ANALYZING LIFE CYCLE EMISSIONS OF SYNTHETIC FERTILIZER AND CYANOBACTERIA BIOFERTILIZER FOR LEMON TREES

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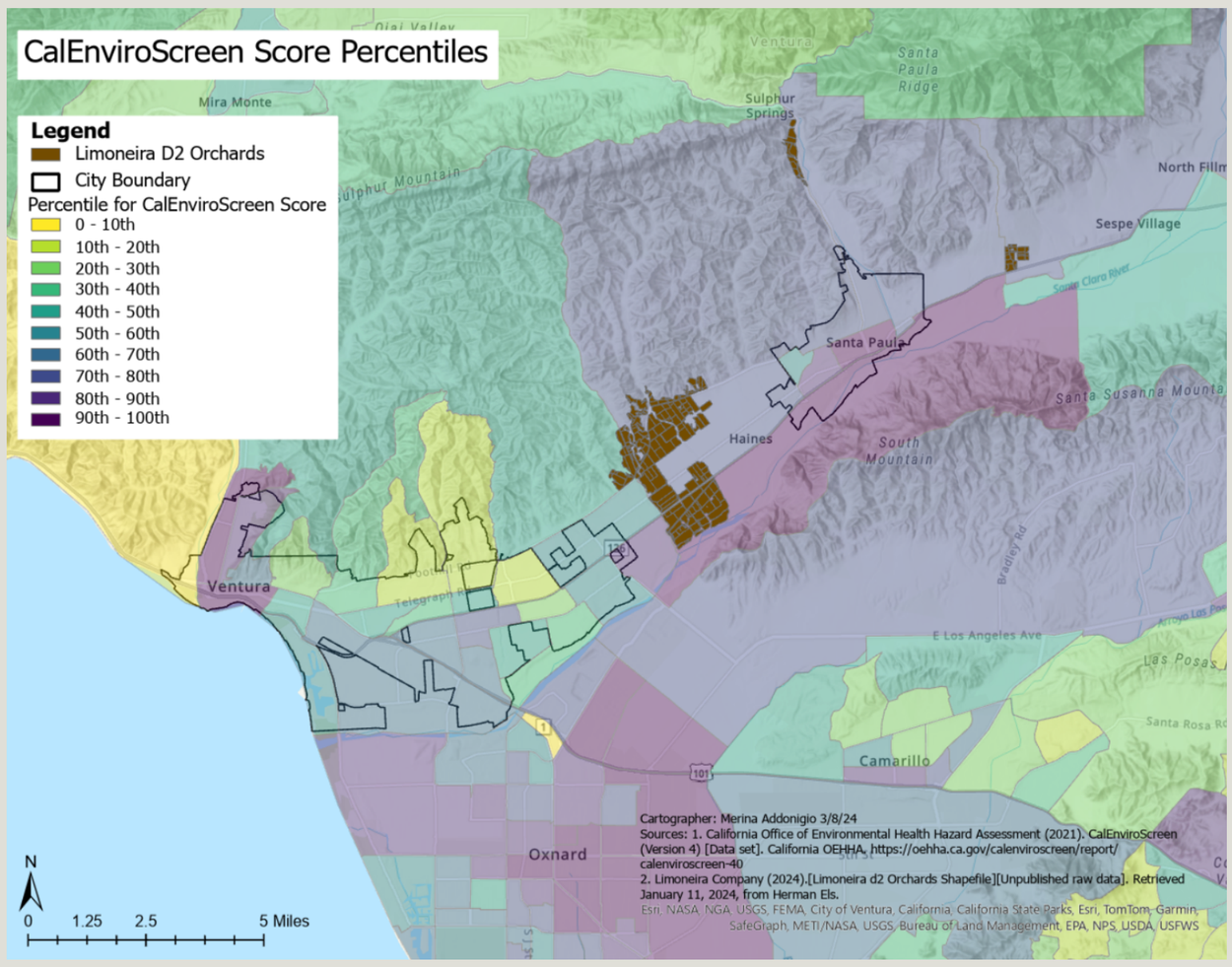
Client: The Limoneira Company

ENVIRONMENTAL PROBLEM

Synthetic fertilizers substantially boost crop yields but cause serious environmental problems, including greenhouse gasses released during their energy-intensive production and pollution from nitrogen and phosphorus runoff. These fertilizers also contribute to air and water quality degradation, causing problems such as ozone depletion and algal blooms, disproportionately affecting vulnerable communities. Limoneira Company, a 130-year-old citrus grower in Santa Paula, CA, wishes to reduce the environmental impact of their lemon production, and is investigating the potential of cyanobacteria as a soil additive. Our project looks at areas of high environmental and health impact potential across the production and transportation phases of the synthetic fertilizer and cyanobacteria used in Limoneira's lemon groves. In addition, we assess if benefits from a reduction of synthetic fertilizer use with the application of cyanobacteria outweigh the added impacts from cyanobacteria use. These results, paired with an understanding of the demographic and health concerns of the local population, can help inform operational decisions to reduce environmental impact.

BACKGROUND AND CONTEXT

Limoneira manages 10,600 acres of citrus and avocado trees in Ventura County. 13.2% of the Ventura County population works in agriculture, and approximately 44.5% of the county's population, including 81.7% in Santa Paula, identify as Hispanic/Latino. Agricultural workers and local communities disproportionately suffer from agricultural practices, enduring compromised air and water quality, heightened exposure to pollutants, and increased health risks. Furthermore, the census tracts surrounding Limoneira's lemon orchards display a broad range of scores from the 30th to the 100th percentiles for overall pollution burden and population vulnerability in California.



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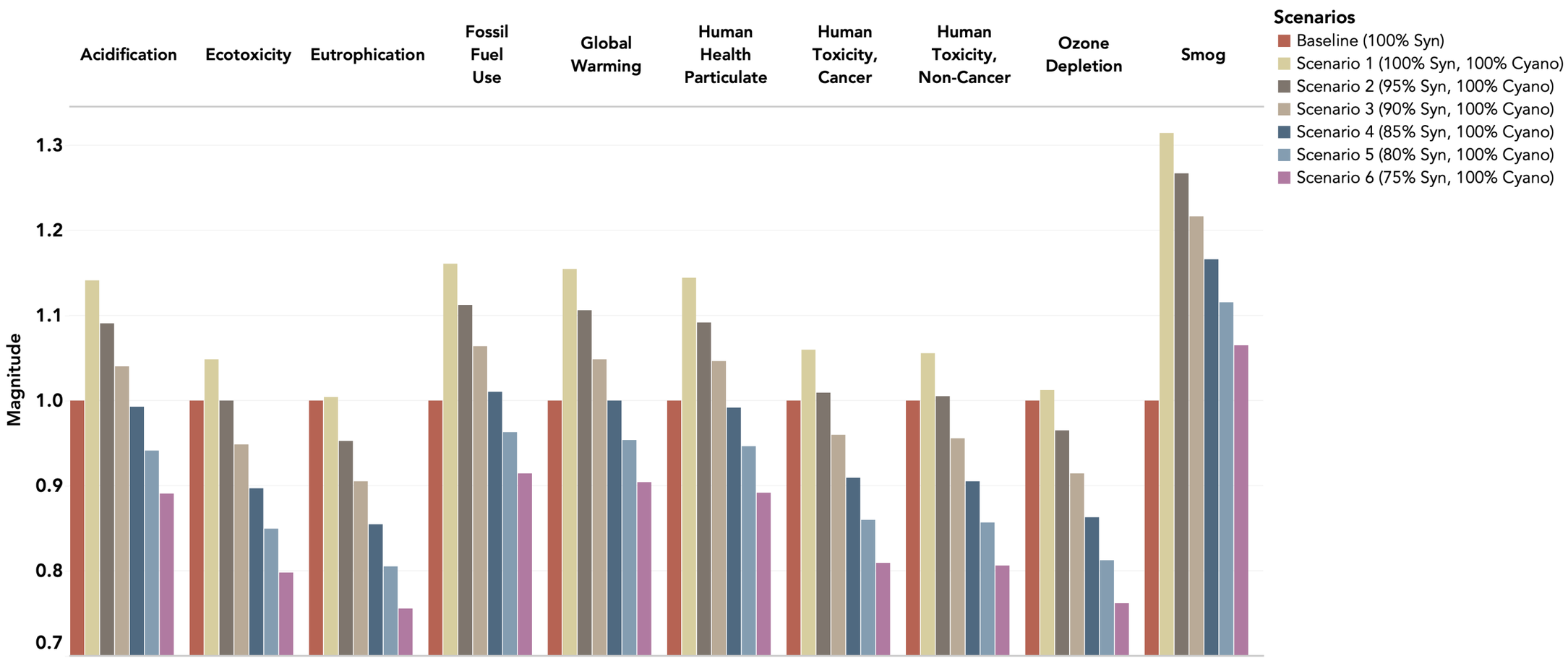
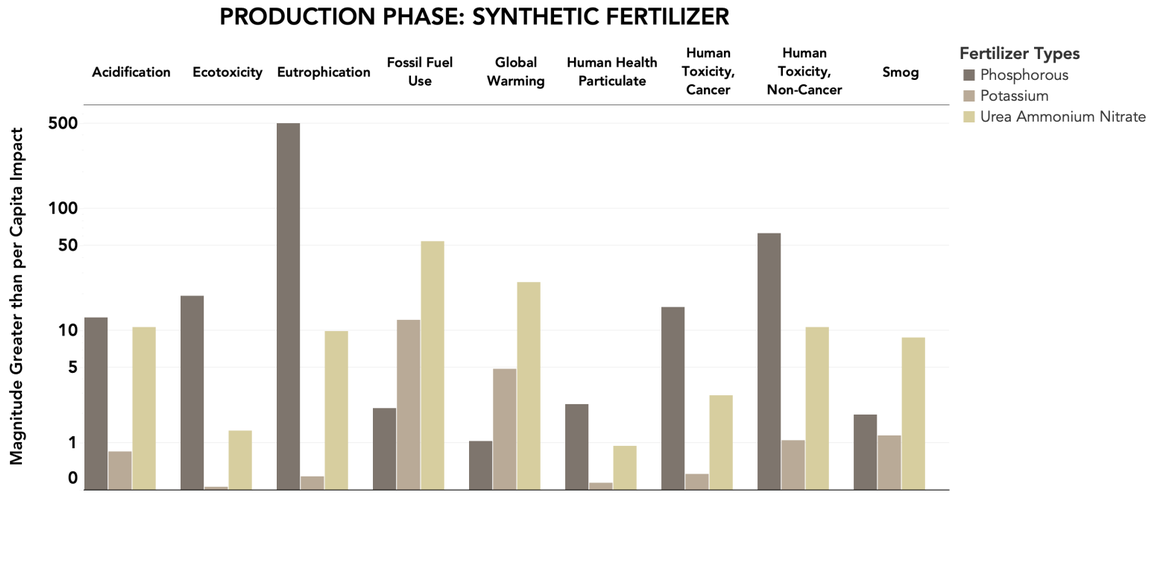
RESULTS AND FINDINGS

LIFE CYCLE ASSESSMENT: SCENARIO ANALYSES



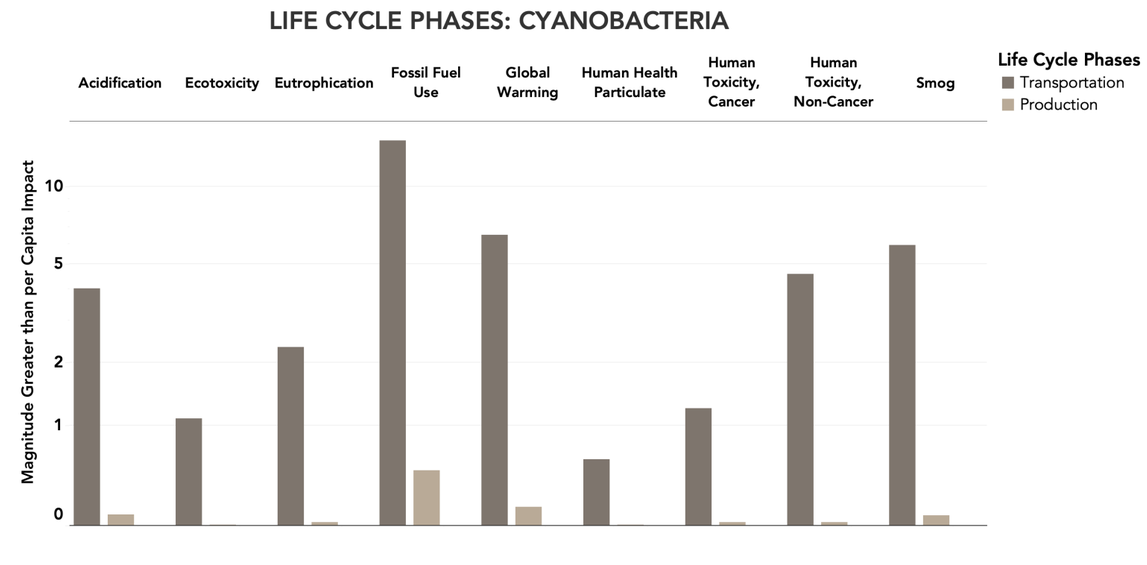
The study modeled six scenarios to compare the impact of reducing synthetic fertilizer use and applying cyanobacteria against a baseline scenario of the current application quantities used at Limoneira. The model indicates that greater environmental impacts occur when producing and applying cyanobacteria alongside the use of synthetic fertilizer at current rates, even with up to a 15% reduction in synthetic fertilizer rates. It is advised to proceed with caution regarding the continued use of cyanobacteria with the current rates of synthetic fertilizer application. If planning to continue the use of cyanobacteria, it is highly recommended to aim for more ambitious synthetic fertilizer reduction targets, exceeding a 20%, to effectively lower impacts from the baseline.

PRODUCTION PHASE: SYNTHETIC FERTILIZER



Potential impacts from synthetic fertilizer production outweighed the impacts from transportation, so the production phase was further explored by comparing the contributions of each fertilizer type. Results were normalized to one Californian's yearly potential impact. Given the limited control over synthetic fertilizer production processes, strategies for impact reduction include a combination of substitution and reduction in use of synthetic fertilizers.

LIFE CYCLE PHASES: CYANOBACTERIA



Transportation for cyanobacteria stands out as a substantial contribution to overall potential environmental impact. Specifically, on-farm transportation is an area where Limoneira has the opportunity to improve performance, potentially through the use of more efficient trucks or the reduction in the number of injection sites.

ENVIRONMENTAL IMPACT

Understanding local community conditions and environmental stressors can empower Limoneira to continue to assess the potential impact of their choices and formulate strategies to mitigate these concerns.

These results can help inform operational decisions for the implementation of cyanobacteria biofertilizer, and highlight knowledge gaps that require further empirical research.

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