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''SOCIAL SCIENCES AND THEREFORE THE MINING SECTOR: SOME INSIGHTS INTO RECENT ANALYSIS TRENDS''

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ABSTRACT

The number of science publications is growing exponentially, so increasing the requirement for understanding the cognitive content of assorted analysis streams and their rising branches. From a scientific discipline perspective, the literature on the mining sector – the commercial sector that extracts ores and minerals from the bottom – has additionally 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 social science research on the mining sector. The publication info of this review includes a collection of 483 systemically elect papers from 976 authors, covering research conducted in seventy-three countries from five continents: continent, Europe, Asia, Australia, and America. Our contribution is two-fold. 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 in the mining sector. Our results show that the social science research on the mining sector shifted from the traditional research streams (e.g., industrialization and growth, colonialization, technological and economic development, and the resource curse) to the new streams of research on social, environmental and economic 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 in the mining

sector.

Keywords:- Mining, Systematic literature review, Authorship, Minerals

1. Introduction:- The number of scientific publications is growing exponentially, doubling every 9–10 years (Bornmann and Mutz, 2015). This growth leaves researchers, policymakers 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 synthesize 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, Sovacool, 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 labor-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 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 Moriches” (Perroux, 1955) with both forward and backward linkages needed for development (Hirschman, 1971, Hirschman, 1958). Furthermore, the intense discussions within the social sciences with the inception of concepts such as the “development” of the “underdevelopment” (Frank, 1973, Frank, 1970, Frank, 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, Sachs and Warner, 1995). For instance, the works by Sachs and Warner, 2001, Sachs and Warner, 1999, Sachs and Warner, 1995 that have been cited thousands of times have formalized 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-curse 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 centered 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 in 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 so-

cial 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 scientific literature review as "a suggests that of distinguishing, evaluating and decoding all obtainable analysis relevant to a selected analysis question, or topic space, or development 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 long 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 subsections.

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 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 data-

base").

2. We analyzed 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 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)

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

Journal	Count	% of 9765	Relevance
Resources Policy	310	3.	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
Sciento metrics	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

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

3. We read and analyzed 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 analyzed 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 the information on which countries the affiliations of co-authors are based. For empirical focus, we analyzed 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 a paper-by-paper basis, analyzing 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.

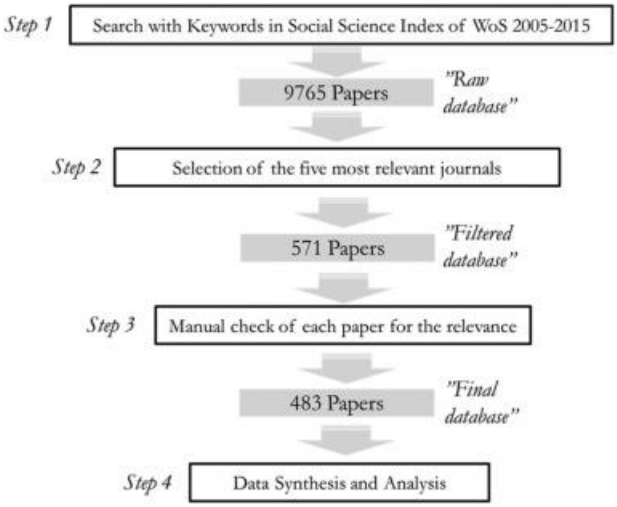

Fig. 1. Four steps of execution.

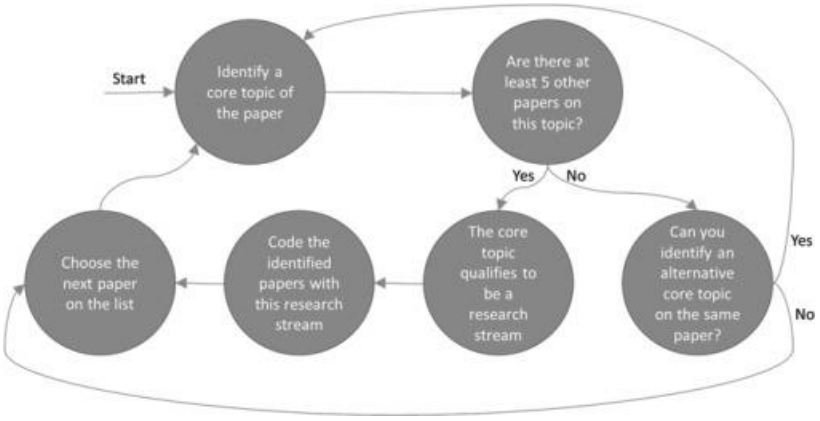

Fig. 2. The protocol for coding the research streams.

2.1.3. Limitations:- In order to manage the massive body of literature, we must delineate the scope of this paper with some methodological constraints. 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 small size such as Natural Resources Forum (a United Nations Sustainable Development journal) as well as the journals that don't seem to be indexed on the internet 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 phys-

ics (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.

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

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, Sovacool, 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).

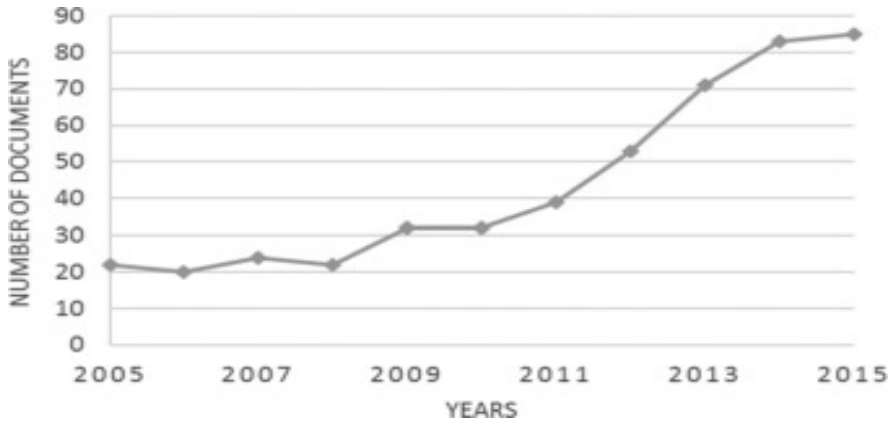

Fig. 3. Evolution of the number of documents over the years in the final database.

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 countries5 accounted for most of the production, up from 53% in 2004 to 60% in 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 the 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.

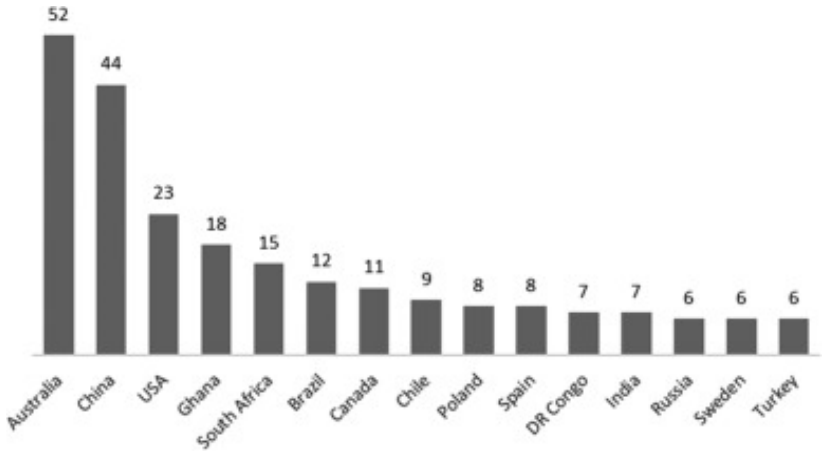

Fig. 4. Countries under empirical focus: The top 15 during 2005–2015.

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 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).

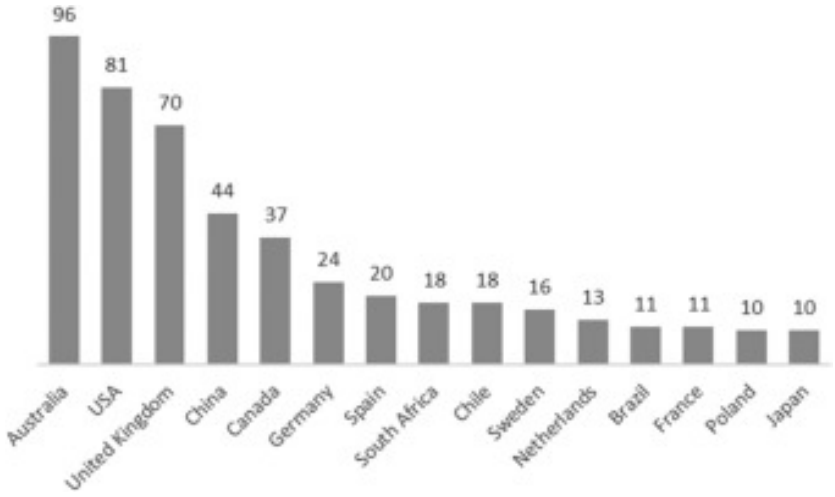

Fig. 5. Authors' countries of affiliation: The top 15 during 2005–2015.

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", "and criticality of the rare earth elements", "material flow analysis and environmental impacts". In the following sub-sections, we first present a general overview (Section 3.1) and then discuss the content and the main findings of the most popular research streams (Section 3.2). We have provided references only for the major contributions, thus illustrating the most representative examples (in terms of both relevance and citation records).

4. Conclusions: -

In this study, we aimed to analyse the current trends in social science research in 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 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 economic 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 in 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 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 a 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.

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