Social Science in AMR project – Working Paper, February 2019

The state of social science research on antimicrobial resistance

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In review – please do not quote

Abstract

This paper investigates the genealogy of social science research into antimicrobial resistance (AMR) by piecing together the bibliometric characteristics of this branch of research. Drawing on the Web of Science as the primary database, the analysis shows that while academic interest in AMR has increased substantially over the last few years, social science research continues to constitute a negligible share of total academic contributions. More in-depth network analysis of citations and bibliometric couplings suggests how the impact of social science research on the scientific discourse on AMR is both peripheral and spread thin. We conclude that this limited social science engagement is puzzling considering the clear academic and practical demand and the many existing interdisciplinary outlets.

Keywords

Antimicrobial resistance; health policy; social science; bibliometrics; network analysis

Introduction

Antimicrobial resistance (AMR) refers to the process whereby microorganisms develop resistance to the antimicrobial against which they were originally vulnerable (Jindal et al., 2015). These resistant bacteria can spread from one person to the next just like any other bacterial infection or they can spread from animals to humans or vice-versa. Antibiotic treatments that we take for granted today are becoming increasingly ineffective; as a result, even minor illnesses, routine surgery or childbirth might become very risky endeavors in the future (Hoffman et al., 2015). While the process of AMR cannot be halted, well-recognized policies and practices already exist that would lead to more sustainable and effective usage of antimicrobial drugs. Despite consensus on what constitutes effective AMR policies and practices, several scholars have begun to call for more systematic social science research that could help address the practical challenges with regards implementation, communication, supranational coordination, agenda-

setting and so on (Carlet et al., 2014; Laxminarayan et al., 2013; Laxminarayan and Malani, 2007; Nathan and Cars, 2014; Roca et al., 2015). So far, the call for social science research into AMR has gone largely unheeded. This paper will present and explore the puzzling fact that AMR has hitherto received so little attention in the social sciences.

Concretely, the paper investigates the genealogy of social science research into AMR by piecing together the bibliometric characteristics of this branch of research. Previous bibliometric studies on AMR concern drug-resistance in specific diseases and bacteria (Qin, 2000; Sweileh et al., 2016a, 2017a, 2017b), certain types of antibiotic agents (Sweileh et al., 2016b), as well as disease surveillance programs (Reaves et al., 2017). This study addresses the gap in the literature relating to the role of the social sciences through a comparative approach and by applying advanced network analysis methods. This study adheres to the PRISMA standard of reporting to provide transparency regarding the data gathering process and reproducibility of the results. The data for the bibliometric research consists of 1,311 contributions pulled from the Social Science Citation Index in Web of Science using a topic search for all records including "antimicrobial resistance" and "antibiotic resistance" in the period 1956-2018. The Web of Science database only includes international journals that meet specified academic criteria with regards publishing standards, editorial content, diversity of authorship, citation rates, and so forth (Thomson Reuters, 2018). Academic contributions in the database are categorized in overarching indices as well as subject categories. The data thus allows for the tracking of academic contributions on AMR over time and across research disciplines as well as subject categories. To account for potential selection bias of publications in Web of Science, the study also draws from other sources, including Google Books and Google Scholar, to validate the findings.

The study proceeds as follows. The following section compares the scope of social science research in AMR to similar global health emergencies. The study then uses network analysis methods to uncover the

characteristics of social science research, revealing power dynamics and disciplinary structure within the citation patterns of the field. Finally, a brief conclusion suggests future directions to better incorporate the social sciences.

The scope of social science research

The academic interest in AMR has increased substantially in the last few years. In 2018, more than six thousand contributions in the Web of Science Citation Index referred to AMR in their topic. This is a quadrupling of the average number of annual contributions in the period 2000-2009. Google Scholar displays a similar trend. The number of AMR publications more than doubled from an annual average of around 7,200 in the period 2000-2009 to an annual average of 16,300 in the period 2010-2017. Even controlling for the overall increase in academic contributions, the academic attention to AMR appears to have increased over time. Today, for every 1,000 contributions in The Science Citation Index, three contributions include references to AMR in their topic. This is up from an average of just one in 2,000 during the 1990s. In other words, AMR gets more academic attention, and the trend appears to be increasing. This rising trend holds true for all three indices. However, the share of social science contributions remains miniscule. Just 1,311 academic contributions were categorized in the Social Sciences Citation Index in 1956-2018. Further, the share of social science contributions compared to science contributions has remained relatively constant throughout the years.

[Figure 1 about here]

Caption: Social science/science-ratio of contributions in the Web of Sciences

Description: Data based on the following topical key-word searches in The Science Citation Index (science) and The Social Sciences Citation Index (social sciences): "Antimicrobial resistance", "Malaria", "Ebola", "AIDS" and "Obesity."

Figure 1 compares the ratio of social science contributions with respect to science contributions across a selection of health challenges. The other health threats all display epidemic characteristics, and the World Health Organization (WHO) has identified them as some of the greatest health threats of the 21st century (WHO, 2017, 2018). A value of 1 indicates parity: if a science contribution on AMR is published, then either another social science contribution will be published alongside it, or the contribution is sufficiently interdisciplinary to also be classified as social science. Two findings stand out from the figure. First, social science research usually lags the sciences when it comes to addressing new and complex health emergencies. In 1991, the ratio never exceeded 0.2 for any of the health threats. Moving forward, the share of social science research increases for all health threats, most notably HIV/AIDS, which is no longer considered life-threatening or highly contagious in most parts of the world. This lag should not be begrudged. It appears reasonable to first seek to understand the pathology and epidemiology of a new health threat before broadening the research to include a socio-economic perspective. The horizontal dashed line expresses the social science/science-ratio across all contributions in the Web of Science, suggesting that the rising ratio is not merely a reflection of a general rising trend of social science contributions vis-a-vis the sciences. Second, while this overarching research dynamic for the social sciences appears to be a general rule, the threat from AMR is very much the exception. The threat of AMR has been known for more than half a century without any noticeable upsurge in attention from the social sciences. The social science/science-ratio never exceeds 0.03 and the average ratio for the period is less than one-third of the second lowest ratio of malaria. Investigating major works on AMR such as peer-reviewed books and reports produces a similar pattern. In the Google Books Database, close to 400 books and reports (with an ISN-number) referred to “antimicrobial resistance” or “antibiotic resistance” in their title. Social science contributions were identified based on three parameters: (i) whether the title included social terms; (ii) whether the contribution was published in a social science series; or (iii) whether some

of the authors had backgrounds in the social sciences. Of the entire corpus of publications, the share of social science publications was negligible, at around one percent. Even books where one would reasonably expect some contributions from social scientists failed to draw on such expertise. None of the more than 50 scholars who contributed to the mammoth work on antimicrobial resistance in developing countries, for example, had a background in the social sciences (Sosa et al., 2010). Other than a few economic reports (O'Neill, 2016; Smith et al., 2001), only two books on AMR had a clear foundation in the social sciences: *Risking Antimicrobial Resistance* written in large parts by sociologists, linguists and psychologists (Jensen and Fynbo, 2018) and *One Health and the Politics of Antimicrobial Resistance* written by an M.D. with a degree in public policy (Kahn, 2016). This lack of social science attention to AMR in the academic literature is particularly troublesome considering the clear demand for more social science research.

The characteristics of social science research

The relatively limited scope of social research in AMR motivates a deeper dive into the underlying characteristics of the field. This study constructs a network based on the patterns of 48,847 citations within all existing social science contributions to visualize the nature of scholarly discourse (see Online Appendix for code). Figure 2 visualizes the network of social science citations. The network includes top outlets that received at least 0.2 percent of the total citations in the corpus of contributions, representing both academic journals and organizational reports. Each node within the network represents the aggregated citations of each outlet. Outlets are connected by edges which signify the level of similarity between outlets. Similarity between outlets is measured through bibliometric coupling, which expresses to what extent outlets A and B are co-cited in outlet C, based on the assumption that publications in scientific outlets that are cited together share similar characteristics in terms of their content (Leydesdorff, 2007; Leydesdorff and Rafols, 2011). For example, journal articles citing publications from *British Medical Journal* may be more likely to also cite *Pediatrics*, compared to an outlet such as *Preventive*

Veterinary Medicine, which focuses on treating animals. As such, *British Medical Journal* and *Pediatrics* would likely be the most similar of these three journals, in terms of bibliometric coupling. Turning to the network visualization, we see this is indeed the case the case: looking to the north of the network, *British Medical Journal* and *Pediatrics* are directly connected by an edge, while information must travel through numerous pathways to reach *Preventive Veterinary Medicine* towards the south.

The study uses the social network analysis concept of "betweenness centrality" as a proxy for power and interdisciplinarity within the network (Freeman, 1978). Betweenness measures to what extent a given node is placed along shortest paths between other nodes within the network. For example, there is no edge between *British Medical Journal* and WHO, indicating that information does not readily flow between these outlets. However, both outlets are joined to *Social Science and Medicine*, demonstrating its control over translating the flow of information between the specialized knowledge in *British Medical Journal* and the more general audience of WHO's reports. Nodes with high betweenness centrality essentially control the flow of information—the network would fall apart if these highly central nodes were removed.

The core of the network consists of medical and microbiology journals that do not aim to publish social science research, including *Journal of Antimicrobial Chemotherapy*, *Applied Environmental Microbiology, New England Journal of Medicine*, *British Medical Journal*, and *Journal of Clinical Microbiology*. Over 55 percent of the network's shortest paths pass through these journals, and the journals also receive a large share of the total citations. Outlets that generally seek impact beyond the field of medicine are decidedly less central to the network. The most central of these non-specialized journals include *Lancet Infectious Disease*, a medical journal explicitly aiming to influence global health policy, the general science journal *PLOS One*, and publications from WHO, which account for approximately 20 percent of the network's shortest paths combined.

[Figure 2 about here]

Caption: Citation network for AMR social science research, 1956-2018

Description: Node size represents the percentage of shortest paths passing through each node. Label size reflects the number of citations per outlet, while darker edges between nodes indicates a higher level of similarity. Node color indicates community membership.

Clearly, social science research on AMR heavily relies on knowledge produced within the natural sciences and medicine. The few social science journals present in the network remain at the periphery, including *Social Science and Medicine*, *Health Policy*, and *American Journal of Public Health*. Among these, *Social Science and Medicine* makes the greatest impact, both in terms of network centrality and total citations. The social science journals are all interdisciplinary and health-domain specific, highlighting that more general social science outlets have failed to penetrate the discourse. Social science research is instead largely represented in outlets relating to public health, including publications from WHO and *Eurosurveillance*, which is funded by the European Commission to address public health challenges. Further, the included social science outlets do not share edges, indicating the lack of a cohesive discourse. For scholarly communication to flow between *Social Science and Medicine* and *Health Policy*, for example, it must pass through *British Medical Journal*. Notably absent are economics outlets. Despite *Health Economics* being the most cited in its field, it did not receive enough citations to be included in the network. This is surprising, considering that economics was the first disciplinary perspective to be applied to AMR. Economic analyses of AMR policies can be traced back to the late 1980's, but the bulk of the work is published after 2010, mainly the in the form of cost-benefit calculations of AMR policies. Recently, studies broadened to address the economic and poverty impacts of AMR, but this does not emerge in the

network (Ahmed et al., 2018; Laxminarayan et al., 2016). Bibliometric data intrinsically weights historical publications, since they can accrue more citations, highlighting a potential limitation in this approach.

Certain groups of outlets within the network may be more well connected in terms of their bibliometric coupling, indicating distinct epistemic communities. This study uses the Louvain algorithm to inductively detect such communities, by finding constellations with maximum intergroup similarity and minimal intragroup similarity (Blondel et al., 2008). Five epistemic communities emerge from this analysis, hand-labeled in terms of their research themes and shared discourse. Again, a strong communicative practice among social science scholars fails to materialize—the social science outlets are spread out across these communities. Instead, medicine and microbiology remain dominant. At the center of the network, we find a cluster of highly cited journals categorized within clinical microbiology. This cluster serves as an interface between pure medical journals to the north, and applied microbiology to the south. Moving further south lies a peripheral cluster of journals engaged with environmental science. The cluster towards the east is the most diverse, containing general science journals such as *Science* and *Nature*, as well as outlets concerned with public health such as WHO, *Eurosurveillance*, *BMC Public Health* and *Tropical Medicine and International Health*. Notably, *Lancet*—a traditional medical journal—also appears in this cluster. This indicates that *Lancet* to a larger extent penetrates the discourse of more general science and policy-related outlets within social science research on AMR, compared to other medical journals.

To illuminate the contrast between AMR research and other pressing global issues, we analyzed the patterns of social science research on climate change. Diverse social science disciplines play distinct roles in climate change research (see Appendix). Not only is research on climate change management on equal footing with the natural sciences in terms of centrality, there are distinct clusters of journals within economics, geography, and behavioral sciences. Similarly, drawing upon a range of social science disciplines can offer numerous benefits to AMR research. Currently, the disciplines of anthropology and

sociology are almost exclusively applied in interdisciplinary public health journals rather than in their respective disciplinary journals. The research mostly relies on qualitative methods to provide insights on policy decision-making, medical practices, patient behavior and public debates. In this journal, for example, sociology constitutes the main social science approach to AMR research where it has recently been applied to expose trauma and stigmatization among refugees and pig farmers (Fynbo and Jensen, 2018; Kamenshchikova et al., 2018).

Conclusion

Academic attention to AMR has increased substantially both in absolute and relative terms. However, the modest attention from the social sciences seems to indicate that these academic fields lag with respect to contributing insights that can help the world in addressing this emerging, complex, and global health crisis. The impact of social science research on scientific discourse on AMR is both peripheral and spread thin. This is regrettable, seeing that scholars and practitioners alike have identified a clear demand for more social science research into the topic. Many high-ranking interdisciplinary journals already engage with the intersection between health and social science. Most social science research on AMR is currently subsumed in public health or medical journals. This type of research should be applauded and encouraged. But given the choice of venues, such research risks never being exposed to and engaging with core social science debates and scholarship. Hence, AMR-research within particular social science disciplines is probably also needed. Social science disciplinary journals have engaged unreservedly with other complex and transboundary themes such as climate change, violent conflicts, human rights and migration. Hence, participation in dedicated social science discourses constitutes an underutilized avenue for developing and validating contributions that investigate AMR thematically. The limited social science interest in AMR stands in contrast to the increased focus on social issues from health agencies. For instance, the *European Centre for Disease Prevention and Control* has held several workshops (the latest

was in December 2018) where social scientists have been invited to provide their perspective on various health challenges including AMR. Social scientists were also invited to provide inputs into the formulation of the charter for the recently conceived *International Centre for Interdisciplinary Solutions on AMR,* which is set to open in 2019. Once operational, this Centre is set to pursue an interdisciplinary profile that also embraces the social sciences. The merits of social sciences are also recognized by the WHO's Antimicrobial Resistance Secretariat. Recently, the Secretariat's director coauthored a contribution that calls on the social sciences to strengthen the global governance dimension of AMR (Padiyara et al., 2018). With these academic and institutional openings in mind, the near absence of pure social science research on AMR is likely to be a supply problem. Accordingly, seeing that the academic infrastructure and demand for such contributions are already there, our proposed solution becomes more of a plea: more social scientists should engage forcefully with the multitude of societal issues related to AMR. Ideally, this should be done in collaboration with medical experts in interdisciplinary journals such as this one. The global threat from AMR is increasingly being compared to that of climate change (Rochford et al., 2018). Such comparison can also be used to illuminate differences in social science research. In earlier decades, social science research into climate change related issues was also limited (IPCC, 1990, 2004). Today, however, the social science/science-ratio for climate change is around 0.3, and the IPCC assessment reports are diversified into reports focusing on the science behind and projections of climate change (*The Physical Science Basis*), and reports drawing on this information to address social issues (*Impacts, Adaptation and Vulnerability* and *Mitigation of Climate Change*) (IPCC, 2014). The global fight against AMR is likely to benefit from the same trajectory for social science research.

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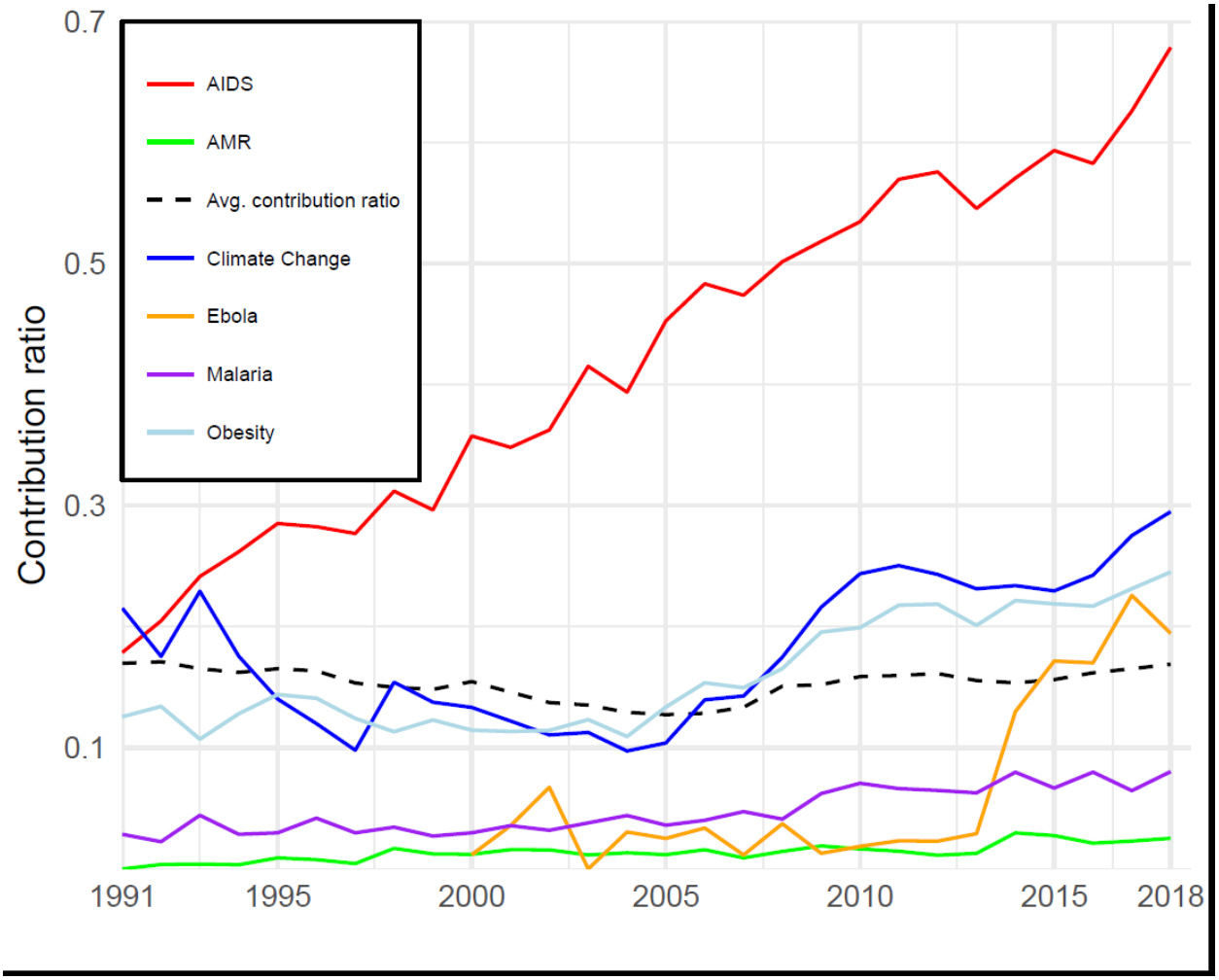
Figure 1: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Contribution ratio
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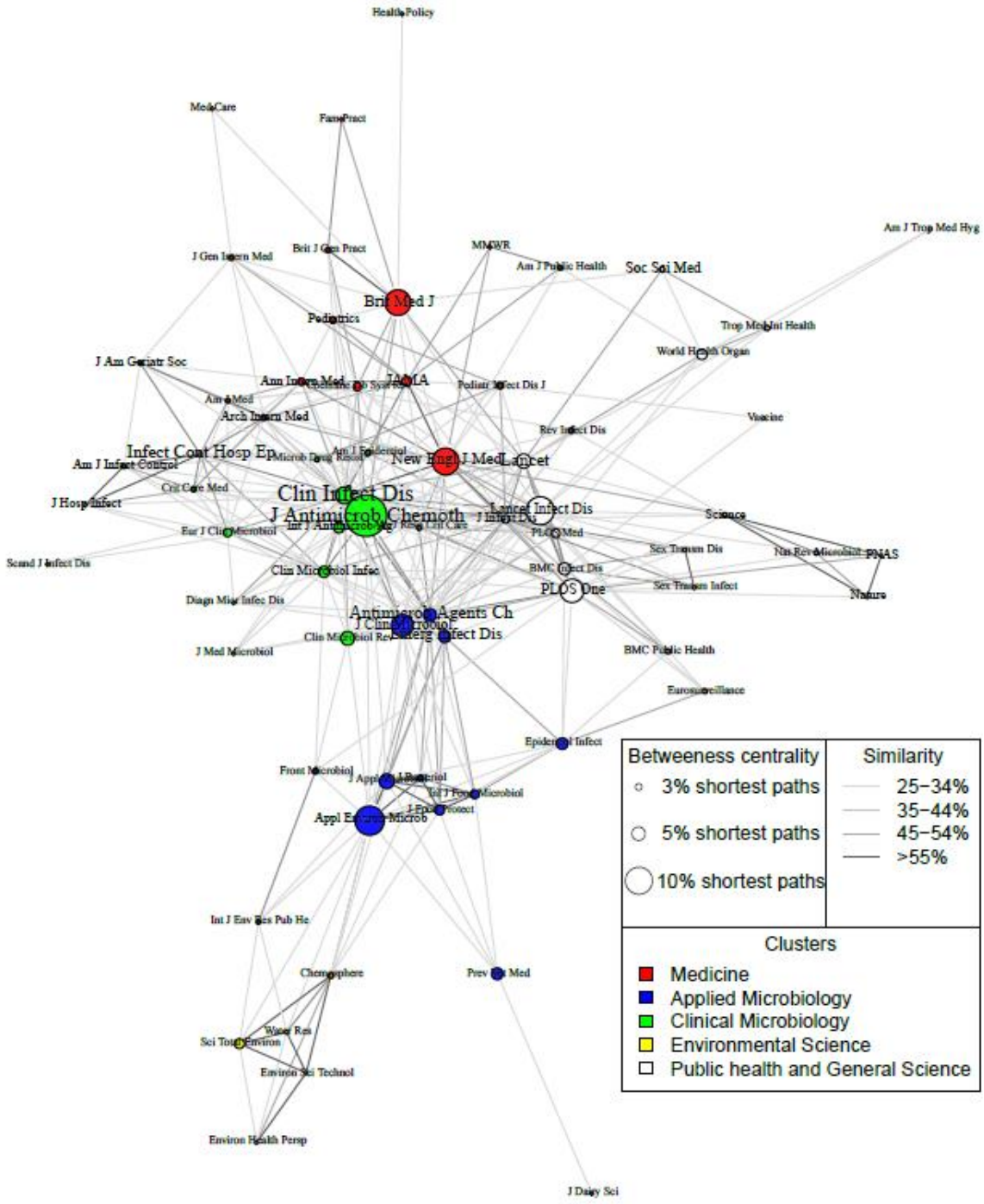
Figure 2: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Environ Health Persp
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10% shortest paths
Similarity
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Clusters
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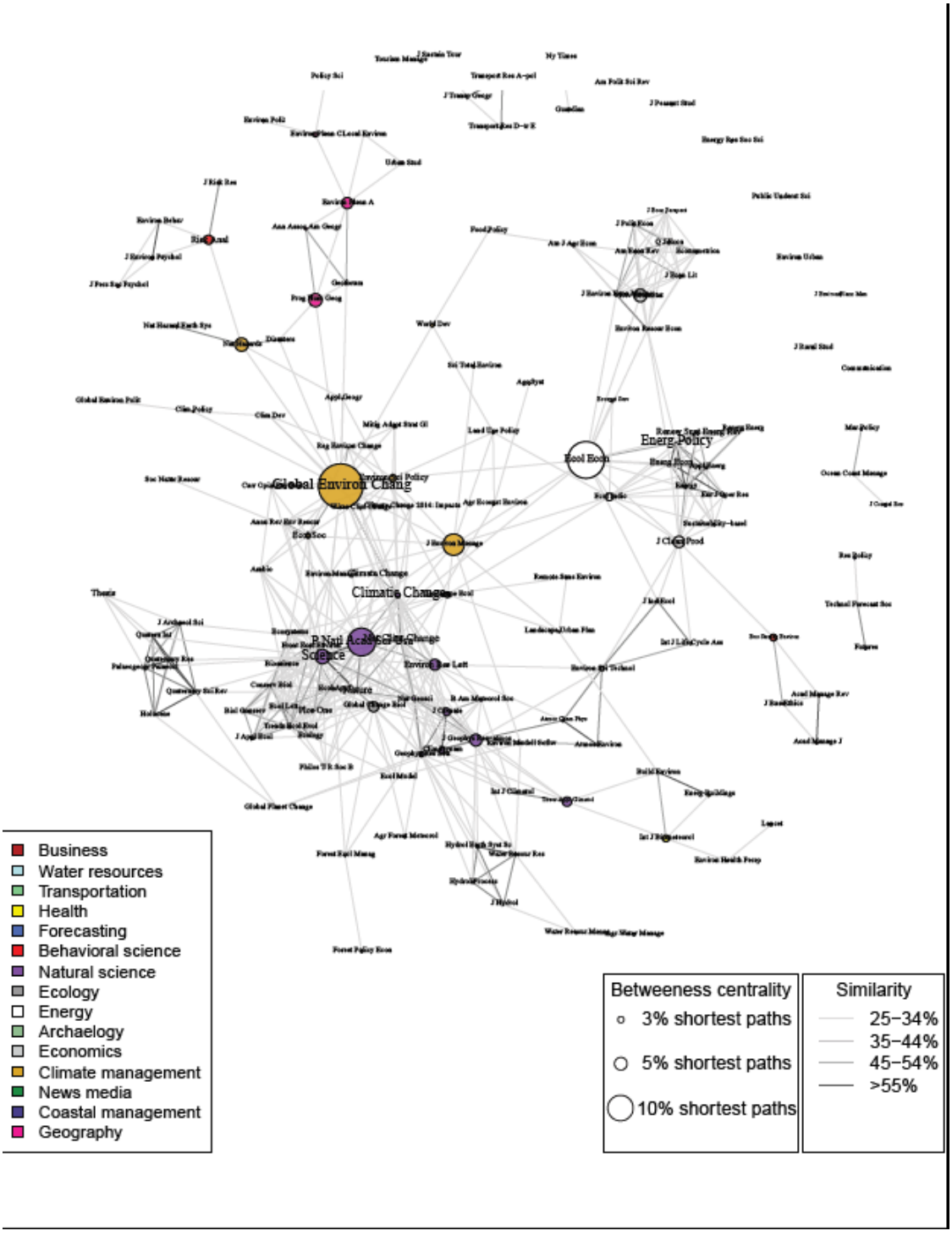
Applied Microbiology
Clinical Microbiology
Environmental Science
Public health and General Science

Appendix: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Economics
Climate management
News media
Coastal management
Geography
Betweeness centrality
3% shortest paths
5% shortest paths
10% shortest paths
Similarity
25−34%
35−44%
45−54%
>55%