

Water Resources Research

COMMENTARY

10.1029/2020WR029480

Key Points:

- Open science is perhaps the most important paradigm shift in the recent history of scholarly publishing
- The path forward requires reconciling our value for open science with the capability to pay for publishing in an open-access journal
- The inherent value of open science should frame any open access decision

Supporting Information:

Supporting Information may be found in the online version of this article.

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Citation:

Clark, M. P., Luce, C. H., AghaKouchak, A., Berghuijs, W., David, C. H., Duan, Q., et al. (2021). Open science: Open data, open models, ...and open publications? *Water Resources Research*, 57, e2020WR029480. <https://doi.org/10.1029/2020WR029480>

Received 16 DEC 2020

Accepted 6 MAR 2021

Open Science: Open Data, Open Models, ...and Open Publications?

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Abstract This commentary explores the challenges and opportunities associated with a possible transition of Water Resources Research to a publication model where all articles are freely available upon publication (“Gold” open access). It provides a review of the status of open access publishing models, a summary of community input, and a path forward for AGU leadership. The decision to convert to open access is framed by a mix of finances and values. On the one hand, the challenge is to define who pays, and how, and what we can do to improve the affordability of publishing. On the other hand, the challenge is to increase the extent to which science is open and accessible. The next steps for the community include an incisive analysis of the financial feasibility of different cost models, and weighing the financial burden for open access against the desire to further advance open science.

1. Motivation

Open science is perhaps the most important paradigm shift in the recent history of scholarly publishing. Much has been published on the potential benefits and the many challenges related to open science and the need to share and document data (Baack, 2015; Hossain et al., 2016; Kattge et al., 2014) and computer code (Baker, 2016; Barnes, 2010; Easterbrook, 2014; Ince et al., 2012) with associated open licenses (Stodden, 2009). Some of the literature on data and software sharing has focused on Earth science in general (David et al., 2016; Gil et al., 2016) or hydrology in particular (Hutton et al., 2016). We now routinely share our data and our model source code; in fact, data/model availability is a requirement to publish in AGU journals (Stall et al., 2017). The FAIR initiative (data/models should be Findable, Accessible, Interoperable, and Reusable) arguably reduces duplication of effort, and can help to accelerate progress on key problems in hydrology and other sciences.

Critically, open science is not just underpinned by open data and open models, but by open publications as well (Björk, 2017; Hey & Payne, 2015; Schiltz, 2018). Open access and open science are seen as a way forward to a faster and more collaborative and inclusive science (Jamali et al., 2020). The trends towards releasing data as soon as it is collected, along with the trends toward open model development, means that data and code are released before external peer review. This naturally increases the pace of innovation but also creates new challenges to provide proper credit to the developers of datasets and models (Gil et al., 2016; Kattge et al., 2014). The accessibility of science for use by individuals and organizations is nevertheless part of a larger contract between the scientific community and society (e.g., Björk, 2017; Guédon et al., 2019). Similar to the health sciences (Jamali et al., 2020; Tennant et al., 2016), open access to scholarly publications is an urgent concern for environmental sciences, like hydrology and climate science, where incomplete and delayed access to the latest science by non-academic entities can exacerbate issues of environmental injustice, environmental pollution, and inadequate risk management. Open science is arguably a moral imperative that requires openness in all aspects of what we do.

The open science paradigm is dramatically changing the publishing landscape. There are new review requirements, including evaluating if the data and model source code are well organized and well documented,

if there is appropriate metadata, and if the models have reproducible test cases. More attention is also given to open access publishing policies, and many funding agencies now require (or at least strongly encourage) publishing in open access journals. For example, Plan S, an initiative from major funding agencies in Europe, requires scientists to publish their work in open repositories or in open access journals (Schiltz, 2018).

As a mechanism to explore these issues, the AGU Hydrology Section and the Water Resources Research (WRR) Editorial Board launched an Open Access Task Force to better understand the challenges and opportunities associated with a possible transition of WRR to open access. The mandate of the task force was to examine the current status of open access publishing, seek input from the community, AGU and its publishers, and to recommend a course for the future of WRR. The primary motivation of this effort was to provide recommendations on improving accessibility to WRR for both readers and authors. Changes in publication models should account for the evolving rules/incentives of funding agencies for some researchers, and avoid new barriers to scholarly publishing for others. A secondary motivation was to improve the understanding of open access options, issues, and challenges within the Hydrology Section membership. More generally, this initiative strives to identify how the WRR publishing model can be improved to better serve the broader hydrology community.

This commentary summarizes the efforts of the AGU Hydrology Section Open Access Task Force. Section 2 provides a review of the status of open access publishing models, including debates on open access publishing. Section 3 provides a summary of community input, obtained through (a) the Town Hall “*Planning for the future of WRR*” held at the 2019 AGU Fall meeting and (b) a survey sent to members of the hydrology community. Section 4 defines a path forward for AGU leadership: it frames the open access problem in terms of the tension between finances and values and provides specific recommendations on the additional work that is needed to define the best publishing model for WRR.

2. Context

2.1. The Status of Open Access Publishing

The publishing landscape is becoming increasingly diverse. Some major open access publishing models are:

1. Gold, fully open: In this model, the article processing charges (i.e., publication fees) are paid by authors, institutions, or funders for all published articles, and articles are freely accessible to all readers
2. Hybrid, open access is optional: In this model, authors, institutions, or funders pay no fees or limited fees (e.g., excess page charges) if the article is not openly accessible, or an additional fee to allow open access for all
3. “Publish-and-read” agreements: In this publishing model, consortia of institutions or libraries negotiate pooled funding for open access publishing. An example of such a publish-and-read agreement is Projekt DEAL in Germany
4. Green: In this model authors deposit articles into open preprint servers or institutional repositories that make them openly available (e.g., arXiv, ESSOAr, EarthArXiv, and university repositories)
5. Bronze: This is a rolling open access model, where journals agree to open materials to non-subscribers after a window of time (e.g., after two years)

AGU currently has 21 peer-reviewed journals – 15 journals offer hybrid subscription + open access options, and six journals are fully open access. WRR currently fits the hybrid model where it is possible for authors, institutions, or funders to pay \$2,500 USD for open access. WRR also fits the Green model where depositing article preprints into preprint servers is allowable and encouraged. Hosting the published version of the article on an institutional repository is allowed after six months. Moreover, WRR fits the bronze publishing model as articles become open to all two years after publication.

Open Access does not only include free to read (“*gratis open access*”) but often also free to use (“*libre open access*”) articles within specified copyrights, both of which are outlined here. Gold Open Access publications are typically licensed for sharing and reuse via a Creative Commons (CC) or similar. A CC license is used when an author wants to give other people the right to share, use, and build upon work that they (the author) have created. CC provides an author flexibility (for example, they might choose to allow only

non-commercial uses of their work) and protects the people who use or redistribute the author's work from concerns of copyright infringement, as long as they abide by the conditions that are specified in the license.

A recent analysis of 67 million open access articles has shown that open access journals receive on average more citations, and this effect is largely due to the Green and Hybrid open access papers (Piwowar et al., 2018). Despite this advantage of open access publications, research has shown that being open or innovative does not make a journal more attractive for early career researchers. Instead what counts are the importance of the journal and perceived prestige (Björk, 2017; Nicholas et al., 2017).

2.2. Debates on Open Access Publishing

The debate on open access is framed by the issue of publishing costs – who pays, and how, and what can be done to improve the affordability of publishing. In many respects, the shift to open access represents a shift from a “reader pays” system to an “author pays” system (Guerrero & Piqueras, 2004), with the publish-and-read agreements being the intermediate ground between these two financial models.

There are several concerns surrounding a potential transition to open access. A key concern is that the “author pays” system is a “pay-to-play” system, which can discriminate against those without funds to support publishing costs (e.g., scientists from developing countries, emeritus professors, unfunded students, and scientists who want to publish after their project has ended, or in disciplines where funding support is very limited or non-existent). It is hence necessary to identify innovative ways to ensure inclusiveness in these pay-to-play publishing models, such as by waiving publication fees in special cases. The shift from “reader pays” to “author pays” means that institutional libraries may spend less money on journal subscriptions. However, a concern is that the costs saved on journal subscriptions does not necessarily translate to an increase in the institutional funds available to pay for open access publishing costs. In fact, where institutional funds for open access publishing exist they are often woefully insufficient, to the extent that some authors are only able to publish in open access journals in the first part of the financial year before all of the institutional funds are spent. Even for institutions or countries where funding is available for open access publications, it is unclear if funding will increase at the same rate as the number of publications. Furthermore, there is the expectation that as more established or prestigious journals switch to open access, the price for open access publications may go up, in part to cover the additional resources spent on peer review, publishing, and press/promotion (van Noorden, 2013).

The debates on the affordability of publishing are inextricably linked to the revenue from scientific publishing. Many in our community react negatively to news of large corporate profits from scientific publishing endeavors. Scientific societies naturally find themselves at the center of these debates when they partner with a private “for-profit” publishing house (as is the case in the relationship between AGU and Wiley). Scientific societies also rely on revenue from scientific publishing (e.g., in the past, up to 40% of AGU's budget came from publications). These debates have led to increased scrutiny of scholarly publishing – there is now more guidance available on the reasonable costs for open access publishing, and there is a push for greater transparency and monitoring of publication costs and fees.

3. Community Input

3.1. Town Hall on “Planning for the Future of WRR”

We gathered input from the community through a Town Hall “*Planning for the future of WRR*” held at the 2019 AGU meeting. Charlie Luce (AGU Hydrology Section) provided an overview of the open access landscape, Matthew Giampoala (Vice President, AGU Publications) provided information on AGU's vision for open access, and Martyn Clark (WRR Editor-in-Chief) discussed the rationale and challenges in open access publishing. The Town Hall also included an “open mic” session to provide an opportunity for members of the AGU Hydrology Section to make their voices heard.

The main points expressed by participants at the Town Hall meeting were as follows (the notes from the discussion are combined and reordered for clarity):

1. Increased transparency in the revenue from publications: Given that AGU receives ~40% of its revenue from publications, how much of that is spent on journals and how much is spent on subsidizing other activities? Response from Matthew Giampoala: It is difficult to separate costs for journals because the budgets and groups are intertwined. AGU is non-profit – while expenses are high, operating costs are also high
2. Explain the contractual arrangement with Wiley: Are AGU journals still society journals? We need to know more about the AGU-Wiley contractual requirements and the ramifications to AGU for changes to the budget model. Response from Matthew Giampoala: We often talk about Wiley being a partner, but AGU owns its journals. AGU used to have in-house production, but there is no economy of scale there. The association with Wiley lets them act as a vendor for us: They host our platform, do production and sales for us, but we own the journal. We have a contract with them that we can renegotiate
3. Cost of publishing: The impression is that cost of publishing in WRR is quite high. EGU also receives 40% of its revenue from publications, all EGU journals are open access, and EGU publishing costs are much lower than AGU (in follow-up personal communication between Martyn Clark and Theresa Blume [February 17, 2021], it was confirmed that the median publication cost for a paper in HESS for the period July 1, 2018 to June 30, 2020 was 1,581 euros or ~\$1,750 USD). It was recommended that we work together with publishers to make production more affordable. Response from Martyn Clark: Publishing fees vary across AGU Journals. Publishing charges for most gold open access journals are \$1,800 (the publication charges in Gold open access journals are \$1,800 for Earth and Space Science, Earth's Future, GeoHealth, Journal of Advances in Modeling Earth Systems. The publication charges are \$2,000 for AGU Advances (an introductory rate) and \$2,500 for Space Weather); hybrid open access publishing charges for most AGU subscription journals are \$3,500 (open access publication charges are \$3,500 for Geochemistry, Geophysics, Geosystems, Global Biogeochemical Cycles, Journal of Geophysical Research (all), Pale-oceanography, Radio Science, Reviews of Geophysics, and Tectonics. Open access publishing charges are \$2,500 for Geophysical Research Letters and Water Resources Research). The hybrid open access publishing charges for WRR are \$2,500 (the justification for lower publishing charges in WRR [compared to other AGU subscription journals] is to make the cost to publish open access articles in WRR more similar to the cost of open access in other hydrology journals)
4. Consider the option to convert all AGU journals to open access at once: In 2000 EGU journals changed all its journals to gold open access at once, which is different from AGU who is approaching it more piecewise. Perhaps AGU is not taking the right approach. Universities need to band together to work for open access deals and changes at funding agencies
5. Support publication costs from low income countries: It is difficult to find money for low income countries to cover publication fees, and so covering some open access fees from low-income countries (LIC) could help. Waivers should be given at submission so that publication costs are not a deterrent. Response from Matthew Giampoala: This is already done. Most journals have discounts for LIC, but it has to expand beyond that for other authors who don't have the capacity to pay

3.2. Open Access Survey

We also held an open access survey to gain more quantitative information on the constraints and preferences for scientific publishing (the survey questions and detailed responses are provided in the supporting information; the summary of survey results is presented in Figure 1). The survey was sent to the AGU Hydrology Section membership, as well as authors who had previously published in WRR (9,956 total mailing addresses). We received over 1,000 responses.

Comparisons between survey demographics and the available author information suggest that the survey respondents were representative of past WRR authors. In terms of career stage, we received the fewest responses from students, possibly because few students make decisions on how to pay for publication costs. We received more responses from mid-career authors than from early career and late-career authors. In terms of institutional affiliation, we received more than four times the number of responses from academics than from government scientists. We received very few (<50) responses from authors in the private sector. We received almost double the number of responses from North America than from Europe, which



Figure 1. Summary of the survey results.

is similar to the WRR submission statistics (500–600 submissions per year from North America vs. 200–300 submissions per year from Europe).

The main conclusions from the survey are as follows:

1. Preference for a publishing model: Participants expressed the strongest preference for the hybrid and gold open access publishing model, and least preference for publish-and-read deals (Figure 1). Participants in Europe had a stronger preference for gold open access over hybrid than participants in North America and Asia (see the supporting information). Government scientists also had a stronger preference for gold open access over hybrid than academics (see the supporting information)

2. Embargo period: Most participants expressed a preference for an embargo period of one year or less, with the strongest preference for an embargo period of six months (Figure 1). The preference for the embargo period did not depend strongly on region, institutional affiliation, or career stage (see the supporting information)
3. Impact of institutional changes: The greatest proportion of participants indicated that institutional changes had no impact on the difficulty or desirability of publishing in open access journals (Figure 1). A greater proportion of participants from Europe are required to publish in open access journals (see the supporting information). Participants from Europe indicated that it was becoming less difficult to publish in open access journals; participants from North America and Asia indicated that it was becoming more difficult to publish in open access journals (see the supporting information)
4. Impact of higher publishing costs: The greatest proportion of participants indicated that they would be less likely to publish in WRR if publishing charges increased (Figure 1). The importance of publishing charges in deciding where to submit was higher in North America and Asia than in Europe, and higher among academics than government scientists (see the supporting information)
5. Sources of funding: The greatest proportion of participants indicated that they primarily used grant funding to pay for publication costs (Figure 1). Government scientists used institutional funding more than they used grant funding; a greater proportion of participants in Europe used institutional funding than participants in North America and Asia (see the supporting information)
6. Extent that funding supports open access fees: The greatest proportion of participants indicated that they could only support open access fees for one or a few publications per year (Figure 1)
7. Factors considered when deciding how much to pay for open access: Sources of funding and journal reputation emerged as the most important factors that affect the decision on how much to pay for open access (Figure 1). Related to journal reputation, the journal impact factor and the quality of the editorial board were also important (Figure 1). The availability of press and promotion was consistently the least important factor when deciding how much participants were willing to pay for open access (see the supporting information)

4. A Path Forward

4.1. Situational Assessment

The path forward for AGU publications (and WRR) requires reconciling our value for open science with the capability of institutions and individuals to pay for publishing in an open-access journal. The decision to convert to open access is hence framed by a mix of finances and values. On the one hand, the challenge is to define who pays, and how, and what can we do to improve the affordability of publishing. On the other hand, the challenge is to increase the extent to which science is open and accessible. The key challenge for the AGU leadership is to bridge the gap between individual preferences and the common good.

Balancing individual preferences with the common good becomes more difficult as more of the responsibility for open science is devolved to individuals. The transition to open access is a transition away from a system where institutions pay (i.e., institutional libraries pay journal subscriptions on behalf of its readers) to a system where the financial responsibility is increasingly devolved to individuals (i.e., many authors are responsible for paying article processing charges). Although institutional funding for publication costs is available in some cases, and more “Publish-and-Read” agreements are signed, this is not the norm (yet). Many authors depend on their grant funding to pay for publication costs.

This shift in financial responsibility creates a dissonance between individual self-interest and the common good. Open science and thus open access are seen to benefit the common good because the science is freely available. However, publishing preferences are at least partly shaped by the limited capability or willingness to pay for publication versus other research expenses. Such dissonance naturally raises questions on the governance of AGU publications (e.g., publication costs and transparency), and also questions on what is best for the community. While not all of the solutions must arise from changes in AGU, AGU can provide the leadership to bring others along in the journey toward more accessible science.

4.2. Recommendations

The decision to convert to open access depends, in large part, on the financial feasibility of the open access model. Converting WRR to open access would be more desirable if (i) publication costs were competitive with WRR's main competitors (e.g., HESS), and (ii) publication charges were waived (or subsidized) for authors without funds for publishing costs.

The task force recommends the following related initiatives to better understand the financial feasibility of open access publishing:

1. Explore trade-offs in open access publishing: The survey provides information on author's willingness to pay, along with the factors that influence author's decision to publish in a specific journal. These survey results now need to be combined with financial analyses to better quantify the trade-offs in open access publishing
2. Identify ways to reduce publication costs: The community is puzzled by the higher publication charges in AGU journals compared to other journals by similar societies (e.g., WRR publication charges are much higher than HESS). The finances of the publishing industry as a whole are rather "mysterious" and reported costs per publication vary widely (van Noorden, 2013). The task force recommends that AGU analyses and explains how it can reduce publishing charges, and the impact that reduced publication charges will have on the publication process, the published articles, and on AGU as an organization
3. Improve organizational transparency: AGU have partnered with a "for profit" publishing house. As a scientific society, it is necessary for AGU to have greater transparency in the governance of its publications. The task force recommends that AGU fully disclose the details of their business relationship with Wiley, the operating costs for AGU Publications (including staff costs at both AGU and Wiley), the revenue from publications, where the publication revenue is spent within AGU, and how much money AGU requires from its publications in order to function effectively
4. Explore avenues to increase institutional support for open access: The varying architecture of publication funding results in varying publication preferences and requirements. National-level or institutional subsidies for publishing in open access journals influence where authors choose to publish. Furthermore, since some articles are completed after the "end" date of a given grant, low-cost publishing outlets are necessary for those articles. If open access is considered an important component of open science, then effort needs to be made to explore to what degree current funding for publishing is an artifact of historical contract and grant language, and whether or how current funding arrangements could be changed to encourage an increased use of open access publishing options. For example, could publication funding be separated from the funding to do the research, and be made available for an extended period after salary and equipment funding is no longer required? Care would need to be taken regarding how different research and education institutions would be affected by changing large scale institutional funding models

These initiatives will help AGU justify its publication costs and increase community support for AGU publications. It will also prompt the scientific community to critically evaluate its increasing shift toward individual responsibility for publication costs, and perhaps to innovate new publication funding models.

4.3. Final Thoughts

If we want to advance the value of science as a fundamental process in obtaining facts to be used in debates on public policy (*sensu* Kirchner, 2017), access to and transparency of the scientific reasoning, analysis and data are central requirements. Elliott and Resnik (2019) make the distinction between scientifically relevant transparency and socially relevant transparency: Scientifically relevant transparency focuses on making it easier for other scientists to build on previous work and evaluate its reliability; societally relevant transparency focuses on helping decision makers and the general public make more effective use of scientific research. Open data and models move us forward in important ways to support the efficiency, reliability, and reputation of the scientific process and increase scientifically relevant transparency. However, timely and equitable access to scientific information by diverse groups beyond the academic community is increasingly becoming a critical determinant of science's role in public policy. This requires that we improve societally relevant transparency as well.

There is time available to consider a possible transition to gold open access in a thoughtful and deliberate way, and to discuss what is best for the community. In contrast to the rapid changes in the publishing landscape, there does not appear to be an overwhelming community desire for AGU/WRR to immediately modify its publication model and to convert to gold open access. In fact, the community survey suggests that “gold” and “hybrid” models are almost equally preferred by the survey participants (there is a slight preference for the hybrid model in North America and for the gold model in Europe). Furthermore, the survey participants indicated that currently institutional changes have a limited impact on the difficulty and desirability of publishing in open access journals.

The path forward to define a publishing model for WRR requires balancing finances and ideals. The necessary financial analysis entails examining the feasibility of alternative cost models, including the opportunities to reduce publishing costs and analysis of the trade-offs among alternative cost models. This financial analysis is only possible through greater organizational transparency (see the recommendations above). The ultimate decision requires weighing the financial feasibility of alternative cost models against the common good of open science. The inherent value of open science should frame any open access decision.

Data Availability Statement

The data from the community survey of open access preferences is presented in the supporting information.

Acknowledgments

The authors appreciate the constructive comments from the reviewers Christa Peters-Lidard and Theresa Blume. The authors also appreciate the efforts of Caroline Aubry-Wake, Anne Jefferson, and Wouter Knoben to take notes during the Town Hall meeting, and the efforts of Antonio Covington to administer and collate information from the open access survey. The authors thank the community members that participated in the Town Hall meeting and those that filled out the survey. Section President Ana Barros provided comments on this report. C. H. David was supported by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

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