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Reconciliation of Conflicting Societal Objectives: Nature Protection vs. Mining †

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Abstract: Critical raw materials (CRMs) like lithium, cobalt, and copper are crucial for our modern economy, driving digitalisation and the energy transition. The EU-funded CIRAN project addresses the challenge of balancing environmental protection and the demand for CRMs. It focuses on developing innovative land-use governance models, social contract frameworks, and business models. These initiatives enable informed and sustainable decisions in mining operations, fostering environmental protection while meeting the growing need for CRMs.

Keywords: supply risks; mineral raw materials; permitting; land-use governance; stakeholder participation

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1. Background

Mining in the European Union (EU) has witnessed a consistent decline throughout the latter half of the 20th century and into the 21st century [1], and the EU is now highly vulnerable to supply risks concerning specific mineral raw materials. Four key factors underlie this vulnerability: (1) some mineral resources are currently known to occur at only a few locations around the world, (2) commercial extraction and processing is dominated by a single country or a small number of countries, (3) politically motivated threats, warfare, or events such as pandemics can suddenly disrupt supply webs, and (4) a fragmented and inconsistent regulatory approach affecting sustainable and the responsible use of resources. To address these concerns, the EU has developed initiatives such as the Action Plan on Critical Raw Materials [2] and the recently advanced Critical Raw Materials Act [3]. These initiatives identify materials that are particularly exposed to supply risks and aim to strengthen the EU's critical raw materials capacities along all stages of the value chain. Concurrently, policy decisions and instruments such as the EU Green Deal (https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (accessed on 14 July 2023) and the Net-Zero Industry Act [4] are pushing forward the transition towards an economy with no net emissions of greenhouse gases by 2050, increasing the demand for primary raw materials in the coming years and decades [5]. Moreover, the EU Green Deal and the Circular Economy Action Plan [6] state that the energy transition should be based on materials obtained in full respect of human rights as well as compliance with social and ecological standards.

The energy transition demands a range of minerals that previously have seen no or little use, such as rare earth elements, alongside metals and metalloids viz. gallium, germanium, selenium, indium, and tellurium, that are normally a by-product of the extraction of main commodities. If imported from outside the EU, sourcing may be marked by ethical concerns and a high risk of displacing negative impacts and externalities from the EU to vulnerable societies abroad. If sourced from within the EU, local communities often resist the projects, fearing the extraction process will cause enduring or permanent damage to

their surrounding ecosystems and ways of life (see [7], for a review of the situation in the EU).

While what a desirable socio-economic trajectory should look like is open to a societal discourse, there seems to be a consensus that adaptations to climate change should not significantly detract from our current lifestyles. However, there may be more radical views on what desirable lifestyles should entail. Implementing the EU policy objectives for phasing out fossil fuels and replacing these with systems to harvest other forms of energy (e.g., wind or solar) will require large additional quantities of raw mineral materials, some of which have previously not been used or have only been scarcely used. All this, together with the continuing paradigm of economic growth, will lead to mineral raw materials needs that cannot be met by recycling for the decades to come but instead require the extraction of primary raw materials.

Mining activities are inherently tied to the presence of mineral resources. However, in the EU, challenges arise due to the dense population and the presence of designated nature reserves, such as RAMSAR Convention zones, Natura 2000 sites, drinking water protection zones, and cultural heritage areas. Additionally, the recent COP-15 on biodiversity held in Montreal in December 2022 called for the declaration of approximately 30% of the world's surface as protected areas, and the EU Biodiversity Strategy for 2030 (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en (accessed on 21 July 2023)) aims to expand the EU network of protected areas and transform 30% of Europe's lands and seas into effectively managed protected areas, with 10% designated as strictly protected. These regions typically do not accept mineral extraction activities.

Such varied demands on (natural) resources inevitably will lead to conflicts over their desired or needed use. This paper discusses how comprehensive mining and land-use management going beyond the active phase of a mine could reconcile such potential conflicts and also explores the strategies and constraints for responsible extraction.

2. Regulatory Constraints

Mineral extraction within the EU occurs already under more stringent regulations than in most other countries around the world and would have the benefit of shorter and more secure supply lines to EU end users. Extraction in the EU is likely to result in greater economic resilience and a smaller carbon footprint. Nevertheless, many countries across the EU are averse to mining in general.

The main reason appears to be the image that mining has in the public and that has been shaped by past mining practices and their resulting environmental and societal impacts and legacies. It is also the fault of many mining companies who in the past exhibited a rather nonchalant attitude towards environmental impacts and a lack of respect to the surrounding communities. While it is true that there is no human activity, including mining, without impact, modern mining technology and mining governance has demonstrated that such impacts and their legacies can be minimised.

As noted above, it is very likely that, in the EU, extractive activities will come into (potential) conflict with other, pre-existing land uses such as nature reserves, water protection zones, or cultural heritage areas. Within some protected zones, other land uses may be allowed but only under strict conditions. An assessment of reference cases of extractive activity in Natura 2000 areas has shown [8] that three elements are essential for successful shared use: (i) stakeholder cooperation and dialogue among actors, (ii) trustworthy, independent impact assessment and mitigation actions fostering the adoption of a Biodiversity Action Plan, and (iii) cohesive remediation plans from the outset, enhancing biodiversity and ecological corridors. These cases demonstrated that extraction of mineral resources can be managed as a time-limited land use, meaning that it can be carried out in responsible ways without causing irreversible damage to such environments.

Past H2020 projects have helped summarise and better understand successes and failures in regulatory processes and land-use planning decisions across the EU. These are embedded in policy frameworks at international and national levels, such as at UN conven-

tions and in EU policy documents, directives, and regulations. In turn, they shape declared and/or codified policies at the national or sub-national level—in certain EU Member States (MS), significant regulatory and policy-making rest at provincial or local levels.

Against that background and drawing on successful case studies, the new Horizon Europe project CIRAN (www.ciranproject.eu (accessed on 11 July 2023)) aims to develop, test, and validate policy-making instruments that balance environmental protection imperatives with diverse societal and economic needs.

3. Systemic Permitting Procedures

Traditionally, land-use planning, protected zone designation, and mine permissions are approached as relatively isolated procedures based on sectoral policies and regulations. As has been shown in past H2020 projects (e.g., MINATURA2020, https://minatura2020.eu (accessed on 10 July 2023) or MinLand, https://www.minland.eu/ (accessed on 11 July 2023)), there may be little interaction either between government departments responsible for the various permitting tasks, such as for land-use planning, environmental protection, water resources, and mineral resources, or between the departments, stakeholders, and affected communities. Likewise, there may be little understanding of multi-factor issues, as the responsible experts and government officials tend to operate only within their respective disciplines.

As a consequence, properties, needs, risks, and impacts are assessed and evaluated in a fragmented way with a high risk that permitting decisions may be inconsistent, even contradictory, and may not take into consideration the full spectrum of societal needs and expectations. A systemic, cross-sectoral approach enables a balanced and integrated risk and impacts assessment during the approval, permitting, and ensuing life-cycle management processes.

Figure 1 models these associated risks as a 'bow-tie' with the central, pivotal aim of developing cohesive solutions for permitting processes, balancing mitigation of increased economic vulnerabilities across EU societies, while reducing environmental vulnerabilities due to poor sectoral policy-making and outmoded regulatory approaches.

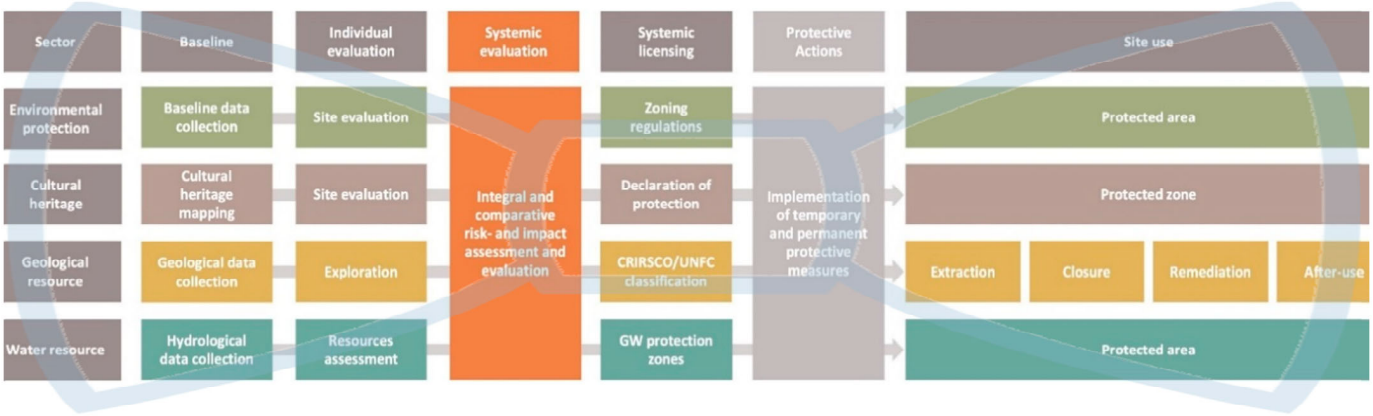

Figure 1. Cross-sectoral risk and impact assessment with a bow-tie model of sectoral policy-making.

An integrated, systemic evaluation ensures that critical investments do not result in negative externalities, such as increased material footprints, excessive emissions, or residue legacies, causing major environmental, social, or economic damage.

Policy-making has long lead times, particularly when it requires significant societal paradigm and behavioural changes. The transposition of EU policies and regulations into national regulations requires yet more time. Therefore, the streamlining of permitting procedures to make them more efficient, effective, fair, and balanced across all of our society's needs, expectation, and ambitions requires a two-tier approach. First, strategic identification of resource management policy elements needing change or adaptation, and,

second, tactical pinpointing of ways to apply regulation and permitting procedures in a systemic, coherent, and consistent manner.

The Horizon Europe CIRAN project explores innovative options for systemic risk and impact assessment along the whole life cycle of a mine and beyond the end of the active phase as a practical bridge from established sectoral evaluation methods to one suited to the new economic, societal, and environmental challenges. It will result in a transparent, system-oriented, 'holistic' approach to managing natural resources above and below ground, as envisaged by, e.g., [9]. This will in turn provide innovative and practical tools for assessing investments in extractive projects against the EU Taxonomy Regulation [10] and related environmental, social, and corporate Governance finance scorecards for investment into mining projects. To this end, active involvement of local communities and regional authorities is crucial from the early stages of decision-making. These stakeholders will play a pivotal role in co-producing the necessary knowledge and shaping the framework of modern social contracts, preventing conflicts and resolving disputes.

4. Justifying Mining Projects

As noted earlier, projected mineral raw materials needs depend strongly on the envisaged future socio-economic trajectory of our societies. As this is open to debate, often the need for mining projects is questioned, blaming the greed of investors or multi-national mining companies as driving forces. In the ensuing societal discourse, it is therefore helpful to reflect on the spectrum of drivers behind the proposals for mining projects and their specific position in the socio-economic system.

While the need for a consistent, systemic approach to the permitting of mining projects as such may be acknowledged, the framing role of policy-decisions, such as the EU Green Deal or other geopolitical decisions, or decisions to subsidise certain technological developments, typically are not adequately considered in discourses. Neither are the likely and possible consequences of such decisions subject to (foresight) modelling at various scales such as, for instance, during strategic environmental impact assessments (cf. [11]).

The so-called DPSIR (Drivers-Pressures-States-Impacts-Responses) framework (Figure 2) has been used for several decades; for instance, its use by the European Environment Agency (EEA) to understand the origin of environmental stressors, such as certain chemicals, the drivers for their use, and the likely consequences of related policy decisions. The same DPSIR framework can be used to assess new mining projects with a view to achieve systemic risk and impact assessments, thus enabling fairer, more efficient permitting procedures for extractive activities in areas of potential land-use conflicts. Accordingly, CIRAN proposes broadening the scope of the classical DPSIR analysis to include societal impact, vulnerabilities, and possible conflicts due to both unmet demand for primary resources and supply web insecurity when supply lines extend outside Europe's span of control. The DPSIR analysis, however, can also include non-tangible drivers and pressures, such as those reflecting the world views of certain stakeholder groups that may shape the public debate.

In a DPSIR analysis, overarching drivers such as policy decisions at the EU or national levels, for instance, the 'Green Deal' and the Energy Transition, become apparent. These clearly result in increased pressure to extract primary mineral raw materials. Because the consequences of such major policy decisions unfold and evolve over long time horizons, sometimes unpredictably and uncertainties abound due to imperfect knowledge and inadequate capabilities in the observation and understanding of the socio-economic mechanisms and the forces determining outcomes.

Foresight studies will aid in better anticipation of likely future sources of pressure, including the rapid evolution of the demand for specific but fast-changing critical raw materials. Such foresight studies aim to assess the likely future evolution of existing technologies, where new technologies may come onto the market over a given time horizon, and what implication all this will have for the mineral raw materials demands.

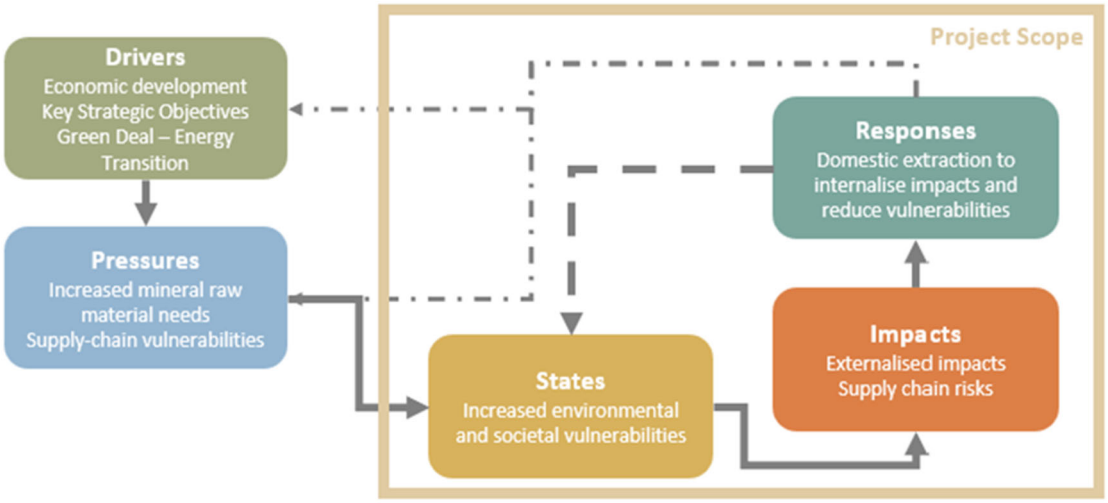

Figure 2. DPSIR framework for mitigating policy-driven externalities and socio-economic vulnerabilities.

Whatever policy decisions result from the transition to circularity and the rational re-use of resources, EU societies likely undergo a turbulent transition lasting one or more decades before sufficient stocks will become available for recycling. This in effect means an inevitable focus on the heavy demand for extracting new primary raw materials to enable technology changes (e.g., at present, chemical elements such as lithium or cobalt for batteries). For the time being, primary extraction occurs mainly outside Europe, where the state of the societies, the environment, and regulatory regimes, including enforcement, may already be fragile. The result is yet higher vulnerability and, further, potentially more severe, negative impacts. It further exposes EU societies to risks of supply web disruption.

When applied to a particular project in question, the DPSIR framework can also make transparent to stakeholders, at all scales, the consequences of decisions to go ahead or otherwise. Thus, overarching drivers will not go away with a decision not to mine, but it may displace the associated risks to more vulnerable societies elsewhere and thus externalise impacts related to our economic activities and societal preferences.

The DPSIR framework, developed against such a backdrop and while taking into the consideration the entire life cycle of a proposed mine, will provide semi-quantitative aid to decide whether extraction can be justified against other imperative societal needs and expectations for the use of a specific site and the protection of its landscape, biodiversity, and ecological function.

5. Systemic Understanding of Mine Sites and Other Land-Uses

Land-use decisions are often seen as exclusive, permitting only one single type of use, often claiming that additional uses would be detrimental to the primary use. Such decisions are frequently made categorical; that is, without an actual and impartial impact assessment of the proposed additional uses. Such decision-making may be enshrined in the legislation of that particular country. It ignores, however, the fact that our world is three-dimensional and that activities at depth, whose footprints overlap when projected to the Earth's surface, do not necessarily interact mechanistically with each other. Thus, a mine at several hundred metres depth does not necessarily communicate with ecosystems at the surface and therefore could co-exist. The absence of interaction between a mine at depth and a surface ecosystem has to demonstrated conclusively by employing appropriate assessments that inform a systems model. Such a model would need to also include, of course, the surface activities associated with the mine, including transport, processing, and any extractive waste management facilities. Such a three-dimensional environmental impact assessment needs to include time as a fourth dimension. The time axis of the model must extend from exploration to beyond the operational phase of the mine; namely,

the envisaged after-use of the mine site and any extractive wastes that may have to be permanently disposed of at the surface after final closure and remediation.

While developing a comprehensive mechanistic model requires considerable effort and money expenditure, it can provide a powerful justification for the co-existence of a mine and other sensitive land uses if there is sufficient economic pressure and societal justification as evaluated by a DPSIR model.

6. Enhanced Mining and Land-Use Governance through Knowledge Co-Creation

Despite the recognition and promotion of a people-centred approach to land use in EU policies, the practice of co-producing land-use practices remains largely on the periphery. While there have been some instances of applying such processes at the operational level, particularly in securing a social license to operate for specific projects, broader engagement in co-producing land-use practices has been limited. These processes have primarily focused on balancing local community preferences with the constraints imposed by remediation solutions for extractive waste sites.

Addressing economic inequality between urban centres and peripheral regions, where mining activities are often concentrated, is another important aspect that requires attention. While modern mines may not create a significant number of new jobs, they can contribute to value creation in a region, which can, in turn, incentivise other supporting economic activities.

To facilitate meaningful and inclusive engagement, it is necessary to establish modern social contract models within the EU. These models should identify the rights, obligations, and responsibilities of governments (both national and regional) and communities affected by mining activities. This paradigm shift would prioritise the value of coupled social-ecological systems and acknowledge the potential dramatic transformations resulting from climate change. By integrating these models into a conceptual framework that can be applied across the EU and beyond, it becomes possible to foster effective community participation in knowledge co-creation and transparent consultation. This inclusive approach would facilitate the identification of reciprocal rights, obligations, and responsibilities needed to enable the co-existence of mineral extraction and environmental protection.

7. The Search for Novel Business Models

One crucial aspect of promoting responsible extractive projects is the development of business models that transition from the traditional linear approach to a circular model. Such models should consider the different life-cycle stages of primary raw material extraction. By adopting a circular approach coupled with effective life-cycle management, it becomes possible to ensure that mining activities are compatible with preferred land uses in the surrounding areas, including downstream from a mine site. While the ideal outcome is to leave minimal mining legacies on the surface, acknowledging that the mine may have permanently altered the landscape is essential. In such cases, the focus should be on creating additional economic and social value by utilising the mine site's infrastructures and promoting biodiversity and ecosystem services that benefit the wider context.

This comprehensive approach necessitates collaboration among a diverse range of disciplines and active involvement from various stakeholders. Knowledge co-creation through stakeholder engagement is a critical component not only in obtaining the initial social license to operate but also for fostering long-term societal integration and maximising economic benefits for the communities impacted by mining projects. By actively involving stakeholders from the early stages of a project, including local communities, regional authorities, and relevant experts, a more holistic and inclusive decision-making process can be achieved. This approach ensures that the concerns and preferences of all stakeholders are considered, helping to build trust, enhance transparency, and create a sense of ownership among the communities affected by mining activities. Additionally, the collaboration of multidisciplinary teams enables the integration of diverse knowledge and expertise, leading to more informed and sustainable decisions regarding mining operations.

Ultimately, the development of responsible extractive projects requires a shift towards novel business models, the consideration of long-term impacts and land-use compatibility, and the active involvement of stakeholders through knowledge co-creation. By embracing these principles, mining projects can become more socially, economically, and environmentally beneficial, contributing to the well-being of local communities and the preservation of natural resources.

8. Conclusions

Europe is currently confronted with a complex dilemma that requires striking a balance between protecting natural environments and biodiversity on one hand and ensuring a sustained and sustainable supply of mineral raw materials on the other. This challenge is further compounded by the need to accelerate the energy transition and mitigate the negative impacts of climate change. While there are ongoing societal debates surrounding these trajectories, it is evident from simple thermodynamic considerations that decarbonising our energy systems will inevitably require increased use of mineral materials. Basic mass balance calculations indicate that the significant impact of recycling on raw materials availability will only be realised several decades from now. Moreover, evolving geopolitical circumstances further jeopardise Europe's raw materials supply situation, adding to the complexity of the challenge.

Resolving this dilemma entails finding a way to secure a domestic supply of mineral raw materials while internalising the associated environmental and social impacts and conflicts instead of relying heavily on imports and exporting the associated externalities of extraction. This represents a critical societal and policy-making challenge in the coming years. Systemic policy-making and permitting processes that integrate all relevant stakeholders can contribute to meeting these challenges.

Addressing this dilemma requires an honest, transparent, systemic, and comprehensive assessment of the physical and societal dimensions of the problem. It is essential to balance environmental and socio-economic risks against one another and against societal preferences, making these trade-offs transparent and subject to open debate. This will undoubtedly be a difficult and contentious discussion, but modern society possesses the means and capabilities to tackle these issues, including the technical aspects involved.

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