Resources Policy 58 (2018) 257–267

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Social sciences and the mining sector: Some insights into recent research trends

Emrah Karakaya*, Cali Nuur

Industrial Economics and Management, KTH Royal Institute of Technology, Lindstedtsvägen 30, 11428 Stockholm, Sweden

ARTICLE INFO

Keywords:
Mining
Systematic literature review
Authorship
Minerals

ABSTRACT

The number of science publications is growing exponentially, thus increasing the need for understanding the knowledge base of various research streams and their emerging branches. From a social science perspective, the literature on the mining sector – the industrial sector that extracts ores and minerals from the ground – has also witnessed steady growth. However, this literature is rather fragmented in regards to the thematic topics and the geographical focus. To respond to this, this paper offers a systematic literature review of the social science research on the mining sector. The publication database of this review includes a set of 483 systemically selected papers from 976 authors, covering empirical research conducted in 73 countries from 5 continents: Africa, Europe, Asia, Australia and America. Our contribution is twofold. Firstly, we provide an analysis of the geography of the research in terms of both authorship and empirical focus. In terms of the geographical coverage of the empirical cases, Australia appears as the most studied country in the field, followed by countries in other regions such as Asia (China, India, Russia and Turkey), Africa (Ghana, South Africa and the Democratic Republic of the Congo), North America (the USA and Canada), Latin America (Brazil and Chile) and Europe (Poland, Spain and Sweden). However, this dispersion is not reflected in the geographical coverage of the affiliations of the authors. Secondly, we identify the most popular social science research topics on the mining sector. Our results show that the social science research on the mining sector shifted from the traditional research streams (e.g., industrialisation and growth, colonialization, technological and economic development, and the resource curse) to the new streams of research on social, environmental and economical sustainability (e.g., the social license to operate, corporate social responsibility, criticality of the rare earth elements, material flow analysis and environmental impacts). Overall, our study serves as an entry point for researches who are interested in social science research on the mining sector.

1. Introduction

The number of science publications is growing exponentially, doubling every 9–10 years (Bornmann and Mutz, 2015). This growth leaves researchers, policy makers as well as practitioners with a sea of knowledge, although several publications have remained unread and uncited for decades (Larivière et al., 2007; Meho, 2007). From a scholarly perspective, the inevitable growth in science has increased the need for understanding the knowledge base of various research streams in a systematic and structured way. Thus, the systematic literature review approach (Tranfield et al., 2003) has become an important method with which to synthetize the cutting-edge scientific knowledge generated by numerous publications in a field at a given point in time. Consequently, the fast-growing social science research literature on industrial sectors (e.g., industry-specific studies on economics, political science, human geography, demography and sociology) has been systematically reviewed in several studies, focusing on, for instance, the energy sector (Sovacool, 2014a, 2014b), the cultural and creative industries (Cho et al., 2016), the agriculture and food sector (Poulsen et al., 2015), the tourism sector (Benckendorff and Zehrer, 2013) and the air transport sector (Ginieis et al., 2012). However, in the social sciences, the mining sector – defined in this paper as "the industrial sector that extracts ores and minerals from the ground" – has not been systematically and extensively reviewed to date.

Historically, the mining sector has been studied using various perspectives, which have, over many decades, enriched our understanding of the dynamics and competitiveness of the industry. Thanks to decades of research, we know how the industry is organized, we understand its operations, prices and labour-related issues as well as the role of mining in spurring economic development, innovations and growth processes. Although the earlier literature did not focus on contemporary issues such as innovations, learning, knowledge spillovers and safety, but

* Corresponding author.
E-mail address: emrah.karakaya@indek.kth.se (E. Karakaya).

https://doi.org/10.1016/j.resourpol.2018.05.014
Received 31 March 2017; Received in revised form 16 May 2018; Accepted 17 May 2018
Available online 07 June 2018

tended to focus on inputs/outputs from the mines, these issues have recently become key topics of research (e.g., Corder et al., 2015; Martinez-Fernandez, 2010; Upstill and Hall, 2006; Walker and Minnitt, 2006). The research on mining has come a long way since Smith (1928) recognized mining output as an important measure of a nation's competitiveness, noting that the prosperity of nations should be measured by the volume of ore output and not by the value it generates. Technological development and knowledge formation as a nexus of transformation in the mining sector that was discussed more than half a century ago (see e.g., Fisher, 1953; Ginsburg, 1957) is still valid. In addition, the academic discourses on the role of mining on development in developing countries that engaged sociologists, political scientists, development economists, and economics and followed the creation of the economic commissions such as the Economic Commission for Latin America (ECLA) by the United Nations in the 1950s have provided us with insights into the mechanisms that condition or constrain development. Interestingly, the discussions on the inability of mining and its locations to develop effectively evolved; for instance, the notion that the mining sector lacked self-propelling growth processes since it did not function as "industries motriches" (Perroux, 1955) with both forward and backward linkages needed for development (Hirschman, 1971, 1958). Furthermore, the intense discussions within the social sciences with the inception of concepts such as the "development" of the "underdevelopment" (Frank, 1973, 1970, 1967), and of the "unequal exchange, "dependency theory" (Emmanuel, 1972) that were mainly underpinned by a Marxian approach and that used mining as well as other resource-exploiting activities/industries as the empirical point of departure have enriched the scholarship on mining.

Following globalization, the notion of the "resource-curse" literature – which, simplified, stated that natural resource-based activities, including mining, had an adverse impact on growth – has emerged (Gylfason, 2001; Sachs and Warner, 2001, 1995). For instance, the works by Sachs and Warner (2001, 1999, 1995) that have been cited thousands of times have formalised the long-standing idea that resources (including minerals) inhibit growth. Although providing explanations, the resource-curse hypothesis has also come under criticism and there are several critical studies that have rejected the idea that a resource curse represents a general trend among resource-based economies. Some social scientists have argued that if you control for the factor of "institutions", the correlation between natural resource abundance and the growth levels disappears (Mehlum et al., 2006). The resource-curse thesis, together with the "Dutch Disease", which has a family resemblance to the resource-course thesis (see e.g., Corden, 1984; Matsen and Torvik, 2005), emerged at a time when the process of globalization and the industrial catching up of some countries could be argued to have resulted in what might be termed as a "new scramble" for natural resources. In addition, there is the observation that some of the richest and/or fastest growing economies have a significant share of natural resources, including Sweden and Australia, where mining, for instance, contributes significantly to GDP. However, the diminishing role of industrial activities in old industrialized nations and the waves of the Tiger economies from the 1950s–1980s that took place without significant natural resource bases provide a solid argument for the presence of the resource curse. At the same time, the proliferation of technologies in, for example, the mining sector, has transformed mining into a highly-automated industry resulting in significant shifts in skills, competencies and working cultures compared to what hitherto has been the case.

More recently, the scholarship on mining has centred on the impact of climate change and mitigation strategies (see e.g., Azapagic, 2004; Hamann, 2003; Moran et al., 2014; Schoenberger, 2016) and spans across several academic disciplines in the social sciences. In addition, the recent research looks at issues such as green supply chain management (Kusi-sarpong et al., 2015; Luthra et al., 2015), the social license to operate (Moffat and Zhang, 2014; Prno and Slocombe, 2012), materials criticality (Glöser et al., 2015; Lapko et al., 2016), policy making (Andriamasinoro and Angel, 2012; Moussa et al., 2015) and financial aspects (Bekiros et al., 2015; Savolainen, 2016). Even though the research has become increasingly diverse, only a few literature reviews have been undertaken to identify the scholarly knowledge base. These reviews focus on only a few sub-fields of social science research on the mining sector rather than having a broader scope. For example, Smith (2013) presented a literature review of the research methods and models used in the assessment of the impacts of extractive resource taxation. He provided an overview of previous research that had drawn from the economic theory of the extractive industries and the theory of optimal taxation. Another example is the study by Savolainen (2016) that reviewed the scholarly literature that conducts real option analyses of metal-mining investments. Savolainen sorted the literature into two groups: focused (valuations and managerial) and project timelines (exploration, development, extraction and reclamation). In general, these literature reviews on the mining sector are specific to only a few sub-fields, and do not attempt to cover a broader range of social science-related topics. Addressing this gap, this paper poses the following research question: *What is the state-of-the-art social science research on the mining sector?*

In order to answer the research question posed in this paper, we use a systematic literature review approach – a common research methodology that synthesizes all relevant studies on a specific topic, limiting the bias of systemic assembly and critical appraisal (Cook et al., 1995, p. 167). The publication database is based on the Social Science Citation Index (SSCI) from the Web of Science database, including 483 papers from 976 authors, covering empirical research conducted in 73 countries from 5 continents (Africa, Europe, Asia, Australia and America). Our analysis is twofold. Firstly, we provide an analysis of the geography of the research in terms of both authorship and empirical focus. Secondly, we identify the most popular social science research topics on the mining sector.

Apart from this introduction, the paper consists of three sections. In Section 2, we explain the research design and the data in detail, including the methodological steps involved in the data collection and data analysis. This section also gives the methodological background for the systematic literature review approach. In Section 3, we provide the results and discussion. This section is divided into two parts: a synthesis of key social science research topics on the mining sector and an analysis of the geography of the research. Finally, the conclusions of the paper and the implications are presented in Section 4.

2. Methodology

2.1. Systematic literature review

In general, the term "systematic literature review" is used to refer to both the methodology employed in a study or the study itself. Kitchenham (2004) defines a systematic literature review as "a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest". Systematic literature review research can be distinguished from traditional narrative reviews in that it adopts a replicable and detailed methodology (Cook et al., 1995; as cited in Tranfield et al., 2003, p. 209). Systematic literature reviews have a longer history in the medical sciences than in other fields such as the social sciences. Today, they are widespread and have become a key research activity in most of the scientific disciplines. Mulrow (1994) argues that there is always a need for systematic literature reviews in order to separate the known from the unknown in the scholarly literature. However, identifying the known and unknown is a challenging process. That is why systematic literature reviews should be conducted with predefined and transparent methodological steps.

In this paper, we follow the three-stage procedure of the systematic literature review from Tranfield et al. (2003), who transferred the principles of the systematic review methodology usually used in the medical sciences into social science-based research. The procedure consists of two major stages: planning and execution. The planning and execution stages, followed by their limitations, are briefly explained in the following sub-sections.

2.1.1. Planning stage

In this stage, we identified the research questions, research objective, the field, the data source and limitations. We have chosen to focus on two dimensions of the social science literature on the mining sector – the key topics and the geographical coverage – as they have not been addressed by the previous relevant reviews. We limited our database source to peer-reviewed journals. We believe that the research published in peer-reviewed journals is a good representation of the scholarly research in a particular field. This is in line with other systematic literature reviews that also limit their sources to peer-reviewed journals (e.g., Crossan and Apaydin, 2010; Sovacool, 2014a). In addition, we limited the time frame to 2005–2015, because we are more interested in the recent contributions rather than the earlier studies.[1]

As a scholarly database, we chose the SSCI from the Web of Science instead of other alternatives such as Scopus or Google Scholar. We are aware of the limitations that the Web of Science includes fewer journals compared to Scopus and Google Scholar (Adriaanse and Rensleigh, 2013; Chadegani et al., 2013; de Winter et al., 2014; Falagas et al., 2008) and that overall, the Web of Science does not include relatively young journals and has as a tougher set of criteria for inclusion. However, the Web of Science serves the purpose of this paper better and it has some practical advantages. Firstly, the Web of Science content is covered by both Scopus and Google Scholar, at over 90% and almost 100%, respectively.[2] Secondly, the journals that are indexed in the Web of Science go through a rigorous evaluation and selection process based on their impact, influence, timeliness, peer review and geographic representation (Testa, 2015). This means that, as we argue, the Web of Science publication database is an important representation of the ongoing research in science.

2.1.2. Execution

This stage includes several parallel phases such as the selection of studies, quality assessment, data extraction and data synthesis. In our review, we have covered these phases with four steps (see Fig. 1).

1. We searched for relevant articles in the Web of Science SSCI database from 2005 to 2015 with a set of keywords, that is, (Mining*) or (Mineral*). The keywords were searched for in the title, abstract and keywords of each publication in the SSCI (on the 8th of September 2016). This step resulted in 9765 publications (i.e., the "raw database").
2. We analysed the content of the journals containing the 9765 publications. This analysis was based on two criteria: relevance to social science research in the mining sector and the number of publications. From those journals that have a high relevance, the five journals with the maximum number of publications were selected. These journals were *Resources Policy*, *Energy Policy*, the *Journal of Cleaner Production*, *Technological Forecasting and Social Change* and *Ecological Economics*. The 571 publications that appeared in these 5 journals (i.e., the "filtered database") were used for the next step. Table 1 shows the counts and percentages of these 5 journals, as well as the 15 journals that were excluded from the database. The excluded journals include papers on minerals in bones and archaeological sites (e.g., in *Journal of Archaeological Science*), minerals in human body (e.g., in *Journal of the American Geriatrics Society*) and data mining (e.g., in *Expert Systems with Applications)*
3. We read and analysed the titles, abstracts and keywords of each publication in order to double-check whether all 571 publications were relevant to the field. This step resulted in the exclusion of 87 papers (1 from *Resources Policy*, 17 from *Energy Policy*, 5 from the *Journal of Cleaner Production*, 60 from *Technological Forecasting and Social Change* and 4 from *Ecological Economics*) and therefore led to the inclusion of 483 articles for the next step.
4. Finally, we analysed the data for 483 articles (i.e., the "final database") in order to answer the research question in this paper. Our analysis was twofold.
   a. We provided an analysis of the geography of the research in terms of both authorship and empirical focus. For authorship, we used

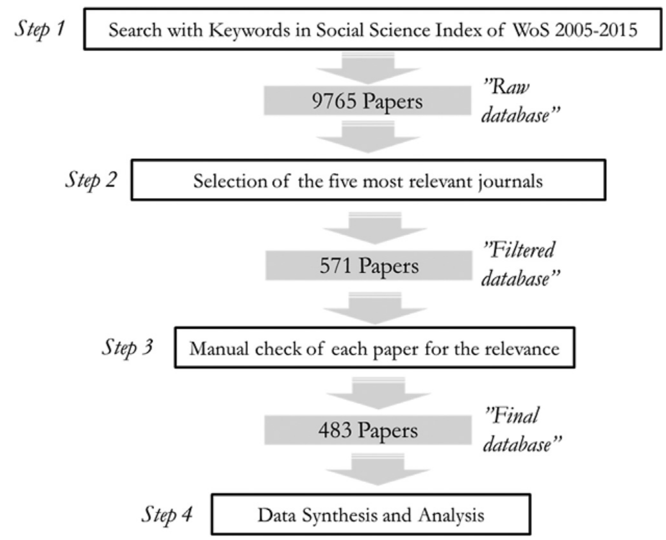

Fig. 1. Four steps of execution.

Table 1
The share and relevance of the journals in the raw database.

Journal[a]	Count	% of 9765	Relevance
Resources Policy	310	3.2%	**Yes**
Journal of Archaeological Science	293	3.0%	No
Expert Systems with Applications	225	2.3%	No
Journal of the American Geriatrics Society	99	1.0%	No
Osteoporosis International	84	0.9%	No
Energy Policy	79	0.8%	**Yes**
Information Processing Management	74	0.8%	No
Journal of Cleaner Production	73	0.8%	**Yes**
American Journal of Physical Anthropology	68	0.7%	No
Decision Support Systems	67	0.7%	No
Scientometrics	67	0.7%	No
Journal of the American Medical Informatics Association	65	0.7%	No
Journal of the American Society for Information Science and Technology	65	0.7%	No
Technological Forecasting and Social Change	64	0.7%	**Yes**
Journal of Women's Health	58	0.6%	No
Journal of Information Science	49	0.5%	No
International Journal of Geographical Information Science	47	0.5%	No
PloS One	47	0.5%	No
Ecological Economics	45	0.5%	**Yes**
Journals of Gerontology Series A Biological Sciences and Medical Sciences	44	0.5%	No

[a] Only the 20 journals that have the highest number of publications are listed.

[1] We are aware that the time period of 2005–2015 can be characterised by several global contextual factors. For instance, the Kyoto protocol entered into force in 2005, committing 192 state parties to reduce greenhouse gas emissions. Also, the time period 2005–2015 witnessed relatively high oil prices except during 2008–2009 when the world hit by a global financial crisis.

[2] Chadegani et al. (2013) show that 92% of the Web of Science journals is indexed in Scopus. Theoretically, all Web of Science journals should be indexed in Google Scholar.

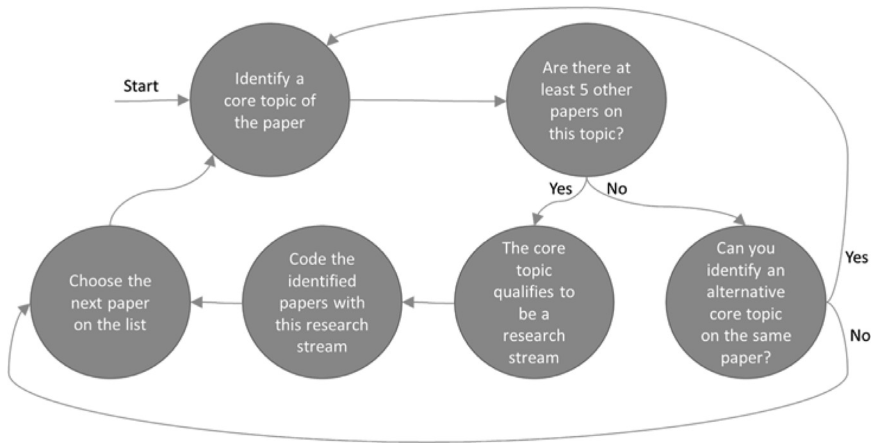

Fig. 2. The protocol for coding the research streams.

the information on which countries the affiliations of co-authors are based. For empirical focus, we analysed the titles, abstracts, keywords and, when required, the full texts, and identified which countries the papers empirically focus on.[3]

b. We identified the research streams based on a coding protocol (see Fig. 2). The protocol was implemented on paper-by-paper basis, analysing the titles, abstracts, keywords, and, when necessary, the full texts.[4] To do so, we ranked the papers in regard to their citations per year and, then, we started the protocol with the paper at the top of the list.

2.1.3. Limitations

In order to manage the massive body of literature, we must delineate the scope of this paper with some methodological constrains. Firstly, the analysis in this paper is limited to the articles in the journals, not to books or to other types of research reports. This means that some topics may not be captured well in the review. Secondly, the paper focuses only on five Web of Science journals in the field rather than all of them. This results in the exclusion of the related journals that are of a small size such as *Natural Resources Forum* (a United Nations Sustainable Development journal) as well as the journals that are not indexed in Web of Science. Thus, we acknowledge our review may miss some new areas of inquiry that have not published in the selected five journals. Thirdly, because of the shortcomings of the keywords used in the literature search, a number of relevant articles, for example, those which do not present with a particular focus on mining in their abstracts, may not qualify for inclusion in the filtered database. Overall, these three major limitations also appear in other literature reviews on social science (e.g., Carlsson, 2016; Sovacool, 2014a). Despite the limitations of our methodology, we expect that the selected articles in the five journals will consist of an important share of timely articles that are representative of the social science research on the mining sector. Also, in order to reduce the bias, a wider body of literature, which is not listed in the database used in this paper, is elaborated through the discussions on the different research streams and the geographical scopes.

2.2. Data description

The final database consisted of abstracts from 483 articles and 976 authors. The mean value of the number of citations per year per paper was 2.27 (with a standard error of 0.13, a median of 1.36 and a maximum of 24.43). The number of authors per paper was 2.02, which is in the range of what has been observed in other social science research, for example, 1.88 in the management field (Acedo et al., 2006). However, the number of authors per paper was very low in comparison with the natural sciences, for example, 3.75 in medicine, 2.53 in physics and 8.96 in high energy physics (Newman, 2001), or in high-impact journals, for example, 5.35 for the reports in *Science* and 9.07 for the articles in *Nature* (van Wesel, 2016). As shown in Table 2, the articles in the final database were published in the format of research articles, reviews, editorial material, book reviews and proceedings' papers. Of these articles, 309 were published in *Resources Policy*, representing 64.0% of the total number of articles in the final database, while the remaining 36.0% was published in the other four journals: *Energy Policy*, the *Journal of Cleaner Production*, *Technological Forecasting and Social Change* and *Ecological Economics*.

It is striking that the number of articles rose dramatically during the 2010s (see Fig. 3). The rise during the 2010s is a common trend in social science research on industrial sectors such as energy (Sovacool, 2014a, 2014b), agriculture and food (Poulsen et al., 2015), as well as in social science research on sustainability (e.g., Karakaya et al., 2014; Karaosman et al., 2016).

3. Results and discussion

3.1. The geography of the research

In the last decade, global mineral production has witnessed some geographical shifts. Firstly, the continent of Europe has seen a steady decrease in mineral production in contrast to a significant increase in the other regions of the world such as Africa, Asia, Latin America, Oceania and North America. Secondly, the developing countries[5] accounted for most of the production, up from 53% in 2004 to 60% in

[3] When identifying the empirical focus of a paper, we categorized each paper under one of the following categories: (1) focus on a single country, (2) focus on multiple countries, (3) focus on broader regions or group of countries, e.g., Europe or developing countries, (4) no empirical focus, e.g., papers on general, methodological or theoretical issues.

[4] We are aware that there are two main ways of identifying research streams in literature: automated curation (e.g., Polyakov et al., 2017) and manual curation (e.g., Carlsson, 2016). In our case, we chose the latter because of the manageable size of our final database as well as our interest in understanding the broader context of each paper.

[5] According to the United Nations Statistics Division, there is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system. In common practice, Japan in Asia, Canada and the United States in Northern America, Australia and New Zealand in Oceania, and Europe are considered "developed" regions or areas. In the international trade statistics, the Southern African Customs Union is also treated as a developed region and Israel as a developed country; countries emerging from the former Yugoslavia are treated as developing countries; and countries in Eastern Europe and in the Commonwealth of Independent States in Europe are not included under either developed or developing regions. Source: http://unstats.un.org/unsd/methods/m49/m49regin.htm.

Table 2
Document types for the final database of 483 articles from 976 authors.

Type	Count
Article	466
Review	5
Editorial Material	4
Book Review	4
Article; Proceedings' Paper	4
Total	483

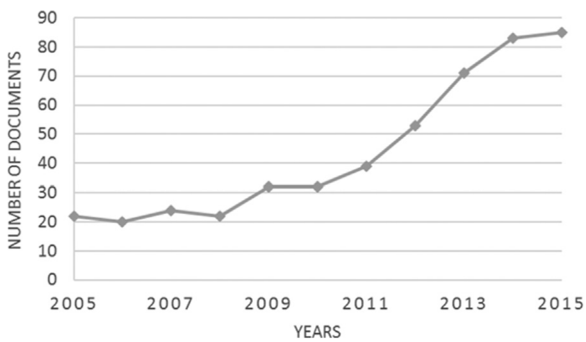

Fig. 3. Evolution of the number of documents over the years in the final database.

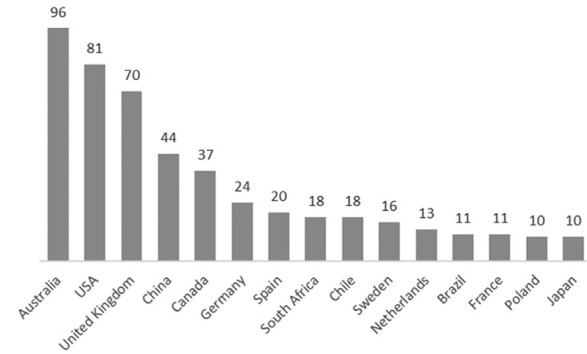

Fig. 5. Authors' countries of affiliation: The top 15 during 2005–2015.

2014, while BRICS countries (Brazil, Russia, India, China and South Africa) increased their share of the total production from 35% to 44% during the same period. As of 2016, China is the top global producer of minerals, followed by the USA, Russia and Australia (Reichl et al., 2016, pp. 20–32).

In our database, Australia comes across as the most studied country in the literature. Fifty-two articles (out of 483) explicitly had an empirical focus on the mining sector in Australia. Australia is followed by countries in Asia (China, India, Russia and Turkey), Africa (Ghana, South Africa and Democratic Republic of the Congo), North America (the USA and Canada), Latin America (Brazil and Chile) and Europe (Poland, Spain and Sweden). Fig. 4 presents the top-15 countries from which the empirical data of the reviewed literature was generated. However, one should consider that not every article in our database necessarily had an explicit geographical focus. Several articles aimed to contribute to methodological or theoretical issues, either with a global perspective or without any articulated geographical boundaries. There are also papers that empirically focus on more than a single country.

Traditionally, the structure of the mining industry has been dominated by large multinational companies, which are mostly registered in the developed countries such as the United States of America, Canada, the United Kingdom and Australia. However, these multinational companies often conduct mining operations in developing regions in Africa, Asia and Latin America, where local communities might be left to pay the costs of social and environmental issues with relatively little economic benefit (Davis and Tilton, 2002; Jenkins and Yakovleva, 2006). When it comes to the social science research on the mining industry, we observe a flow of interest from developed countries to developing countries as well. Although the empirical focus of the research is dispersed between developing and developed countries, a significant proportion of the authors is from developed countries (see Fig. 5).

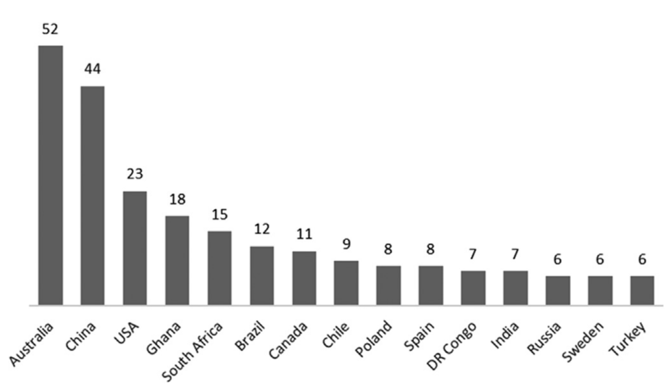

Fig. 4. Countries under empirical focus: The top 15 during 2005–2015.

We have also identified the top ten countries that have the highest ratio between the number of papers from a country and the number of papers that focus on it (see Table 3). Denmark, Switzerland and New Zealand come first on the list as there are no papers that empirically focus on these countries. These three countries are followed by seven other developed countries: Netherlands, Germany and France, the United Kingdom, Austria, Belgium and Italy. As shown in Table 4, the authors from these ten countries may have a higher empirical focus on foreign countries than on their home countries.

3.2. Research streams

Classifying the 483 papers into research streams is a challenging task, either because the abstracts do not provide sufficient information (sometimes requiring the reading of the full article) or because the papers are interdisciplinary (often relating to diverse and overlapping research streams). Despite these challenges, we identified the most popular research streams as "social license to operate", "corporate social responsibility", "criticality of the rare earth elements", "material flow analysis" and "environmental impacts". In the following sub-sections, we first present a general overview (Section 3.2.1) and then discuss the content and the main findings of the most popular research streams (Section 3.2.2-6). We have provided references only for the major contributions, thus illustrating the most representative examples (in terms of both relevance and citation records).

Table 3
The top-ten countries: the ratio between the number of papers from a country and the number of papers that focus on it.

Country	Affiliations of authors [AoA]	Empirical focus [EF]	Ratio [AoA/EF]
Denmark	9	0	–
Switzerland	7	0	–
New Zealand	5	0	–
The United Kingdom	70	5	14
The Netherlands	13	1	13
Germany	24	2	12
France	11	1	11
Austria	6	1	6
Belgium	6	1	6
Italy	6	1	6

Table 4
Empirical focus of the selected countries.

Country	Empirical focus[a]
Denmark	China (2), Azerbaijan (1), Liberia (1), Tanzania (1), Brazil (1), India (1)
Switzerland	Kyrgyzstan (1), Spain (1), Madagaskar (1), Guinea (1)
New Zealand	Papua New Guinea (2), Australia (1), South Africa (1), Sierra Leone (1)
United Kingdom	Ghana (7), United Kingdom (4), Australia (3), Sierra Leone (3), China (2), Guyana (2), Madagaskar (2), Tanzania (2), Argentina (1), Brazil (1), Canada (1), DR Congo (1), Ecuador (1), Kazakhstan (1), Myanmar (1), Nigeria (1), Papua New Guinea (1), Russia (1), Thailand (1), Zambia (1), Zimbabwe (1)
Netherlands	China (2), DR Congo (2), Australia (1), Brazil (1), Turkey (1)
Germany	Argentina (1), Burkina Faso (1), China (1), Czech Republic (1), Ecuador (1), Germany (1), Ghana (1), Indonesia (1), Iran (1), Russia (1), Saudi Arabia (1), Turkey (1), Uganda (1)
France	Czech Republic (1), Kyrgyzstan (1), South Africa (1), Burkina Faso (1), Canada, Mali (1), Australia (1)
Austria	Austria (1) Romania (1), China (1)
Belgium	DR Congo (4), Belgium (1)
Italy	China (1), Mongolia (1), Australia (1), Italy (1)

[a] The papers with a focus on broader regions or group of countries, e.g., Europe or developing countries, as well as the papers without empirical focus, e.g., papers that focus on general, methodological or theoretical issues, are excluded.

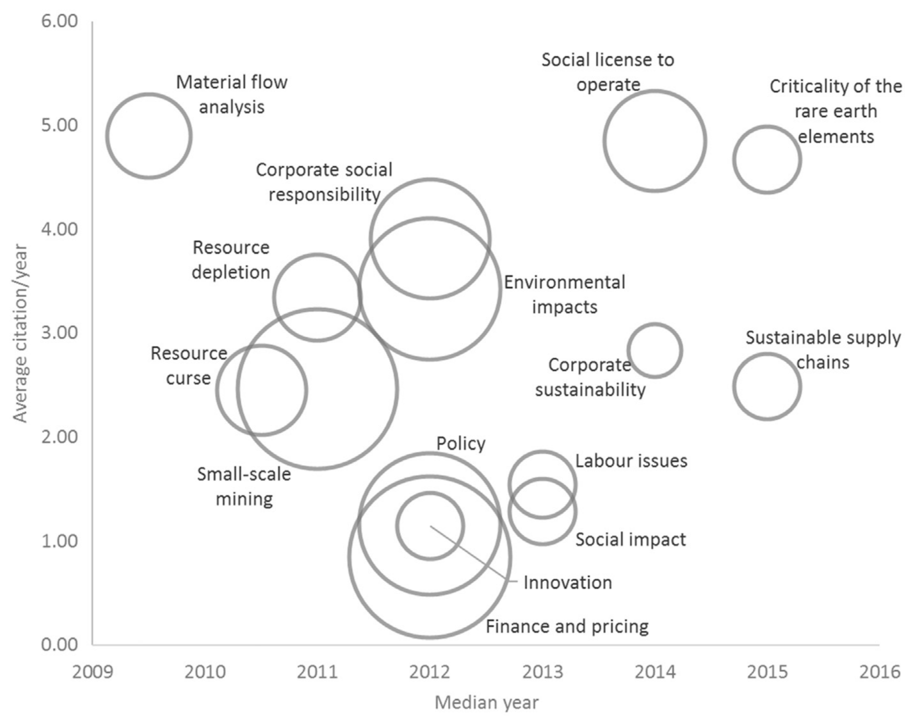

Fig. 6. Identified research streams during 2005–2015.

3.2.1. General overview

Based on our analysis in the final database, we identify 15 research streams. We have been able to categorize 321 papers under one of these steams while 162 of them remained uncategorized. In Fig. 6, we present these 15 research streams in respect to number of publications, median year of the publications and average number of received citations per year. The reason for 162 papers to remain uncategorized is manifold: unclear focus of a paper, numerous research focuses, focus on outlier topics (which are not studied by others in the list) or generic focus (e.g., studies that focus on multiple industrial sectors beyond mining).

In terms of average citation per year, the top five research streams are *social license to operate, corporate social responsibility, criticality of the rare earth elements, material flow analysis* and *environmental impacts (*which are discussed in-depth in the following sub-sections). The rest of the research steams are *resource depletion* (e.g., studies on resource degradation and peak minerals), *corporate sustainability* (e.g., on business practices that considers social, economic and environmental aspects as well as their reporting), *sustainable supply chains* (e.g., on green supply chain and supply risk), *small-scale mining* (e.g., on artisanal mining) resource curse (e.g., on the paradox that countries with an abundance of natural resources have tendency to lag), *labour issues* (e.g., on workplace safety, long distance commuting and employment), social impact (e.g., on displacement, housing and human rights), *policy* (e.g., on policymaking, subsidies and governance), *innovation* (e.g., on technology development, automation and R&D), and *finance and pricing* (e.g., on mineral prices, economic costs and investments).

3.2.2. Social license to operate

One of the earliest appearances of the term "social license to operate" in scholarly research goes back to the study undertaken by Esty and Porter (1998), which defines it as a firm's moral obligation to operate within the expectations of the community. Later, Post (2000) pointed out that a company's "social license to operate" was recognized mostly by the companies involved in the extraction, development, or heavy use of natural resources, for example, in petroleum exploration, mining, forestry and land development. In addition, Post's (2000) study extended the definition by Esty and Porter (1998), as the social license to operate goes beyond a moral obligation because communities can slow and resist business activities to protect the community from unacceptable risk. Today, a social license to operate is an important but hard-to-measure concept that has been studied by several researchers in the field.

From those articles specifically focusing on the social license to operate, three articles – all of which are published in *Resources Policy* – stand out with their high number of citations per year. One of them is the study by Prno and Slocombe (2012). Overall, the paper draws on examples from Northern Canada and discusses the key governance and institutional arrangements from which a social license to operate in the mining sector evolved. To conceptualize the social license to operate, the authors use a slightly modified version of the framework developed by Lemos and Agrawal (2006) that was originally developed to describe the mechanisms and strategies of environmental governance. In the mining sector, according to Prno and Slocombe (2012), a social license to operate means the ongoing approval and wide acceptance by society of a mining project. They argue that a social license to operate is a complex phenomenon which involves three kinds of actors (the state, civil society and the market) and their relationships (co-management, public–private and social–private arrangements) in order for the venture to be successful.

Among those articles focusing on the social license to operate, two other studies with high citation rates are those by Owen and Kemp (2013) and Moffat and Zhang (2014). Owen and Kemp (2013) provide a critical discussion of the term "social license" and its usage in the mining sector. The paper asserts that it is an informal (or tacit) license, without which companies could still operate (amid some protests and delays). The authors argue that, although the discussions on the social license have raised the profile of social issues, the concept has failed to articulate a collaborative developmental agenda for the mining sector. This means that the social license in the mining sector is (at the moment) more about reducing some of the opposition to mining projects rather than increasing engagement and collaboration in the long term. In order to change this, the authors suggest that industrial actors in the mining sector should develop a less defensive and more constructive approach. Otherwise, the distrust by stakeholders and the threat from opposition groups will not be diminished in the long term.

Moffat and Zhang (2014) develop a model of the critical elements of the social license and apply it to a longitudinal study in an Australian mining region. The model is composed of five interdependent variables (i.e., procedural fairness, contact quantity, contact quality, impacts on social infrastructure and trust), which explain the dependent variable of acceptance and approval. The survey data was collected from 267 local residents who lived in the region affected by the operation of a coal seam gas company. The results show how the five variables relate to each other and how they conceptually construct a social license. Overall, the authors articulate the central role of trust for the social license to operate.

3.2.3. Corporate social responsibility

For several decades, corporate social responsibility has been studied not only in management science in general (Lindgreen and Swaen, 2010; Mcguire et al., 1988; Zenisek, 1979) but also in other social sciences for specific industrial sectors such as food (Maloni and Brown, 2006) and tourism (Henderson, 2007). In this vast literature, it is often defined as the actions of firms that contribute to social welfare, beyond the interests of the firm and beyond the requirements set by law (Mcwilliams and Siegel, 2001). In the mining sector, corporate social responsibility initiatives by the firms are viewed as the key factors that enable the emergence of the social license to operate (Prno and Slocombe, 2012) as well as to some extent the achievement of sustainability (Jenkins and Yakovleva, 2006).

From those articles with a special focus on corporate social responsibility, three articles stand out with their high citation rates per year. Firstly, Jenkins and Yakovleva (2006) explore the disclosure of social and environmental issues by the top-ten mining companies in the world (by market capitalisation). Through a content analysis of the reports of these companies from 1999 to 2003, they study the changing nature of the reports towards an integrated corporate social responsibility policy. They show that the media disclosure for corporate social responsibility in the mining sector is increasing. However, as they argue, the lack of confidence regarding whether a firm's corporate social responsibility policy is applied in practice remains a complex challenge to tackle.

Secondly, as an introduction to a special issue of *Resources Policy*, namely "Corporate Social Responsibility in the Extractive Industries: Experiences from Developing Countries", Hilson (2012) provides the historical background and details of the state-of-the-art debate on the subject. He argues that corporate social responsibility was a "Western" construct, which is driven by the invisible pressures of the comprehensive environmental regulations, labour unions and consumer demands in developed countries. He questions the corporate social responsibility activities of multinational companies in the extractive industries in the developing countries in Latin America, sub-Saharan Africa and Asia. Some of these multinational companies opt to operate in developing counties because of tax breaks, low royalty payments and low labour standards – which in turn contradicts the spirit of corporate social responsibility. Hilson (2012) argues that the impact of corporate social responsibility activities in the developing world is a grey area that would need further research.

Finally, a recent paper by Govindan et al. (2014) investigate the drivers of corporate social responsibility under six categories: societal, supply chain, environmental, financial, voluntary and mandatory. Interestingly, this study is one of the very first studies to empirically focus on India. Having a multi-stakeholder perspective (including government, society and the media), the authors conclude that government regulations and codes of conduct are the most important drivers of corporate social responsibility in the mining sector in India. The other drivers, with less importance, are the firm's reputation, the company´s image, conservation of the environment, the media, NGOs and social activists.

3.2.4. Criticality of the rare earth elements

The rare earth elements are often considered as a group of 17 chemical elements including 15 lanthanides, plus yttrium and scandium (Golev et al., 2014; Humphries, 2012). In contrast to what their name denotes, rare earth elements are abundant in the earth. However, they are difficult to extract economically (Gupta and Krishnamurthy, 2005). China is the predominant supplier of rare earth elements, along with a strong capacity to process them into end products such as permanent magnets (Stegen, 2015). The discourse on the criticality of these elements has rapidly intensified since 2010 – when China significantly reduced its export quotas.

In our database on the social sciences, from those articles specifically focusing on the criticality of the rare earth elements, three articles stand out with their high number of citations per year. Golev et al. (2014) studied the existing and emerging supply chains of rare earth elements outside of China – the country that dominates the production of these elements. The authors argue that there was no lack of rare earth element resources, but rather a supply chain risk. They identify mining initiatives in the USA, Australia, Russia, India, Kazakhstan, France, Malaysia and Estonia as existing and emerging supply chains that could be an alternative to offset China's domination. In addition, they argue that reprocessing industrial waste tailings and recycling end-of-life consumer products could be considered as new sources of rare earth elements, contributing to both supply chain security and environmental sustainability.

Stegen (2015) argues that the monopolistic dominance of China for rare earth elements and permanent magnet production was a potential growing threat to the development of efficient lighting and renewable energy technologies. This paper reiterates the common wisdom that reliance on a single supplier – regardless of which country it is – carries risks. A case in point was that China exerted political pressure on Japan by using its control over supplies during a dispute in 2010. Overall, Stegen (2015) discusses four different ways of addressing the rare earth shortages: (1) finding substitute materials; (2) changing the end use products (so that rare earth elements are not heavily needed); (3) reopening old mines or exploring new mines; and (4) recycling. To address these shortages, the article suggests that policy makers should develop assets such as technological know-how and intellectual capital in their respective countries outside China. One of way doing this could be through a thorough support scheme for research and development as well as the generation of scientists and engineers in new fields.

Wübbeke (2013) examines the narratives behind the Chinese policy of rare earth elements that resulted in the tightening up of its export quotas. The article argues that China's policy was motivated not only by geopolitical reasons but also by domestic concerns over the environment and industrial competitiveness. This means that the geopolitical narrative, for example, China's tendency to use its dominance in rare earth elements as an instrument of global politics, is not the main reason behind China's policy. The concerns over resource depletion and low prices in technologically important fields at the domestic level are also important reasons behind its policy. According to Wübbeke (2013), Chinese policy makers, via export quotas, intended to take some control of the prices of rare earth elements and compensate for the ecological damage that had been caused in China.

3.2.5. Material flow analysis

Brunner and Rechberger (2003) define material flow analysis as a systematic assessment of the flows and stocks of materials within a defined system in space and time. The philosophical underpinnings of material flow analysis are rooted in the concept of anthropogenic systems, for example, a company, city, or region functioning as a living organism with metabolic processes (Baccini and Brunner, 2012). Material flow analysis is often used as a synonym for material flow accounting. However, material flow accounting represents only one of the several steps of material flow analysis, and it is anchored in economic accounting (Bringezu and Moriguchi, 2002, p. 79).

From the articles on material flow analysis, three articles – all published in *Ecological Economics* – stand out with their high number of citations per year. Firstly, Krausmann et al. (2009) examine the annual global extraction of materials under four major categories: (1) biomass, (2) fossil fuels, (3) industrial minerals and metallic ores, and (4) construction minerals for the period 1900–2005. Overall, they find that global material use had increased eightfold during the last century, resulting in a twofold increase in material use per capita. This was mainly driven by the sharp increase in the global use of biomass, fossil fuel industrial minerals, metallic ores and construction minerals – especially after World War II – even though there was a decrease in biomass usage. However, the global increase was not reflected in the amount of materials required per unit of GDP – the value of which (in 2005) amounted to only 40% of the 1900 value.

Secondly, based on a material flow dataset compiled for the year 2000, Steinberger et al. (2010) examine the global material use of biomass, construction minerals, fossil energy carriers and industrial minerals. To do so, they focused on three dimensions: (1) variability and the distributional inequality in material consumption; (2) the influence of population, GDP, land area and climate on material consumption and trade; and (3) coupling between material flows. The results of the study show that biomass was the most equitably distributed resource, while other mineral material groups were not, being closely coupled to each other. In addition, biomass use was largely driven by population, while the other mineral material groups were significantly related to economic development.

Thirdly, Spatari et al. (2005) present an estimation of the accumulation of copper-bearing products in use and in waste reservoirs during the twentieth century in North America. The authors find that the copper cycle showed a recycling rate of 40% from post-consumer waste, indicating that another 60% was landfilled, dissipated, or lost from the economic system. They argue that the loss may accelerate in the future because of the increasing rate of electronic equipment use – especially if the waste from used electronics would not efficiently collected and processed.

3.2.6. Environmental impacts

The environmental effects of mining have been a key topic in the academic discourse for decades (see e.g., Cappuyns et al., 2006; Dudka and Adriano, 1997; Salomons, 1995). Our database shows that the topic has remained important in the recent literature as well. Three articles stand out with their high number of citations per year. Firstly, Liu et al. (2007) study the evolution of industrial carbon emissions from 36 industrial sectors in China over the period 1998–2005. They find that three energy-intensive sectors – (1) raw chemical materials and chemical products, (2) non-metal mineral products, and (3) smelting and pressing ferrous metals – accounted for 59.3% of the total increased industrial CO_2 emissions. Although the energy intensity of these three sectors decreased by 29%, 19% and 24% respectively, they accounted for more than 50% of industrial energy consumption in China.

Secondly, Mudd (2010) discusses the environmental sustainability of mining in Australia, quantifying the principal trends. The study has five major findings. Firstly, the production of minerals and metals grew nearly exponentially over the last few decades. Secondly, the ore grades (also the ore quality and impurities) have been gradually declining. Thirdly, due to a major shift from underground to open cut mining, the waste rock that is excavated has increased nearly exponentially over the last few decades. Fourthly, although the economic mineral and metal resources are still growing to some extent, the time needed to use up the remaining resources is declining. Fifthly, the transparency of the sustainability of mines (e.g., over waste rock, tailings, energy, cyanide and water consumption, greenhouse emissions etc.) is increasing thanks to the emergence of sustainability reporting protocols. Finally, the resource intensity for a unit of mineral production will increase as mines will shift to lower grade and more refractory deposits.

Thirdly, Kuik and Hofkes (2010) discuss the possible border-adjustment measures in the EU Emissions Trading Scheme (ETS) with a special focus on carbon leakage – the transfer of production to other countries with laxer emission constrains. They carry out a number of simulations based on three scenarios: (1) The EU ETS without trade restrictions, (2) the EU ETS with border adjustments based on the direct CO_2 emissions per unit of a similar product in the EU, and (3) the EU ETS with border adjustments based on the average direct CO_2 emissions per unit of production in the foreign (exporting) country. The findings showthat border adjustments have a higher potential to reduce the sectoral rate of leakage of the iron and steel industry in comparison with the leakage of the mineral products sector, including cement.

3.3. Some suggestions for future research

Our study can provide some implications for future research. In terms of geography of research, the empirical focus (as expected) is generally on the countries where mining activities are conducted. Although our data shows that an important portion of the papers empirically focus on developing countries, the institutional affiliations of authors are, however, not a mirror image of this dispersion. This may not be that surprising as this is perhaps the nature of research in recent years, e.g., researchers in developed countries have the resources to apply and receive research grants to empirically investigate mining which is conducted in developing countries. However, the underlying reasons for this discrepancy need further investigation. As economic geographers have argued for decades (Feldman, 1993; Marshall, 1920; Maskell, 1999; Porter and Stern, 2001), even in the context of globalization, the mechanisms of industrial competitiveness such as knowledge formation, innovations, competence generations, technological development and the institutional context may remain local. Also, when conducting empirical qualitative research, the location of the researcher is important since the researchers may draw different conclusions depending on whether they belong to the phenomenon they choose to study, i.e., having an insider or outsider role. Both roles have their own advantages and disadvantages (Bartunek and Louis, 1996; Unluer, 2012). Hence, it can be fruitful to conduct further empirical research (co-) led by researchers who are in close proximity to the mines in developing countries where local knowledge, e.g., insider perspective, may be essential.

In terms of research streams, our data shows that there is a growing interest in sustainability-related topics. Such interest can also be seen in social science research literature on other industrial sectors such as energy (Araújo, 2014), food (Beske et al., 2014) and tourism (Ruhanen et al., 2015). This trend may be because of the practical concerns on social, environmental and economic sustainability issues as well as the financial support from the growing number of public and private funding bodies. In general, sustainability research is transforming into a more transdisciplinary and heterogeneous form, often working at the science-policy-practice interface (Rau et al., 2018). In our database, sustainability researchers also address, to some extent, a heterogeneous group of topics, e.g., social license to operate, corporate social responsibility and sustainable supply chains. However, not many scholars in our database use a perspective of "sustainability transitions"– a field of research that study the long-term and multi-dimensional transformation processes through which established socio-technical systems, such as sectors like transportation, mining or energy supply, shift to more sustainable modes (Markard et al., 2012, Karakaya et al. 2018). For future research, the frameworks commonly used in sustainability transitions literature, e.g., the multi-level perspective (e.g., Geels, 2006), strategic niche management (e.g., Nill and Kemp, 2009), technological innovation system (e.g., Bergek et al., 2008) and transition management (e.g., Rotmans and Loorbach, 2009), might be interesting points of departure for scholars aiming at understanding the industrial dynamics of the mining sector. Also, we recognize that topics related to automation, e.g., internet of things, artificial intelligence and big data, have been an interest of only a few studies in our database (e.g., Bellamy and Pravica, 2011; Perrons and McAuley, 2015). Given the growing number of practices and rising expectations on automaton in general (see e.g., Brynjolfsson and Mcafee, 2014), it can be interesting for future research to focus on the industrial dynamics of automation in mining sector as well as its relevance for the environmental, social and economic sustainability.

4. Conclusions

In this study, we aimed to analyse the current trends in the social science research on the mining sector. Based on a systematic literature review of 483 articles from 2005 to 2015, we provided an analysis of the geography of the research in terms of both authorship and empirical focus as well as identified and discussed the most prominent research topics in the field.

In terms of the geographical coverage of the empirical cases, Australia appears as the most studied country in the field, followed by countries in other regions such as Asia (China, India, Russia and Turkey), Africa (Ghana, South Africa and the Democratic Republic of the Congo), North America (the USA and Canada), Latin America (Brazil and Chile) and Europe (Poland, Spain and Sweden). However, this dispersion is not reflected in the geographical coverage of the affiliations of the authors. This is mostly because a significant share of the research on the empirical cases in developing countries is conducted by researchers affiliated with the institutions in developed countries.

Our results show that the social science research on the mining sector has been progressively growing. Interestingly, the focus has shifted from the traditional research streams, for example, industrialisation and growth (e.g., Rostow, 1956), colonialization (e.g., Hobson, 1938), technological and economic development (e.g., Ginsburg, 1957) and the resource curse (e.g., Auty, 1994; Sachs and Warner, 2001), to the new streams of research on social, environmental and economical sustainability. These include various topics such as the social license to operate (e.g., Moffat and Zhang, 2014; Owen and Kemp, 2013; Prno and Slocombe, 2012), corporate social responsibility (e.g., Govindan et al., 2014; Hilson, 2012; Jenkins and Yakovleva, 2006), criticality of the rare earth elements (e.g., Golev et al., 2014; Stegen, 2015; Wübbeke, 2013), material flow analysis (e.g., Krausmann et al., 2009; Spatari et al., 2005; Steinberger et al., 2010) and environmental impacts (e.g., Kuik and Hofkes, 2010; Liu et al., 2007; Mudd, 2010).

In terms of research implications, this study represents a starting point for researchers who aim to conduct social science research on the mining sector. However, this study has some limitations that can be overcome by future research. For future literature reviews of the field, it is important to advance the analysis with a broader coverage of journals, as well as the inclusion of books and other kinds of literature. It is also important to deepen the understanding of why some research topics have become more popular than others and why there are only few researchers from some countries with high mineral reserves. In addition, establishing a future research agenda, which goes beyond the scope of this paper, could be an important way forward.

Acknowledgements

We thank the Marcus Marianne Wallenberg Foundation of Sweden for partially funding this research within the project 'The Renaissance for the Periphery? Analysing the conditions for industrial transformation' (Grant no. MMW 2013.0194). We also would like to thank Yulia Lapko for her feedback on the previous version of this paper. In addtion, we are thankful to the constructive comments made by the editors and anonymous reviewers of the journal who helped us to improve our paper.

References

Acedo, F.J., Barroso, C., Acedo, F.J., Barroso, C., Casanueva, C., Galán, J.L., 2006. Co-Authorship in Management and OrganizationalStudies: An Empirical and Network Analysis Studies: An Empirical and Network Analysis*. http://dx.doi.org/10.1111/j.1467-6486.2006.00625.x.

Adriaanse, L.S., Rensleigh, C., 2013. Web of science, scopus and Google scholar: a content comprehensiveness comparison. Electron. Libr. 31, 727–744. http://dx.doi.org/10.1108/EL-12-2011-0174.

Andriamasinoro, F., Angel, J., 2012. Artisanal and small-scale gold mining in Burkina Faso: suggestion of multi-agent methodology as a complementary support in elaborating a policy. Resour. Policy 37, 385–396. http://dx.doi.org/10.1016/j.resourpol.2012.04.004.

Araújo, K., 2014. The emerging field of energy transitions: progress, challenges, and opportunities. Energy Res. Soc. Sci. 1, 112–121. http://dx.doi.org/10.1016/j.erss.2014.03.002.

Auty, R.M., 1994. Industrial policy reform in six large newly industrializing countries: the resource curse thesis. World Dev. 22, 11–26. http://dx.doi.org/10.1016/0305-750X(94)90165-1.

Azapagic, A., 2004. Developing a framework for sustainable development indicators for the mining and minerals industry. J. Clean. Prod. 12, 639–662. http://dx.doi.org/10.1016/S0959-6526(03)00075-1.

Baccini, P., Brunner, P.H., 2012. Metabolism of the Anthroposphere: Analysis, Evaluation, Design. MIT Press.

Bartunek, J.M., Louis, M., 1996. Insider/Outsider Team Research. Sage, Thousand Oaks (CA).

Bekiros, S., Arreola, J., Hammoudeh, S., 2015. Multivariate dependence risk and portfolio optimization: an application to mining stock portfolios. Resour. Policy 46, 1–11. http://dx.doi.org/10.1016/j.resourpol.2015.07.003.

Bellamy, D., Pravica, L., 2011. Assessing the impact of driverless haul trucks in Australian surface mining. Resour. Policy 36, 149–158. http://dx.doi.org/10.1016/j.resourpol.2010.09.002.

Benckendorff, P., Zehrer, A., 2013. A network analysis of tourism research. Ann. Tour. Res. 43, 121–149. http://dx.doi.org/10.1016/j.annals.2013.04.005.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., Rickne, A., 2008. Analyzing the functional dynamics of technological innovation systems: a scheme of analysis. Res. Policy 37, 407–429. http://dx.doi.org/10.1016/j.respol.2007.12.003.

Beske, P., Land, A., Seuring, S., 2014. Sustainable supply chain management practices and dynamic capabilities in the food industry: a critical analysis of the literature. Int. J. Prod. Econ. 152, 131–143. http://dx.doi.org/10.1016/j.ijpe.2013.12.026.

Bornmann, L., Mutz, R., 2015. Growth rates of modern Science: a bibliometric analysis based on the number of publications and cited references. J. Assoc. Inform. Sci. Technol. 66, 2215–2222. http://dx.doi.org/10.1002/asi.

Bringezu, S., Moriguchi, Y., 2002. Material flow analysis. A Handbook of Industrial Ecology. pp. 79–90. http://dx.doi.org/10.4337/9781843765479.00017.

Brunner, P.H., Rechberger, H., 2003. Practical Handbook of Material Flow Analysis. CRC/ Lewis Publishers.

Brynjolfsson, E., Mcafee, A., 2014. The Second Machine Age. W. W. Norton & Company.

Cappuyns, V., Swennen, R., Vandamme, A., Niclaes, M., 2006. Environmental impact of the former Pb-Zn mining and smelting in East Belgium. J. Geochem. Explor. 88, 6–9. http://dx.doi.org/10.1016/j.gexplo.2005.08.005.

Carlsson, B., 2016. Industrial dynamics: a review of the literature 1990–2009. Ind. Innov. 23, 1–61. http://dx.doi.org/10.1080/13662716.2015.1120658.

Chadegani, A.A., Salehi, H., Md Yunus, M.M., Farhadi, H., Fooladi, M., Farhadi, M., Ale Ebrahim, N., 2013. A comparison between two main academic literature collections: web of science and scopus databases. Asian Soc. Sci. 9, 18–26. http://dx.doi.org/10.5539/ass.v9n5p18.

Cho, R.L.T., Liu, J.S., Ho, M.H.-C., 2016. What are the concerns? Looking back on 15 years of research in cultural and creative industries. Int. J. Cult. Policy 6632, 1–20. http://dx.doi.org/10.1080/10286632.2015.1128417.

Cook, D.J., Sackett, D.I., Spitzer, W.O., 1995. Methodological guidelines for systematic reviews of randomized control trials in health care from the postdam consultation on meta-analyisis. J. Clin. Epidemology 48, 167–171.

Corden, W.M., 1984. Booming sector and dutch disease economics: survey and consolidation. Oxf. Econ. Pap. New Ser. 36, 359–380.

Corder, G.D., Golev, A., Giurco, D., 2015. "Wealth from metal waste": translating global knowledge on industrial ecology to metals recycling in Australia. Miner. Eng. 76, 2–9. http://dx.doi.org/10.1016/j.mineng.2014.11.004.

Crossan, M.M., Apaydin, M., 2010. A multi-dimensional framework of organizational innovation: a systematic review of the literature Mary M. J. Manag. Stud. http://dx.doi.org/10.1111/j.1467-6486.2009.00880.x.

Davis, G.A., Tilton, J.E., 2002. Should Developing Countries Renounce Mining? A Perspective on the Debate.

de Winter, J.C.F., Zadpoor, A.A., Dodou, D., 2014. The expansion of Google Scholar versus Web of Science: a longitudinal study. Scientometrics 98, 1547–1565. http://dx.doi.org/10.1007/s11192-013-1089-2.

Dudka, S., Adriano, D.C., 1997. Environmental impacts of metal ore mining and processing: a review. J. Environ. Qual. 26, 590. http://dx.doi.org/10.2134/jeq.1997.00472425002600030003x.

Emmanuel, A., 1972. Unequal exchange: A study of the imperialism of trade, Modern reader, PB-188.

Esty, D.C., Porter, M.E., 1998. Industrial ecology and competitiveness. strategic implications for the firm. J. Ind. Ecol. 2, 35–43. http://dx.doi.org/10.1162/jiec.1998.2.1.35.

Falagas, M.E., Pitsouni, E.I., Malietzis, G. a., Pappas, G., 2008. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. FASEB J. 22, 338–342. http://dx.doi.org/10.1096/fj.07-9492LSF.

Feldman, M.P., 1993. An examination of the geography of innovation. Ind. Corp. Chang. 2, 451–470. http://dx.doi.org/10.1093/icc/2.1.451.

Fisher, J.L., 1953. Natural resources and technological change. Land Econ. 29, 57–71.

Frank, A.G., 1973. Sociology of Development and Underdevelopment of Sociology. Afrografika Publishers.

Frank, A.G., 1970. The development of underdevelopment. Mon. Rev. 18, 17–31. http://dx.doi.org/10.14452/MR-018-04-1966-08_3.

Frank, A.G., 1967. Capitalism and Underdevelopment in Latin America 93 NYU Press.

Geels, F.W., 2006. Co-evolutionary and multi-level dynamics in transitions: the transformation of aviation systems and the shift from propeller to turbojet (1930–1970). Technovation 26, 999–1016. http://dx.doi.org/10.1016/j.technovation.2005.08.010.

Ginieis, M., Sánchez-Rebull, M.V., Campa-Planas, F., 2012. The academic journal literature on air transport: analysis using systematic literature review methodology. J. Air Transp. Manag. 19, 31–35. http://dx.doi.org/10.1016/j.jairtraman.2011.12.005.

Ginsburg, N., 1957. Natural Resources and Economic Development. Dev. Change.

Glöser, S., Tercero, L., Gandenberger, C., Faulstich, M., 2015. Raw material criticality in the context of classical risk assessment. Resour. Policy 44, 35–46. http://dx.doi.org/10.1016/j.resourpol.2014.12.003.

Golev, A., Scott, M., Erskine, P.D., Ali, S.H., Ballantyne, G.R., 2014. Rare earths supply chains: current status, constraints and opportunities. Resour. Policy 41, 52–59. http://dx.doi.org/10.1016/j.resourpol.2014.03.004.

Govindan, K., Kannan, D., Shankar, K.M., 2014. Evaluating the drivers of corporate social responsibility in the mining industry with multi-criteria approach: a multi-stakeholder perspective. J. Clean. Prod. 84, 214–232. http://dx.doi.org/10.1016/j.jclepro.2013.12.065.

Gupta, C.K.K., Krishnamurthy, N., 2005. Extractive Metallurgy of Rare Earths, International Materials Reviews. CRC presshttp://dx.doi.org/10.1179/imr.1992.37.1.197.

Gylfason, T., 2001. Natural resources, education, and economic development. Eur. Econ. Rev. 45, 847–859. http://dx.doi.org/10.1016/S0014-2921(01)00127-1.

Hamann, R., 2003. Mining companies' role in sustainable development: the "why" and "how" of corporate social responsibility from a business perspective. Dev. South. Afr. 20, 237–254. http://dx.doi.org/10.1080/03768350302000085910.

Henderson, J.C., 2007. Corporate social responsibility and tourism: hotel companies in Phuket, Thailand, after the Indian Ocean tsunami. Int. J. Hosp. Manag. 26, 228–239. http://dx.doi.org/10.1016/j.ijhm.2006.02.001.

Hilson, G., 2012. Corporate Social Responsibility in the extractive industries: experiences from developing countries. Resour. Policy 37, 131–137. http://dx.doi.org/10.1016/j.resourpol.2012.01.002.

Hirschman, A., 1971. Political economics and possibilism. In: A Bias for Hope. Yale University Press, New Haven.

Hirschman, A.O., 1958. The Strategy of Economic Development. Yale University Press, New Haven.

Hobson, J.A., 1938. Imperialism: A Study. Spokesman Books.

Humphries, M., 2012. Rare Earth Elements: The Global Supply Chain. Congressional Research Service, pp. 1–27.

Jenkins, H., Yakovleva, N., 2006. Corporate social responsibility in the mining industry: exploring trends in social and environmental disclosure. J. Clean. Prod. 14, 271–284. http://dx.doi.org/10.1016/j.jclepro.2004.10.004.

Karakaya, E., Hidalgo, A., Nuur, C., 2014. Diffusion of eco-Innovations: a review. Renew. Sustain. Energy Rev. 33, 392–399.

Karakaya, E., Nuur, C., Assbring, L., 2018. Potential transitions in the iron and steel industry in Sweden; towards a hydrogen based future? J. Clean Prod Forthcoming. Available from: https://doi.org/10.1016/j.jclepro.2018.05.142.

Karaosman, H., Morales-Alonso, G., Brun, A., 2016. From a systematic literature review to a classification framework: sustainability integration in fashion operations. Sustainability 9, 30. http://dx.doi.org/10.3390/su9010030.

Kitchenham, B., 2004. Procedures for Performing Systematic Reviews. Jt. Tech. Report. Keele Univ.

Krausmann, F., Gingrich, S., Eisenmenger, N., Erb, K.H., Haberl, H., Fischer-Kowalski, M., 2009. Growth in global materials use, GDP and population during the 20th century. Ecol. Econ. 68, 2696–2705. http://dx.doi.org/10.1016/j.ecolecon.2009.05.007.

Kuik, O., Hofkes, M., 2010. Border adjustment for European emissions trading: competitiveness and carbon leakage. Energy Policy 38, 1741–1748. http://dx.doi.org/10.1016/j.enpol.2009.11.048.

Kusi-sarpong, S., Bai, C., Sarkis, J., Wang, X., 2015. Green supply chain practices evaluation in the mining industry using a joint rough sets and fuzzy TOPSIS methodology. Resour. Policy 46, 86–100. http://dx.doi.org/10.1016/j.resourpol.2014.10.011.

Lapko, Y., Trucco, P., Nuur, C., 2016. The business perspective on materials criticality: evidence from manufacturers. Resour. Policy 50, 93–107. http://dx.doi.org/10.1016/j.resourpol.2016.09.001.

Larivière, V., Gingras, Y., Archambault, É., 2007. The decline in concentration of citations 1900–2007.

Lemos, M.C., Agrawal, A., 2006. Environmental governance. Annu. Rev. Environ. Resour. 31, 297–325. http://dx.doi.org/10.1146/annurev.energy.31.042605.135621.

Lindgreen, A., Swaen, V., 2010. Corporate social responsibility. Int. J. Manag. Rev. 12, 1–7. http://dx.doi.org/10.1111/j.1468-2370.2009.00277.x.

Liu, L.C., Fan, Y., Wu, G., Wei, Y.M., 2007. Using LMDI method to analyze the change of China's industrial CO_2 emissions from final fuel use: an empirical analysis. Energy Policy 35, 5892–5900. http://dx.doi.org/10.1016/j.enpol.2007.07.010.

Luthra, S., Garg, D., Haleem, A., 2015. An analysis of interactions among critical success factors to implement green supply chain management towards sustainability: an Indian perspective. Resour. Policy 46, 37–50. http://dx.doi.org/10.1016/j.resourpol.2014.12.006.

Maloni, M., Brown, M., 2006. Corporate Social Responsibility in the supply chain: an application in the food industry. J. Bus. Ethics 68, 35–52. http://dx.doi.org/10.1007/s10551-006-9038-0.

Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. Res. Policy 41, 955–967. http://dx.doi.org/10.1016/j.respol.2012.02.013.

Marshall, A., 1920. Principles of Economics: An Introductory Volume, Eight Edition. London(MacMillan).

Martinez-Fernandez, C., 2010. Knowledge-intensive service activities in the success of the Australian mining industry. Serv. Ind. J. 30, 55–70. http://dx.doi.org/10.1080/02642060802317820.

Maskell, P., 1999. Localised learning and industrial competitiveness. Camb. J. Econ. 23, 167–185. http://dx.doi.org/10.1093/cje/23.2.167.

Matsen, E., Torvik, R., 2005. Optimal Dutch disease. J. Dev. Econ. 78, 494–515. http://dx.doi.org/10.1016/j.jdeveco.2004.09.003.

Mcguire, J.B., Sundgren, A., Schneeweis, T., 1988. Corporate Social Responsibility and firm financial performance. Acad. Manag. J. 31, 854–872.

Mcwilliams, A., Siegel, D., 2001. Corporate Social Responsibility: a theory of the firm P. Acad. Manag. J. 26, 117–127.

Mehlum, H., Moene, K., Torvik, R., 2006. Institutions and the resource curse. Econ. J. 116, 1–20.

Meho, L.I., 2007. The rise and rise of citation analysis. Phys. World 20, 32–36. http://dx.doi.org/10.1088/2058-7058/20/1/33.

Moffat, K., Zhang, A., 2014. The paths to social licence to operate: an integrative model explaining community acceptance of mining. Resour. Policy 39, 61–70. http://dx.doi.org/10.1016/j.resourpol.2013.11.003.

Moran, C.J., Lodhia, S., Kunz, N.C., Huisingh, D., 2014. Sustainability in mining, minerals and energy: new processes, pathways and human interactions for a cautiously optimistic future. J. Clean. Prod. 84, 1–15. http://dx.doi.org/10.1016/j.jclepro.2014.09.016.

Moussa, S.N., Deyi, J., Lin, L., 2015. Analysis of Guinean new mining fiscal regime: considerations for improvement. Resour. Policy 46, 113–126. http://dx.doi.org/10.1016/j.resourpol.2015.04.007.

Mudd, G.M., 2010. The environmental sustainability of mining in Australia: key megatrends and looming constraints. Resour. Policy 35, 98–115. http://dx.doi.org/10.1016/j.resourpol.2009.12.001.

Mulrow, C.D., 1994. Rationale for systematic reviews. Br. Med. J. 309, 597–599.

Newman, M.E., 2001. Scientific collaboration networks. II. Shortest paths, weighted networks, and centrality. Phys. Rev. E 6401, 16132. http://dx.doi.org/10.1103/PhysRevE.64.016132.

Nill, J., Kemp, R., 2009. Evolutionary approaches for sustainable innovation policies: from niche to paradigm? Res. Policy 38, 668–680. http://dx.doi.org/10.1016/j.

respol.2009.01.011.
Owen, J.R., Kemp, D., 2013. Social licence and mining: a critical perspective. Resour. Policy 38, 29–35. http://dx.doi.org/10.1016/j.resourpol.2012.06.016.
Perrons, R.K., McAuley, D., 2015. The case for "n«all": why the Big Data revolution will probably happen differently in the mining sector. Resour. Policy 46, 234–238. http://dx.doi.org/10.1016/j.resourpol.2015.10.007.
Perroux, F., 1955. Prise de vues sur la croissance de l'économie française, 1780–1950. Rev. Income Wealth.
Polyakov, M., Chalak, M., Iftekhar, M.S., Pandit, R., Tapsuwan, S., Zhang, F., Ma, C., 2017. Authorship, collaboration, topics, and research gaps in environmental and resource economics 1991–2015. Environ. Resour. Econ. 1–23. http://dx.doi.org/10.1007/s10640-017-0147-2.
Porter, M.E., Stern, S., 2001. Innovation: location matters. MIT Sloan Manag. Rev. 42, 28–36. http://dx.doi.org/10.1016/j.neuron.2009.08.001.
Post, J.E., 2000. Moving from geographic to virtual communities: global corporate citizenship in a Dot.com world. Bus. Soc. Rev. 105, 27–46. http://dx.doi.org/10.1111/0045-3609.00063.
Poulsen, M.N., McNab, P.R., Clayton, M.L., Neff, R.A., 2015. A systematic review of urban agriculture and food security impacts in low-income countries. Food Policy 55, 131–146. http://dx.doi.org/10.1016/j.foodpol.2015.07.002.
Prno, J., Slocombe, D., 2012. Exploring the origins of "social license to operate" in the mining sector: perspectives from governance and sustainability theories. Resour. Policy 37, 346–357. http://dx.doi.org/10.1016/j.resourpol.2012.04.002.
Rau, H., Goggins, G., Fahy, F., 2018. From invisibility to impact: recognising the scientific and societal relevance of interdisciplinary sustainability research. Res. Policy 47, 266–276. http://dx.doi.org/10.1016/j.respol.2017.11.005.
Reichl, C., Schatz, M., Zsak, G., 2016. World Mining Data 2016. 31. Federal Ministry of Science, Research and Economy of Austria, pp. 1–255.
Rostow, W.W., 1956. The take-off into self-sustained growth. Econ. J. 66, 25–48.
Rotmans, J., Loorbach, D., 2009. Complexity and transition management. J. Ind. Ecol. 13, 184–196. http://dx.doi.org/10.1111/j.1530-9290.2009.00116.x.
Ruhanen, L., Weiler, B., Moyle, B.D., McLennan, C.J., 2015. Trends and patterns in sustainable tourism research: a 25-year bibliometric analysis. J. Sustain. Tour. 23, 517–535. http://dx.doi.org/10.1080/09669582.2014.978790.
Sachs, J.D., Warner, A.M., 2001. The curse of natural resources. Eur. Econ. Rev. 45, 827–838. http://dx.doi.org/10.1016/S0014-2921(01)00125-8.
Sachs, J.D., Warner, A.M., 1999. The big push, natural resources boom and growth. J. Dev. Econ. 59, 43–76. http://dx.doi.org/10.1016/S0304-3878(99)00005-X.
Sachs, J.D., Warner, A.M., 1995. Natural resource abundance and economic growth (No. w5398). Natl. Bur. Econ. Res. http://dx.doi.org/10.1017/CBO9781107415324.004.
Salomons, W., 1995. Environmental impact of metals derived from mining activities: processes, predictions, prevention. J. Geochem. Explor. 52, 5–23. http://dx.doi.org/10.1016/0375-6742(94)00039-E.
Savolainen, J., 2016. Real options in metal mining project valuation: review of literature. Resour. Policy 50, 49–65. http://dx.doi.org/10.1016/j.resourpol.2016.08.007.
Schoenberger, E., 2016. Environmentally sustainable mining: the case of tailings storage facilities. Resour. Policy 49, 119–128. http://dx.doi.org/10.1016/j.resourpol.2016.04.009.
Smith, J.L., 2013. Issues in extractive resource taxation: a review of research methods and models. Resour. Policy 38, 320–331. http://dx.doi.org/10.1016/j.resourpol.2013.06.004.
Smith, O.G., 1928. Natural resources. Am. J. Sociol. 34. http://dx.doi.org/10.1177/002795018611800106.
Sovacool, B.K., 2014a. What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. Energy Res. Soc. Sci. 1, 1–29. http://dx.doi.org/10.1016/j.erss.2014.02.003.
Sovacool, B.K., 2014b. Diversity: energy studies need social science. Nature 511, 529–530. http://dx.doi.org/10.1038/511529a.
Spatari, S., Bertram, M., Gordon, R.B., Henderson, K., Graedel, T.E., 2005. Twentieth century copper stocks and flows in North America: a dynamic analysis. Ecol. Econ. 54, 37–51. http://dx.doi.org/10.1016/j.ecolecon.2004.11.018.
Stegen, S.K., 2015. Heavy rare earths, permanent magnets, and renewable energies: an imminent crisis. Energy Policy 79, 1–8. http://dx.doi.org/10.1016/j.enpol.2014.12.015.
Steinberger, J.K., Krausmann, F., Eisenmenger, N., 2010. Global patterns of materials use: a socioeconomic and geophysical analysis. Ecol. Econ. 69, 1148–1158. http://dx.doi.org/10.1016/j.ecolecon.2009.12.009.
Testa, J., 2015. Web of Science core collection journal selection process, Thomson Reuters.
Tranfield, D., Denyer, D., Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review*. Br. J. Manag. 14, 207–222. http://dx.doi.org/10.1111/1467-8551.00375.
Unluer, S., 2012. Being an insider Researcher While Conducting Case Study Research. Qual. Rep. 17, 1–14. http://dx.doi.org/10.1016/S0016-7185(99)00025-1.
Upstill, G., Hall, P., 2006. Innovation in the minerals industry: Australia in a global context. Resour. Policy 31, 137–145. http://dx.doi.org/10.1016/j.resourpol.2006.12.002.
van Wesel, M., 2016. Evaluation by citation: trends in publication behavior, evaluation criteria, and the strive for high impact publications. Sci. Eng. Ethics 22, 199–225. http://dx.doi.org/10.1007/s11948-015-9638-0.
Walker, M.I., Minnitt, R.C.A., 2006. Understanding the dynamics and competitiveness of the South African minerals inputs cluster. Resour. Policy 31, 12–26. http://dx.doi.org/10.1016/j.resourpol.2006.04.001.
Wübbeke, J., 2013. Rare earth elements in China: policies and narratives of reinventing an industry. Resour. Policy 38, 1–11. http://dx.doi.org/10.1016/j.resourpol.2013.05.005.
Zenisek, T.J., 1979. Corporate Social Responsibility: a conceptualization based on organizational literature. Source Acad. Manag. Rev. Acad. Manag. Rev. 4, 359–368. http://dx.doi.org/10.5465/AMR.1979.4289095.