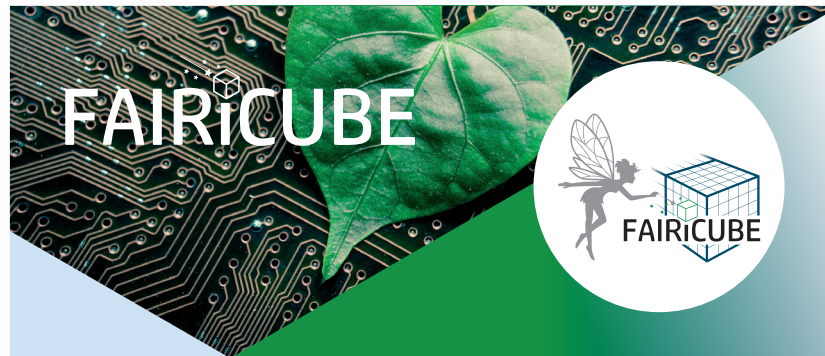


# Flyer FAIRiCUBE

General flyer



**Deliver the power of data cubes and machine learning (ML) to decision/policy makers and data scientists.**

## Why FAIRiCUBE?

There is an ever-increasing amount of earth observation data available, largely in the form of data cubes. The relevant data formats are quite mature, data is (at least partially) freely available, various data processing libraries as well as visualization and data storage tools have been developed. Additionally, compute platforms can be used, they scale well and are becoming affordable.

Despite these relevant evolutions, non-EO experts who would greatly profit by integrating these resources into their work are still struggling to make full use of the available data as well as relevant analysis and processing tools. Diverse aspects continue to confound potential users, such as:

- How to connect different data sources with storage & compute resources? What if you bring your own data?
- What computational aspects must be considered when dealing with gridded spatiotemporal data?
- How can we share tooling such as (trained) machine learning models?
- How do we visualize and share the results with the relevant stakeholders?
- How can we properly document what processing has been applied to the data? How can we include this essential provenance information?

## Our vision

Within FAIRiCUBE, we demonstrate a harmonized data space, the FAIRiCUBE Hub, where we connect all the pieces required for a data science pipeline into a user-friendly framework, where everything is FAIR (Findable, Accessible, Interoperable, Reusable) and TRUSTable (Transparency, Responsibility, User focus, Sustainability, and Technology). In this manner, we illustrate how the Green Deal Data Space (GDSS) could be formed pertaining to gridded data and the analysis thereof.

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## FAIRiCUBE

### FAIRiCUBE HUB

The FAIRiCUBE Hub is a crosscutting platform and framework for data ingestion, provision, analysis, processing and dissemination, tightly integrated to the common European data spaces. As such, the FAIRiCUBE Hub is intended to support domain experts and data scientists to access and analyze pre-processed data without being burdened by technical issues.

It aims to provide an overview of data and processing modules readily available to unleash the potential of environmental, biodiversity and climate data. Potentially, every scientist or decision maker that works with regular discretized spatiotemporal data can benefit from FAIRiCUBE Hub. This way, the power of

data cubes and ML can be unlocked for a wider community. All the elements of the FAIRiCUBE Hub already exist, for example as part of community tools like GitHub or commercial solutions provided through our data cube collaborators rasdaman and EuroDataCube/EOX. We nevertheless need to make sure these elements are interoperable. Like puzzle pieces fitting together, each piece much seamlessly slot into the next piece; where this is currently not possible, we develop shims to enable such seamless integration. Our vision is to define, standardize and if required create these connections.

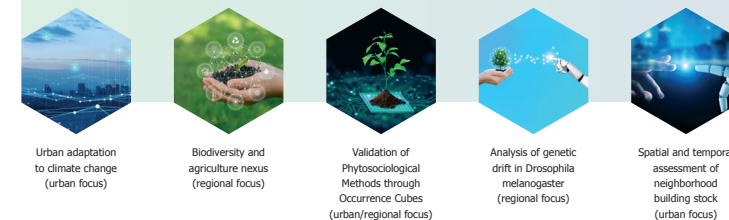


### Use cases

Five Use Cases have been designed to illustrate how data-driven projects can benefit from cube formats, infrastructure, and computational benefits. The requirements from these Use Cases will drive the development of the FAIRiCUBE Hub. The use cases address different aspects such as:

- EU green deal action items
- different scales (urban / regional)
- pilot cities (Barcelona, Vienna, Oslo, Luxembourg)
- using different objectives and technical platforms

### The five use cases are



This project has received funding from the Horizon Europe program of the EU under grant agreement No 101059238. Duration of the project: 2022 - 2025 (36 months).

**Partners:** NILU - The climate and environmental research institute (Coordinator), Epsilon Italia, Natural History Museum Vienna, EOX IT Services, Constructor University Bremen, Wageningen University and Research, 4sfera Innova, space4environment.



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# Flyers FAIRiCUBE

Use case flyer 1



### Use case objective

Climate change poses several challenges to cities, such as droughts, urban heat waves, changing precipitation patterns, floods and (peri-)urban biodiversity loss. These impacts are interrelated with factors like land use activities around cities and the socio-economic setting. Datasets on these factors are available, but they are complex to integrate and analyze due to their heterogeneity, format and quality. The goal of UC1 is to harmonize the diverse datasets into structured data cubes and provide a comprehensive "toolkit" for their analysis.

### Potential applications

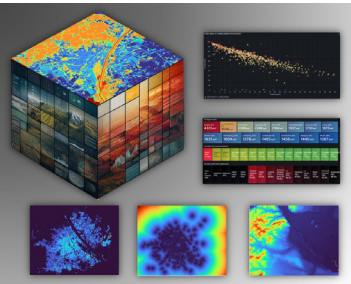
The data analysis toolkit should support European institutions, local policy makers and scientists to make well-informed decisions when addressing climate change's multifaceted impacts. One European data cube collects indicators from different domains for many cities. It can be used to identify cities with similar characteristics, assess climate change impacts across the continent and the influence of different factors on cities adaptation capacity.

On the local scale, we work closely with city municipalities to create city cubes and define specific goals. For example, study the effects of various environmental variables on perceived temperature. Where possible, solutions developed for one city will be scaled to other cities.

### The data cubes

The European data cube contains data from the climate, land and socio-economic domains. Clustering analysis has been employed to discover cities that are similar with respect to the impact of climate change and their adaptation strategies. This dataset is available [here](#).

To understand the effect of covariates on perceived temperature, the first step is to have an accurate measure. We aim at achieving it by integrating in the city cube weather station data. Where no station is available, the values will be predicted based on land surface temperature, DEM and other variables.



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General information - About Faircube

The five use cases are

Urban adaptation to climate change (urban focus)

Biodiversity and agriculture nexus (regional focus)

Validation of Phytosociological Methods through Occurrence Cubes (urban/regional focus)

Analysis of genetic drift in *Drosophila melanogaster* (regional focus)

Spatial and temporal assessment of neighborhood building stock (urban focus)

### Deliver the power of data cubes and machine learning (ML) to decision/policy makers and data scientists.

**Why FAIRiCUBE?**  
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Despite these relevant evolutions, non-EO experts who would greatly profit by integrating these resources into their work are still struggling to make full use of the available data as well as relevant analysis and processing tools. Diverse aspects continue to confound potential users, such as:

- How to connect different data sources with storage & compute resources? What if you bring your own data?
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### Our vision

Within FAIRiCUBE, we demonstrate a harmonized data space, the FAIRiCUBE Hub, where we connect all the pieces required for a data science pipeline into a user-friendly framework, where everything is FAIR (Findable, Accessible, Interoperable, Reusable) and TRUSTable (Transparency, Responsibility, User focus, Sustainability, and Technology). In this manner, we illustrate how the Green Deal Data Space (GDDS) could be formed pertaining to gridded data and the analysis thereof.

### Objective

The objective of the FAIRiCUBE project is to enable players from beyond classic Earth Observation (EO) domains to provide, access, process, and share gridded data and algorithms in a FAIR and TRUSTable manner.

This project has received funding from the Horizon Europe program of the EU under grant agreement No 101059238  
Duration of the project: 2022 - 2025 (36 months).  
**Partners:** NILU - The climate and environmental research institute (Coordinator), Epsilon Italia, Natural History Museum Vienna, EOX IT Services, Constructor University Bremen, Wageningen University and Research, 4sfera Innova, space4environment.


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# Flyers FAIRiCUBE

Use case flyer serie

FAIRiCUBE

Use Case 1



Urban adaptation to climate change

A FAIRiCUBE use case by Wageningen Research

**Use case objective**

Climate change poses several challenges to cities, such as droughts, urban heat waves, changing precipitation patterns, floods and green urban biodiversity loss. These impacts are interconnected with factors like land use activities around cities and the socio-economic setting. Depending on these factors and models, but they are complex to integrate and analyse due to their heterogeneity, format and quality. The goal of UCL is to harmonize the diverse datasets into structured data cubes and provide a comprehensive "toolbox" for their analysis.

**The data cubes**

The European data cube contains data from the climate, land and socio-economic domains. Challenging analysis has been employed to discover sites that are similar with respect to the impact of climate change and their adaptation strategies. This dataset is available [here](#).

To understand the effect of covariation on perceived temperature, the first step is to have an accurate measure. The aim of achieving it by integrating in the city cube weather station data. Where no station is available, the values will be predicted based on land surface temperature, DEM and other variables.

**Potential applications**

The data analysis toolbox should support European institutions, local policy makers and scientists to make well-informed decisions when addressing climate change's multifaceted impacts. One European data cube collects indicators from different domains for many cities. It can be used to identify cities with similar characteristics, assess climate change impacts across the continent and the influence of different factors on cities adaptation capacity.


On the local scale, we work closely with city municipalities to create city cubes and define specific goals. For example, study the effects of various environmental variables on perceived temperature. Where possible, solutions developed for one city will be scaled to other cities.



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Use Case 2



Biodiversity and agriculture nexus

A FAIRiCUBE use case by Wageningen Research

**Objective**

The main aim of Use Case 2 is to investigate the impact of agricultural activities on the environment (e.g., soil, groundwater, emissions etc.) and further on biodiversity. Within the use case customised machine learning tools are utilised within data cube-based information. The expected results are related to land use activities and data pipelines including a prototype of a model that predicts causal relations between changes in farmland biodiversity and specific agricultural practices in the Netherlands.

**Approach**

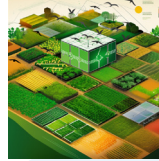
Three main data categories (biodiversity, environment and agriculture) are handled primarily within their individual processing flows and data cubes, which are then ultimately merged using causal machine learning. Modelling methods such as causal inference and discovery provide insights into the underlying mechanisms describing the impact of agricultural practices on biodiversity. They do not only statistically predict the correlations but also provide meaningful explanations for these predictions, enhancing the overall interpretability of the model results.

All the tools are expected to be provided within FAIRiCUBE hub as shared data infrastructure and documented. [FAIRiCUBE Hub](#) | [FAIRiCUBE Jobs](#)

**Applications**

The established model can be used by decision makers in agriculture and environmental protection by supporting better-informed decisions such as selecting more relevant indicators practices promoting biodiversity through specific applications:


- **Spatial categorization:** The results of the observation and estimation steps for biodiversity can be used to categorize agricultural landscapes and e.g. administrative regions, based on predicted scenarios.
- **Causal modelling:** Causal modelling allows reasoning about potential situations to answer "What if?" type of questions and creating scenarios for farmland landscape development considering biodiversity favorable conditions.
- **Smart tools:** The presented approach aims at improved understanding of causalities between farm activities and changes in biodiversity. When results are sufficiently robust, the model could be incorporated into advisory tools for farmers or policy makers, to help assess the consequences of actions.



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Use Case 3



Environmental Adaptation Genomics in Drosophila

A FAIRiCUBE use case by Natural History Museum Vienna

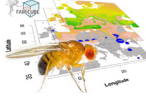
**Use case objective**

The objective of Use Case 3 is to integrate genomic data of the fruit fly *Drosophila melanogaster*, which is one of the best-studied model organisms and a model for human evolution, with comprehensive environmental and climate information. This multidisciplinary approach aims to identify how environmental factors shape genetic variation and influence evolutionary processes. Taking benefit from already available and newly generated genomic datasets from European and North American populations, the study has two major goals:

1. To assess the influence of geographic, environmental and climate on genetic variation on selected fly populations as a continent-wide scale. By correlating population genomics with environmental data, the study aims to uncover genetic targets affected by environmental selection pressures.
2. To address the impact of urbanization on genetic variation and adaptation considering factors such as soil sealing, pollution, and habitat fragmentation. Understanding how urban environments affect genetic variation and adaptation to our civilisation ongoing biodiversity loss and climate change.

**Possible future applications**


Overall, Use Case 3 aims to advance our understanding of the relationship between genetic variation, environmental factors, and evolutionary processes. By integrating diverse datasets and employing innovative analytical techniques, the study seeks to shed light on the mechanisms driving adaptation in *D. melanogaster* populations, with broader implications for biodiversity conservation and pest management strategies in the face of global environmental changes.



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FAIRiCUBE

Use Case 4



Spatial and temporal assessment of neighborhood building stock

A FAIRiCUBE use case by RUB

**Use Case objective**


UCL addresses the pressing need to evaluate and map the potential for energy retrofitting and circularity in residential buildings to align with the European Union's ambitious climate goals.

Currently, buildings are major contributors to both energy demand and greenhouse gas emissions. These sustainable practices in construction build grounds for reducing environmental impact, enhancing resilience, and averting raw material price hikes.

However, a significant challenge lies in the scarcity and fragmentation of data on building materials and properties. This gap impedes informed decision-making on investments and the promotion of circular and local materials.

**Possible applications**


UCL aims to bridge this divide by developing an agile model which enables the assessment of in-situ materials, energy performance, and emissions of residential building stocks. The model will allow to estimate optimal renovation rates and evaluate the climate neutrality potential in four European cities: Barcelona, Luxembourg City, Oslo, and Vienna. These assessments may also be adapted for optimization work, considering local constraints such as financial and climate budgets, as well as the decarbonisation of energy sources. Researchers, analysts, city planners, and sustainability consultants may find the developed model useful. In addition, the developed model is crucial for the EU Green Deal to achieve energy efficiency, reduce emissions, and promote sustainable construction.



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Use Case 5



Validation of Phytosociological Methods

A FAIRiCUBE use case by

**Objective**

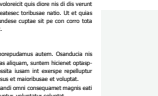
UCL measures ecological data cubes to assess the impact of land use changes on biodiversity. The data cubes contain information on the spatial distribution of plant species and their environmental requirements. The data cubes are used to assess the impact of land use changes on biodiversity and to develop strategies for biodiversity conservation.

**Approach**

Based on the data cubes, the study aims to develop a model that can predict the impact of land use changes on biodiversity. The model will be used to assess the impact of land use changes on biodiversity and to develop strategies for biodiversity conservation.

**Applications**

The model will be used to assess the impact of land use changes on biodiversity and to develop strategies for biodiversity conservation.



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