Environmental Evidence

SYSTEMATIC MAP PROTOCOL

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Mapping the predicted and potential impacts of metal mining and its mitigation measures in Arctic and boreal regions using environmental and social impact assessments: a systematic map protocol

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Abstract

Background: Since the 1960s, environmental impact assessments (EIAs) and recently, social impact assessments (SIAs), have been conducted during the planning stages of large development projects to identify potential adverse effects and propose mitigation measures to ameliorate these impacts. EIAs and SIAs should outline all possible positive and negative effects of a proposed action or development on ecological and social systems, respectively, including biodiversity, flora and fauna, abiotic components (such as air quality), human health, security and wellbeing. The work outlined herein aims to generate a list of all possible direct and indirect effects of metal mining (including gold, iron, copper, nickel, zinc, silver, molybdenum and lead) along with the impacts of mitigation measures proposed, that are mentioned in EIAs and SIAs in Arctic and boreal regions of the following countries/regions: Canada, Alaska (USA), Greenland, the Faroe Islands, Iceland, Norway, Sweden, Finland and Russia.

Methods: We will conduct searches for environmental and social impact assessments in Swedish and English, and until theoretical saturation is reached (i.e. no new action-impact pathways are identified). We will perform searches of specialist websites (e.g. public repositories of environmental and social impact assessments) and Google Scholar. We will also contact relevant stakeholders (that have been identified in the wider 3MK project https://osf.io/cvh3u/) and make a call for additional information. Eligibility screening will be conducted at two levels: title and full text. Meta-data will be extracted from eligible studies including type of mining activity, location of mine, type of impacts, and planned mitigation measures. Findings will be presented narratively, in a searchable relational database and in an evidence altas (a cartographic map). We will produce a framework of different mining impacts and related mitigation measures from practitioners' knowledge reflected in EIAs and SIAs. This framework will further form the basis of a multiple knowledge base on mining impacts and mitigation measures generated from different knowledges including scientific, Indigenous, and practitioners' knowledge.

Keywords: Extractive industries, Metal mines, Social-environmental systems, Resource extraction

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Background

The Arctic and boreal regions, its people, ecosystems and economy are changing at a fast pace. While a warming climate is often mentioned as a major driver of current change, the establishment and expansion of extractive industries—mining and the extraction of hydrocarbons—have been major drivers of both social and environmental changes in many northern places, both historically and in recent years [1]. As mining activities increase regionally [2] and globally [3], there is an urgent need to assess social and environmental impacts as well as mitigate negative impacts.

Since the 1970s, environmental impact assessments (EIAs) are routinely conducted and in many cases enforced for all large development projects, including changes in industrial land use and decommissioning activities. Social impact assessments (SIAs) are fairly recent add-ons to the assessment of environmental impacts. Together, these assessments should describe the positive and negative effects and alternatives to a proposed activity on ecological (EIA) and social (SIA) systems, including biodiversity, flora and fauna, abiotic components (such as air quality), human health, security, and wellbeing [4]. They also describe and estimate the nature and likelihood of damaging events in connection with a proposed activity and propose measures to eliminate, reduce, control or compensate these impacts and ameliorate impacted systems. They typically evaluate the significance of indirect, direct and cumulative impacts. EIAs are the basis of many permitting and licencing decisions (unlike SIAs for which there is often no legal requirement). The strengths and weaknesses of EIAs and SIAs are currently in focus of both research and policy (e.g. [5]), which is important for improving impact assessment and licensing processes.

The key difference between EIAs and SIAs is that the latter focuses on the impacts to local human communities, which is important not only in attempting to minimise harm (as with EIAs), but also to consider the voices of local communities in the proposed activities. All EIA legislation has a requirement for public consultation, which is not always the case in SIA processes. SIAs may be part of EIA (as is the case in Finland) or, as of more recently, can be a separate stand-alone document (as in Greenland).

The process of producing EIAs and SIAs is different in different countries/regions across Arctic and boreal regions [5, 6]. For example, in Sweden, prospecting and/or exploring can be done without an EIA [5], but for a mining permit (concession) a developer must submit a 'concession EIA' to the Mining Inspectorate. After the mining permit has been approved, the developer needs to submit an application for an environmental permit along with a second EIA (without the sections already covered by the concession EIA) to the Land and Environment Court [7]. There is no Swedish requirement to produce SIA, but some impacts to local communities and human wellbeing, and their mitigation measures, are usually listed within the (concession) EIA. In Alaska, the impact assessment process is guided by federal environmental law and the National Environmental Policy Act. The proponent submits an environmental assessment, after which the government determines if a much broader and detailed environmental impact statement (EIS) is needed. EISs include both social and environmental impacts. In Canada, under the federal EIA legislation, after the government has determined that there is a need for a detailed assessment of the impacts, they issue guidelines for preparation of an EIS to the proponent (for example of the guidelines see here: [8]). The government then reviews the submitted EIS, writes a report with conclusions, and the minister issues an environmental assessment decision document [9]. The EIA systems in Canada's 3 northern territories (Yukon, Northwest Territories, Nunavut) are different than the federal EIA system. For example, in Yukon, the Yukon Environment and Socio-economic Assessment Board prepares the EIS, not the project proponent [10].

As summarised by Haddaway et al. [11], mining activities can have multiple, positive, negative, direct and indirect impacts on social and environmental systems. They can cause land use change, soil and water contamination, increase in noise level and dust. Mining activities can have multiple impacts on biodiversity [12, 13] and human wellbeing [e.g. [14, 15], often affecting traditional practices of Indigenous peoples [16]. Still, there is a paucity of reviews of the impacts on indigenous peoples and lands (see [17–19]). Evidence on the direct and indirect effects of mitigation measures is disparate; spread across disciplines and knowledge systems, including science research knowledge, indigenous and local knowledge, and practitioner knowledge. This map will collect information on the impacts and their mitigation measures of metal mining in Arctic and boreal regions in order to collate knowledge held within EIAs and SIAs.

Stakeholder engagement

This map is a part of a project called 3MK ('Mapping the impacts of Mining using Multiple Knowledges') (Formas' Annual Open Call Grant No. 2017-00683, https://osf.io/cvh3u/). The review question for this map was designed in the funding proposal written in response to Formas' Annual Open Call in 2017. Upon receipt of the grant, the project's working and advisory groups refined the scope of the map. The scope was further revised during an open stakeholder meeting (Stockholm Environment Institute,

September 2018) involving representatives of Swedish government agencies, academia and industry (see Stakeholder Engagement Methodology Document, https://osf.io/cvh3u/). The protocol was further revised based on inputs received through an open public call for comments (November 2018).

Objective of the review

The primary question for this systematic map is:

What predicted and potential direct and indirect impacts of metal mining and related mitigation measures in Arctic and boreal regions are identified by environmental and social impact assessments?

This review aims to generate a list of predicted and potential, direct and indirect impacts of mining and its mitigation measures based on a review of EIAs and SIAs in Arctic and boreal regions (see *Population*, below). This mapping exercise will produce a framework of different mining impacts and related mitigation measures from practitioners' knowledge base (and reflected in EIAs and SIAs). This framework will further form the basis of a multiple knowledge base (sensu [20]) on mining impacts and mitigation measures generated from different knowledges including scientific, Indigenous, and practitioners' knowledge (for more information see the project website: https://osf.io/cvh3u/ and a protocol of a map that aims to collate research evidence on the same subject [11]).

Definitions of the question components

Population(s) Environmental and social systems around or within the direct sphere of influence of (proposed) metal mines in boreal and Arctic countries and regions: Canada, Alaska (USA), Greenland, the Faroe Islands, Iceland, Norway, Sweden, Finland and Russia. The focus on metal mining (including gold, iron, copper, nickel, zinc, silver, molybdenum and lead) was selected based on the importance and presence of these mines for the Arctic and boreal context (as they represent 88% of Arctic and boreal mines [21]).

Intervention(s)/Exposure(s) Metal mining, including construction, operation, maintenance, expansion, decommissioning, reopening, repurposing and abandonment of mines (as exposures) and proposed mitigation measures (as interventions).

Outcome(s) Any direct or indirect, positive or negative impacts or mitigation measure described in EIAs and SIAs.

Methods

This review will follow the Collaboration for Environmental Evidence guidelines and standards for evidence synthesis in environmental management [22] and it conforms to ROSES reporting standards [23] (see Additional file 1).

Searching for articles

The aim of this map is to collate and describe the environmental and social impacts of mining and potential mitigation measures as they are conceived by practitioners working with EISs and SIAs that can be further configured into a framework. As a result, the extent of searching will be driven by the need to reach information/theoretical saturation to complete a comprehensive list of impacts and mitigation measures and not to extract and synthesise all published and relevant information on the subject [24]. Once a specific outcome (an impact or a mitigation measure) has been identified, new occurrences of these outcomes (from other sources) will not be relevant unless they expand or modify the existing outcome. Since the knowledge base consists of technical documents, potentially following specific EIA/SIA guidelines (e.g. [4]), the reports and the impacts and mitigation measures reported within them are likely to be somewhat formulaic and repetitious (particularly within a country and relating to similar types of mining activities), and as a result we believe it will be clear when information saturation has been reached for a specific country, region or type of mining (i.e. no new action-outcome links are identified when screening additional documents). In addition, we will track the number of novel outcomes per manuscript, and plot these on an accumulation curve. We will stop searching for new outcomes as close to the asymptote as resources allow.

The search strategy will include two phases. First, we will purposively search for 5 diverse examples of EIAs and SIAs from each eligible country/region (see *Population,* above). The initial screening of the included examples will be conducted simultaneously with meta-data extraction to allow identification of theoretical saturation. Second, and based on the results of the initial search (and extraction), we will randomly select an additional 5 further EIAs/SIAs from each country. We will repeat this second step until new outcomes (see *Eligibility criteria* for a list of eligible outcomes) cease to emerge and all elements of the map are well-described (i.e. once the outcome accumulation curve is close to the asymptote and the theoretical saturation is reached).

Since there are no public repositories of EIAs/SIAs for each eligible country/region we will look for studies by searching several different sources as follows: specialist websites; web-based search engines; public archives, and, direct stakeholder contact and calls for relevant information (see details for each of these searches below).

Specialist websites

We will search for EIAs and SIAs in the following websites and national public repositories:

1. *Alaska, USA* EPA's EIS Database (from October 1, 2012) (https://cdxnodengn.epa.gov/cdx-enepa-II/public/action/eis/search), Bureau of Ocean Energy Management (https://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Environment/Environmental-Analysis/Environmental-Impact-Statements-and–Major-Environmental-Assessments.aspx), The National Environmental Policy Act (https://ceq.doe.gov/index.html) and The Permitting Dashboard (https://www.permits.performance.gov).
2. *Canada* Canadian Environmental Assessment Registry (https://ceaa-acee.gc.ca/050/evaluations), Nunavut Impact Review Board (http://www.nirb.ca), Northern Territory Environmental Protection Authority (https://ntepa.nt.gov.au/environmental-assessments), Yukon Environment and Socio-economic Assessment Board Online Registry (http://www.yesabregistry.ca/wfm/lamps/yesab/lowspeed/projectsearch.jsp;time=1536745438401), The Mackenzie Valley Environmental Impact Review Board (http://reviewboard.ca/), Prospectors & Developers Association of Canada (https://www.pdac.ca/).
3. *Finland* Joint website on Finland's environmental administration (http://www.ymparisto.fi/fi-FI/Asioinnti_luvat_ja_ymparistovaikutusten_arviointi/Ymparistovaikutusten_arviointi/YVApaatokset), the Finnish Network of Sustainable Mining (https://www.kaivosvastuu.fi/).
4. *Greenland* Government of Greenland (http://naalakkersuisut.gl).

In Sweden, the EIAs might be obtained from the Mining Inspectorate (https://www.sgu.se/bergsstaten/lagstiftning/sammanfattning-av-regelsystemet/) and found in the archives of the court system. We have yet to identify public repositories for EIS/SIAs in the Faroe Islands, Iceland, Norway, and Russia (also see "Supplementary searches".

Depending on functionalities of each of these repositories, we will search for relevant EIAs and SIAs either manually (i.e. searching relevant pages of organisational websites) or using simple English and Swedish language search terms: *mine; mining; iron, copper, lead, nickel, zinc, gold, silver, molybdenum, "impact assessment", "impact statement", "transboundary impact assessment".*

Search engines

Searches will also be performed in Google Scholar, which has been shown to be an especially effective tool for grey literature searches [25]. These searches will combine terms related to metal mining with impact assessment terms as follows:

allintitle: mine OR mining OR iron OR copper OR lead OR nickel OR zinc OR silver OR gold OR molybdenum "impact assessment"

The first 1000 search results will be extracted as citations using Publish or Perish software [26].

Supplementary searches

As some countries do not have a public repository of EIAs or SIAs, we will contact stakeholders and request eligible EIAs/SIAs. Relevant stakeholders are being identified by the 3MK project under which this mapping exercise is being conducted. We will also contact responsible agencies and will announce calls for EIAs and SIAs through relevant networks such as ResearchGate, Resource Extraction and Sustainable Arctic Communities website (https://www.rexsac.org) or through networks connected to the Arctic EIA project of the Arctic Council Sustainable Development Working Group (https://www.sdwg.org/activities/sdwg-projects-2017-2019/arctic-eia/arctic-eia-new/).

Assembling library of search results

A library of all the search results will be assembled in an excel spreadsheet and/or a review management software (e.g. EPPI reviewer [27]) and any possible duplicated records will be removed prior to screening.

Article screening and study eligibility criteria

Screening process

Screening will be conducted at two levels: at title, and at full text. Potentially relevant titles will be retrieved at full text (tracking those that cannot be accessed and reporting this in the final review). Retrieved records will then be screened at full text, with each record being assessed by one experienced reviewer.

Prior to commencing screening, consistency checking will be performed with all reviewers on a subset of articles at both title and full text level screening. A subset of 40 title records and 5 full text records will be independently screened by two reviewers. The results of this screened subset will then be compared between reviewers, with all disagreements discussed in detail and eligibility criteria clarified where necessary. Where the level of agreement is low (e.g. below c. 0.6 agreement according to the Kappa test), further consistency checking will be performed on an additional set of articles and then discussed.

Eligibility criteria

Eligible population(s) Environmental and social systems around or within the direct sphere of influence of (proposed) activities related to gold, iron, copper, nickel, zinc, silver, molybdenum and lead mining in Arctic and boreal regions: Alaska (USA), Canada, Greenland, the Faroe Islands, Iceland, Norway (including Svalbard), Sweden, Finland and Russia.

Eligible intervention(s)/exposure(s) Metal mining construction, operation, maintenance, expansion, decommissioning, reopening, repurposing and abandonment; and proposed mitigation measures.

Eligible outcome(s) Any affected aspect of social, technological or environmental systems. The impacts and mitigation measures are theoretical, potential or predicted.

Eligible study type(s) EIAs and SIAs. We will include EIAs/SIAs published in English and Swedish (which reflects language skills of the review team). Eligible studies with full texts in non-eligible languages will be recorded, but they will not be included in the final map. We will identify them as potentially relevant but not assessed. We will discuss a potential for cultural bias in the final report, since criteria for generating SIA and EIA reports may vary in different contexts reflecting local perceptions of social and environmental values.

We will provide a list of documents excluded at full text, with reasons for exclusion provided for all excluded reports.

Study validity assessment

In accordance with systematic mapping methodological guidance [28], study validity assessment will not be conducted.

Data coding strategy

Coding and meta-data will be extracted into a spreadsheet (or a relational database (e.g. MS Access)). Information on the type of mining activity, location of the (real or planned) mine, type of impacts, and suggested mitigation measures will be extracted. A draft coding sheet for meta-data extraction is provided in Additional file 2. This draft coding sheet was produced through initial scoping and testing by two reviewers.

To test the repeatability of coding and meta-data extraction, two reviewers will independently code and extract meta-data from 5 eligible EIAs and/or SIAs. All disagreements will be discussed, and the coding and meta-data extraction sheet and instructions will be revised where necessary.

Study mapping and presentation

Extracted meta-data will be described narratively. From extracted outcomes (predicted and potential impacts and mitigation measures) we will produce an impact and mitigation framework, linking actions (e.g. mining operation) to outcomes (e.g. alternation of the soil profile and related proposed mitigation measures). We will compare the divergencies and convergences between this framework (based on practitioners' knowledge) and a list of impacts and mitigation measures reported in research evidence (see [11]). The identified knowledge will also be presented in the form of an interactive, searchable open-access database containing the detailed coding and extracted meta-data. The contents of the systematic map database will be visualised in an evidence atlas (an interactive cartographic map).

Additional files

Additional file 1. ROSES form for systematic map protocols.

Additional file 2. Coding sheet.

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Authors' contributions

BM drafted initial version of the protocol. NH, PL and AN commented on and edited the drafts. All authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare they have no competing interests. Members of the Advisory Team will be prevented from providing advice or comments relating specifically to documents to which they may have contributed.

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