Evaluation of the Environmental Impact of Different Clothing Materials

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Motivation

- Global demand for textiles products is steadily increasing with population growth [3]
- 63% of textiles → Derived from petrochemicals (includes polyester) [3]
- 24% of textiles → Produced from cotton [3]
- Findings could help support UN Sustainable Development Goal 12
  - Responsible Production and Consumption

Methodology

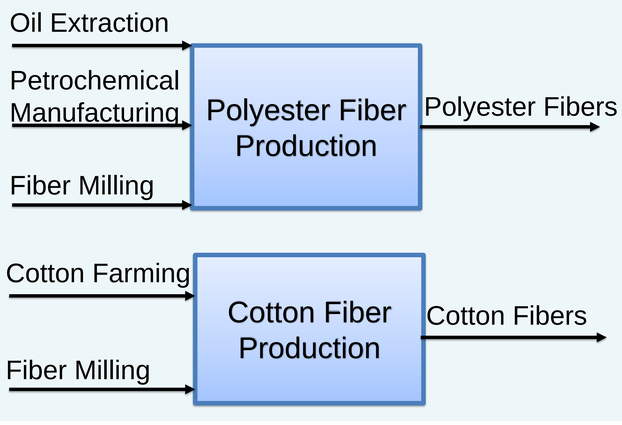
- Determine costs of inputs for polyester and cotton fiber production
- Conduct EIO for polyester and cotton fiber production using Carnegie's EIO-LCA tool [1]
- From research, determine end-of-life impacts
- Use fiber production & end-of-life results to find which textile has a lower environmental impact

Research Objective

Conduct a hybrid Economic Input-Output Life Cycle Assessment (EIO-LCA) to evaluate the energy requirements, greenhouse gas emissions, water demands and other environmental indicators of synthetic textiles (polyester) and natural textiles (cotton) to determine which textile has less of an environmental impact

EIO System Boundaries

The main differences in synthetic and natural fiber production were determined to be during the fiber production stage [2]. The inputs for each fiber are shown.



EIO Data

Input Costs

- Each input cost was estimated from commodity prices, farm production costs and average market values
- Input sector was identified in Carnegie's online EIO-LCA tool [1]
- Scaled up to 1 million kg of fiber

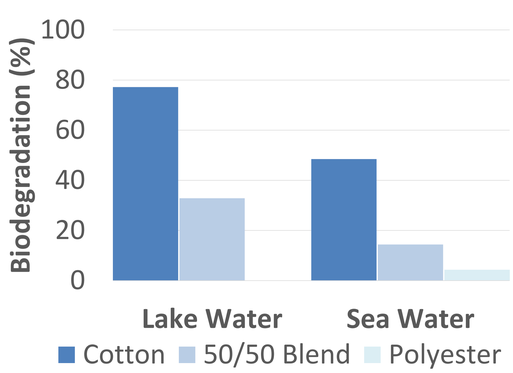
Output Data

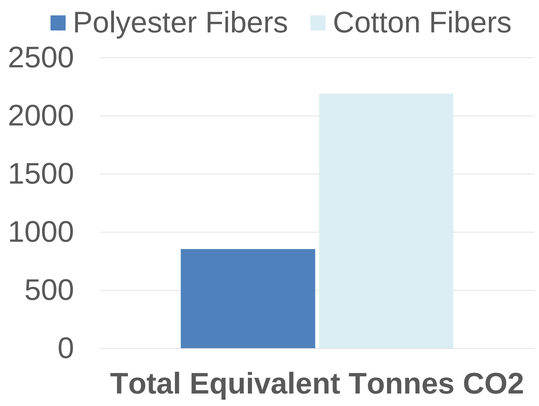
- The emission, energy and water data for each input were summed to find the respective fiber production output

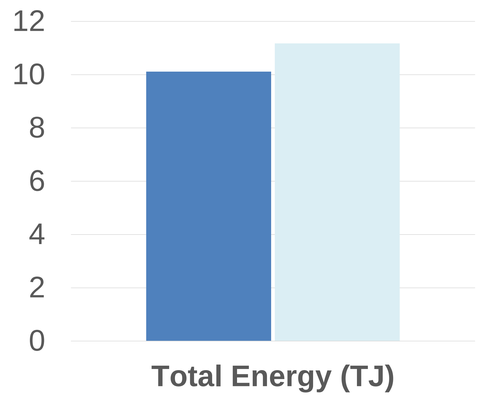
	Cost per kg	Sector
Polyester Fibers	**$1.14**	-
Oil Extraction	$0.20	211000
Petrochemical Manufact.	$0.51	325110
Polyester Fiber Milling	$0.43	325222
Cotton Fibers	**$1.19**	-
Cotton Farming	$0.76	111920
Cotton Textile Milling	$0.43	314999

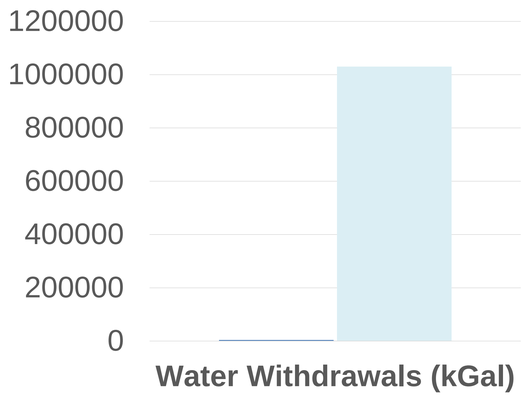
Results and Analysis

- EIO data for fiber production shows cotton releases more emissions, uses energy, and has greater water withdrawals [1]
- Research shows cotton's end-of-life releases less emissions [4]
- Cotton biodegrades in water but polyester sees minimal [5]
- Thus, polyester was determined to be more environmentally friendly, but special attention needs to be given to the end-of-life stage (recycling, disposal, etc.)









Future Work

- Focus more in depth on use and end-of-life stage
  - Recycle/reuse rate, life span, use differences, disposal patterns of textiles
- Look into impact of different animal, plant, mineral and synthetic textiles (wool, silk, rayon, nylon, etc.)

Works Cited

[1] Carnegie Mellon University. "CMU - Economic Input-Output Life Cycle Assessment – Carnegie Mellon University." *CMU - Economic Input-Output Life Cycle Assessment - Carnegie Mellon University*, 2018, www.eiolca.net/.

[2] Moazzem, Shadia, et al. "Assessing Environmental Impact of Textile Supply Chain Using Life Cycle Assessment Methodology." *The Journal of The Textile Institute*, vol. 109, no. 12, 2018, pp. 1574–1585., doi:10.1080/00405000.2018.1434113.

[3] Sandin, Gustav, and Greg M. Peters. "Environmental Impact of Textile Reuse and Recycling – A Review." *Journal of Cleaner Production*, vol. 184, 2018, pp. 353–365., doi:10.1016/j.jclepro.2018.02.266.

[4] Velden, Natascha M. Van Der, et al. "LCA Benchmarking Study on Textiles Made of Cotton, Polyester, Nylon, Acryl, or Elastane." *The International Journal of Life Cycle Assessment*, vol. 19, no. 2, 2013, pp. 331–356., doi:10.1007/s11367-013-0626-9.

[5] Zambrano, Marielis C., et al. "Aerobic Biodegradation in Freshwater and Marine Environments of Textile Microfibers Generated in Clothes Laundering: Effects of Cellulose and Polyester-Based Microfibers on the Microbiome." *Marine Pollution Bulletin*, vol. 151, 2020, p. 110826., doi:10.1016/j.marpolbul.2019.110826.