Climate Change Adaptation: Overarching Framework to Address Overlapping Industry Guidelines

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Abstract

From extreme weather events to changes in climate patterns, the adverse effects of climate change are felt across the world. Current scientific projections outline that, even withstanding international pledges to reduce emissions globally (i.e., climate change mitigation); the global mean temperature will increase by two to three degrees Celsius until 2100 (compared to pre-industrial mean temperatures). Addressing climate change acute and chronic physical risks, i.e., climate change adaptation, is becoming equally important as climate change mitigation, if not more, to create sustainable developments and operations. Determining when, how, and to what degree to adapt to climate change effects are questions of utmost importance and consequence.
Complex transportation networks, water intensive operations, work force and geographical diverse communities, and intensive social and environmental permitting requirements are only some of the reasons for the long lived and capital-intensive mining operations to be vulnerable to adverse climate change effects.

Several industry bodies and authorities have devised pragmatic guidelines to tackle climate change adaptation for various industry sectors. These guidelines, however, often serve specific angles and therefore, utilize conflicting language and terminologies in conjunction appear conflicting with each other.

In this paper, we review the climate change adaptation challenges to the mining and metallurgical projects and industrial operations. We propose an overarching climate change adaptation framework to envelope various industry guidelines and practical engineering considerations and studies. We review the nature and scales of adaptive responses that must be understood before embarking on climate change adaptation journey. The proposed framework encompasses seven steps, starting from understanding the context, scope, and scale, and arriving at adaptation implementation.

Keywords: Climate change, Adaptation, Mitigation, Adaptive capacity, Sustainable development.

1. Climate Change in the Mining & Metallurgical Industries

In June and July of 2022, severe persistent heat waves developed across Europe with temperature anomalies leading to the highest recorded temperatures ever across the continent. Wildfires burned large swathes of lands across various counties. In France, an estimated total of 17 000 hectares were burned with more than 24 000 people evacuated. Overall, Europe recorded more than 5 000 heat related deaths, half of which from Spain alone. While the world is struggling to reduce greenhouse gas emissions to mitigate and prevent more climate change, the adverse effects of these changes are here, and the society needs to brace for them.

Weather and climate related hazards such as floods, hurricanes, extreme temperatures, and wildfires constitute about 90 % of all disasters [1]. At the same time, only 4 % of spending on disasters goes towards disaster prevention and preparedness, with 96 % spent on response, [2] painting a grim picture for the world that is anticipating more frequent adverse effects due to climate change.

The industrial complex of today has evolved drastically from yesteryear through increased optimization and reliance on limited resources. Particularly, the contemporary mining industry today utilizes complex transportation networks across large geographical spreads, operate climate and water sensitive processes, and maintain multinational work forces from diverse communities. Mining operations are required to maintain social license to operate and satisfy ever-increasing environmental permitting requirements. Mining industry with its long life and capital-intensive operations have become more vulnerable to adverse climate change effects. The International Council on Mining and Metals (ICMM) has conducted a review of its member organizations to gauge the materialized effects of climate change on mining operations and concluded no company or geography is immune of extreme weather and climate change [3].

To address these vulnerabilities to climate change, a growing number of industry bodies and authorities have devised pragmatic guidelines to tackle climate change adaptation for various industry sectors. These guidelines, however, are either vague and overly qualitative, or serve specific purposes and are tailored to specific sections of industries; they utilize conflicting languages and terminologies and hence are difficult for any organization to navigate and implement.

This paper review several of current industry related climate change adaptation guidelines and proposes an overarching climate change adaptation framework to envelope various industry guidelines and practical engineering considerations and studies. We review the nature and scales of adaptive responses that must be understood before embarking on climate change adaptation journey. The proposed framework encompasses seven steps, starting from understanding the context, scope, and scale, and arriving at adaptation implementation.

1.1 Climate Change Mitigation versus Adaptation

The terminology around climate change mitigation and adaptation can be used interchangeably in various contexts particularly when referring to climate change risks versus the climate change itself. However, most of the scientific literature when referring to the climate change itself utilize *mitigation* as to reduce carbon emissions to help prevent - more - global warming; while the *adaptation* is used to refer to adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Figure 1 depicts the definitions of climate change mitigation and adaptation as in a causal risk diagram (bowtie). Climate change mitigation measures are aimed at reducing the organization’s greenhouse gas emissions produced during their operations, utilized to generate the energy they import or in the way the organization’s output is used. At the same time, climate change adaptations are those measures we take to accommodate to the climate change already being experienced or forecasted in the future.

With major climate change induced risks and vulnerabilities of the operations identified, preliminary cost benefit analysis or the bounding analysis underlining the limits of potential variabilities of future climate projections, the next goal is to incorporate the study results into the design criteria, or implementation plans.

4.8 Climate Change Adaptation Implementation

Climate change adaptation implementation consist of several distinct phases. It commences with conceptual development followed by prefeasibility and feasibility studies. This sequence signifies increasing level of project/engineering definition and cost estimate accuracy. Feasibility level study usually results in the budget authorization and initiation of detail engineering of the proposed solution. Completion of detail engineering is a precursor to the project procurement and construction activities.

Each phase requires set-up, planning, execution, and control. Planning and set-up consist of developing work plans as well as establishing baselines and project team structure. Execution and control are focused on the target deliverables scope, quality, and schedule. The project plans are implemented and maintained while scope and/or schedule changes are managed.

As with other engineering implementation projects, for climate change adaptation it is very important to understand and meet all stakeholder expectation from a delivery standpoint.

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