DE CIENCIA E INNOVACIÓN

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa

Thank you! | www.lifewatch.eu/bees-2023