

PathOS

Open Science Impact Pathways —

Attributing
Academic, Societal and Economic impact
to Open Science

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Athena RC | OpenAIRE | OPIX

Open Science promises significant
academic – **societal** – economic benefits

Are our plans
working?



Image : [Envato Elements](#)

Investments, expectations & returns

eOSC OBSERVATORY

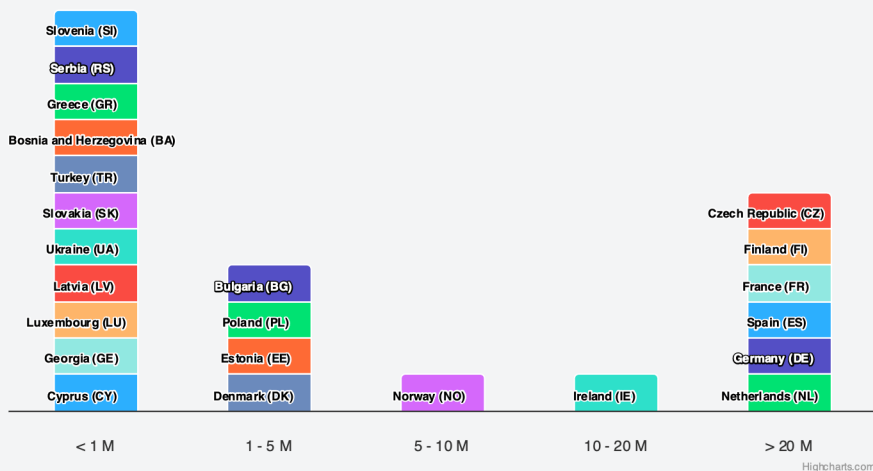
Total amount of financial investments in EOSC and Open Science in 2021 (in millions of Euro)

400.89 M

2022

Country investments in EOSC and Open Science

(in ranges)



- Impact comes in many shapes and forms, very often **intangible**
- Are we investing in the right **instruments** to truly realize the promise?
- Are we achieving **expected** outcomes?
- What key pathways and **enablers** are driving the impact?
- How can we measure and **monitor** impacts and accurately **attribute** them to Open Science?

PathOS Objective

Identify and quantify the **Key Impact Pathways of Open Science** across academia, society, and the economy to enhance understanding and drive informed policy-making.

Beyond state of the art

- Map the **Causal Pathways** for Open Science
- Design and estimate **OS Impact Indicators** for selected case studies
- Use **data-driven, AI-assisted** methodologies
- Formulate a **Cost-Benefit Analysis** framework for Open Science



Universidade do Minho

Pathos

— Open Science Impact Pathways

Programme: Horizon Europe

Call: HORIZON-WIDERA-2021-ERA-01

Type of Action: Research and Innovation

Topic: Modelling & quantifying the impacts of Open Science practice

Grant Agreement No.: 101058728

Duration: Sep 2022 – Aug 2025

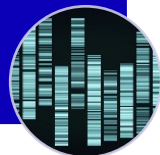


Funded by
the European Union

Based on Investigative Case Studies

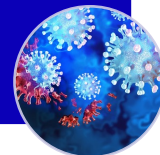
Innovation from
Open Research
resources - ELIXIR

Bioinformatics



Open Science
practices during
the Covid-19
pandemic

COVID-19



Emerging AI:
Impact on
Climate and
Gender through
Open Science

**Emerging
Topics**



Cross cutting
effects due to
open research data
from national
repository

**EASY – The
Netherlands**



Research data and
knowledge use /
uptake in non-
academia

FRANCE



Accelerating
collaborations
within academia &
industry

**RCAAP -
Portugal**



Key Outputs

<https://pathos-project.eu/>



01

Frameworks

- OS Impact Pathways
- Cost-Benefit Analysis for OS

04

Case Study Deep Dives

- OS impact assessments, Causality focus
- Cost-Benefit evaluations (*Elixir UniProt & RCAAP case studies*)

02

Handbook of OS Indicators

- Indicator "Recipes"
- Tools and Datasets

05

Training & Engagement

- Training for policy-makers & research administrators

03

Literature Insights & Registry

- Lit Review on OS impacts
- Online registry of OS stories

06

Recommendations

- Guidelines and best practices
- Project-derived insights



Literature Review

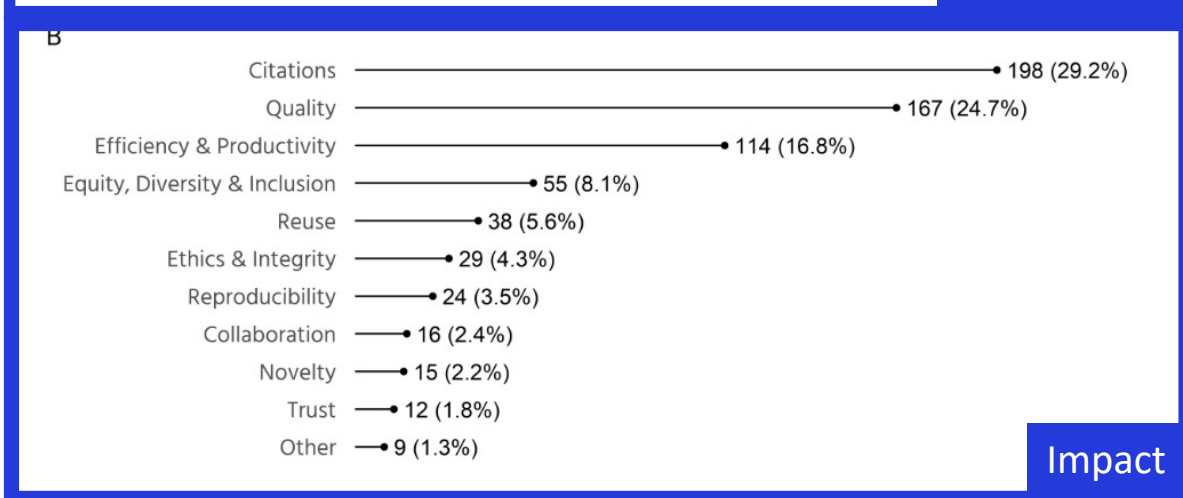
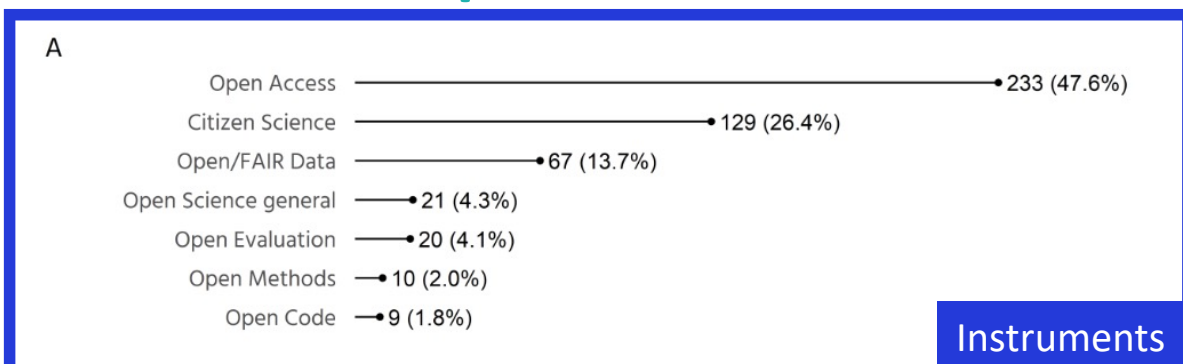
Existing evidence for Impact

725 Scientific Papers

https://www.zotero.org/groups/5331667/the_academic_societal_and_economic_impacts_of_open_science/library

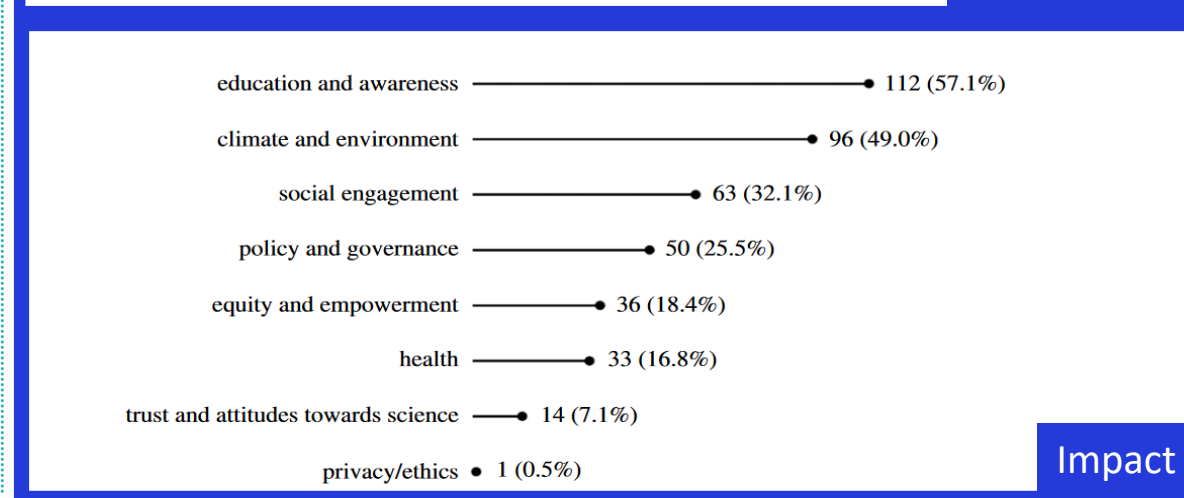
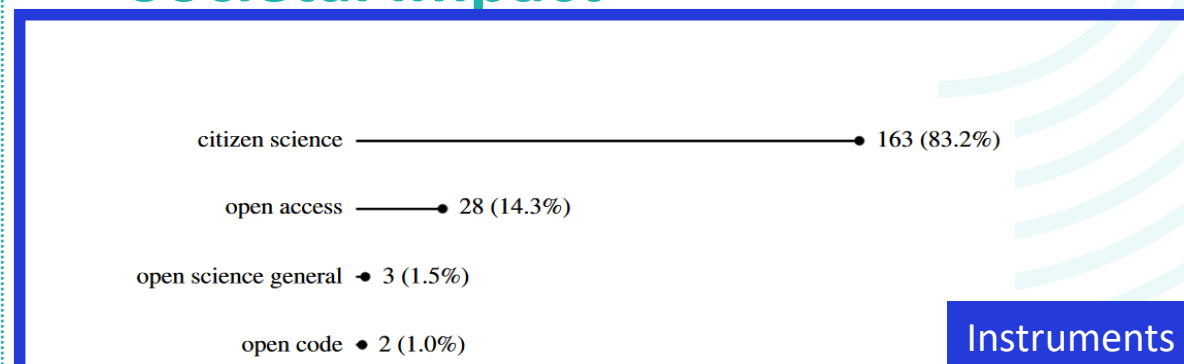
Existing Evidence

Academic Impact



Mechanisms that drive impact: public participation, collaborative creation of data, uptake of data and stakeholder engagement

Societal Impact



Existing Evidence

Economic Impact

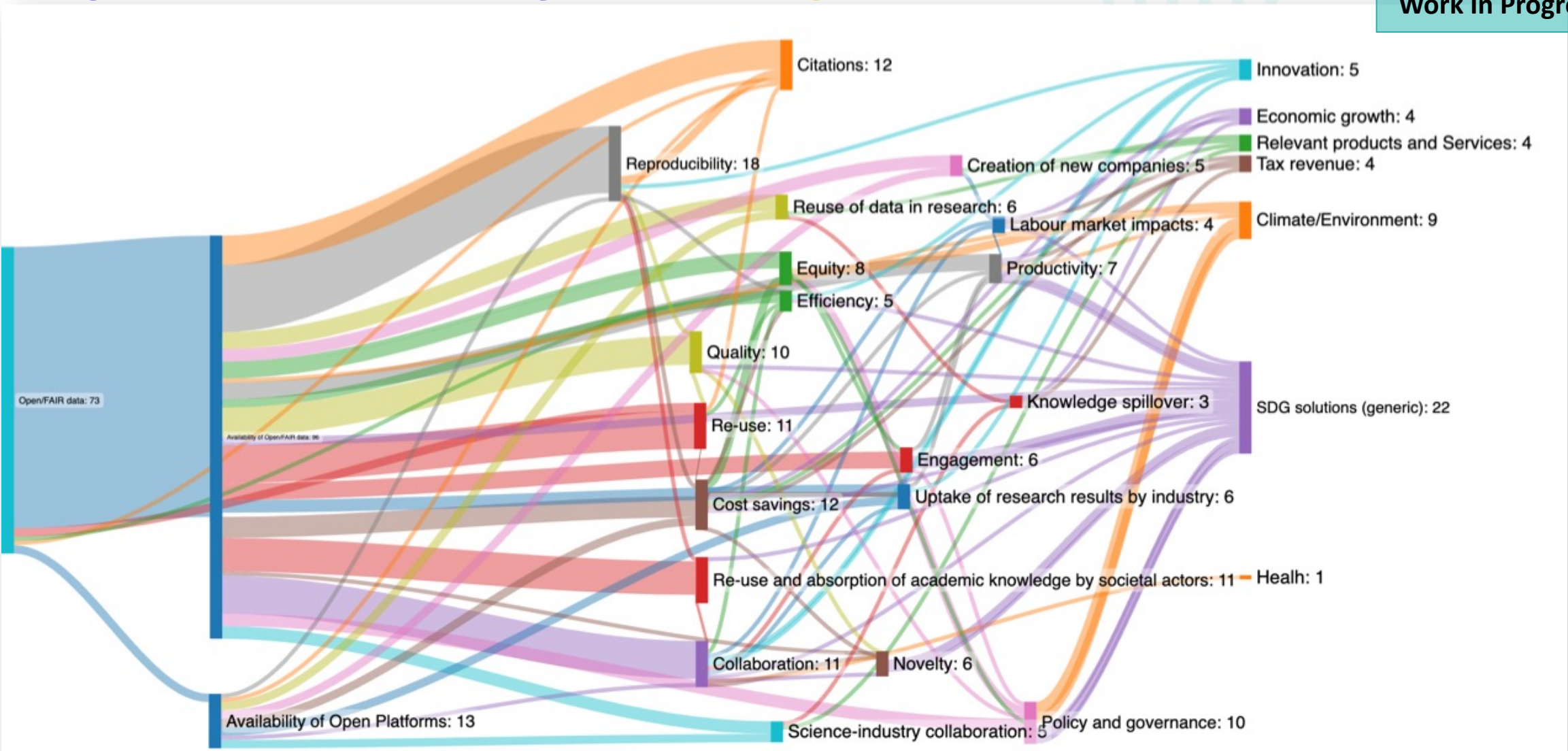
- Scarce company data
- Many theoretical papers on expected gains, but **few with real evidence**
- Most papers on Open Science, OA and Open Data, **few** on Citizen Science, Open Source or Open Code
- Most evidence comes from the **medical and biotech** sector

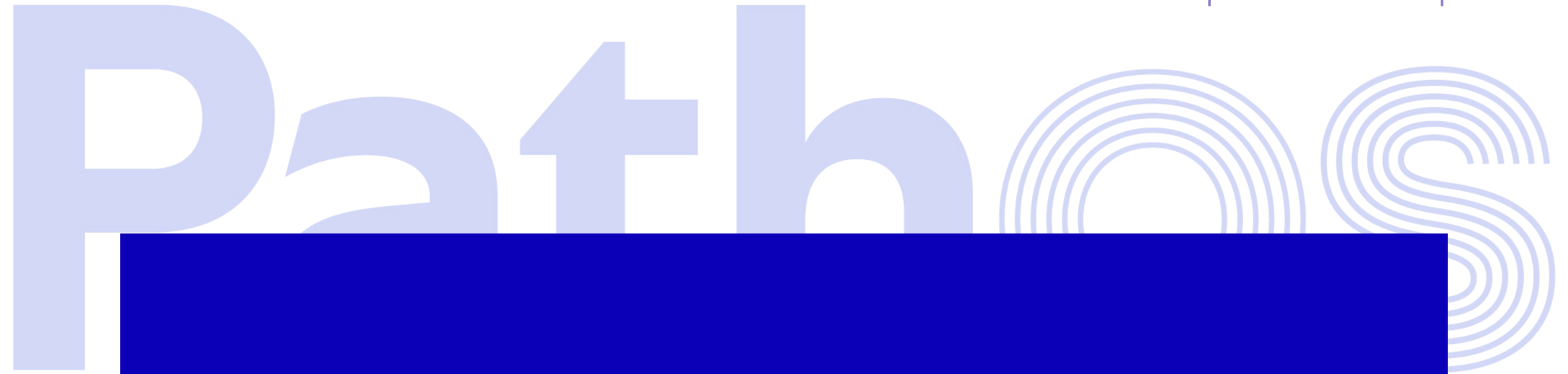
Challenges & Implications

- **Lack of Standards:** No clear definitions for OS impact
- **Causality/Correlation:** Hard to directly measure impact relationships
- **Knowledge Gaps:** Robust evidence missing in many areas, “streetlight effect”

Impact Pathways for Open Data

Work In Progress





Quantifying Impact - Indicators & Causality

Indicators - State-of-the-Art

- **Academic:** Well-developed for traditional metrics, e.g., citations
- **Open Science:** Practices are well-covered. **Training** and **policies** need better indicators
- **Reproducibility:** Challenging to measure. Some indicators under development - *collaboration with TIER2 project*
- **Societal & Economic Impact:** Less developed and harder to measure

Use of Proxies

Academic Impact	Societal Impact
Readership impact	Uptake in and impact on to societal issues
Citation Impact	Uptake by media
Collaboration intensity	Scientific literacy
Diversity	Uptake by policy makers
Extra-academic collaborations	Reproducibility
Interdisciplinary	Introduction to Reproducibility
Economic Impact	Consistency in reported numbers
Science-industry collaborations	Impact of Open Code in research
Innovation output	Impact of Open Data in research
Socially relevant products and services	Inclusion in systematic reviews or meta-analyses
Economic growth of companies	Level of replication
Labour market impact of Open Science	Polarity of publications
Cost savings	Reuse of code in research
	Reuse of data in research

Causality - Challenges

- **Complex Relationships:** Multiple factors make establishing direct causal links difficult
 - Example of confounding factors:** Increased collaboration after Open Data policies could also be due to more funding or training, complicating attribution
- **Causal Thinking in Interpretation:** Indicators alone are insufficient—interpreting their significance requires understanding **causal pathways**

Pathways

Case Study – France Open Science Infrastructure



recherche.data.gouv.fr

Impact of Open Science – Platform Access Logs

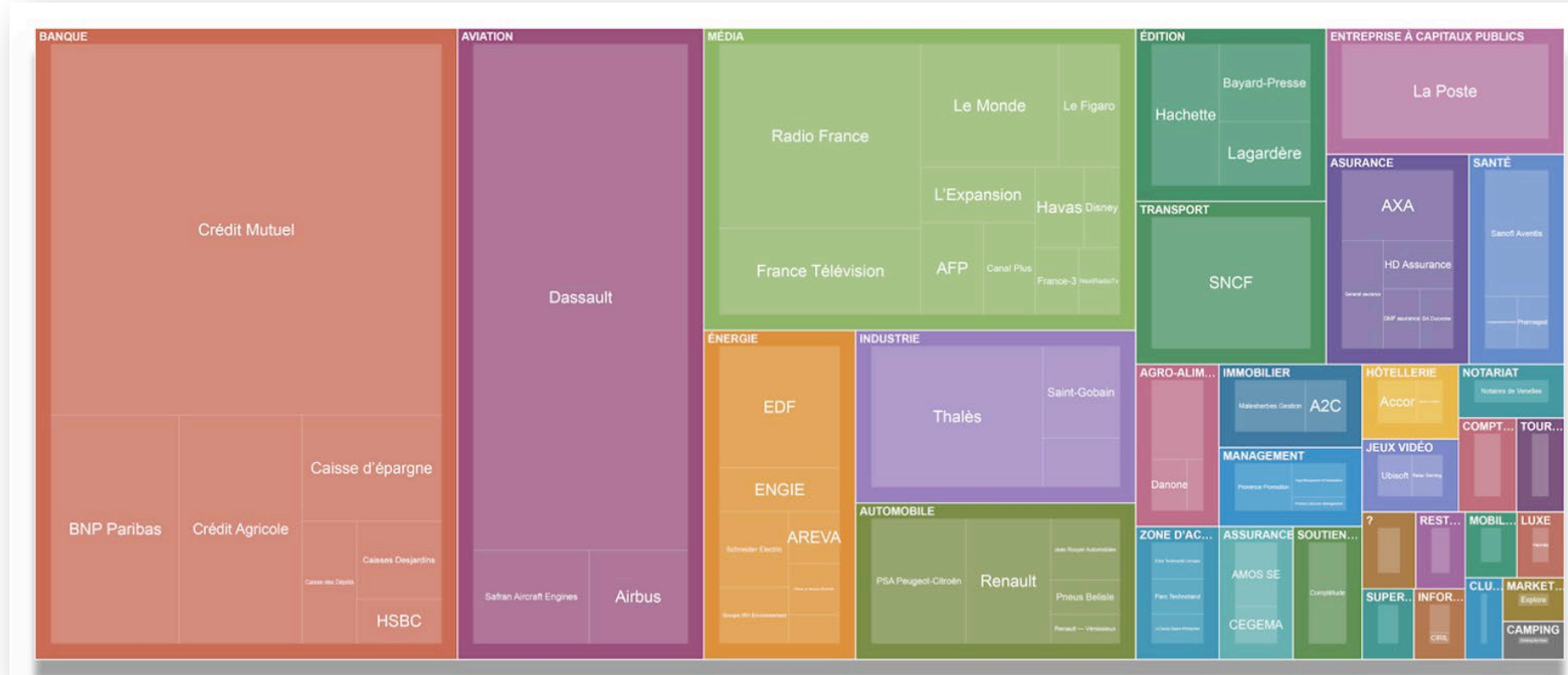
Simply put: **Who** accesses, **What**, from **Where**?

The diagram illustrates the structure of platform access logs for three entities: OpenEdition, HAL (science ouverte), and recherche.data.gouv.fr. The logs are organized into three main categories, each with a list of specific data points:

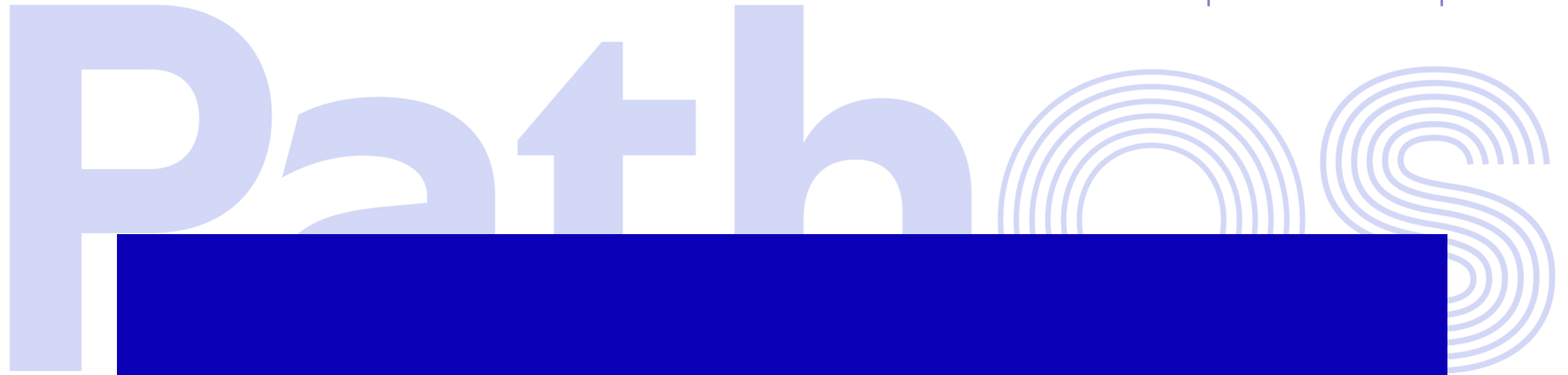
- WHICH SCIENTIFIC RESSOURCES**
 - Genre
 - Discipline
 - OA status
 - Language
 - Year
- ARE ACCESSED BY WHOM**
 - IP-based typology of viewers
 - Date/time
 - Location
- ARE SHARED BY WHOM**
 - Referer-based typology of citers
 - Date/time
 - Language

Uptake by Enterprises

Work In Progress



Color: Type of enterprise (bank, aviation, media, etc.)
Size: Number of times an OA article or dataset was accessed



Case Study –
Emerging AI trends in climate change



Emerging AI Topics in Climate Change – What

- 1. Impact on Innovations:** Assess how **different OA routes influence** the development of AI methodologies and tools applied to climate research
- 2. Gender Analysis:** Measure the effect of OA on gender equality, specifically on **women's representation as authors**

Emerging AI Topics in Climate Change - **How**

Harness the power of big data and deep learning

- **OpenAIRE Graph:** 180 mi publication records & 4 mi projects
- **PATSTAT:** 200 mi records from **PATSTAT**

Benefits

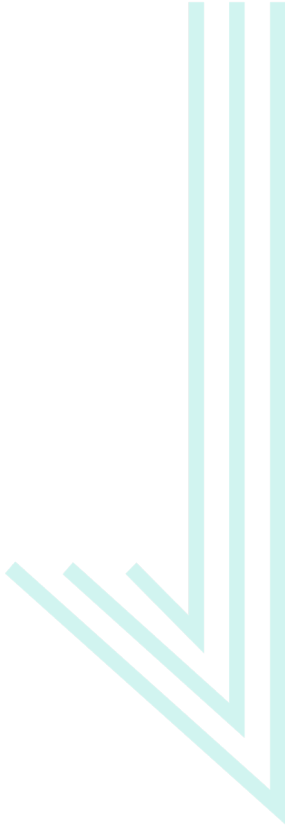
- **Policy Impact:** Evidence-based, **novel AI-driven indicators**, informed decision-making
- **Causality Insights:** Causal links, **not just correlations**
- **Transparency & Reproducibility:** Based on **open data** — enabling transparency, validation, reuse

Emerging AI Topics in Climate Change - How

1. Establish **causality** by building **control groups** to make meaningful comparisons, accounting for OA routes, funding types, gender mandates, etc.
2. Enable **rich pathway analysis at every step**
3. Track **end-to-end research journey**, from funding to publication, from citations to technological innovation
4. Track **technological innovations** and **emerging interdisciplinary topics**: Fields of Science, Emerging Technologies for **Green and Digital**, Technology adoption
5. Assess **equality and diversity** within research fields via author gender representation


PathOS Moving Forward

- Develop “**causal indicators**” for inclusion in the PathOS Handbook
- Have **causality narratives for all case studies**
- Address **causality** in our frameworks
- Deliver **Cost Benefit Analysis methodology** for Open Science



Feedback & Dialogue

Join Us



Training Programme

Coming in Q4/2024


A training programme for policy makers, policy officers and research administrators

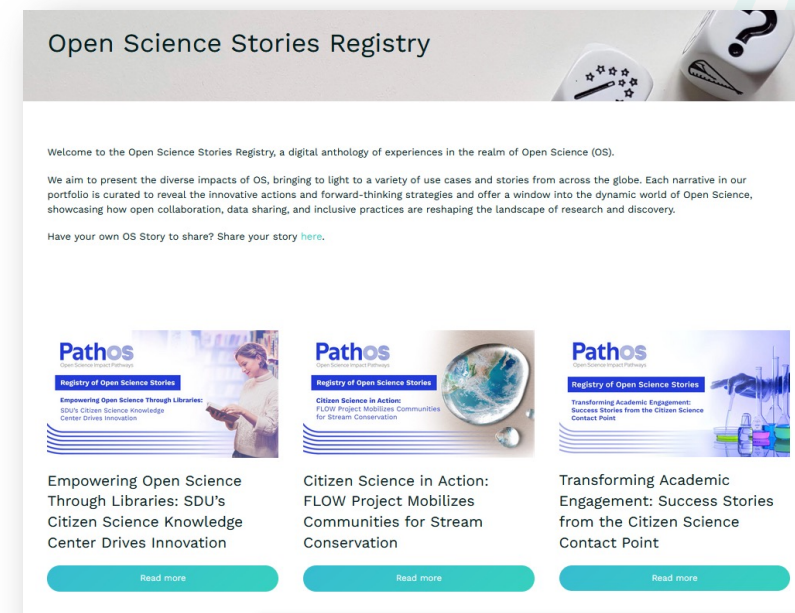
[Sign Up!](#)



PathOS OS Indicator Handbook

Introduction
Open Science >
Academic Impact >
Societal Impact >
Economic Impact >
Reproducibility >

- [Feedback form](#)
-  [GitHub editing](#)
- Validation Campaign (via email) – *Sign up!*




Open Science Stories Registry

Welcome to the Open Science Stories Registry, a digital anthology of experiences in the realm of Open Science (OS).


We aim to present the diverse impacts of OS, bringing to light to a variety of use cases and stories from across the globe. Each narrative in our portfolio is curated to reveal the innovative actions and forward-thinking strategies and offer a window into the dynamic world of Open Science, showcasing how open collaboration, data sharing, and inclusive practices are reshaping the landscape of research and discovery.

Have your own OS Story to share? Share your story [here](#).




Pathos
Registry of Open Science Stories
Empowering Open Science Through Libraries: SDU's Citizen Science Knowledge Center Drives Innovation

[Read more](#)



Pathos
Registry of Open Science Stories
Citizen Science in Action: FLOW Project Mobilizes Communities for Stream Conservation

[Read more](#)



Pathos
Registry of Open Science Stories
Transforming Academic Engagement: Success Stories from the Citizen Science Contact Point

[Read more](#)

[Share your Open Science Story](#)

PathOS

Thank you!

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<https://pathos-project.eu/> →

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