

## IS-ENES3 Deliverable D2.3

### Final Report on Innovation

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### ABSTRACT

Innovation on data and data services described here is delivered through training activities which enable access, through service on tools, and through services on data. Additional innovation on HPC, Models and Tools is described in detail in a separate deliverable and summarised here.

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## Executive Summary

This report covers innovation on data and data services through networking (WP3), services (WP7), and research and development (WP10) and provides a brief summary of innovation on HPC, Models and Tools which is reported on in more detail in D4.5 White paper on innovation on tools, platforms, and techniques.

Innovation arises both through exploitation of IS-ENES3 outputs and through IS-ENES3 activities which promote or enable the wider use of assets managed by the infrastructure.

Innovation on data and data services described here is delivered through training activities which enable access, through service on tools, and through services on data. Additional innovation on HPC, Models and Tools is described in detail in a separate deliverable and summarised below.

## 1. Introduction

This paper covers in full networking activities carried out in WP3, innovation enabled through services in WP 7, and transfer of new capabilities developed in WP10 into the commercial and operational sectors and provides a summary of activities related to tools, platforms and service which are covered in full in D4.5.

### Foreground and Background

Innovation, for the EC, is the process of bringing research knowledge into practical use. IS-ENES3, as a community networking and support activity, is not only applying innovation to new knowledge developed within the project (foreground), but also to knowledge of partners (background) and community knowledge.

## 2. Methodology and Results

Innovation on data and data services has taken place through community engagement activities which give people the knowledge and skills needed to exploit data assets in the ENES Climate Data Infrastructure (CDI) and through service activities which deliver ENES CDI assets to a broad spectrum of users, many of them outside the research sector, and through the development of new standards and services which make data more accessible.

### 2.1 Innovation on data and services

#### WP3 Community engagement

As part of this WP several workshops and short and longer training sessions were organized. We focused especially on young impact researchers and people working for climate services providers (commercial and public sector), but climate researchers were also welcome. We also paid special attention to reaching these target groups in Eastern European countries.

Participants to these activities from national meteorological, hydrological and environmental institutes and companies often also work on the development of climate services for society. It is expected that they can use the information from the schools for their climate service development. However, also some researchers at institutes or universities work on the development of (operational) climate services. Although we did not ask specifically whether participants expected to use the information from the organized activities, we know from conversations with some individual participants that they will use it to develop and improve climate services. Below some information about various activities is given and the number of participants from national meteorological, hydrological and environmental institutes and companies is specified.

- [Impact schools and data school \[Task 3.2, KNMI, Activity\]](#)

In 2020 and 2021 the IS-ENES3 consortium organized three virtual Schools on ‘Climate data use for impact assessments’ (<https://is.enes.org/training-detailed/#autumn-school>, <https://b4est.eu/virtual-schools-on-climate-data-use-for-impact-assessments>). The aims of the schools were:

- To make knowledge of the IS-ENES consortium available for future scientists all over Europe (e.g. on standardization, ESMValTool, C4I portal);
- To give VIA-researchers (Vulnerability, Impact and Adaptation), climate services providers, etc. basic knowledge for working with climate data;
- To enhance interaction between climate scientists and impact researchers.

Each course comprised 56 study hours for six weeks. The lectures were provided by members of the IS-ENES3 consortium. The participants spent 20 hours on case studies in groups of 2 or 3 persons, combining climate science with impact expertise. Each course was followed by an anonymised evaluation survey.

In the table below the distribution of the participants over the schools is given. Besides universities/PhD candidates, there were also a considerable number of participants from (governmental) research institutes, national meteorological, hydrological and environmental institutes and some companies. The report on the schools (D3.2) indicates how the participants rated the schools, although not specified per type of organization they are working for. Evaluation forms showed that the participants valued the courses highly, especially the work on the case studies. All lectures were seen as useful or very useful. The more practical lectures were valued the highest. When asked if the participants expected to use the knowledge from the schools in the next 6 months, in each school, a large majority said yes, a minority said maybe and no one answered no. In 2022 a EGU session on “From vision to action: transdisciplinary approaches for providing climate change impact and adaptation information and capacity development” (under the themes “climate and society” and “Inter- and transdisciplinary sessions”) was organized where five participants from the impact schools presented their work. Through a LinkedIn group the participants also stay in contact with each other.

The results of the evaluation were also used to plan further short training sessions such as the clinic on bias adjustment, the webinar and workshop on ESMValTool and the spring school in Romania (see below).

	Impact schools			Data school
	Autumn school	Spring school	Summer school	
University (and directly linked institutes; PhD and researchers)	8	12	12	30
Research institutes (governmental or other)	5	6	5	7
Companies	3	1	3	2
Meteorological Institute	4	0	1	1

In September 2022 a data science summer school was organized (<https://is.enes.org/training-detailed/#ds-school>). Also in this school many researchers participated, but also 3 persons from national meteorological institutes and companies.

- [Short trainings/schools/demonstrations \(Task 3.1\)](#)

Several short trainings/courses were organized a.o. to give more information/training on tools (further) developed by the IS-ENES projects. Also these activities aimed to reach (young) scientists (climate, impacts) and those working on climate services. The last group contains especially people working for companies (commercial and non-profit) and meteorological and hydrological organizations and environmental agencies.

During the period 2020-2022 some online meetings were organized, from which we have information on the type of participants/subscribers, presented in the table below. The workshops on climate indices for Eastern Europe were organized as part of the project plan (<https://is.enes.org/workshops-detailed/#climate-indices> and M3.5<sup>1</sup>). The webinars and online trainings were organized (<https://is.enes.org/training-detailed/#virt-clinic>, <https://www.emetsoc.org/events/event/esmvaltool-webinar-and-online-workshop/>), based on the additional requests from the impact schools. The majority of the participants worked as researchers either at universities or research institutes, however, there were also a considerable number of participants from meteorological, hydrological and environmental institutes/agencies, who may use the information to improve their services to society<sup>2</sup>. The clinic on bias-adjustments of climate model data also attracted 10 persons from commercial companies. No explicit evaluations from

<sup>1</sup> [Report: Workshop on climate indices - Eastern Europe perspective](#)

<sup>2</sup> An example: the information on bias correction methods is also used by the Dutch Meteorological institute to decide which methods fit best for tailoring of climate information for the new KNMI'23 scenarios.

these webinars were carried, however, the large number of subscribers indicated that these subjects were interesting to a large number of persons (the recorded webinars and presentations were made available to all subscribers).

	Workshop climate indices Eastern Europe	Bias adjustment clinic	ESMValTool webinar	ESMValTool online training
University	21	58	36	29
Research institutes	21	48	42	20
Companies	2	10	1	1
Meteorological, hydrological environmental institutes/agencies	30	25	28	14

In May 2022 a 3-day school on climate data processing and climate data for impact assessments was organized in Romania (<https://is.enes.org/training-detailed/#ee-school>). This school had more hands-on training with some specific climate data tools, as requested in the evaluation of the impact schools (one participant from the impact school participated too). The majority of the participants were working for universities, however also 10 participants were from meteorological institutes from various Eastern European countries. One day the participants worked on case studies, such as estimating the impact of climate change on agricultural production or the impact of the increase of extreme rainfall in cities, which can also be used to develop climate services.

## WP7: Data standards, distribution and processing services

- [Delivery of data to non-academic users by core data service](#)

Analysis of registered users at CEDA identified 18,000 non-academic users<sup>3</sup>. A survey was published to ask non-academic users about their use of the services. The survey was posted on CEDA’s web site and social media channels, but achieved disappointing results: no responses were received. We concluded that non-academic users were not being reached through the channels used to advertise the survey. The option of mailing the 18,000 users was considered, but eventually rejected because CEDA does not have an established mechanism for mass mailings at this scale.

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<sup>3</sup> This is the number of non-academic users registered for all CEDA services.

This experience delivered an important lesson: despite having large numbers of non-academic users, CEDA does not have a clear means of mass communication with users. This limitation shows that more effort is needed if we are going to build and maintain a meaningful relationship with the broad community of non-academic data users.

- [Delivery of data to non-academic users through specialist support and services](#)
- Work with C3S Climate Data Store (CDS) to provide access to CMIP and CORDEX data (see Figure 1). The C3S aims to provide consistent and authoritative information about climate change supporting adaptation and mitigation policies. Through this activity, IS-ENES3 is facilitating access to climate model data for C3S users, including scientists, consultants, planners and policymakers, the media and the public. IS-ENES3 partners have been and continue to be funded by C3S to deliver a range of added-value services which allow the CDS users to exploit climate projections:
  - Improved level of service through mirroring of delivery systems.
  - Improved quality control.
  - Bespoke documentation.
  - On-demand processing services to support data integration into CDS applications.
  - Software tools to automate the creation of climate indices.

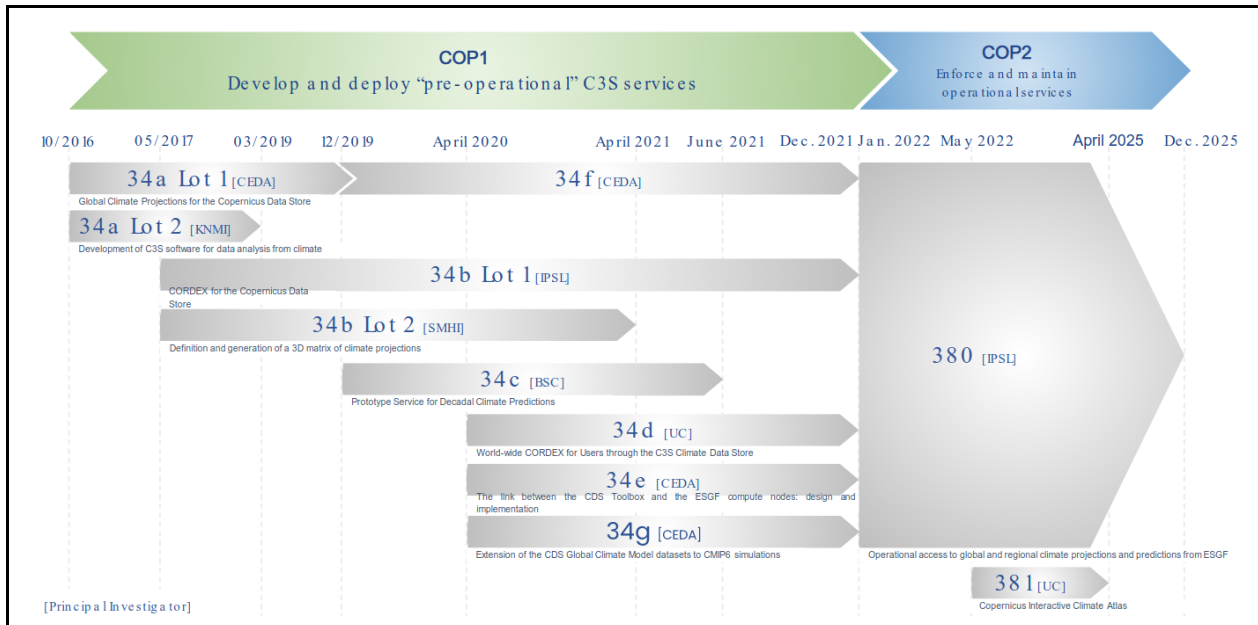


Figure 1: Overview of contributions by IS-ENES3 partners to the C3S Climate Data Store, taken from [Levavasseur \(2023\)](#). Each arrow represents a separate C3S project funded through an open invitation to tender. IS-ENES3 partners also contributed to additional projects in the C3S Quality Control and Sectoral Information Services using knowledge and expertise developed in IS-ENES3.



- Work with the Climate Data Factory has supported the production of downscaled information for the Coupled Model Intercomparison Project phase 5 (CMIP5) and Coordinated Regional Climate Downscaling Experiment (CORDEX) using data obtained from ESGF services (delivered by WP7) and a statistical downscaling tool developed by CNRS-IPSL. This work supported production of commercial products by The Climate Data Factory.
  - [Training on use of ENES CDI services and applications](#)
- Training on the ESGF downloader "synda": ease data downloads from the ESGF for all users in a user-friendly way. This activity facilitates the replication of CMIP and CORDEX data to multiple host institutions, supporting access by a broad user community which spans academic and non-academic users.
- Training on data traceability through the ES-DOC ecosystem: increases analysis consistency by comparing model schemas and tracking dataset modifications. The error-reporting facility was of particular interest to climate service and climate assessment stakeholders.

## 2.2 Innovation on HPC, Models and Tools

Innovation on HPC, Models, and Tools is reported in detail in D4.5 White paper on innovation on tools, platforms, and techniques<sup>4</sup>. The paper covers networking (in WP4), services (in WP6), and development work on OASIS, Cylc, NEMO, and the Unified European platform for sea ice modelling (in WP8).

Two principal pathways for innovation were identified:

- Feeding into well-established innovation workflows in operational weather and oceanography centres where efficient coordination between operations and research ensures that research outcomes can feed smoothly into enhancements of operational services.
- Feeding through to non-academic users through established user networks.

The close relationship between research and operational services within NWP centres was identified as a strength in enabling efficient innovation with the caveat that it makes measuring and reporting of innovation difficult.

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<sup>4</sup> Final draft: <https://docs.google.com/document/d/19aN626JkQBleIcV9HhyZT9EUfD1mij3a/edit>

## **3. Conclusions and Recommendations**

### **3.1 Highlights**

A strong relationship between IS-ENES3 and the Copernicus Climate Change Service (C3S) has been established, resulting in strong innovation with project partners delivering a range of bespoke data and metadata products to C3S in order to facilitate the exploitation of information available in the CMIP and CORDEX research archives.

Within the HPC, models and tools area of work, a large amount of innovation took place through the existing structures in national weather and oceanography centres where there is good coordination between research and operational activities. The strong representation of these operational centres in the IS-ENES3 consortium enabled efficient exploitation of this innovation pathway.

### **3.2 Recommendations**

Training which informs potential users outside the research community of the potential benefits of tools developed and promoted by IS-ENES3 has been a strong source of innovation and should be continued where possible. This is the case for data but also for software tools.

There is a need for improvement in our ability to engage with the thousands of non-research users who access our infrastructure.

Partnership with C3S has provided a rich and effective innovation pathway and the relationship should be promoted and strengthened.