Climate Resilience of Chemical Infrastructures: Exposure Assessment and Options for Preparedness

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Background/Objectives. Chemical facilities are exposed to a diverse set of internal and external hazards. Natural hazards, such as floods, earthquakes, and storm surges, can be particularly dangerous since they can span a large geographic area and impact surrounding communities and emergency response resources in complex ways. Some natural events are linked to extreme weather events, which are predicted to become more frequent, intense, and long-lasting as a result of climate change. Although the burden of the changing climate on the chemical industry has started to be recognized by international and national entities and within scientific literature, nuanced understanding of climate change impacts on chemical facilities has limited the sector's ability to better prevent, prepare, respond, and even recover from natural hazards. To address this gap, our team undertook a resilience-driven approach (using India as a case study) that characterizes climate hazards, evaluates exposure, and identifies options for better climate preparation for chemical facilities.

Approach/Activities. Our analysis leveraged three types of data centered around: 1) chemical facilities locations, 2) climate model projections, and 3) current regulations in India. Climate model projections were sourced from three global circulation models (CanESM5, NorESM2-MM, and MPI-ESM1-2-HR) while the chemical facility and regulations datasets were sourced from market and public sources. The climate data were processed and analyzed to generate region-specific metrics to capture future trends in precipitation, temperature, and sea level rise hazards relative to historic climate patterns. Hazard-specific trends were paired with local regulations to evaluate possible exposure risk and identify options for preparedness. A visualization tool was also developed to synthesize the spatial and temporal data in an interactive manner.

Results/Lessons Learned. Our findings indicate that the states of Gujarat and Maharashtra have significant chemical production that is particularly vulnerable to climate change. In particular, a majority of the facilities are located within 20 km of the coast, which are expected to experience 0.365 m and 0.309 m increases in mean sea level for Gujarat and Maharashtra, respectively, by 2100. These impacts are also accompanied by greater precipitation (and higher temperatures), with up to 69% (28%) and 71% (26%) of the years exceeding historical 95^{th} (90^{th}) percentile of total annual precipitation (maximum annual temperature) in the two states. The increased precipitation and sea level rise would increase the risk of flooding, a hazard that has already contributed to significant human and infrastructure damage in India. To better prepare for these hazards, we outline a number of questions that can guide facility preparedness activities. Such activities would be further improved and enhanced by national flood maps and building permit modifications. Interactive, visualization tools can also be helpful for translating complex datasets into actionable insights, but proper planning is needed to ensure appropriate data are collected and processed to support answering priority concerns by facility owners and operators.