



Potential Environmental Impacts of Lithium Mining

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Outline

- Background
- Lithium Mining Process
 - Brine
 - Mining
- Lithium Mining Impact
 - Water Cost
 - Pollution
 - Land Degradation
 - Environmental Impact
 - Human Health Impact
- Alternative Technologies
- Conclusion
- Questions?
- References

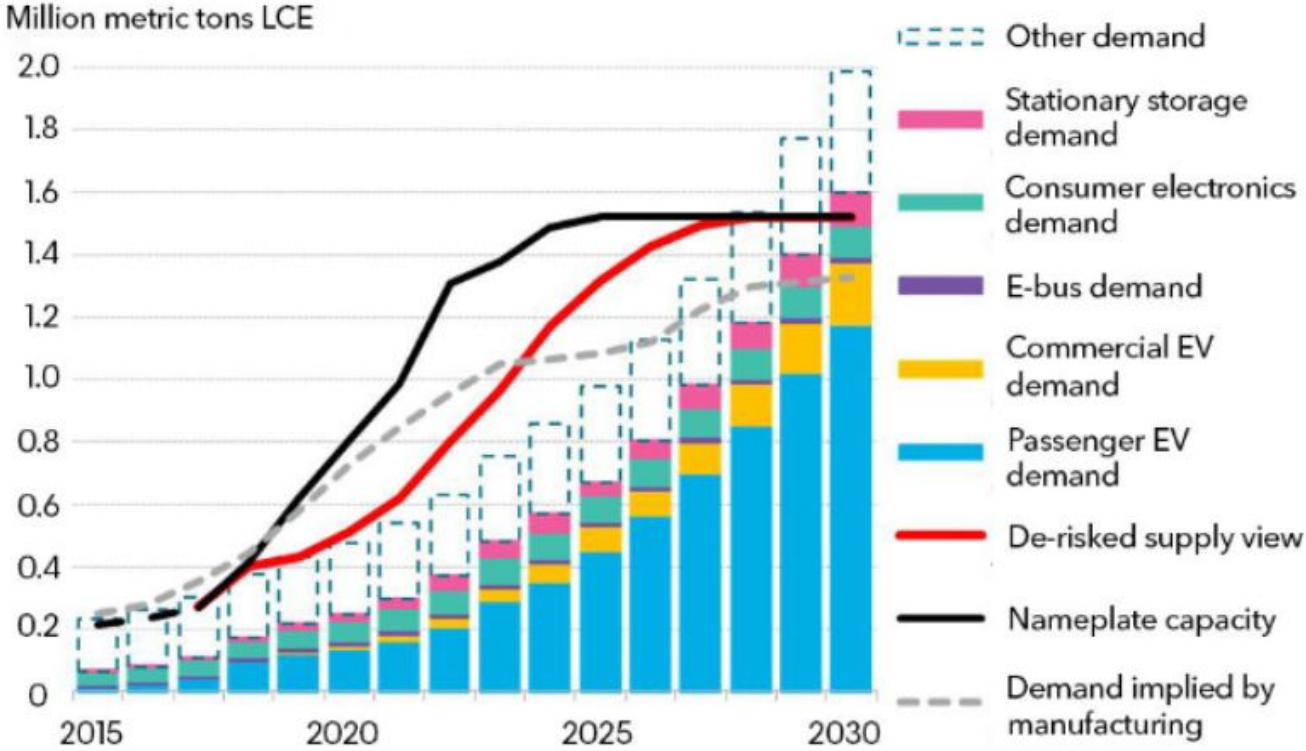
Background

- Lithium is an essential component in lithium-ion batteries .
- 70% of the world's lithium comes from the “lithium triangle” (Argentina, Bolivia and Chile) [1].
- Demand for lithium-ion batteries is projected to grow by more than 500% between 2020 and 2030 to reach 2.2 million metric tons [1].



Lithium Enriched Clay [2]

Projected Lithium Demand [3]



Lithium Extraction

- **Two Main Types of Extraction:**
 - 1. When Lithium is a liquid
 - **Evaporation pools (this slide)**
 - 2. When lithium is a solid
 - Mining (next slide)

- **Brine extraction process:**
 - 1. Pump water underground
 - 2. Brine mixture surfaces in pools
 - 3. Evaporate the water
 - 4. Purify the lithium
 - 5. Extract the lithium



Lithium Evaporation Pools in Chile [4]



Lithium Extraction Continued

- **Two Main Types of Extraction:**
 - 1. When Lithium is a liquid
 - Evaporation pools (last slide)
 - 2. When lithium is a solid
 - **Mining (this slide)**

- **Lithium Mining Process:**
 - 1. Excavation
 - 2. Transport to processing plant
 - 3. Crush and heat
 - 4. Mill into powder
 - 5. Mix with acid & heat again
 - 6. Remove waste
 - 7. Extract the lithium

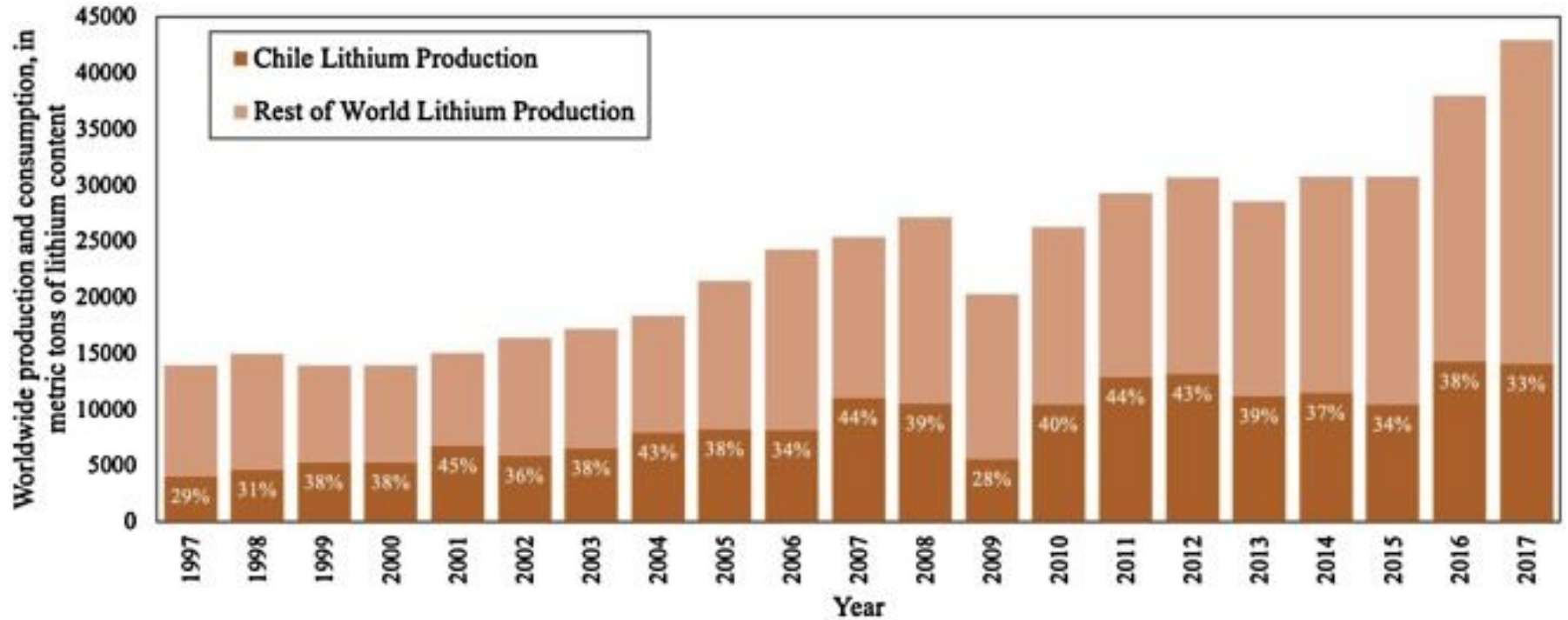
Water Cost

- 500,000 gallons of water per ton of lithium. [1]
- Chile produces 38% of the world's lithium [1]
- Chile is in a ongoing water crisis with 19 million citizens living in areas of “severe water scarcity” [6]



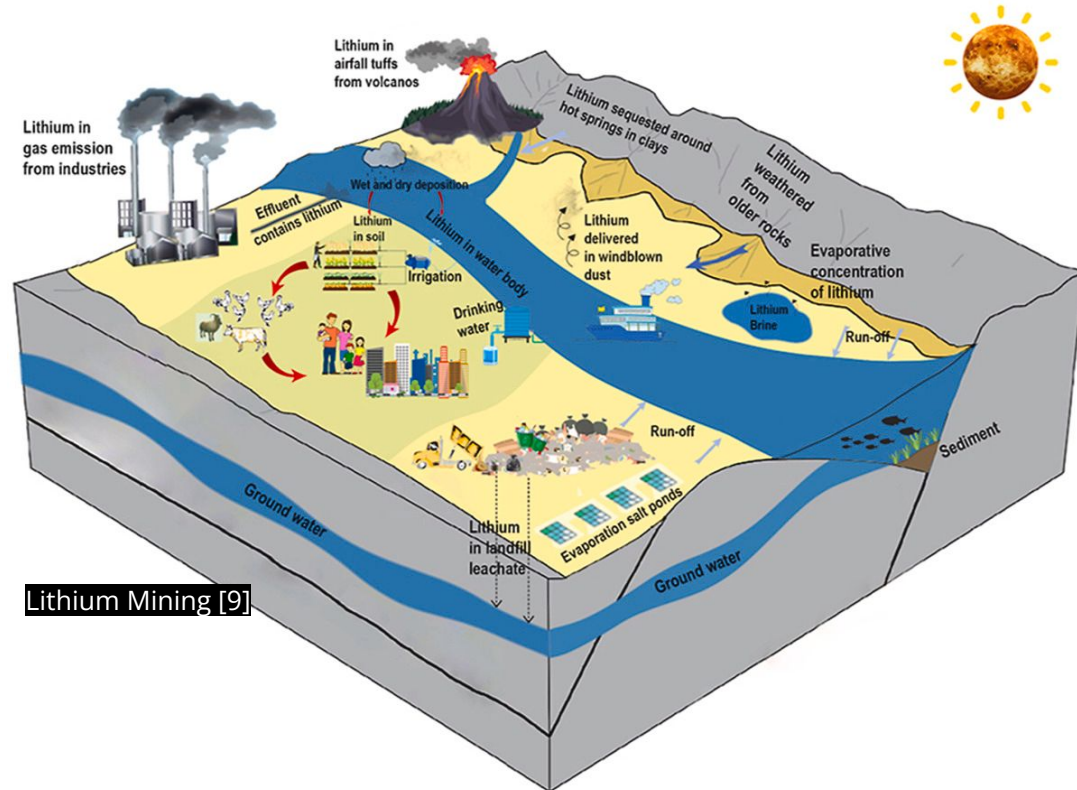
Melon River in Chile is dry [7]

Worldwide vs Chile Lithium Production Between 1997 and 2017 [8]



Lithium Pollution

- **Using brine pools:**
 - Potential PVC failure
 - Contamination of local water
 - **Water usage (500,000 gallons per ton of lithium extracted)**
 - Flora and fauna disease
- **Mining the lithium:**
 - Contamination of local water
 - Flora and fauna disease
 - Waste disposal
 - Noise and light pollution
- **Mining lithium is more expensive and demanding than evaporating it**



Land Degradation

- **Direct Effects: [10]**
 - Radioactive materials unearthed
 - Soil erosion
 - Habitat destruction
- **Indirect Effects: [10]**
 - Vegetation loss
 - Deforestation
 - Machine exhaust pollution
 - Sinkholes



Lithium Open Pit [11]

Environmental Impact

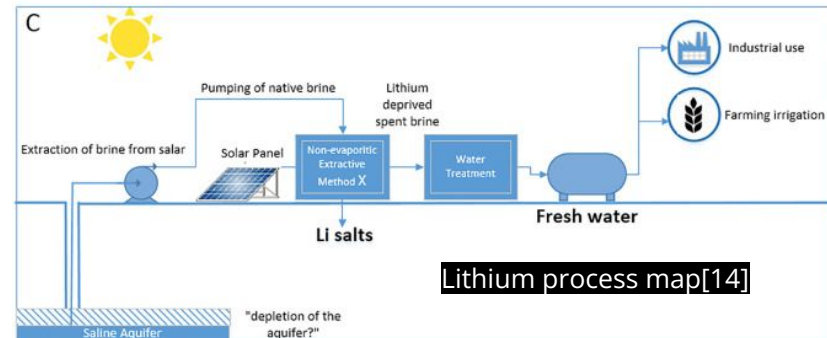
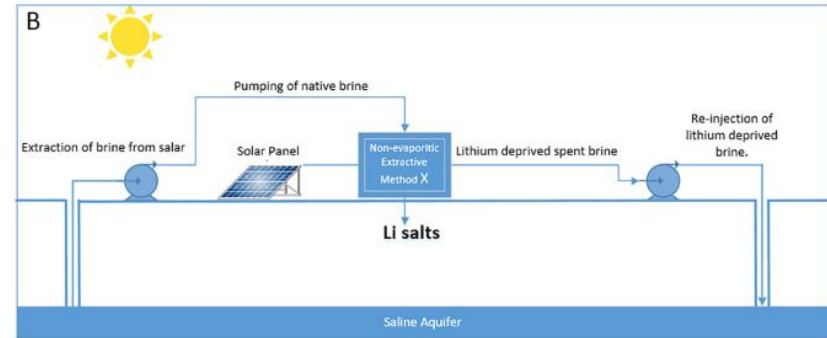
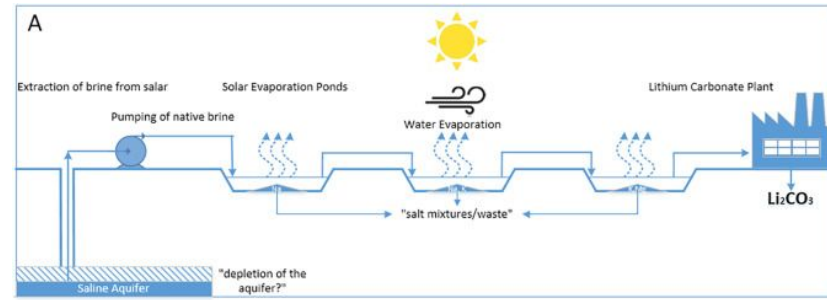
- **Water Effects [10]:**
 - High water consumption
 - Pollution (Acidic and metallic water)
- **Air Effects [10]:**
 - Open pits mining generates large amounts of dust
 - Vegetation destruction
 - Radiation pollution
 - Acid fumes
- **Species Extinction [10]:**
 - Ecosystem effects
 - 40% of species eliminated

Human Health Impact

- Respiratory Diseases [12]:
 - CWP (Black Lung)
 - Silicosis
 - Commonly found in miners but can affect surrounding area as well
- Lithium poisoning (lithium leakage) [13]:
 - Health risks of water with lithium
 - Effects on the human body
 - Effects on aquatic life
 - Increase in concentrations of lithium
- Environmental Degradation [10]:
 - Destruction of an entire area of land
 - Pollution of water with 'tailings'
 - Heavy erosion and floods

Alternative Technologies [1]

1. Increase concentration of lithium using additives
2. Using materials which can selectively absorb lithium
3. Treat the brine in selectively capture absorbent bed
4. Selectively capturing lithium ions using electrolysis
5. Using chromatography to separate lithium brine
6. Condense lithium chloride into brine



Lithium process map[14]

Conclusion

- Lithium is used in rechargeable batteries and EVs.
- Extracting lithium creates tons of pollution
- Electric is not a green alternative to gas yet
- Alternative/improving techniques for extracting lithium should be explored.



References

1. R. B. Kanuda, "Potential environmental impacts of lithium mining," *Taylor & Francis*, 07-Apr-2020. [Online]. Available: <https://www.tandfonline.com/doi/abs/10.1080/02646811.2020.1754596?journalCode=nrnl20>. [Accessed: 03-Mar-2023].
2. C. Cole, "Nevada lithium mine wins ruling; Green Energy Fights Rage on," *NBCNews.com*, 08-Feb-2023. [Online]. Available: <https://www.nbcnews.com/science/environment/nevada-lithium-mine-wins-ruling-green-energy-fights-rage-rcna69679>. [Accessed: 03-Mar-2023].
3. S. Lu, "Will the real lithium demand please stand up? challenging the 1MT-by-2025 orthodoxy," *BloombergNEF*, 28-Oct-2019. [Online]. Available: <https://about.bnef.com/blog/will-the-real-lithium-demand-please-stand-up-challenging-the-1mt-by-2025-orthodoxy/>. [Accessed: 03-Mar-2023].
4. V. Beiser, "Clean Power at a steep price," *Sierra Club*, 13-Dec-2022. [Online]. Available: <https://www.sierraclub.org/sierra/4-november-december/feature/lithium-mining-electric-vehicles-clean-power-steep-price>. [Accessed: 03-Mar-2023].
5. A. Katwala, "The devastating environmental impact of Technological Progress," *WIRED UK*, 27-Oct-2019. [Online]. Available: <https://www.wired.co.uk/article/lithium-copper-mining-atacama-desert>. [Accessed: 03-Mar-2023].
6. M. Igin, "Chile water crisis: Causes, effects, and solutions," *Earth.Org*, 12-Jan-2023. [Online]. Available: <https://earth.org/chile-water-crisis/#:~:text=Water%20availability%20in%20Chile%20has,to%20be%20halved%20by%202060>. [Accessed: 03-Mar-2023].
7. G. Fleitas, "Chile drought causing water shortage amidst virus crisis," *Phys.org*, 05-Apr-2020. [Online]. Available: <https://phys.org/news/2020-04-chile-drought-shortage-virus-crisis.html>. [Accessed: 03-Mar-2023].
8. W. Liu, D. B. Agusdinata, and S. W. Myint, "Spatiotemporal patterns of lithium mining and environmental degradation in the Atacama salt flat, Chile," *International Journal of Applied Earth Observation and Geoinformation*, 29-Apr-2019. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S0303243419300996?via=ihub>. [Accessed: 03-Mar-2023].
9. N. Bolan, "From mine to mind and mobiles – lithium contamination and its risk management," *Environmental Pollution*, 31-Aug-2021. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S0269749121016493>. [Accessed: 03-Mar-2023].
10. R. Coffey, "What is open-pit mining? definition, examples, environmental impact," *Treehugger*, 26-Jul-2022. [Online]. Available: <https://www.treehugger.com/what-is-open-pit-mining-definition-and-environmental-impact-5219892>. [Accessed: 03-Mar-2023].
11. AVZ Minerals, "Manono lithium-tin project," *Mining Technology*, 09-Mar-2021. [Online]. Available: <https://www.mining-technology.com/projects/manono-lithium-tin-project/>. [Accessed: 03-Mar-2023].
12. CDC, "CDC - Mining Topic - Respiratory Diseases - NIOSH," Centers for Disease Control and Prevention, Aug. 11, 2022. <https://www.cdc.gov/niosh/mining/topics/respiratorydiseases.html#:~:text=Symptoms%20include%20irritation%20of%20the> (accessed Mar. 05, 2023).
13. J. Shen *et al.*, "The toxicity of lithium to human cardiomyocytes," *Environmental Sciences Europe*, vol. 32, no. 1, Apr. 2020, doi: <https://doi.org/10.1186/s12302-020-00333-6>.
14. V. Flexer, C. F. Baspineiro, and C. I. Galli, "Lithium recovery from brines: A vital raw material for green energies with a potential environmental impact in its mining and processing," *Science of The Total Environment*, vol. 639, pp. 1188–1204, 2018.
15. M. Burton, A. Hunter, and Y. Y. Li, "The lithium market is hotter than ever and traders are moving in," *Bloomberg.com*, 29-Oct-2022. [Online]. Available: <https://www.bloomberg.com/news/articles/2022-10-29/the-lithium-market-is-hotter-than-ever-and-traders-are-moving-in>. [Accessed: 05-Mar-2023].

Questions?