An Overview of Open Science in Italy

Alessia **Bardi**[1], Leonardo **Candela**[1], Dario **Mangione**[1,2], Gina **Pavone**[1]

[1] *Istituto di Scienza e Tecnologie dell'Informazione "A. Faedo" - Consiglio Nazionale delle Ricerche, Via G. Moruzzi 1, Pisa, Italy*
[2] *Università di Pisa, Dipartimento di Informatica, Largo B. Pontecorvo, 3, Pisa, Italy*

Abstract

Open Science is a phenomenon pervading scientific practices to make scientific research and its outputs more accessible, transparent, and collaborative. It is gaining momentum globally, and various initiatives were and are underway to promote it. However, implementation varies across disciplines, regions, and institutions. This paper overviews the current state of open science implementation in Italy by analysing the established policies, the scientific production, and the available services documented by several publicly available information systems.

Keywords

Open Science, Italy, Survey and overview

1. Introduction

Open science aims to promote a collaborative approach to the scientific process, utilising operations and technologies to enhance the dissemination and accessibility of knowledge and scientific outputs [1], [2]. Several diverse initiatives are supporting its development, including worldwide organisations' recommendations, e.g. [3], funding bodies' policies and research programmes, e.g. [4], national plans and strategies, e.g. [5], and research performing organisations plans, e.g. [6].

In June 2022, Italy published its national plan for open science [7], a policy document proposing an overall vision with specific strategies for five axes of intervention: scientific publications, research data, research evaluation, scientific community and coordination activities at the European level, and, derived from the pandemic experience, open data models for public health. Among the many recommendations, this document advocates for the set-up and maintenance of Institutional repositories, the development and adoption of open access policies, and the development of a national infrastructure for monitoring and assessment, as they play a fundamental role in enforcing open access to scientific knowledge and ensuring the efficient dissemination and accessibility of research outputs.

Several initiatives aimed at understanding the implementation of open science practices have been performed or are ongoing. The Curtin Open Knowledge Initiative curates a dashboard measuring open access performance for 225 countries and 50,438 institutions [8]. At the European level, the Open Science Monitor, created by the European Commission, aims to provide data and insights to understand the progress of open science in Europe and other countries worldwide [9]. Another monitoring initiative is the Open Science Observatory, which uses the data from OpenAIRE e-infrastructure and other public sources to provide data visualisations on open science indicators in Europe [10]. At the national level, for example, the French Open Science Monitor [11] measures the progress of open science in

---

the country following the national plan for open science; the National Open Access Monitor [12] is going to be developed in Ireland, to analyse and track progress towards open access.

In Italy, the solutions to implementation and monitoring open science practices are not "systemic", i.e. there is no officially endorsed infrastructure or system called to collect the scientific outcomes or to support the implementation of the national plan for open science. However, there are initiatives aiming at studying the open science phenomenon in Italy. The Working Group on Open Science, promoted by the CoPER (the board of Italian public research institutions), has recently published two studies on policies and practices concerning open access to scientific literature [13] and research data [14]. A working group comprising representatives of several Universities and public research institutions is launching a campaign to collect a set of indicators on open science, including the presence and any updates to policies (divided into policies on open access to literature, policies on data management, and policies on software), as well as the number of open access products in institutional archives, distinguishing between green, gold, or hybrid OA [15].

This paper analyses the current state of key elements characterising open science implementation in Italy as emerging from several information systems: the adoption of policies from Italian institutions, the number of research products available, and the array of services supporting open science. Institutional policies have been collected and categorised based on their type; the content of repositories has been examined according to the type of access provided to the hosted products (whether closed or open); the services were identified to understand their typologies.

2. Methodology

We defined the following research questions to drive the study:
1. How many open science and research data management policies have been established by Italian institutions? What's their coverage and proposed approaches?
2. What scientific production of Italian research falls under the open science umbrella?
3. What are the typologies of existing services for supporting open science in Italy?

In order to comprehensively explore the landscape of open science in Italy, diverse data sources were utilised, as illustrated in the visual representation accompanying this study (see Fig. 1). The diagram details the sources, the processes, and the resulting data sets for this national-level analysis.

The basis of this study is the result of the aggregation of data from a crowdsourcing activity of policies and regulations adopted by Italian universities and research organisations (including research performing and research funding organisations), born within the Open Access Italia mailing list, from the catalogue of policies of the open-science.it portal[2], as well as from the survey by the Open Science Working Group of CoPER on the monitoring of institutional policies for the management of scientific data [14].

From the resulting list of 131 organisations, among universities recognised by the Ministero dell'Università e della Ricerca[3] and research organisations that participated in the surveys, we developed a corpus of 101 open access policies, regulations, and guidelines.

We followed a bottom-to-top approach for analysing the corpus, creating the research product categories targeted by the selected policies on a need-to-know basis rather than enumerating a fixed set of elements to observe from the start. This process resulted in 6 categories of research products, namely 'any', 'literature', 'data', 'software' (including code), 'other' as a residual one (including but not limited to educational resources, portals, and digital libraries), and 'open infrastructures'. The category 'any' has been used in cases of open and intensional definitions of research products, which avoided extensional or ostensive formulations, preventing us from identifying a more specific category. We also

---

[2] Open-science.it Catalogue website https://open-science.it/catalogue
[3] https://dati-ustat.mur.gov.it/dataset/metadati

created two categories for mentions of a data management plan (DMP) and for references to FAIR data management practices, respectively.
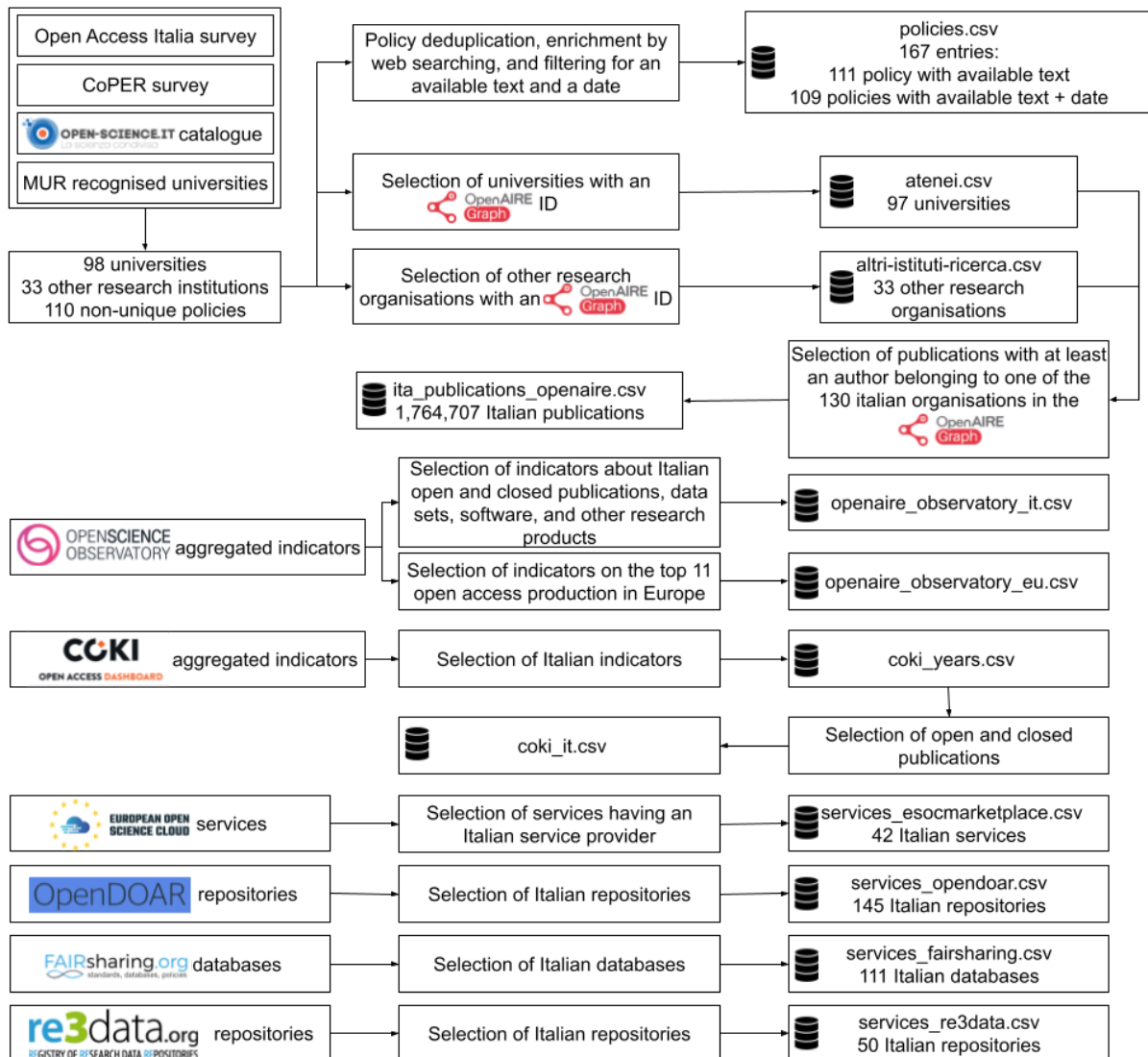

Figure 1: A graphical representation of the data identification and selection process characterising this study. It includes the name of the file in the released dataset [16].

To obtain a more reliable periodisation, we created a data set integrating the information collected with official news of documents previously published but no longer available, recovered through ad hoc searches on the websites of the organisations and snowballing.

The final data set consists of 109 entries, among policies, regulations and guidelines, from 73 distinct organisations, covering a timespan from 2008 to 2023.

For investigating the Italian open science production/output, we used the OpenAIRE Open Science Observatory[4] [10] with a temporal coverage from 2015 to 2023, with data updated on 27 December 2023, and the Curtin Open Knowledge Initiative (the COKI Open Access Dashboard[5] [8]), with a temporal coverage from 2000 to 2023. Both offer aggregated statistics about open access production by country and organisation. Because the

---

OpenAIRE Open Science Observatory includes data about peer-reviewed articles, datasets, software and other types of research products, we also analysed the OpenAIRE Graph[6] to generate charts on any kind of publications, including grey literature (e.g. technical and project reports, presentations, posters). In particular, we rely on the public version of the OpenAIRE Graph released in January 2024 [17]. To identify the portion of the graph suitable for this study, the set of 130 Italian research organisations identified above (among the 131 selected organisations, one does not have an OpenAIRE identifier) was exploited. The subset of publications with at least one affiliation to one of those organisations has been added to the dataset. We also limited the analysis to the same time coverage of the OpenAIRE OS Observatory (2015-2023). The final data set consists of 1.764.707 publications. The analysis was performed using a Zeppelin Notebook hosted in the OpenAIRE infrastructure of the data centre of ICM, University of Warsaw, with Spark and Spark SQL code [18].

To identify the services supporting open science in Italy, we relied on the EOSC marketplace and thematic registries. Specifically, we used re3data, OpenDOAR, and FAIRsharing to identify repositories and knowledge bases.

The dataset underlying this study was published on Zenodo [16].

3. Analysis

3.1. Policies

A total of 109 potential documents have been identified at the institutional level, varying in their degree of encouragement, rule establishment, or regulation of open access and open science practices within research institutions. Among these, 18 have been subsequently surpassed by later updates[7]. Furthermore, in 8 cases, we found information, for example, on institutional portals, about the existence of some kind of policy, yet we could not find the documents themselves[8].

In detail, 18 of these documents are explicitly labelled as regulations (bearing the term "regolamento" in their title), while 80 are policies, and 10 are guidelines. Additionally, some others employ more ambiguous terms such as best practice ("buona pratica"), disciplinary ("disciplinare"), provisions ("disposizioni"), position statement and the like.

Figure 2 shows the growing trend towards adopting an open science policy by Italian organisations from 2008 onward. As of 2023, 72 Research Performing Organizations (RPOs) have at least one policy regulating access to scientific output that is available and which is provided with a date. Only four policies have a broad scope, encompassing all

---

[6] OpenAIRE Graph, https://graph.openaire.eu

[7] The following list documents the institution that have updated their policy and the respective year of update: (i) Istituto Nazionale di Astrofisica, 2020; (ii) Università degli studi di Palermo, 2021; (iii) Università degli studi di Cagliari, 2022; (iv) Fondazione Edmund MACH, 2022; (v) Istituto Nazionale di Fisica Nucleare, 2023; (vi) FONDAZIONE TELETHON, updates in 2017 and 2022, guidelines added in 2023; (vii) Istituto Nazionale per l'Analisi delle Politiche Pubbliche, 2021; (viii) Istituto Superiore di Sanità, 2020; (ix) Scuola normale superiore di Pisa, 2022; (x) Università Ca' Foscari Venezia, 2023; (xi) Università degli studi di Messina, updates and Research Data Management policy added in 2023; (xii) Università degli studi di Milano, updates in 2020, data policy added in 2022; (xiii) Università degli studi di Parma, 2020; (xiv) Università degli studi di Perugia, 2021; (xv) Università degli studi di Pisa, 2017; (xvi) Università degli studi di Sassari, 2022; (xvii) Università degli studi di Siena, 2021; (xviii) Università degli studi di Trento, 2022

[8] The institutions whose policy was not found and the respective year of the document were (i) Fondazione Edmund MACH, 2011; (ii) FONDAZIONE TELETHON, 2010; (iii) FONDAZIONE TELETHON, 2017; (iv) Istituto Nazionale di Fisica Nucleare, 2016; (v) Università degli studi di Bologna, 2023; (vi) Università degli studi di Parma, 2018; (vii) Università degli studi di Perugia, 2015; (viii) Università degli studi di Pisa, 2015.

research products; of these, two specify that the definition includes articles, data, software, and other research outputs, while the other two do not provide further details.

Figure 2: Temporal progression of RPOs with a policy tracking the evolution of introduced documents over time. Each organisation is represented by the date of the first introduction of the policy. One policy does not bear a specific year, and it is not counted.

As of 2023, the majority of organisations focus on literature (69 organisations, cf. Fig. 3). However, in recent years, a growing number of organisations have broadened the range of the research products considered by their policies. In particular, 26 of the observed organisations specify how to handle research data, 11 refer to software, and 9 also mention other research products.

Among the organisations mentioning research data, 19 refer to FAIR data management practices [19], and 16 also make some reference to the production of a Data Management Plan (DMP). However, while envisaging criteria and support measures for creating a DMP, none of the analysed documents included such a research product among the categories to be deposited and preserved.

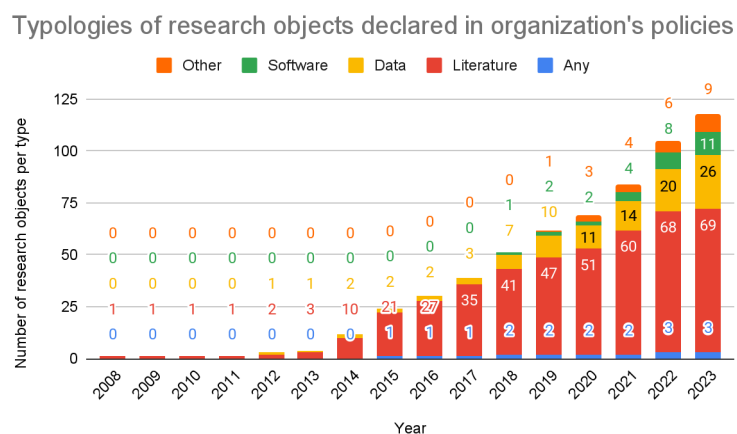Finally, open infrastructures, which are essential for open science, are only addressed by one policy.

Figure 3: Temporal progression of typologies of research objects explicitly considered by the organisations in their policies. A policy may consider many typologies of research objects.

In some cases, the documents also give indications on the services to use (namely repositories for the deposition of the artefacts). As for literature, the most frequently mentioned services are IRIS [20] and DSpace [21] (about 76%), corresponding to the

institutional repositories. In a few other cases, we found generic references to an OA repository or the generalist platform Zenodo. A similar pattern is observed in the case of data, with 43% of references pointing to institutional systems (IRIS or DSpace) and the remaining citations to Zenodo or, more broadly, open access repositories. This suggests that it is almost consequential for institutions emitting a policy to cater for its support by local repositories.

3.2. Research production

Both the OpenAIRE Open Science (OS) Observatory and the COKI Open Access Dashboard show a continuous increase in open access articles. As summarised in Table 1, the trend is confirmed by our analysis of data in the OpenAIRE Graph, which includes grey literature.

The OpenAIRE OS Observatory reports that Italy is the third European country for the number of open access publications, after the United Kingdom and Germany,[9] with 63.82% of peer-reviewed articles of Italian organisations published from 2015 to 2023 in open access. On average, in the period 2015-2023, Italy published circa 72K OA peer-reviewed articles per year, with peaks of 94K in 2020 and 2021.

The COKI dashboard, which only includes publications with a DOI from Crossref, reports similar data: 57.4% of OA publications on average per year, with peaks of 96K in 2020, 106K in 2021 and 2022, and 98K in 2023. COKI ranks Italy as the fourth European country in the number of OA publications after the United Kingdom, Germany, and France, and the 9th worldwide.[10]

Table 1
Comparison of the analysis of OA production in Italy

Source	Type of content	Total OA%	OA% in 2015	OA% in 2023
OpenAIRE OS Observatory	Peer-reviewed articles from the OpenAIRE Graph	63.82%[11]	55.3%	68.85%
COKI Dashboard	Articles with a DOI from Crossref	57.4%[12]	46.7%	63.83%
OpenAIRE Graph	All types of publications	56%	49.16%	63.09%

Thanks to our analysis of the OpenAIRE Graph, we confirm similar observations, also counting non peer-reviewed articles and grey literature of several types like preprints, presentations, reports, and theses. OA publications are more than 980K (56%), 640K are closed (36%), and the rest have restricted access rights, are under embargo or have no information about access rights. As shown in Figure 4, the share of OA publications is constantly growing, exceeding 50% in 2017 and reaching 63% in 2023.

---

[9] Data retrieved from the OpenAIRE Open Science Observatory for Europe: https://osobservatory.openaire.eu/continent/europe/overview (accessed 07/02/2024)

[10] Data retrieved from the COKI Dashboard: https://open.coki.ac/ (accessed 07/02/2024)

[11] The OpenAIRE OS Observatory reports a total of 51.3% of OA publications. 63.82% is the percentage obtained by counting the data available for the chart "Publications over time" with temporal coverage 2015-2023.

[12] The COKI Dashboard reports a total of 47% of OA publications. 57.4% is the percentage obtained by counting the available data with temporal coverage 2015-2023.
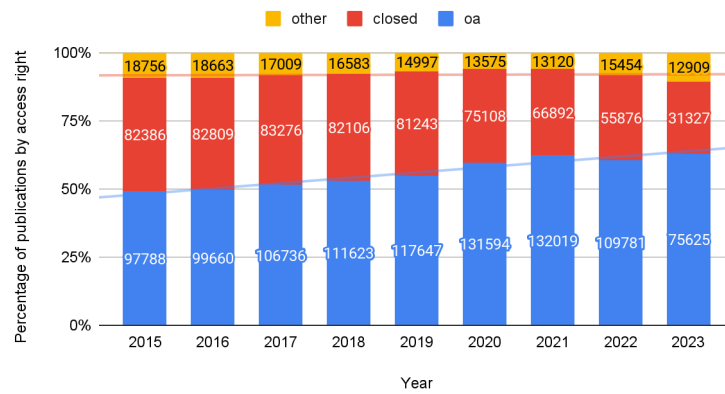
Figure 4: Italian publications by year and access rights

The analysis of the Italian subset of the OpenAIRE Graph shows a stronger uptake of open access for articles published in journals (Fig. 5) than for other types of publications like books, book chapters, and articles in conference proceedings (Fig. 6). While journal articles published in open access is over 60% since 2015, only 47% of other types of publications published in 2023 are available in open access.
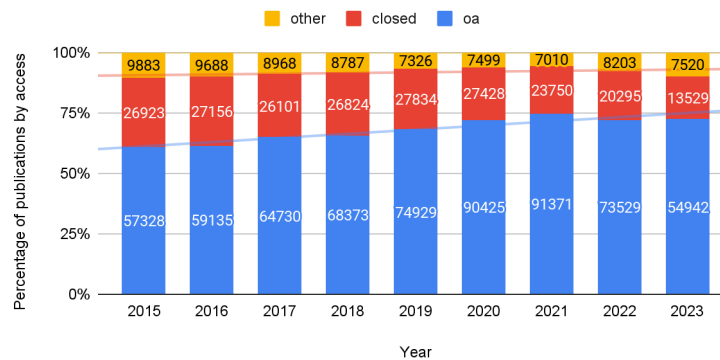
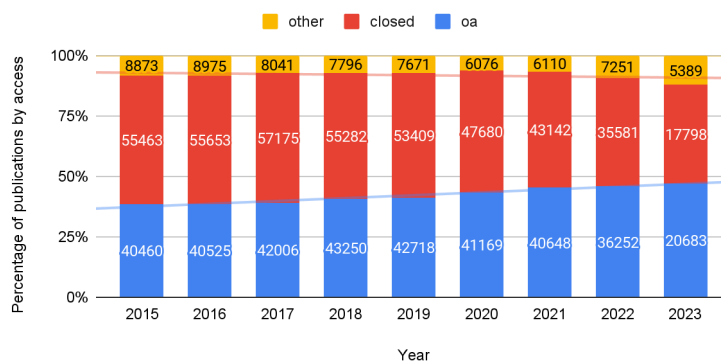**Figure 5**: Italian journal articles by year and access rights

Figure 6: Italian publications not published in journals by year and access rights

The OpenAIRE OS Observatory and the COKI Dashboard also report about Gold Open Access publications, namely articles published in full OA journals. According to the OpenAIRE OS Observatory, 47% of publications from 2015 to 2023 are Gold Open Access; COKI reports 43% from 2000 to 2023. Both percentages are underestimations because there is no definitive list of OA journals. DOAJ (Directory of Open Access Journals) and the list of Gold ISSNs maintained by the University of Bielefeld [22] are the known most complete sources[13]. Only a subset of them is indexed in Crossref, which is the only source of the COKI Dashboard. The OpenAIRE Graph includes metadata from both Crossref and DOAJ, resulting in better coverage.

Both COKI and OpenAIRE also report the growth of articles published in green open access until 2020 (Fig. 7 and 8), confirming the success of repositories as trusted depots for research outputs. From 2021 on, we observe a significant increase in the percentage of gold open access publications.
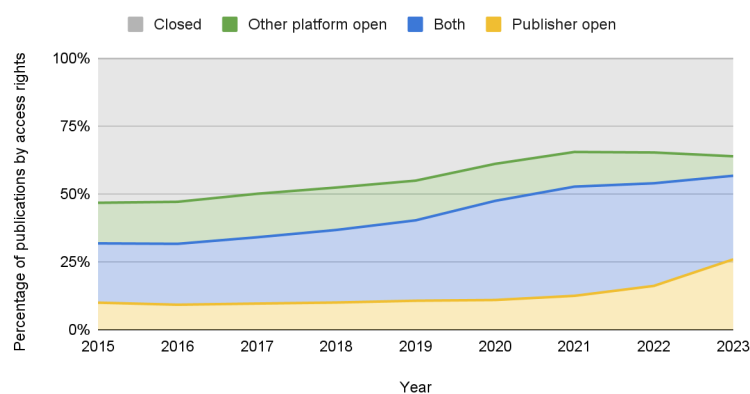
Figure 7: Gold and green OA trends from the COKI Dashboard.

Figure 8: Gold and green OA trends from the OpenAIRE Open Science Observatory.

Our analysis of the OpenAIRE Graph shows that the number of Italian preprints steadily grows from 2016 to 2021, and, despite the lower numbers in 2022 and 2023, their percentage with respect to the complete Italian research production doubled from 4% in

2013 to 9% in 2023 (Fig. 9). The significant increase in 2020 reflects an international trend reported in [23] on the growth of preprints about COVID-19.

Figure 9: Italian preprints published per year from 2015 to 2023 from OpenAIRE
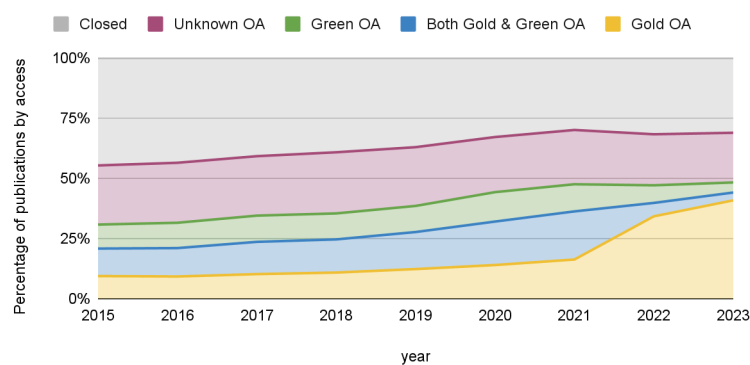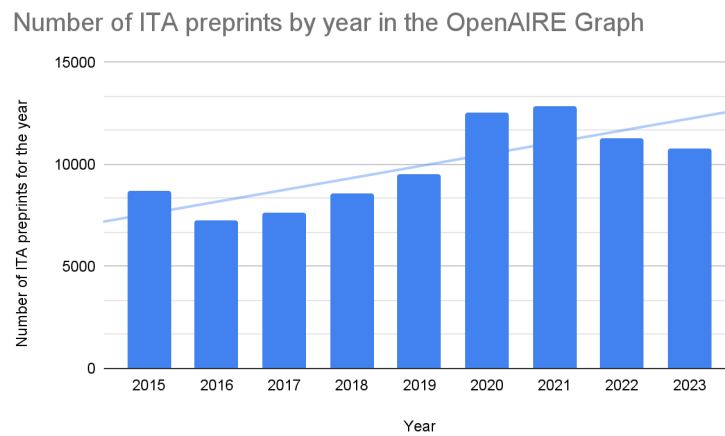
While our analysis of the OpenAIRE Graph and the COKI dashboard focus only on open access publications, the OpenAIRE OS Observatory also reports about other open science practices, like the deposition of research data and software sharing.

The apparent growth trend observed for OA publications is not observable for data, software and other types of research products (Tab. 2). For the latter, we instead observe a generic decrease in the total numbers. One possible explanation is the growing attention to metadata quality and the availability of data, software and "catch-all" repositories that support the deposition of objects that can be appropriately typed as "software" or "research data" instead of using a generic "Other type" as it used to be in traditional publication repositories.

Table 2
OA vs Non-OA figures for datasets, software, and other types of products from the OS Observatory for Italy (data retrieved in Feb. 2024).

Year	Dataset		Software		Other	
	OA	Non-OA	OA	Non-OA	OA	Non-OA
2015	67	187	1	33	3287	6192
2016	37	301	6	37	3358	6391
2017	68	301	9	15	3475	6416
2018	249	376	5	14	3630	6297
2019	173	656	15	16	3470	5991
2020	188	396	37	12	3240	4689
2021	202	284	19	24	3166	4695
2022	197	222	19	30	2828	3991
2023	168	119	20	9	1582	2104

The total number of software and datasets is probably too small (in the order of hundreds for research software, about 1K for research data) to support any type of analysis. Notwithstanding, Italy is reported among the top 10 European countries for the number of open access datasets and among the top 5 for open source software (Tab. 3).

Table 3

Open access products by country from the OS Observatory (data retrieved in Feb. 2024)

	OA Publications	OA Datasets	OS Software	OA Other
1st	GBR (2,305,078)	ESP (26,887)	GBR (362)	GBR (248,355)
2nd	DEU (1,318,069)	NLD (15,004)	ESP (315)	ESP (233,449)
3rd	**ITA (1,108,555)**	GBR (13,661)	DEU (246)	RUS (147,095)
4th	FRA (1,081,303)	BLR (8,297)	FRA (156)	BEL (116,172)
5th	ESP (1,027,000)	DEU (6,725)	**ITA (139)**	**ITA (95,635)**
6th	NLD (748,457)	IRL (6,663)	CHE (108)	DEU (92,514)
7th	CHE (516,206)	PLO (3,569)	NLD (87)	PRT (89,569)
8th	TUR (451,736)	AUT (2,465)	BEL (50)	FIN (74,269)
9t	RUS (390,546)	PRT (2,053)	NOR (45)	UKR (70,985)
10th	SWE (389,557)	TUR (2,028)	EST (36)	FRA (66,033)
11th	POL (389,009)	**ITA (1,670)**	DNK (29)	TUR (61,173)

Further research could investigate if the low numbers are due to low quality metadata (e.g. missing affiliation information), a gap in the OpenAIRE Graph, or the lack of practice from researchers, who may find it tedious to add an entry in their institutional repository or Zenodo for software they shared via GitHub, for example.

3.3. Italian services for open science

The implementation of any open science practice requires the availability of suitable services that span from repositories and archives up to catalogues, collaborative research environments, and even monitoring tools to get some quantitative and qualitative insights on the ongoing development of open science practices. Although there are global services that can be successfully adopted, the development of some country-driven ones is also encouraged and promoted [7]. National services are likely to be configured to better respond to local needs, policies and decisions. Moreover, their development benefits from a deeper understanding of the local settings. However, identifying and collecting information about services falling under the Italian umbrella is challenging because of the lack of an authoritative and unifying registry listing the "appointed" one according to a country-based policy, i.e. there is no official list of Italian services for open science that Italy endorses.

Potential sources of information for the identification of Italian services are (a) OpenDOAR[14], the global directory of open access repositories launched in 2005; (b) re3data [24], a global directory of research data repositories launched in 2012; (c) the EOSC Marketplace[15], the catalogue of services of the European Open Science Cloud; (d) FAIRSharing [25], a registry of standards, databases, and repositories; and, (e) the OpenAIRE Graph, which aggregates metadata records from the previous sources and integrates them with additional sources like the list of journals from DOAJ and Crossref and CRIS systems from the DRIS registry.

According to OpenDOAR, in January 2024, 145 Italian open access repositories existed. The vast majority of them are institutional repositories (134), 10 are disciplinary ones, and one is an aggregating repository. Half of them are based on DSpace (49%) [21], 15% rely on EPrints, while 32% are developed using other solutions, including proprietary ones. The predominance of DSpace-based repositories in Italy depends on the large uptake of the CINECA Institutional Research Information System (IRIS) [20] from many institutions, a solution including a DSpace-based repository. Italy is the 12th country in terms of the number of repositories.

According to re3data, in February 2024, there were 50 registered research repositories run by Italian institutions versus the 39 reported in 2019 in the final report of the Open Science Monitor commissioned by the European Commission [9]. Most of these repositories (40) are disciplinary repositories, 18 are institutional, and 8 are categorised as both institutional and disciplinary. Concerning the underlying technology, in the case of 15, it is unknown; for others, they use either CKAN, DSpace, Dataverse, EPrints, or other technologies.

According to the EOSC Marketplace, there are 42 services operated by an Italian organisation or a research network in which an Italian organisation has a leading role, as detailed in Table 4.

Table 4
EOSC services provided by Italian organisations

Provider	Number of services
D4Science (CNR-ISTI)	23
Blue-Cloud (coordinated by CNR)	1
Institute of Atmospheric Pollution Research (CNR-IIA)	1
Italian National Institute of Nuclear Physics	10
CINECA	1
National Institute of Astrophysics	2
Consorzio per il Sistema Informativo	1
University of Padua	1
University of Florence	1
Terradue	1
TOTAL	42

The typologies of services registered in the EOSC Marketplace are well beyond the repositories captured by OpenDOAR or re3data. It includes services for research data processing and analytics, services for research data discovery and access, virtual research environments and science gateways [26].

Finally, according to FAIRSharing, there are 111 research databases (this definition includes knowledge bases and repositories) being run by or in collaboration with an Italian institution.[16]

3.4. Discussion

The objective of this study was to describe the uptake of open science in Italy with a data-driven approach. The rationale is twofold. Firstly, obtaining a comprehensive overview of open science in Italy is useful for tracking changes over time and identifying trends in research practices. Examining open science practices at a national level is valuable for pinpointing areas that need improvement and developing targeted strategies to enhance these practices. Secondly, understanding the national context offers insights into the specific services required to promote the adoption of open science values and practices.

We selected several trusted sources of information to minimise any bias that could affect one single source.

As for policies, a temporal increase has been noted, accompanied by growing attention to the variety of research products and by the start of an updating process, albeit presently confined to a selected subset of institutions with established policies. This evolving process

---

is still underway, and it is plausible that further developments will confirm the inclination to broaden the spectrum of scientific outputs under consideration and regulation.

The trend of open access publishing exhibits a gradual and consistent increase over time without significant leaps (cf. Sec. 3.2). This appears to be attributed to the proliferation of open-access-friendly practices driven by various and multifactorial influences, starting with European mandates that may have exercised a notable influence, given the country's fifth position in research funding from the European Commission.[17] The spread of institutional policies aligns with this trajectory. Further investigations could delve into the role and impact of additional factors, such as European or national regulations and initiatives promoting open access, to verify the weight of top-down initiatives and the diffusion of grassroots practices with a horizontal trajectory.

Concerning services (cf. Sec. 3.3), although not pretending to be comprehensive, the picture emerging from our investigation suggests a wealth of suitable services for supporting open science practices. Actually, the great majority of the identified services are (institutional) repositories primarily dealing with literature while open science outcomes are expected to go well beyond literature.

Another aspect of open science that was slightly analysed was the engagement with society and the participation in Citizen Science projects and initiatives. Information about Citizen Science initiatives was manually gathered from the official websites of the European Citizen Science Association (ECSA)[18] and the Citizen Science Italy ETS (CSI)[19]. The EU-Citizen.Science platform supported by the European Citizen Science Association reports 25 projects in Italy and 31 active Italian organisations. Compared with other European countries, Italy is second only to Spain with 52 projects and 42 organisations.[20] The high relevance in Italy of Citizen Science is also demonstrated by the foundation of the Citizen Science Italia ETS (CSI) in February 2023, with participation from different research organisations and universities. The CSI website reports 39 Citizen Science projects related to various research disciplines (quality of the air and water, marine biology, biodiversity, alien species, and pollinators).[21]

4. Conclusion

This paper was an initial attempt to develop an understanding of the implementation of open science in Italy by collecting data on existing policies, scientific production, and services from open access information systems. The emerging figures are certainly an underestimation of Italy's actual contribution.

It is desirable that, in the near future, Italy will start developing its own information system to systematically collect the national contribution to open science in an authoritative manner. The availability of such a system will bring benefits for several players including governing bodies, policy makers, global service providers, and researchers.

Future studies could delve into examining the effects of institutional policies and investigate how to derive adjustments from a comprehensive monitoring system of open access and FAIR practices trends.

Data and Software Availability

---

[17] Data retrieved from the OpenAIRE MONITOR Dashboard for the European Commission on 22/12/2023: https://monitor.openaire.eu/dashboard/ec/funding/overview

[18] European Citizen Science Association (ECSA) https://www.ecsa.ngo/

[19] Citizen Science Italia https://www.museonaturalemaremma.it/csi/

[20] Data retrieved from https://eu-citizen.science/ on 22/12/2023

[21] Data retrieved from https://www.museonaturalemaremma.it/csi/ on 22/11/2023

The data and the software that support the findings of this study are openly available on Zenodo [16], [18].

Acknowledgements

References

[1] S. Bartling and S. Friesike, 'Towards Another Scientific Revolution', in *Opening Science*, S. Bartling and S. Friesike, Eds., Cham: Springer International Publishing, 2014, pp. 3–15. doi: 10.1007/978-3-319-00026-8_1.

[2] B. Fecher and S. Friesike, 'Open Science: One Term, Five Schools of Thought', in *Opening Science*, S. Bartling and S. Friesike, Eds., Cham: Springer International Publishing, 2014, pp. 17–47. doi: 10.1007/978-3-319-00026-8_2.

[3] UNESCO, 'UNESCO Recommendation on Open Science', UNESCO, 2021. doi: 10.54677/MNMH8546.

[4] European Commission, 'The EU's open science policy', 2021. [Online]. Available: https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en

[5] Ministère de l'Enseignement supérieur et de la Recherche, 'Second French Plan for Open Science', Ministère de l'Enseignement supérieur et de la Recherche, 2021. [Online]. Available: https://www.ouvrirlascience.fr/second-national-plan-for-open-science-npos/

[6] European Organization for Nuclear Research (CERN), 'CERN Open Science Policy'. 2022. [Online]. Available: https://opensite.cern/policies

[7] G. Rossi, R. Caso, D. Castelli, and E. Giglia, 'Italian National Plan for Open Science', Ministero dell'Università e della Ricerca, Decreto Ministeriale n. 268 del 28-02-2022, 2022. [Online]. Available: https://www.mur.gov.it/it/atti-e-normativa/decreto-ministeriale-n-268-del-28-02-2022

[8] J. P. Diprose *et al.*, 'A User-Friendly Dashboard for Tracking Global Open Access Performance', *The Journal of Electronic Publishing*, vol. 26, no. 1, May 2023, doi: 10.3998/jep.3398.

[9] The Lisbon Council and ESADE Business School, 'Study on Open science: monitoring trends and drivers', D2.4 PP-05622-2017, 2019.

[10] G. Papastefanatos *et al.*, 'Open Science Observatory: Monitoring Open Science in Europe', in *ADBIS, TPDL and EDA 2020 Common Workshops and Doctoral Consortium*, vol. 1260, L. Bellatreche, M. Bieliková, O. Boussaïd, B. Catania, J. Darmont, E. Demidova, F. Duchateau, M. Hall, T. Merčun, B. Novikov, C. Papatheodorou, T. Risse, O. Romero, L. Sautot, G. Talens, R. Wrembel, and M. Žumer, Eds., in Communications in Computer and Information Science, vol. 1260. , Cham: Springer International Publishing, 2020, pp. 341–346. doi: 10.1007/978-3-030-55814-7_29.

[11] E. Jeangirard, 'Monitoring Open Access at a national level: French case study', in *ELPUB 2019 23d International Conference on Electronic Publishing*, OpenEdition Press, Jun. 2019. doi: 10.4000/proceedings.elpub.2019.20.

[12] C. Ferris, 'National Open Access Monitor: IReL Project Plan', Nov. 2022, doi: 10.5281/ZENODO.7331431.

[13] A. G. Chiodetti, A. Gasperini, M. Locati, and M. Sala, 'Risultati del sondaggio Politiche e infrastrutture per l'Open Access per pubblicazioni e letteratura grigia', CoPER, Report, May 2023. doi: 10.15161/OAR.IT/77023.

[14] M. Locati *et al.*, 'Risultati del sondaggio sulle politiche di gestione istituzionale dei dati scientifici', CoPER, Report, Jul. 2023. doi: 10.15161/OAR.IT/77195.

[15] Gruppo di lavoro italiano Monitoraggio attività di Open science, 'Schema di monitoraggio attività di Open Science', Dec. 2023, doi: 10.5281/ZENODO.10389873.

[16] A. Bardi, L. Candela, D. Mangione, and G. Pavone, 'An Overview of Open Science in Italy - Data Set'. Zenodo, Feb. 2023. doi: 10.5281/zenodo.10611000.

[17] P. Manghi *et al.*, 'OpenAIRE Graph Dataset'. Zenodo, Jan. 16, 2024. doi: 10.5281/ZENODO.10488385.

[18] A. Bardi, 'An Overview of Open Science in Italy - Computational Notebook'. Zenodo, Feb. 09, 2024. doi: 10.5281/ZENODO.10640720.

[19] M. D. Wilkinson *et al.*, 'The FAIR Guiding Principles for scientific data management and stewardship', *Sci Data*, vol. 3, no. 1, p. 160018, Dec. 2016, doi: 10.1038/sdata.2016.18.

[20] A. Bollini, M. Mennielli, S. Mornati, and D. T. Palmer, 'IRIS: Supporting & Managing the Research Life-cycle', *Universal Journal of Educational Research*, vol. 4, no. 4, pp. 738–743, Apr. 2016, doi: 10.13189/ujer.2016.040410.

[21] M. Smith *et al.*, 'DSpace: An Open Source Dynamic Digital Repository', *D-Lib Magazine*, vol. 9, no. 1, Jan. 2003, doi: 10.1045/january2003-smith.

[22] A. Bruns, Y. Cakir, S. Kaya, and S. Beidaghi, 'ISSN-Matching of Gold OA Journals (ISSN-GOLD-OA) 5.0'. Bielefeld University, p. 9762253 bytes, 175164 bytes, 2022. doi: 10.4119/UNIBI/2961544.

[23] G. L. Vasconcelos, L. P. Cordeiro, G. C. Duarte-Filho, and A. A. Brum, 'Modeling the Epidemic Growth of Preprints on COVID-19 and SARS-CoV-2', *Front. Phys.*, vol. 9, p. 603502, Mar. 2021, doi: 10.3389/fphy.2021.603502.

[24] H. Pampel *et al.*, 'Making Research Data Repositories Visible: The re3data.org Registry', *PLoS ONE*, vol. 8, no. 11, p. e78080, Nov. 2013, doi: 10.1371/journal.pone.0078080.

[25] the FAIRsharing Community *et al.*, 'FAIRsharing as a community approach to standards, repositories and policies', *Nat Biotechnol*, vol. 37, no. 4, pp. 358–367, Apr. 2019, doi: 10.1038/s41587-019-0080-8.

[26] M. Arezoumandan, L. Candela, D. Castelli, A. Ghannadrad, D. Mangione, and P. Pagano, 'Virtual Research Environments Ethnography: a Preliminary Study', in *Proceedings of the 14th International Workshop on Science Gateways, Trento, Italy*, 2022. doi: 10.5281/zenodo.7883104.