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Review article

Social impacts of bauxite mining and refining: A review

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ABSTRACT

This article presents an extensive review of scientific publications focused on how the impacts of bauxite mining and refining have been investigated. This includes results on which types of impacts have been addressed in scientific publications and details concerning social impacts in the years 2010–2020. The analysis reveals that while environmental impacts are most prominent in academic publications, social impacts have been increasingly investigated in recent years. Between 2011 and 2020, there have been 14 publications covering social impacts, compared to eight publications from 1981–2010. Focusing on social impacts, the present study finds a range of impacts including access to resources, impacts on landscape, economic impacts (e.g., job creation, local support programmes and infrastructure creation) and public unrest. The review also emphasises the importance of considering the context of social impacts and how impacts are distributed between social groups. These findings are useful for consideration in future impact assessment practices as well as furthering research in the intersection between mining and impact assessment.

1. Introduction

Raw materials are vital for economic development and the well-being of populations, and society is therefore dependant on an abundant supply of them. Today, many of the goals for the green transition could not be reached without the contribution of raw materials that are supplying the process industry and creating jobs across the value chains. In this context, the aluminium industry offers one of the most fundamental materials for achieving climate end circularity goals. Aluminium is the base metal of the future for applications in various sectors (including transport, constructions, packaging, renewable energy technologies, batteries and electricity transmission cables). Approximately 68Mt of primary aluminium is produced globally each year (IAI, 2021), only 4Mt of which is produced in Europe. Aluminium production is expected to increase globally up to 175Mt in 2050, indicating a significant increase in production (IAI, 2021).

Aluminium production begins with bauxite, the "aluminium ore", which is mined primarily in tropical and sub-tropical areas, the largest bauxite deposits found in Guinea, Australia, Brazil and Jamaica. Australia, with five mines, is currently the largest bauxite producer, while large mines are also found in Guinea, Brazil and China (Australian Aluminium Council, 2022a; Mining Technology, 2021; Wagner, 2010). This bauxite is subjected to the Bayer process for the extraction of aluminum hydrate, most (90%) of which is calcined to produce alumina in refiners, which is then converted into aluminum metals in smelters via the Hall–Héroult electrolysis process.

Aluminium production has a range of impacts, including environmental impacts, such as greenhouse gas emissions from energy consumption and dust pollution, and changes in landscape and ecology from the extraction of raw materials (Dragastan et al., 2009; Lee et al., 2017; Paraskevas et al., 2016). While bauxite mining and refining can contribute to the development of local communities, it has also been found to result in social issues, which will be explored in this paper, as well as compromise health, trigger conflicts in local communities and lack transparency and democracy in the processes (Kivinen et al., 2020; Lee et al., 2017; Oskarson, 2013; Knierzinger 2014). As production increases, the significance of these impacts can also be expected to increase, giving cause to explore which social impacts are relevant to consider moving forward. As part of the planning process for large projects with potential impacts, such as bauxite mining and refining projects, various forms of impact assessment can be applied (IAIA, 2009).

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While there has been an increasing focus on research and publications regarding mining and social impacts or social impact assessments in general, this review focuses explicitly on the mining and refining of the raw material bauxite. Several studies have analysed and evaluated various impacts related to bauxite mining and refining. Country reviews on environmental impacts have been conducted, such as for Malaysia (Lee et al., 2017) and Romania (Dragastan et al., 2009). Further particular aspects of the mining and refining processes, such as residue utilisation and treatment, have been the subject of many review papers (see e.g. Borra et al., 2016; Collin et al., 2020; Di Carlo et al., 2019, Ding et al., 2017; Martins et al., 2020; Xue et al., 2019). A single review has been conducted focusing specifically on children's health (Feisal, 2018). The various reviews have pointed out different challenges and ways of improving planning, technology, logistics and promoting cleaner and more sustainable means of production.

The current paper contributes with an exploration of the social impacts of bauxite mining and refining based on the international scientific literature. The main objective is to create an overview of possible social impacts and benefits related to bauxite mining and refining. The literature review thus follows a semi-systematic approach (Snyder, 2019) focused on mapping and synthesising the knowledge from scientific publications exploring the questions:

- *Which impacts related to bauxite mining and refining are addressed in scientific publications? And more specifically, how extensively analysed and investigated are social impacts?*
- *Which specific social impacts related to bauxite mining and refining are identified in scientific publications over a 10-year period, and what characterises these social impacts?*

The reason for only analysing documents from the past 10 years is that we expect them to address issues that remain relevant compared to the earlier studies, which may no longer be representative of the current situation from the perspective of social acceptance and awareness. As a backdrop for the review, the following section explores some perspectives of social impacts.

2. Social impacts

This review uses the definition of social impacts put forward by the International Association for Impact Assessment in their best practice principles for social impact assessment (Vanclay, 2003). Accordingly, social impacts are broadly defined as "*all issues that affect people, directly or indirectly*" (Vanclay, 2003: 8). A social impact can therefore be anything that concerns or affects any group of people. To support the definition, Vanclay proposes categories of social impacts covering a range of specific aspects of life, as can be seen in Table 1. These categories should not be viewed as a complete list of social impacts but will be used along with the definition to guide the identification and sorting of articles as well as the analysis.

Social impacts are closely linked to environmental impacts, as human and environmental systems are highly intertwined. As the IAIA best practice principles state, "*social, economic and biophysical impacts are inherently and inextricably interconnected. Change in any of these domains will lead to changes in the other domains*" (Vanclay, 2003: 6). The environmental system is the basis for the existence of a human system providing, for example, resources and regulated surroundings (Slootweg et al., 2001). The close link is seen in the categories in Table 1, where one category is "Environment", meaning that impacts on the environment can also be impacts on people. Social impacts and health impacts are also closely linked, health impacts can be viewed as a distinct type of impact and be addressed separately, but they can also – as seen in Table 1 – be part of social impacts (Slootweg et al., 2001).

The more detailed characterisation and evaluation of social impacts – whether negative or positive, their magnitude etc. – depends among other things on the context and recipient of the impact (Glasson et al., 2012). If a vulnerable recipient is impacted, for example, this can be assessed as more severe than if a more robust recipient is exposed to the same impact (Boyle and Barnes, 2016). Impacts in general and perhaps social impacts in particular can also be perceived and characterised very differently by different people or stakeholders with different backgrounds, stakes, culture etc. As stated by Glasson et al. (2012: 126) about socio-economic impacts, "*[t]here are no easily applicable state of local society standards against which the predicted impacts of a development can be assessed*". This also means that a group or community is not necessarily homogenous in terms of how they perceive social impacts; a social impact can be viewed as positive by one person and negative by another, depending on their viewpoint, how the impact affects them personally, and a number of other factors (Boyle and Barnes 2016; Vanclay et al., 2015).

Table 1
Categories of social impacts, based on Vanclay (2003).

Impact category	Explanation
Everyday life	How people live, work, play and interact with one another on a day-to-day basis
Culture	People's shared beliefs, customs, values and language or dialect
Community	Its cohesion, stability, character, services and facilities
Political systems	The extent to which people are able to participate in decisions that affect their lives, the level of democratisation taking place, and the resources provided for this purpose
Environment	The quality of the air and water people use; the availability and quality of the food they eat; the level of hazard or risk, dust and noise they are exposed to; the adequacy of sanitation, their physical safety, and their access to and control over resources
Health and wellbeing	Health is a state of complete physical, mental, social and spiritual wellbeing – not merely the absence of disease or infirmity
Personal and property rights	Particularly whether people are economically affected or experience personal disadvantage which may include a violation of their civil liberties
Fears and aspirations	Their perceptions of their safety, fears about the future of their community, and aspirations for their future and that of their children

In the following sections, we first present the methodology behind the literature search, the screening of the documents and the subsequent analysis. We then present the main outcome; first, we review the overall results of the literature review in terms of the development in bauxite impact studies over the years. Afterwards, the more detailed findings concerning social impacts are presented. Finally, the findings are discussed. Here, we present a series of impact categories identified as important to consider in future impact assessments and take into consideration when implementing new projects and choosing technologies.

3. Methodology

This paper presents a semi-systematic, in-depth review of peer-reviewed scientific publications within the topic of social impacts of bauxite mining and refining (Snyder, 2019). The review aims to provide an overview of the field based on peer-reviewed scientific publications encompassing both a quantitative component, including a historical development, and a qualitative component, focussing more on the details on the state of knowledge of social impacts (Snyder 2019). The method applied involved a literature search and a subsequent sorting and review of the documents identified. In the following two paragraphs, we describe the process, delimitations and motivations behind the choices made.

3.1. Literature search

The literature review aimed at collecting representative studies

describing the social impacts occurring in the mining and refining of bauxite. The Scopus academic database was used for the initial literature search, using the keywords "bauxite" and "impact" in combination with the timeframe 1981–2021. The timeframe was chosen based on a search with no timeframe, which yielded no results before 1983, as the search was performed in 2021 and set to start in the year 1981, providing a 40-year timeframe. Only final versions were included in the search.

The search string used was the following:

TITLE-ABS-KEY (impact AND bauxite) AND (LIMIT TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "ch") OR LIMIT TO (DOCTYPE, "re") OR LIMIT TO (DOCTYPE, "bk")) AND (LIMIT TO (PUBSTAGE, "final"))

The literature search included scientific articles, book chapters, reviews and books written in English in the 1981–2021 period in the Scopus database. No geographical limitation was applied. After manually removing duplicates, irrelevant documents (based on a screening of titles and keywords) and documents that did not address any of the types of impacts mentioned or where bauxite proved to be non-central to the study presented, 235 documents remained. These 235 publications were selected for the review process, 25 of which are focussed on an EU context, while others focus either on other specific geographical contexts (e.g. Australia) or have no specific geographical focus. A spreadsheet was used to organise the documents from the search. The documents were arranged chronologically, the following information registered for each document: title, authors, DOI, document type, year of publication, location of the project(s) investigated, mining/refining/waste-categorisation, keywords. Regarding mining, refining and waste, the initial focus was on mining and refining. Waste was also included in the course of the analysis due to the impact of bauxite residue resulting from the Bayer process.

3.2. Review process

The choice to include the broad term "impact" in the search (and not combining it with the term "social") was motivated by our awareness of different definitions of environmental impact and economic impacts in the field of impact assessment. These terms sometimes include social impacts, even if not specified as such. Thus, the environmental impact assessments mandated in some countries and jurisdictions cover a broad definition of environment, including various types of impacts on humans besides the more biophysical impacts (IAIA, 2009; Morrison-Saunders, 2018). According to the definition we apply (in alignment with the definition provided by Vanclay 2003), these impacts are to be considered social impacts.

The review process included two main steps, the first concerning an initial screening of the documents from the search. Using inductive coding, different types of impacts were identified, more specifically the documents covering social impacts. This led to the distinction of five main impact categories: "environmental", "economic", "health", "social" and "climate". Which of the 235 documents addressed which types of impacts was then registered and can be seen in Fig. 1. As stated in section 1.1, environmental, health and social impacts are closely intertwined, which raises questions regarding the approach where we divide them into separate types. For analytical purposes, however, to be able to highlight social impacts, we have chosen to view them separately to be able to compare the level of attention they have in literature. This also reflects much of the impact assessment practice found today (Pope et al., 2013).

As part of the review, an overview of some of the specific impacts was carried out.

Environmental impacts in the documents include:

- Impacts on water, air, flora, fauna, land use, pollution, emissions, waste and landscape.

Economic impacts in the documents screened include:

- Impacts on the efficiency or commercial value/cost of production to the benefit of the operating companies.

Health impacts in the documents screened include:

- Impacts on worker health, safety and work environment, as well as the health of those residing in the area; also health issues deriving from environmental damage.

Social impacts in the documents screened include:

- Impacts on humans and communities, including impacts on migration, rights to land, gender, job creation and livelihoods.

Climate impacts in the documents screened include:

- Impacts on the local and global climate, adaptation strategies and means to reduce greenhouse gas emissions.

The second step of the review involved a more in-depth analysis of the ten documents from the period 2011–2022 addressing social impacts. The analysis focussed on identifying which social impact categories were covered.

The ten documents published on the topic in the 10-year period are presented in Table 2. As the table illustrates, with the exception of Wagner 2010, the articles take a point of departure in a specific case:

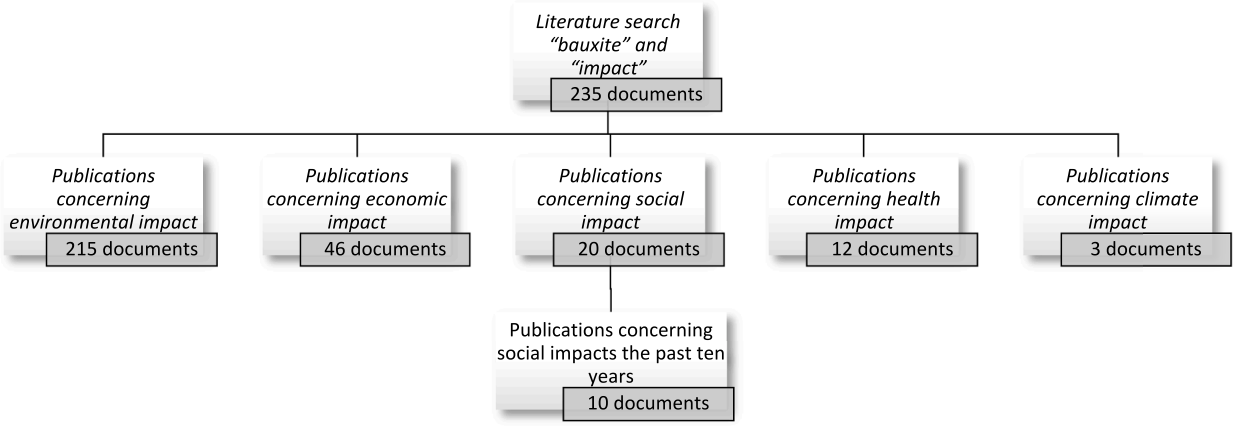

Fig. 1. Overview of literature search and findings from the period 1981–2021. Some articles concern more than one type of impact; the number of articles in the second row therefore sums up to more than the total number in row one.

Table 2
The publications included in the study.

Author(s)	Year	Country	Title
Al-Dubaisi	2011	Saudi Arabia	*Development of bauxite and alumina resources in the Kingdom of Saudi Arabia*
Burton et al.	2012	Australia	*Public preferences for timeliness and quality of mine site rehabilitation: The case of bauxite mining in Western Australia*
de Barros et al.	2012	Brazil	*Characterization of the bauxite mining of the Poços de Caldas alkaline massif and its socio-environmental impacts*
Deveson	2011	Australia	*The agency of the subject: Yolngu involvement in the Yirrkala Film Project*
Kuan et al.	2020	Malaysia	*Narrowing the gap between local standards and global best practices in bauxite mining: A case study in Malaysia*
Lobo et al.	2018	Brazil	*Mapping mining areas in the Brazilian Amazon using MSI/Sentinel-2 Imagery (2017)*
Marston	2012	Vietnam	*Bauxite mining in Vietnam's Central Highlands: An arena for expanding civil society?*
Nayak	2012	India	*Sustainable mineral-Intensive growth in Odisha, India*
Oskarsson	2012	India	*AnRak aluminium: Another Vedanta in the making?*
Wagner	2010	Global	*Sustainable bauxite mining: A global perspective*

either a country, region or mining project. The main theme for the articles differs. Deveson (2011), Marston (2012) and Oskarsson 2012 all have a strong focus on the involvement and perspective of local communities or groups, thereby touching on social impacts. Lobo et al. (2018) focus on a specific method, and Burton et al. (2012) focus on rehabilitation as a specific part of the mining process, including the social impacts in these specific parts. However, most of the articles focus on analysing bauxite mining more generally, including the impacts for people and society, with a view to improving the practice and making it more sustainable. This includes Al-Dubaisi (2011), De Barros et al. (2012), Nayak (2012), Wagner (2010) and Kuan et al. (2020). None of the articles has a distinct focus on social impact assessment.

The publications were subject to a grounded text analysis, where text concerning social impacts was gathered and analysed in terms of the category and details of the social impact in question. Two further issues emerged for analysis from this initial analysis:

- Whether the impact is positive or negative.
- Which groups are impacted.

The positive/negative impact issue emerged as interesting, because the data showed that seemingly similar impacts were represented very differently in terms of whether positive or negative. The issue of which groups were affected emerged for analysis because the data showed a wide variety in affected groups depending on the scope of the specific project.

Due to the delimitation guiding this paper, the analysis only includes impacts in the publications with a clear social focus; and thus not impacts only described as related to the categories "environment" and "health and wellbeing", as they overlap with environmental and health impacts; for example, noise impacts on workers' hearing or increased risk of traffic accidents, which is only described as a health issue with no focus on possible wider social implications.

4. Forty years of bauxite impact studies – screening results

As mentioned in the previous section, the initial screening led to the identification of five impact types addressed in the 235 publications from the literature review. See Fig. 2 for an overview of how many publications address each impact type. It deserves mention that some publications concerned two or more of the five types. The total number of publications therefore exceeds the number of investigations of different types of impacts.

Over the 40-year period covered by the search, the main category addressed is environmental impacts, with 215 publications. Economic impacts are studied in 46 of the publications, social impacts in 20, while health impacts are only investigated in 12 of the publications and climate impacts in just three.

The number of publications concerning the impacts of bauxite mining and refining have generally increased: from five publications in the period 1981–1985 to 83 publications in 2016–2020. Fig. 3 shows the distribution over 5-year intervals of the number of publications addressing each impact type; for all of the years under investigation, the vast majority of studies have focused on environmental impacts. While the studies published in the 1980s and 1990s almost solely concerned environmental impact and economic impacts, the new millennium brought an increased focus on social issues, health and climate. The number of studies concerning economic impacts and environmental impacts also increased.

The tendency illustrated in Fig. 3 reflects how the environmental impact was the original focus of impact assessments, while social and health impacts later emerged on the impact assessment agenda.

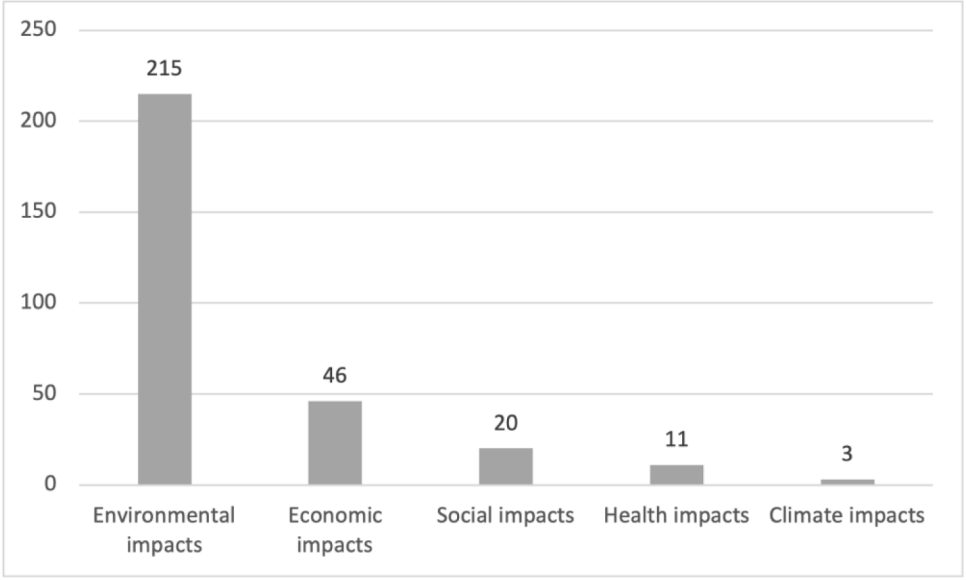

Fig. 2. Number of academic publications concerning different impact types.

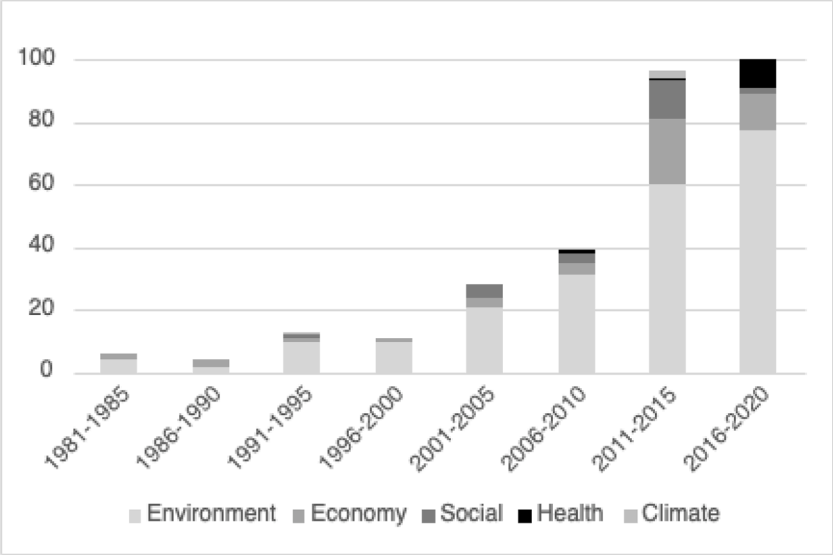

Fig. 3. Distribution over 5-year intervals of the number of publications addressing each type of impact.

Interestingly, health impacts seem to have gained much attention – also over social impacts – in later years.

5. Analysis and results: social impacts

The social impacts found in the review are shown in Table 3 under the following overall headings: *socio-economy, resources, demography, land use and rights* and *community development*. For each social impact, it is noted whether it is described as negative or positive, which impact category it covers (referring to Vanclay, 2003), the groups impacted and the publications where they are identified. As stated in Section 2, whether an impact is positive or negative depends on the context. We therefore report here on how the impact is described as positive or negative in the specific publications and the context they address.

The number of impacts described in the publications as positive/negative for each overall heading, as found in the literature review, are reported in Fig. 4.

Table 3 illustrates how eight of the 23 identified impacts relate to the category "Environment". The impacts are mainly described as negative, such as the pollution of water resources used by local populations. In the case of Odisha India, for example, it is described how "*[s]urrounding water sources get polluted when untreated or partially treated waste water is let out into the open fields of the surrounding villages around the mines, washeries, beneficiation plants… This water is highly polluted by mining effluents and can not be used for drinking and bathing purpose*" (Nayak, 2012: 46) This echoes the analysis in Fig. 4, that many impacts described as negative are related to resources and land and thus environment, and it corroborates the statements in Section 2 that social and environmental impacts are closely intertwined.

Many of the social impacts described as negative are related to access and rights to resources, mainly land and water, due to either restrictions or the depletion or destruction of resources (Barros et al., 2012; Deveson, 2011; Lobo et al., 2018; Nayak, 2012; Oskarsson, 2012). This can have a broad spectrum of impacts, both in a very utilitarian view (e.g. loss of livelihood) and in terms of impacts on aspects of culture and everyday life that are connected to the resource. Two of the publications point out how limited numbers of women find mining-related employment, as "*women only constituted 10% of the workforce, generic of mining norms which is traditionally more tilted towards a male work-force*", and women therefore benefit less from mining projects than do men (Kuan et al., 2020: 3; Wagner, 2010). This is an example of how the access to resources – in this case, resources from the project – can be unevenly distributed among social groups, which highlights the importance of this aspect in assessing and mitigating impacts.

Many of the social impacts pointed out in the publications are related to the economy created by the project. This can be relatively direct impacts on the local community, such as local job creation, local-business growth or profit from land leasing, as well as more indirect impacts, where the authorities can use tax revenue from the project to boost the local community (e.g. investment in infrastructure or education) (Al-Dubaisi, 2011; Barros et al., 2012; Kuan et al., 2020; Wagner, 2010). In turn, the economic growth can spark other social impacts; here, the example found is lower out-migration from rural areas to urban areas, countering the dilution of rural areas (Al-Dubaisi, 2011). The literature also points out more direct impacts from the activities in the facility under assessment, such as material damage and limited use of outdoor areas due to dust, and visual impacts from the changing landscape (Barros et al., 2012; Kuan et al., 2020; Nayak, 2012). Some impacts stem from resistance and protest against bauxite projects and related activities, which can lead to public unrest and even violence (Kuan et al., 2020; Oskarsson, 2012). As described by Oskarsson (2012: 32) in the case of Odisha in India, "*one example of this is how the work to improve a road meant to transport ore by trucks down the hills to the refinery was disrupted in June 2012 by a Maoist group. In this attack, construction workers were beaten up and machinery set on fire*". Such impacts are generally directed at the projects and those employed or associated with the project; however, they can also impact the wider community and everyday life. Moreover, the conditions for work at the facility also have consequences for the project employees and their families, such as a long commute (Al-Dubaisi, 2011). An impact that seems to be in another category altogether is how, in one of the cases studied, the resistance against the bauxite mining project sparked the rise of a nationwide environmental movement (Marston, 2012). This is the only example found of an impact in the political systems category.

The social impacts also include other impacts more or less actively created by the project owner, such as training, various social and health support programmes, and providing local populations with rights to the land at the closure of the project (Al-Dubaisi, 2011; Wagner, 2010). The impacts found in the literature also include some that are less actively created in the sense that they are aimed at other issues but can indirectly also have social impacts. This includes the infrastructure developed for the use of the project, which can also benefit the wider community and the rehabilitated land after mining, which can have recreational value (Barros et al., 2012; Wagner, 2010). Another not actively created impact is that created by the uncertainty about the project in the period before it is either approved or rejected. Kuan et al. (2020) describes the

Table 3
Social impacts identified in the publications.

Description	Negative/ positive	Impact category	Impacted groups	Reference
Socioeconomy				
Related business: Economic and service gain from business related to the activities	Positive	- Personal and property rights - Community	Local businesses and business owners Local population	Kuan et al., 2020, Wagner 2010
Land leasing: Local residents profiting from leasing land to mining	Positive	- Personal and property rights	Landowners	Kuan et al., 2020
Job creation: Jobs created by the project	Positive	- Personal and property rights - Everyday life	Local and national population	Al-Dubaisi 2011, Burton et al., 2012, Kuan et al., 2020, Wagner 2010
Investments in local communities: Project revenue (incl. taxes) used for e.g. infrastructure or education	Positive	- Everyday life - Community	Local population	Barros et al. 2012; Wagner 2010
Loss of agriculture: Contamination and destruction of agriculture	Negative	- Environment - Health and well-being - Community - Personal and property rights	Local agriculture, industry and farmers	Marston 2012, Nayak 2012
Loss of livelihood	Negative	- Community - Environment	Local tribal population	Nayak 2012, Oskarsson 2012
Crop failure: Crop failure due to dust	Negative	- Environment - Health and well-being - Community	Local farmers	Nayak 2012
Resources				
Depletion of water resources: Depletion, contamination and draining of water used for drinking and hygiene	Negative	- Community - Environment - Health and well-being	Local and regional population	Nayak 2012, Oskarsson 2012, Lobo et al., 2018, Marston 2012
Material damage: Damage from dust to equipment, clothes, buildings, water etc.	Negative	- Community - Environment	Local population	Kuan et al., 2020
Visual impacts: Impact on landscape due to removal of vegetation and soil	Negative	- Everyday life - Environment	Local population	Barros et al. 2012
Demography				
Migration: Less migration from rural to urban areas, removing related strains, shortages and socio-economic risks	Positive	- Community - Personal and property rights - Environment	Local and regional population in rural areas	Al-Dubaisi 2011, Barros et al. 2012
Unrest and violence: Social unrest, including violence aimed at those associated with the mine	Negative	- Everyday life - Personal and property rights - Fears and aspirations	Employees and others related to the mine	Oskarsson 2012, Kuan et al., 2020
Family life: Impacts on family life from working conditions at the facility	Negative	- Everyday life	Employees	Al-Dubaisi 2011
Gender discrimination: Very low percentages of women employed and thus low degree of benefits from employment	Negative	- Personal and property rights	Women	Kuan et al., 2020, Wagner 2010
Land use and rights				
Rights to land: Providing rights to land after the project ends	Positive	- Everyday life - Culture - Community - Personal and property rights	Local population	Barros et al. 2012
Rights to land: Displacement and removing access and/or rights of local populations to land	Negative	- Everyday life - Culture - Community - Environment - Personal and property rights	Local population	Deveson 2011, Kuan et al., 2020, Oskarsson 2012, Wagner 2010
Confinement: Limited use of outdoor areas due to e.g. heavy traffic, dust and noise	Negative	- Everyday life	Local population	Nayak 2012
Restraints due to uncertainty about project: Settlers unable to exploit land while waiting for uncertain projects	Negative	- Personal and property rights	Landowners	Kuan et al., 2020
Community development				
Training: Development of competences	Positive	- Everyday life - Personal and property rights	- Employees - Local and regional population	Al-Dubaisi 2011, Wagner 2010
Social and health programmes: Support of community initiatives, health and sanitation programmes etc.	Positive	- Community - Culture - Health and well-being	Local population	Wagner 2010
Infrastructure development: Development of infrastructure that also benefits the community	Positive	- Community	Local population	Wagner 2010

(*continued on next page*)

Table 3 (*continued*)

Description	Negative/ positive	Impact category	Impacted groups	Reference
Recreational assets: Added as a result of rehabilitation after the mining	Positive	- Everyday life	Local and regional population	Burton et al., 2012
Mobilisation of civil society: Creation of an environmental or social movement	Positive	- Political systems	National population	Marston 2012

restrictions on use of land during this period, but the uncertainty can also have wider implications as described by Oskarsson (2015).

Interestingly, some of the social impacts pointed out in the publications can also be viewed or used as mitigation measures, which are defined as "*what can be done to enhance and fine-tune the preferred development alternative to minimise adverse impacts and maximise positive outcomes*" (Morrison-Saunders, 2018: 41). This is the case for the impacts actively created by the project owner; perhaps most prominently, the social and health programmes.

6. Conclusion and discussion

This final section concludes the review by returning to the questions that have guided the review and discussing the findings.

Focussing first on the question of which impacts from bauxite mining and refining are addressed in scientific publications, the review shows that the publications reviewed focus on environmental, economic, social, health and climate impacts. Regarding how extensively they are analysed and investigated, environmental impacts are by far those that are included most often. Looking at the development over time, environmental and economic impacts were also those analysed at the earliest stage (until the early-2000s), when the other impact types really emerge.

Regarding which social impacts from bauxite mining and refining the review finds in the latest scientific publications, Table 3 shows the large array of social impacts identified. Overall, this covers impacts on socio-economy, resources, demography, land use and rights, and community development.

One issue that characterises the social impacts found in the review is that the same or almost the same impact can be perceived categorised as negative or positive depending on the context of each mining project. For example, the *right to land* is described in most publications as a negative impact, where this right is stripped from local populations. However, rights to land are also mentioned as a positive impact when the project secures the transfer of rights to the land to local populations after the closure of the project. Another example is how the economic benefits are described as positive but can also have a downside if the situation is one of a boom–bust cycle where they cannot be sustained after the lifespan of the project (see e.g. Kuan et al., 2020). This points towards the extreme importance of context when dealing with social impacts, as well as the importance of looking into impacts during the whole lifecycle of the activity under assessment. Results such as these also point towards the need for a more nuanced view of impacts – not focussing on impacts as positive/negative but instead viewing them as "desired" or "undesired" and perhaps even also "desired by some" and "undesired by others". This highlights the fact that communities and groups are not necessarily in agreement in terms of how they perceive social impacts, as stated in Section 2, and underlines the importance of who is consulted about social impacts and that one or two people do not necessarily represent an entire group. Such disagreements within, for example, a local community concerning social impacts might trigger a dispute – in itself a social impact. Such perspectives can bring completely different impacts to light.

Another indicator of the importance of context for social impacts is that many of the impacts can be at different levels and affect different groups. For example, the positive/negative impacts from employment at the facility can affect very different groups, from the local to the international levels, depending on where the project recruits its employees from. Or the example of how women typically benefit less from the positive effects of employment opportunities. Not all the publications explicitly state which specific groups are affected by the impacts, so an approximation has been made. This issue emphasises the importance in SIA of working explicitly with which groups are affected by specific impacts and how burdens and benefits are distributed.

Due to the great importance of context, it is not possible to identify from the review, which impacts are most significant – such an assessment depends on the context of the specific project. However, the review does indicate that some impacts are more commonly in focus in bauxite production, measured by the number of publications in which they are identified. In this way, the negative impacts appear related to *rights to land* and *depletion of water resources*, and the positive impacts from *job creation* are the impacts receiving the most focus, as they are each mentioned in four of the publications. The negative impacts from *loss of*

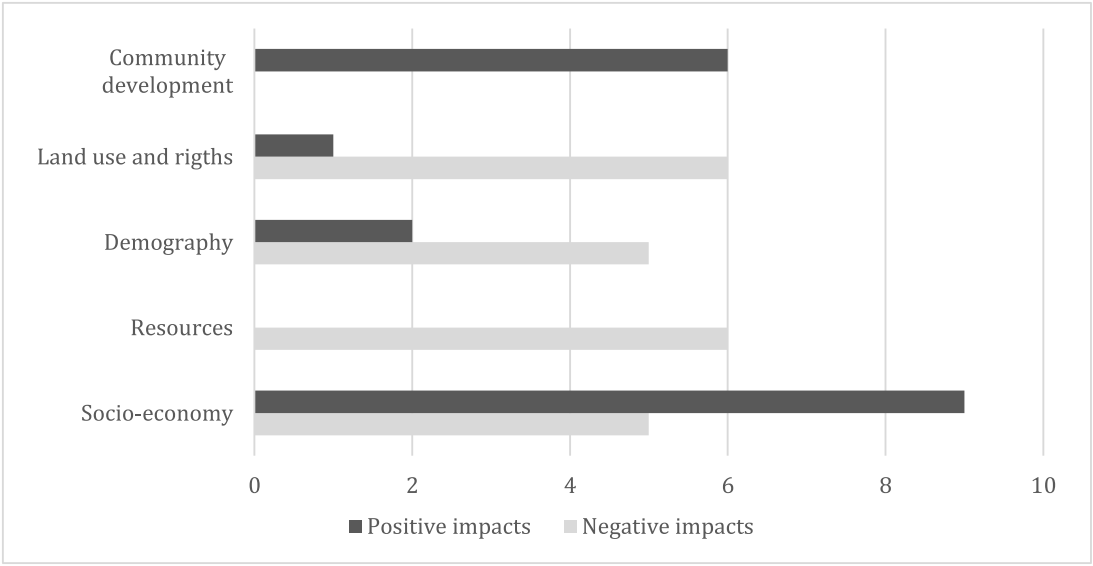

Fig. 4. Frequency of impacts described as positive and/or negative impacts identified in the publications for each overall heading.

agriculture, gender discrimination and *unrest and violence* as well as the positive impacts from *related business, investments in local communities* and *training* also receive more focus than others, as they are all mentioned in multiple publications. In any case, it is important to consider all of the possible impacts, as the specific context is so very determining for the assessment and significance of impacts.

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