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Aspasia Togia, Eleftheria Koseoglou, Sofia Zapounidou, Nikolaos Tsigilis

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Open access infrastructure in Greece : current status, challenges and perspectives

Aspasia Togia, Eleftheria Koseoglou, Sofia Zapounidou and Nikolaos Tsigilis

Introduction

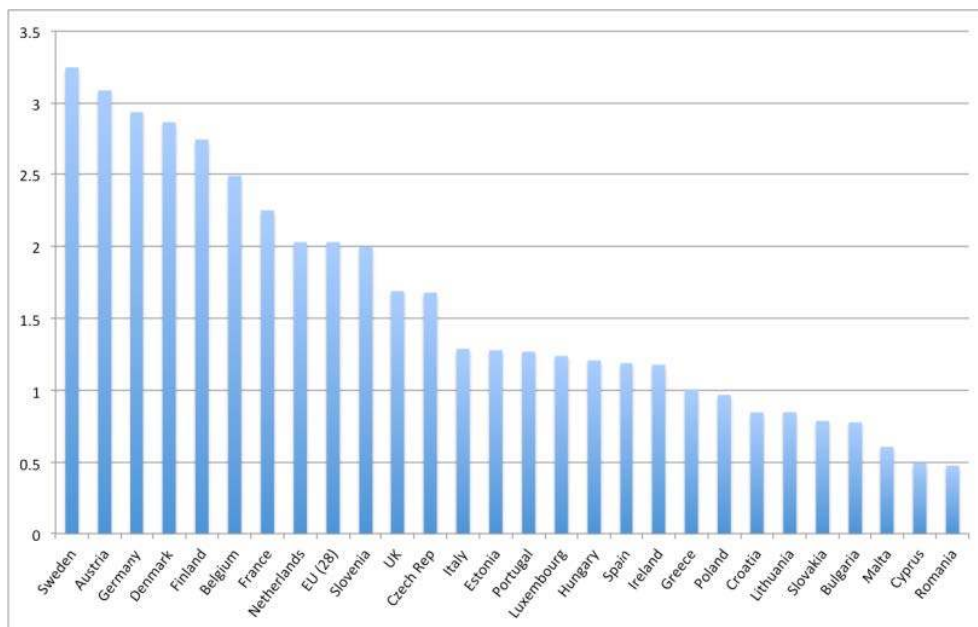
- 1 Advances in information technology and the globalisation of science have brought significant changes in the ways research is created, disseminated and consumed. Open Access (OA) has become an important component in scholarly communication and is growing fast (Laakso et al., 2011 ; Morrison, 2013), mainly due to the benefits it provides to individuals, universities and the research in general, as well as to the support it has received from governments, organisations, institutions, and libraries. OA seeks to remove price and permission barriers (Suber, 2012) so that scientific literature is freely available on the public internet permitting users to use it for any “lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself” (Chan et al., 2002). The movement of OA is associated with the notion of open science, which basically concerns the sharing of knowledge. Rather than a standard form of open access being adopted, a range of different OA types have been developed, with varied approaches to issues such as reader rights, reuse rights, copyrights, and cost of publishing. Different models include :
 - Libre OA (Suber, 2008) : free of charge, it extends user’s rights to reuse beyond fair use.
 - Gratis OA (Suber, 2008) : free of charge, it allows no uses beyond fair use.
 - Delayed OA : paid access initially, becoming free to read after a delay period or embargo (Willinsky, 2009 ; Laakso & Björk, 2013).
 - Gold OA : unrestricted online access to articles published in scholarly journals, sometimes with a publication fee (Archambault et al., 2014 ; Chan et al., 2002).

- Green OA : articles are published in toll-access journals, but self-archived in an OA archive, usually an institutional or a disciplinary repository. (Björk et al., 2010 ; Harnad et al., 2008). Most Green OA does not extend reuse rights.
 - Hybrid OA : articles are published in subscription journals but are free to read against an article processing charge (APC) (Laakso & Björk, 2013).
 - Bronze OA : articles are free to read on the publisher website, without an explicit Open license (Piwowar et al., 2018).
- 2 The most common distinction is between Gold and the Green OA, and it is unclear which approach will predominate. Harnad et al. (2008) suggest that the faster and more secure way to achieve 100 % OA is providing a mandate for the green road. Suber (2012) suggests that the green and the gold routes have complementary advantages and the balance between them will ensure unrestricted access to publicly funded research.
 - 3 There is evidence that OA is associated with higher impact of research products as a result of availability and reuse (Tennant et al., 2016), contributing at the same time to the enhancement of the quality of research through the transparency and the democratisation it offers (Elsabry, 2017). It enables readers outside of academia to use scientific literature for personal problem solving, increase their understanding of science and see how public money is being invested (Zuccala, 2010). OA gives universities the opportunity to increase their ranking position (Baldock, 2017) and offers a viable solution to escalating costs of academic journals (Houghton et al., 2009).
 - 4 Several governments and national research bodies, in the European context particularly, have set their goals of publishing between 50 % and 80 % - if not all - of their national research output as open access within the next years. Towards this end, policies, budget provisions and administrative structures are being developed accordingly (Schimmer, Geschuhn, & Vogle, 2015). OA is a core strategy in European Union, and since 2006 the European Commission has been developing policies on OA and open science through many reports, guidelines, recommendation, projects and initiatives initiatives (European Commission, 2017), while OpenAIRE/OpenAIRE- Advance project (<https://www.openaire.eu/>) is the implementation of open access via successful infrastructure comprised of a human network and robust technical services. European Union identifies three main tenets to ensure that everyone will have access to scientific papers published in Europe : "Sharing knowledge freely", "open access", and "reusing research data" (United Nations University, 2016).
 - 5 OA infrastructure is necessary for implementing open access and open science in any country. Open access infrastructures in Greece have been steadily improving over the past years, as more and more stakeholders follow international trends and participate in European networks and projects. The aim of the present paper is to give a description of the Greek OA infrastructure with emphasis on academic repositories and OA journals. Building upon previous literature (Banou & Kostagiolas, 2007 ; Chantavaridou, 2009 ; Georgiou & Papadatou, 2010) and relying of data collected from directories and aggregators, such as OpenDoar, ROAR and OpenDoaj, as well as from systematic research by the authors, the article presents information relating to the state-of-the-art of OA in order to identify current trends and future challenges. In addition, to in an effort to examine the level of OA availability of the Greek scholarly output, we used the Unpaywall database (<https://unpaywall.org>) to find OA information for publications authored by researchers affiliated with Greek HEIs.

Research landscape and scholarly communication in Greece

- 6 The three main funding sources of Research and Development (R&D) activities in Greece are the public funding, the business enterprise sector, and the European Union. In Higher Educator Sector specifically, public funding is the main source, providing 66,3 % of the total funds in 2016, while the European Union and the enterprise sector provided 18 % and 7.3 % respectively (National Documentation Centre, 2018). In 2016 R&D constituted 1.01 % of GPD placing Greece below the average expenditure in EU countries (Figure 1).

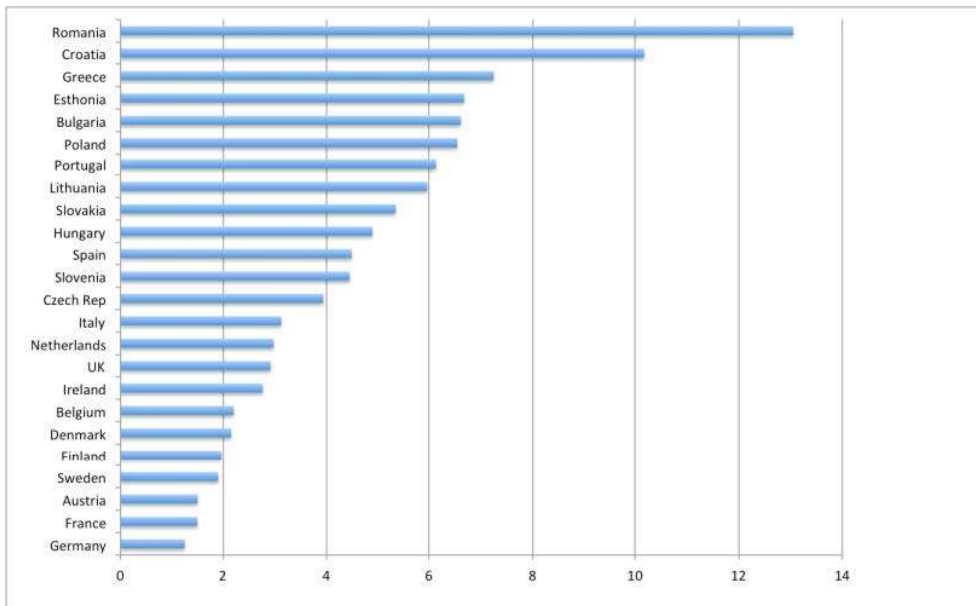
Figure 1. GERD as a percentage of GDP in 2016



(Source : Eurostat)

- 7 Research is carried out by three main institutions : HEIs, Research Centres supervised by the General Secretariat for Research and Technology, and Public Hospitals. In 2014, Greek publications accounted for 2.10 % of the total publications produced in EU, and 1.06 % of the publications produced in OECD member countries. Since 2007, and after a period of continuous growth, the share of Greek publications and the position of Greece, both in EU and OECD, have been declining. However, considering the number of publications in relation to the national expenditure on R&D, Greece is in the first positions within EU, a fact indicating the high productivity of the research system in the country (Figure 2).

Figure 2. Number of publications per millions spent on R&D in 2014



(Source : National Documentation Centre)

- 8 The publishing industry in Greece is characterised by traditional, small to medium sized, family-owned enterprises. Scientific publications are being produced by three kinds of publishers : exclusively STM publishers, general publishers, which publish scientific books, and organisations, such as scientific institutions, museums, etc. (Banou & Kostagiolas, 2007). The STM publishing production represents a very small proportion of annual book production, which is oriented to Humanities and Literature (Table 1). Nearly half of the STM books are translations of foreign titles (Georgiou & Papadatou, 2010).

Table 1. Book production by subject 2007-2011

Subject	2007	2008	2009	2010	2011
Humanities & SS	26.0 %	25.4 %	25.3 %	28.1 %	26.7 %
Pure & Applied Sciences	6.6 %	7.4 %	7.7 %	7.5 %	6.0 %
Literature	21.5 %	21.0 %	23.7 %	24.3 %	27.9 %
Children's books	17.6 %	20.5 %	19.6 %	17.7 %	18.0 %
Auxiliary school books & ELT	8.6 %	8.1 %	6.0 %	5.7 %	5.9 %
Art books	7.5 %	6.9 %	7.4 %	6.9 %	6.8 %
General, practical & self-help books	12.2 %	10.5 %	10.2 %	9.8 %	8.5 %

(Source : National Book Centre)

- 9 With regard to scholarly journals, Georgiou & Papadatou (2010) recorded 163 active peer-reviewed journals in 2009. The majority of them were published by scholarly and professional societies in the field of Medicine and Social Sciences (Table 2). However, these represent only a small proportion of the total research output of the country, as, especially in the area of STM, researchers largely publish in international journals.

Table 2. Peer-review journals and their publishers

Subject	Peer- review titles	Academic	Research	Society	Commercial	Other
Humanities & Arts	19	2	8	6	3	
Medical Sciences	61	2	1	53	4	1
Science	17	5	4	5	3	
Social Sciences	58	13	4	15	21	5
Technology	8	4		4		
Total	163	26	17	83	31	6

(Source : Georgiou & Papadatou, 2010)

- 10 In 1998, and as a response to the shrinking journal collections in Greek academic libraries due to stagnant budgets and high price increases, a national consortium, the Hellenic Academic Libraries Link (Heal-Link), was established. Members of Heal-Link are 54 libraries – all Greek academic institutions, the National Library of Greece, many research centres, and some special libraries. Its main purpose is to provide the entire academic and research community access to electronic journals of various disciplines and publishers. In addition, Heal-Link negotiates license agreements for groups of members interested in specific electronic resources (Hormia- Poutanen, 2006). All Heal-Link members have access to the full-text of approximately 11,000 international journals and 67,000 e-books. The cost of Heal-Link license agreements is covered by the Ministry of Education. In addition to the content provided through Heal-link, academic libraries also acquire print and electronic resources through their own budgets. The largest part of academic libraries funding comes from their parent institutions, which in turn are almost exclusively dependent by state funding.

Open access in Greece

- 11 Progress in Greece in the OA issues is mainly the result of the rapid evolution in the content management approach, which has been taken place since 2000, driven mainly by academic libraries, and materialised due to EC funding (Georgiou & Papadatou, 2010). Open access to scientific content, despite the gaps in the regulatory framework on research, has been supported through the enhancement of e-infrastructures, mainly towards the development of institutional repositories, but also through the participation of the relevant stakeholders in EU programmes. Greek organisations that play an

important role in the area of open access/open science, both within the country and at European level are the following :

- i. The Greek Research and Academic network (GRNET S.A.), that provides research organisations with network technologies and cloud infrastructures ;
 - ii. The “Athena” Research and Innovation Centre, which provides management services for research and Linked Open Data services to support open access initiatives of the public sector ;
 - iii. The National Documentation Centre (EKT), which aggregates and provides access to the Greek scientific output ;
 - iv. The HEAL-Link, which provides services related to HEIs’ open access repositories (General Secretariat for Research and Technology, 2016).
- 12 Although many academic libraries make extensive reference to OA, and the Rectors’ Conference approved, in 2012, open access for the dissemination of scientific results, and signed the Berlin Declaration, neither HEIs nor research centres have adopted the relevant policies. There are only four institutional OA mandates registered in ROARMAP, three by universities and one by a research centre : the International Hellenic University, the Technical University of Crete, the Panteion University, and the Archimedes Centre for Modeling, Analysis & Computation. However, the latter two have not specific policy terms. Policies of the Archimedes research centre are mainly content, submission and preservation policies rather than deposit mandates, and Panteion University states that its policy is in line with Berlin Declaration, without specifying specific terms. International Hellenic University’s policy, adopted in 2015, is mandatory for peer-reviewed manuscripts, books, book chapters, working papers, technical reports and EDTs, while encourages its members to deposit research datasets as well. Technical University’s of Crete policy, in effect since 2014, encourages the deposit of peer-reviewed articles, books, technical reports, and research datasets.
- 13 Public research funding agencies, on the other hand, have not been very active in implementing OA policies. A first step towards this direction is the requirement placed upon the researchers participating in the “Diversity, inequalities and social inclusion” Programme to submit publications to an open access repository, or, alternative, publish in OA journals.
- 14 Developments at policy level may be slow, but OA infrastructure has been steadily expanding and improving in recent years, mainly thanks to the funding through Structural Funds. The National Documentation Centre (EKT) maintains a scientific aggregator (<https://openarchives.gr>), which harvests the metadata of collections that are OAI-PMH compatible and provides a single-point-of-access to digitised contents of academic and research institutions, archives, libraries and scientific societies. The platform includes a harvester, which collects metadata from individual sites and repositories. After harvesting, the content is semantically enriched by a bilingual vocabulary and semantic enrichment system, which offers semantic cohesion and improve its searchability, presentation and multilinguism by the Semantics.gr. The import process takes place through the Aggregator accumulation management environment and the content is finally published on the OpenArchives.gr portal. The portal layout has been recently redesigned to provide improved search and browsing facilities. Openarchives.gr hosts 72 different collections, such as journals, institutional repositories, archives, scientific publications, books and collections of grey literature. It offers access to

approximately 650.000 items, including more than 200,000 scientific articles, 170,000 theses or dissertations, 47,000 conference items and many more.

- 15 EKT has developed the National Archive of PhD Theses, which currently contains bibliographic records with metadata for 38446 and the full-text of 35787 PhD theses from all HEIs in Greece as well as PhD theses awarded to Greek scholars by foreign universities. The full-text is available for browsing and printing one-page-at-a-time. The PDF is made available for download to registered users that have accepted the pertinent terms and conditions.

Institutional repositories

- 16 The EU funded national projects enabled almost every academic institution in Greece to develop its own repository. As a result, 28 out of 36 HEIs run an institutional repository (Table 3). Of those, 15 are listed in DOAR and 13 are registered in ROAR. Overall, DSpace is the software more frequently used, and Dublin Core the prevalent metadata format. However, only three repositories are aggregated by the OpenAIRE portal, while OAI-PMH compliance tests using the OAI PMH Validator & Data Extraction Tool (Banos, c2011-2018) revealed that 18 repositories have validated OAI-PMH services. All repositories host multiple types of collections, ranging from grey literature and journal archives to administrative documents and educational resources. A closer look at the contents reveals that they mostly include EDTs. This is related to the fact that HEIs regulations require students to submit an electronic copy of their theses to the IR.
- 17 In nine cases there is free and unrestricted access to the contents of the repository. In sixteen repositories the full text of some items is not available, while in 3 institutions access is limited to registered users or affiliated members. Half of the repositories contain publications of faculty members, though the numbers are extremely small compared to the institutions' overall research output, and access to the full-text is limited. For instance, in the case of the Aristotle University of Thessaloniki, the largest university in Greece that runs one of the richest repositories in the country, only 30 % of the publications contributed by faculty are available in full text.

Table 3. Institutional repositories in Greek HEIs

Institution	Subjects	Content	OA	Self-deposit	Metadata	System	DOAR	ROAR	OAI-PMH validated	Aggregated by OpenAIRE
Agricultural U of Athens	Agricultural Sciences	Theses & Dissertations ; Digitised material	Partial, depending on rights and licenses	✓	DC	DSpace			✓	
Aristotle U of Thessaloniki	Multidisciplinary	Theses & Dissertations ; e-prints ; Educational material	Partial, depending on rights and licenses	✓	DC	Invenio	✓	✓		✓

Institution	Subjects	Content	OA	Self-deposit	Metadata	System	DOAR	ROAR	OAI-PMH validated	Aggregated by OpenAIRE
Athens U of Economics & Business	Economics, Business, Accounting & Finance, Marketing, Informatics	Theses & Dissertations ; Working papers	Yes	✓	DC	Fedora				
Demokritus U of Thrace	Multidisciplinary	Theses & Dissertations ; Digitised material	Partial, depending on rights and licenses		DC	DSpace				
Harokopio U	Environment & Ecology, Geography, Tourism, Economics, Informatics, Nutrition	Theses & Dissertations ; e-prints ; Digitised material	Yes	✓	DC	Fedora	✓			
Hellenic Open U	Multidisciplinary	Dissertations ; Educational material	Restricted to university members	✓	DC	DSpace				
International Hellenic U	Multidisciplinary	Theses & Dissertations	Yes	✓	DC	DSpace	✓	✓	✓	
National U of Athens	Multidisciplinary	Theses & Dissertations ; e-prints ; Digitised material	Partial, depending on rights and licenses	✓	DC	Fedora	✓	✓		
National Technical U	Multidisciplinary	Theses & Dissertations ; e-prints ; Digitised material	Partial, depending on rights and licenses	✓	DC	DSpace	✓	✓	✓	

Institution	Subjects	Content	OA	Self-deposit	Metadata	System	DOAR	ROAR	OAI-PMH validated	Aggregated by OpenAIRE
Panteion U	Social Sciences	Theses & Dissertations ; educational material ; Digitised material	Yes	✓	DC	Fedora	✓	✓		
Technical U of Crete	Engineering	Theses & Dissertations ;	Partial, depending on rights and licenses	✓	DC	Custom	✓		✓	
U of the Aegean	Multidisciplinary	Theses & Dissertations ; e-prints ; Digitised material ;	Partial, depending on rights and licenses	✓	DC	DSpace	✓			
U of Crete	Multidisciplinary	Theses & Dissertations ; Technical reports ; Digitised material	Partial, depending on rights and licenses	✓	DC	Custom	✓	✓	✓	
U of Ioannina	Multidisciplinary	Theses & Dissertations ; e-prints ; Educational material ; data sets	Partial, depending on rights and licenses	✓	DC	DSpace			✓	
U of Macedonia	Economic and Social Studies	Theses & Dissertations ; e-prints ; Educational material ; data sets	Partial, depending on rights and licenses	✓	DC	DSpace	✓	✓	✓	
U of Patras	Multidisciplinary	Theses & Dissertations ; e-prints ; Technical reports	Yes	✓	DC	DSpace	✓	✓	✓	✓

Institution	Subjects	Content	OA	Self-deposit	Metadata	System	DOAR	ROAR	OAI-PMH validated	Aggregated by OpenAIRE
U of Peleponnese	Multidisciplinary	Theses & Dissertations	Restricted to university members		DC	DSpace			✓	
U of Piraeus	Economics	Theses & Dissertations ; Digitised material	Yes	✓	DC	DSpace	✓	✓	✓	✓
U of Thessaly	Multidisciplinary	Theses & Dissertations ; Digitised material	Partial, depending on rights and licenses		DC	DSpace	✓	✓	✓	
U of Western Macedonia	Fine Arts, Engineering and Education	Theses and Dissertations	Yes		DC	DSpace			✓	
Alexaander TEI of Thessaloniki	Multidisciplinary	Dissertations ; e-prints ; Educational material	Partial, depending on rights and licenses		DC	DSpace	✓	✓	✓	
TEI of Athens	Multidisciplinary	Dissertations ; e-prints ; Educational material	Partial, depending on rights and licenses	✓	DC	DSpace			✓	
TEI of Central Macedonia	Multidisciplinary	Dissertations ; e-prints ; Educational material ; digitised material	Partial, depending on rights and licenses	✓	DC	DSpace			✓	
TEI of Crete	Multidisciplinary	Dissertations ;	Yes		DC	DSpace				

Institution	Subjects	Content	OA	Self-deposit	Metadata	System	DOAR	ROAR	OAI-PMH validated	Aggregated by OpenAIRE
TEI of Eastern Macedonia	Multidisciplinary	Dissertations ; e-prints	Partial, depending on rights and licenses		DC	DSpace			✓	
TEI of Epirus	Multidisciplinary	Books ; e-prints	Partial, depending on rights and licenses	✓	DC	DSpace	✓	✓	✓	
TEI of Western Greece	Multidisciplinary	Dissertations	Yes	✓	DC	DSpace			✓	
TEI of Western Macedonia	Multidisciplinary	Dissertations	Restricted to registered users	✓	DC	ePrints		✓		

OA journals

- 18 A comprehensive research at the time of writing this paper revealed 116 active OA scholarly journals. The majority of them (70 %) are published in the fields of Arts/ Humanities and Social Sciences. Medical Sciences are third in the row, with 29 % of journals, followed by Science and Engineering. Academic institutions and societies are more active in journal publishing. Sixteen journals are being published by research centres, 7 by other institutions, such as museums and hospitals, and 5 by commercial publishers (Table 4). Thirty- one of these journals are listed in DOAJ and 26 in ROAD.

Table 4. OA journals

Subject	Academic	Research	Society	Commercial	Other	Total
Humanities/Arts	19	7	9	1	1	37
Medical Sciences	5	2	17	3	2	29
Science	5	2	3	1	1	12
Social Sciences	15	4	12		2	33
Technology	4			1		5

Subject	Academic	Research	Society	Commercial	Other	Total
Total	48	15	41	6	6	116

- 19 An important initiative in OA publishing has been the development of EKT's ePublishing services, which aim at providing open access to digital scholarly content, as well as a range of integrated publishing services to the academic community. ePublishing has been developed with open access interoperable technology and it currently hosts 33 academic journals, 26 eBooks and 18 eProceedings, by 36 accredited Greek publishers, mainly societies and academic institutions. Besides the organisation, documentation and dissemination of metadata and content of scholarly journals, ePublishing services also include training and consulting on OA publishing, including intellectual property issues, the standardisation of the editorial process, and the interoperability of systems.

OA publications in international venues

- 20 As it has already been mentioned, most of Greece's research output is channeled to international journals. In order to get a rough picture of the percentage of this content that is OA we used Unpaywall (<https://unpaywall.org/>) to find out open access versions of articles authored by Greek researchers. "Unpaywall is powered by a database of 100 million scholarly papers. Of these, about 16 million have links to fulltext open access, making it the largest open database of legal Open Access" (Unpaywall, n.d.). Unpaywall harvests OA content from a wide range of sources including repositories, pre-print servers, gold OA journals, hybrid journals, and services like DOAJ and Crossref. We selected the top ten Greek universities in the Scimago Institutions Rankings (<http://www.scimagoir.com/index.php>). These include seven general, multidisciplinary universities and three specialised institutions in Engineering, Agriculture, and Economics respectively (Table 5).

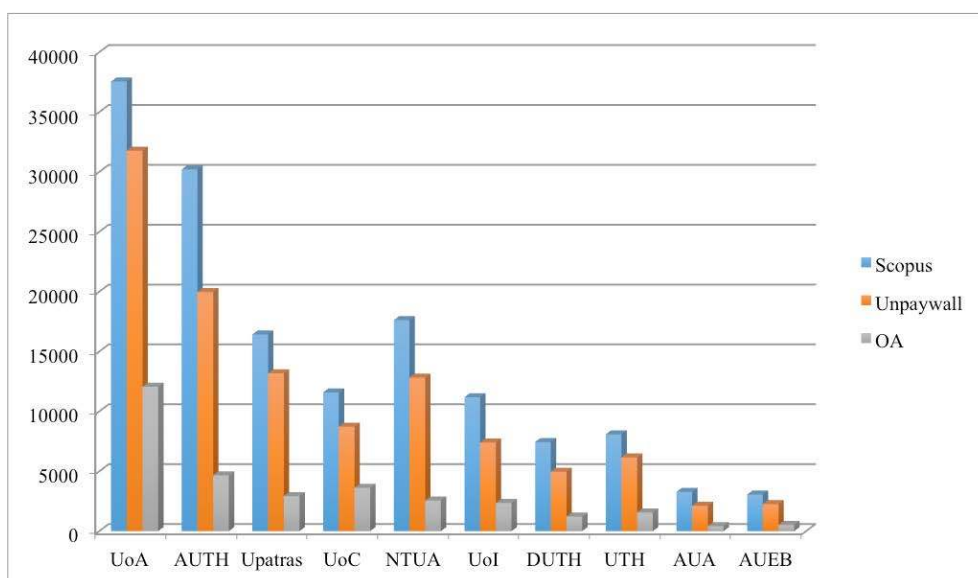
Table 5. Top rating Greek universities

University	Faculties	Departments	Teaching staff	Scopus Publications (2008-2017)
1.National University of Athens (UoA)	8	33	1764	37550
2.Aristotle University of Thessaloniki (AUTH)	11	41	1944	30213
3.University of Patras (UPatras)	5	24	705	16432
4.University of Crete (UoC)	5	16	485	11585
5.National Technical University (NTUA)	9	9	514	17619

University	Faculties	Departments	Teaching staff	Scopus Publications (2008-2017)
6.University of Ioannina (Uoi)	7	15	510	11186
7.Democritus University of Thrace (DUTH)	8	19	579	7448
8.University of Thessaly (UTH)	5	18	435	8087
9.Agricultural University of Athens (AUA)	2	6	177	3282
10.Athens University of Economics & Business (AUEB)	3	8	187	3059

- 21 We used Scopus to collect the publications of authors affiliated to the above institutions. Publications without DOI were excluded from the Unpaywall check. Lists of DOIs in sets of 10000 were uploaded to Unpaywall and the check results were emailed to us as spreadsheets. When multiple versions of OA are available, Unpaywall includes the “best” OA evidence, prioritizing publisher-hosted content over content found in repositories (Bosman & Kramer, 2018).
- 22 Of the 146461 publications found in Scopus 126486 (86.4 %) had a DOI. 109358 DOIs were located in the Unpaywall database and of them only 31905 (29.2 %) corresponded to publications available in OA form. Open access publications accounted for the 21.8 % of all publications authored by researchers affiliated to the institutions included in the sample. OA levels were similar for all institutions, ranging between 20 % and 30 %, except for the University of Crete and the University of Athens, which had rates of 41.5 % and 38 % respectively (Figure 3).

Figure 3. Publications of Greek Universities



- 23 Types of publications are presented in Table 6. The overwhelming majority were journal articles, 32.5 % of which were available in some kind of OA form.

Table 6. Publication types

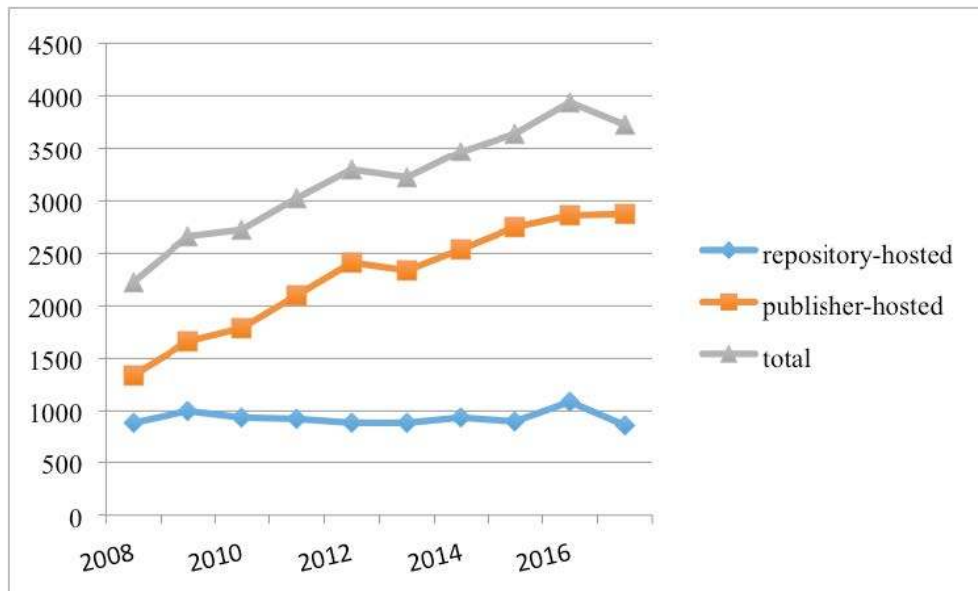
Publication Type	OA		Non OA		Total N
	N	%	N	%	
Book	46	8.2	524	91.8	570
Book chapter	668	10.7	5559	89.3	6227
Journal article	30026	32.5	62371	67.5	92397
Monograph	6	6.7	84	93.3	90
Proceedings	1123	11.3	8822	88.7	9945
Other	36	28.1	92	71.9	128
Total	31905	29.2	77452	70.8	109358

- 24 Data showed that 75 % of the OA versions of articles were hosted by publishers, thus representing gold, bronze or hybrid articles, while the rest 25 % were green papers, hosted by repositories. However, the opposite is the case with respect to papers in conference proceedings, the majority of which are available in repositories (Table 7).

Table 7. OA host

Publication Type	Publisher		Repository		Total N
	N	%	N	%	
Book	32	69.6	14	30.4	46
Book chapter	79	11.8	589	88.2	668
Journal article	22348	74.4	7678	26.6	30026
Monograph	0	0	6	100	6
Proceedings	114	10.2	1009	89.8	31905
Other	30	83.3	6	16.7	128
Total	22603	70.8	9302	29.2	31905

Figure 4. OA over time



- 25 Figure 4 presents the number of OA publications by host type and publication date. A gradual increase in the level of OA for 2008-2014 is observed. This upward trend is interrupted in 2013, when there is a drop in OA levels. The increase seems to be driven by significant growth in gold and hybrid/bronze open access, while the number of repository-hosted items remains unchanged over time. The drop in 2017 may be due to delayed OA.

Discussion and conclusions

- 26 This study includes a brief of the Greek OA landscape, with emphasis on academic Institutional Repositories and open access journals. In addition, it provides an analysis of the OA availability of research outputs produced by Greek researchers and published in international venues.
- 27 In the past ten years Greek OA scholarly journals have been significantly increased : from 84 reported in 2009 by Georgiou & Papadatou (2010) to 116 today. Academic institutions have emerged as key players in OA publishing, alongside the various scientific and professional societies that prevailed a few years ago. Indicative of this trend are the recent initiatives of some academic libraries to provide electronic publishing platforms and host OA journals published by university faculties, departments etc. These services, together with EKT's publishing, seem to have been particularly well received by scholars in Humanities and Social Sciences, and they have contributed to the escalation in the number of OA titles in these areas. However, many aspects of OA journal publishing have to be considered, such as compliance with open standards and technologies, adequate search and retrieval functions, standardised preservation solutions, viable business models and sustainability (Georgiou & Papadatou, 2010 ; Hodgson, 2014).
- 28 Repositories are now established in the majority (72 %) of HEIs in Greece, and openarchives.gr functions as a national aggregator for OA content. All repositories host various kinds of collections and very often the same type of material is labeled by

different collection names across the repositories, making the categorisation of material rather difficult. Moreover, multiple types of contents present a challenge for end user searching and retrieval (Georgiou & Papadatou, 2010). IRs do not have an explicit copyright policy neither do they include guidelines about copyright issues. Despite their numerical increase, they do not reflect the extent of the research output of their academic communities. Their focus is on collecting postgraduate and doctoral theses, and these dominate the content of the collections. The extremely low numbers of articles and conference papers – not to mention research data – suggest that Greek scholars have not been convinced to deposit their research outputs, despite the heavy investment of financial and human resources needed to establish and maintain an IR. The development of institutional OA policies is critical for OA implementation and there is evidence that institutional mandates play an important role in the uptake of OA at HEIs (Pinfield, 2015). Of equal importance is the need to promote the benefits of open access to researchers and highlight its advantages in terms of greater impact, more citations and increased visibility. Well-funded implementation, regular policy review, improved repository service, and consistent advocacy of the advantages of OA, all have been recognised as important elements required to achieve a successful OA model (Armbruster, 2010).

- 29 In an effort to estimate what proportion of the literature produced by Greek researchers is available OA, we used Unpaywall service to examine a sample of scholarly publications of authors affiliated to Greek universities. We found 29 % of all DOI-assigned publications are OA, a score similar to those found in other studies and falls within the range that has been reported for European countries (Bosman & Kramer, 2018 ; Piwowar et al., 2018). Levels of green OA were rather low, accounting for nearly 30 % of all OA publications. However, this figure is not representative of the total level of green OA, as publications also available in some form of gold OA are excluded by Unpaywall. Low levels of green OA have been also attributed to the incomplete harvesting of institutional repositories (Bosman & Kramer, 2018). In fact, IRs of Greek HEIs are not included in the Unpaywall sources of OA content.
- 30 So far, Greek academic institutions do not generally support their staff in taking full advantage of the benefits of OA. University of Patras is the first university in Greece to actively encourage OA by participating in the Open Library for Humanities and the institutional OA programme of MDPI. Furthermore, subscription to BioMed Central enables faculty members to publish their research results in OA journals and have a discount on publication costs.
- 31 Looking ahead, the implementation of national open policies and funders mandates is the main challenge for the development of open access in Greece. Towards this goal, the active and systematic engagement of all stakeholders (policy makers, funders, librarians, researchers and the wider academic community) is required. Funding bodies and research organisations must adopt OA policies for both publications and research data. According to the national roadmap towards the implementation of the European Research Area (ERA), until 2025, all publicly funded research will be freely accessible. In addition, Greece will investigate ways to support the transition from the existing subscription- based system to a model of OA, examining the financial aspects of such

models and determining the process of the transition (General Secretariat for Research and Technology, 2016).

- 32 There are also several requirements to be met at the infrastructural level, including :
- Using ORCID IDs for Greek faculty and researchers to enable disambiguation and discoverability of their work
 - Establishing user-friendly self-archiving workflows in Greek IRs. Use of DOIs and the CrossRef API could facilitate the processes and be considered. Archiving Greek publications in IRs is a challenge due to lack of DOIs. Therefore, publications in Greek conferences and journals could be archived by librarians and through a self-archiving process
 - Integrating tools that may support sharing (e.g. share buttons) or may give an idea regarding impact (e.g. citations from Scopus or PubMed, alternative metrics such as number of views/downloads, or tweets from the Altmetric.com API)
 - Depositing of citation data by Greek OA journals as open structured separable data in open citations projects (e.g., <https://i4oc.org/>, or <http://opencitations.net/>)
 - Promoting the interoperability of IRs with other OA infrastructure at national and international level.
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ABSTRACTS

Open access (OA) is a global movement to make research results widely available by removing price and permission barriers. OA infrastructure is necessary for implementing open access and open science in any country. The aim of the present paper is twofold : (i) to give a description of the Greek OA infrastructure with emphasis on academic repositories and OA journals, and (ii) to examine the OA availability of publications authored by Greek researchers and published in international journals. Results indicated that Open access infrastructures in Greece have been steadily improving over the past years, with 28 out of 36 HEIs running their own IR and 116 OA journals being published. The OA availability of the literature produced by Greek researchers is similar to that found in other studies and falls within the range that has been reported for European countries. Although numbers seem rather satisfactory, there are a number of challenges that have to be addressed at both the infrastructural and the policy level, the most important being the implementation of national open policies and funders mandates.

INDEX

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AUTHORS

ASPASIA TOGIA

ATEI of Thessaloniki, Greece

ELEFThERIA KOSEOGLOU

Aristotle University of Thessaloniki, Greece

SOFIA ZAPOUNIDOU

Aristotle University of Thessaloniki, Greece

NIKOLAOS TSIGILIS

Aristotle University of Thessaloniki, Greece