

Mine and Flow and Nothing Grow

Spatial Economics Project Pitch

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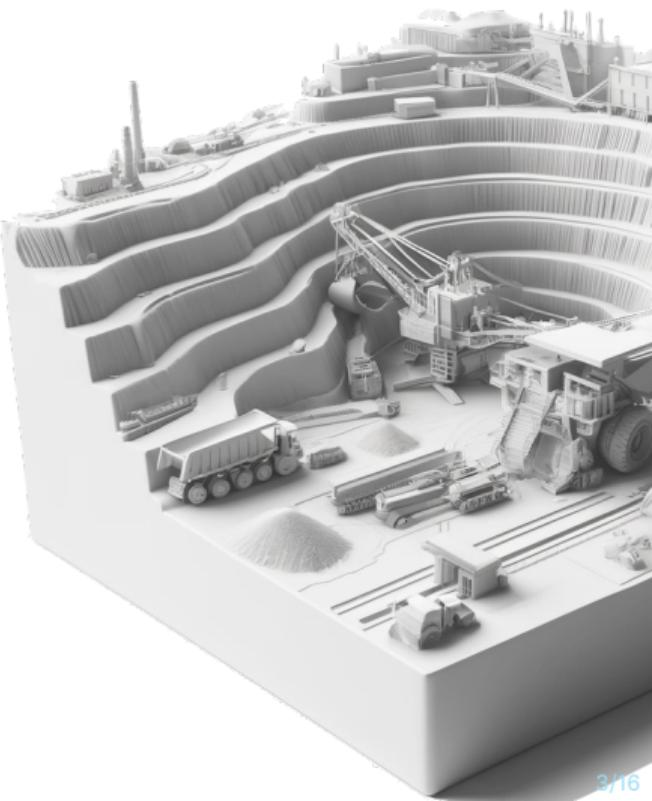
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What Do We Want to Find Out?

Data

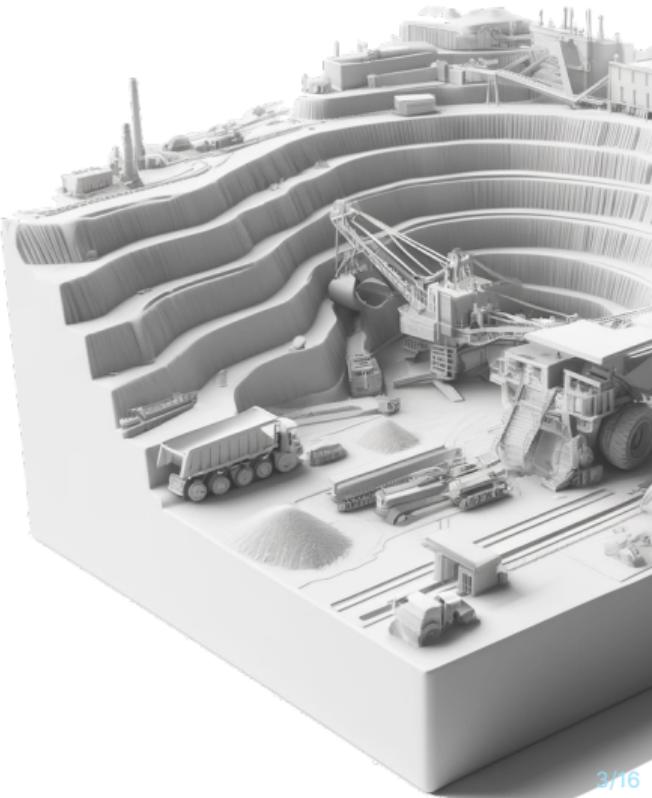
Empirical Framework

Metals Be Mine, Problems Be Thine



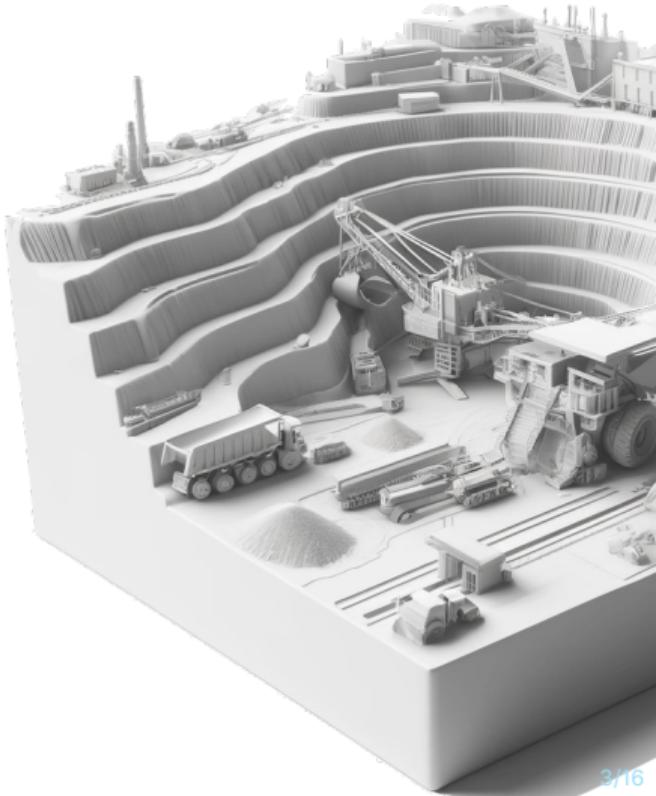
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- The African **resource extraction** industry is thriving. Mining activity yields **economic benefits**.



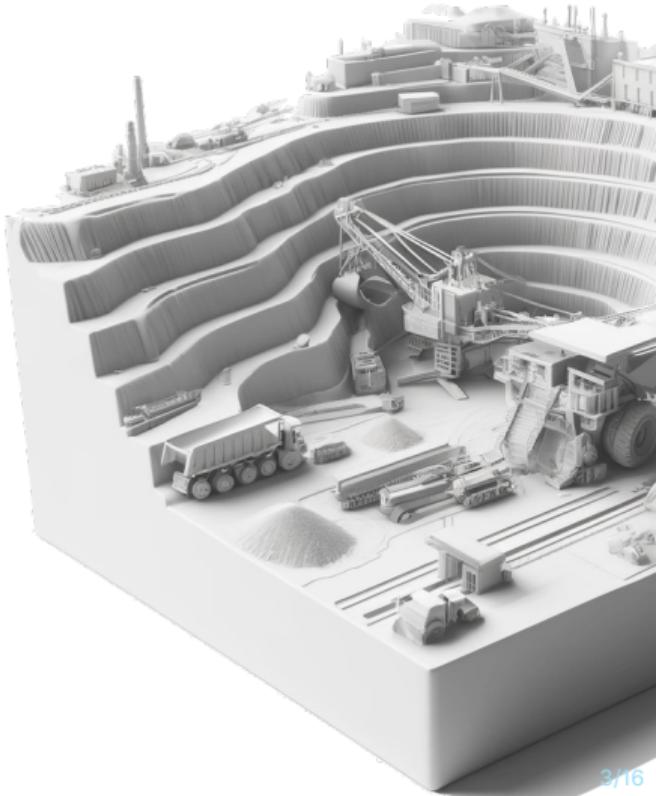
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- Mines also generate **negative externalities**, ranging from corruption (Berman et al., 2017) to air-pollution-induced declines in **agricultural productivity** (Aragón & Rud, 2015).

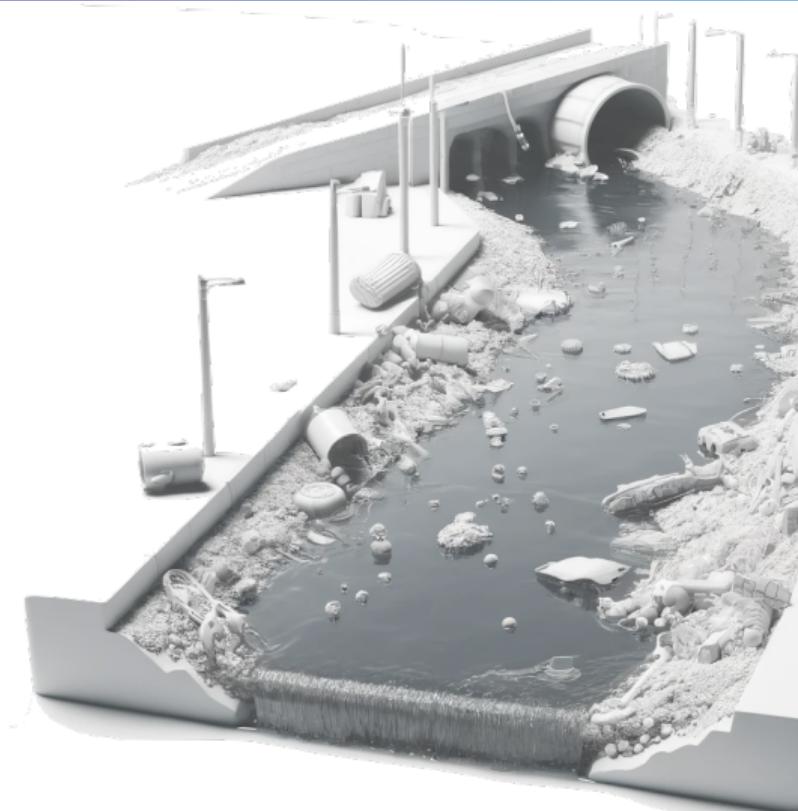


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- We want to take a look on how **water pollution** affects **crop yields**.

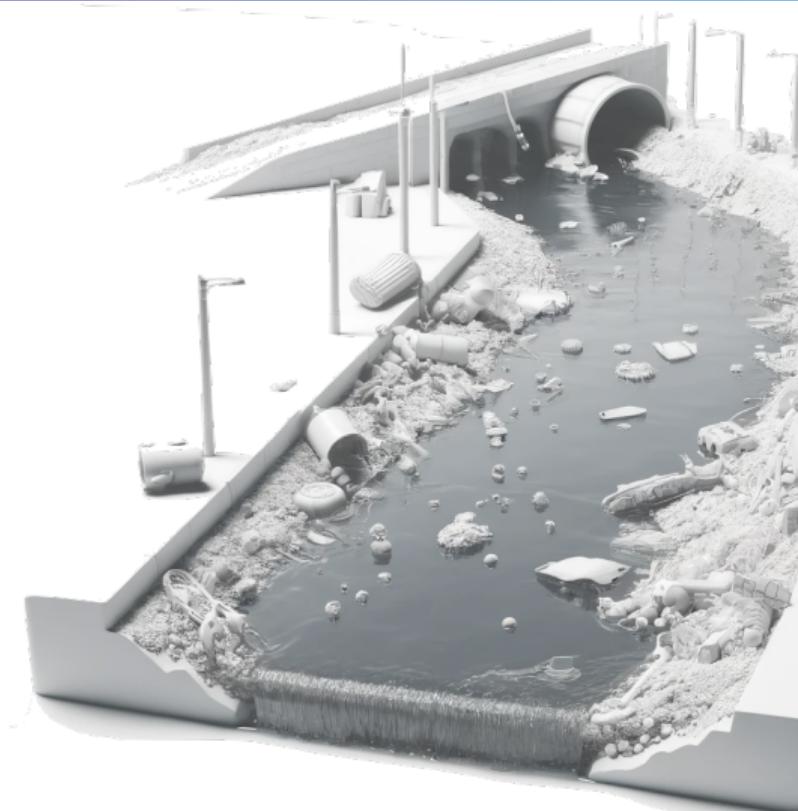


How Does Pollution Travel?



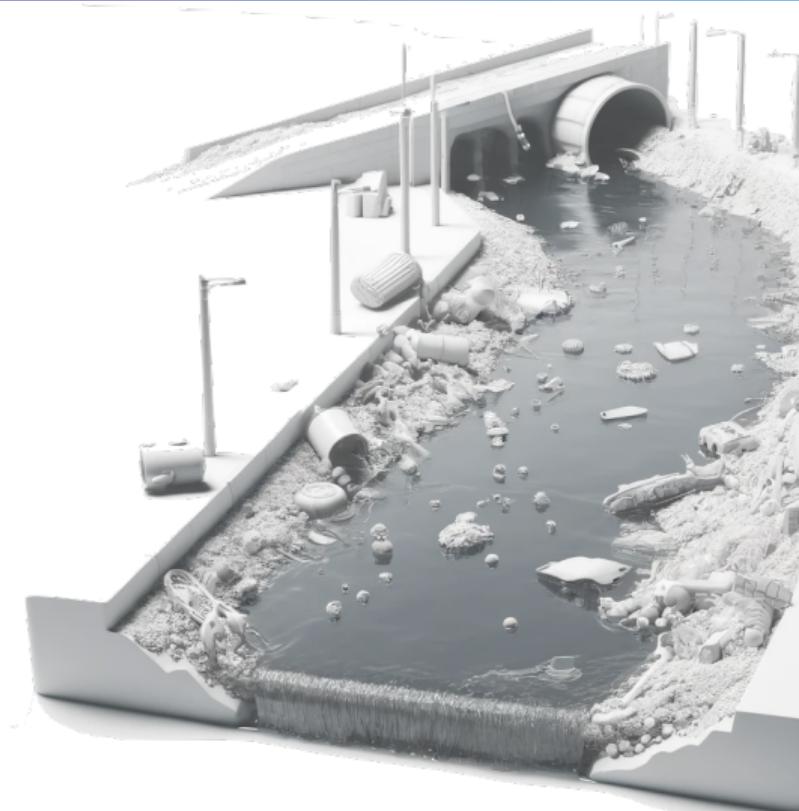
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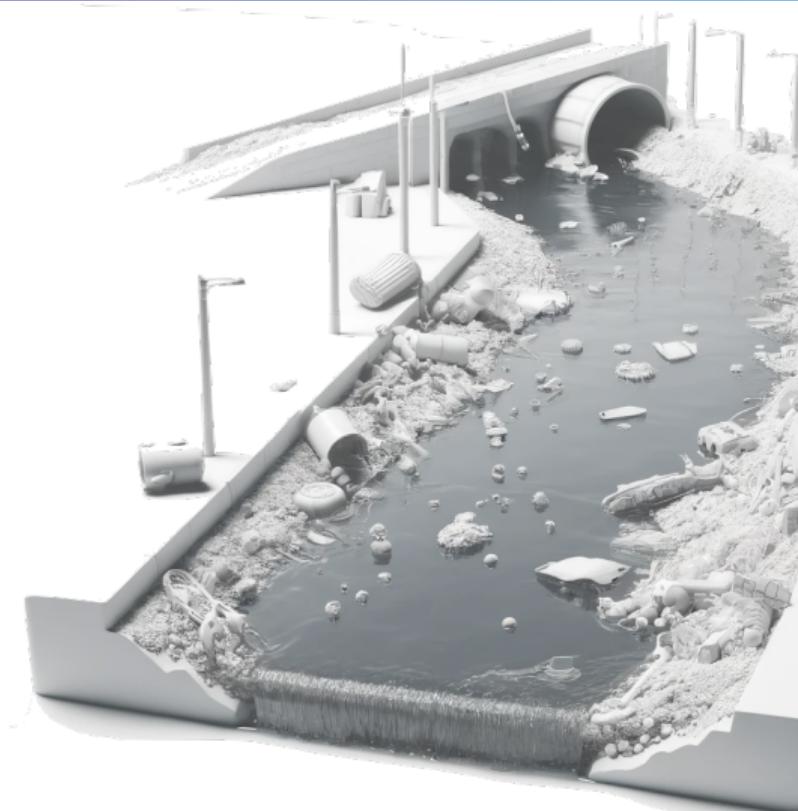
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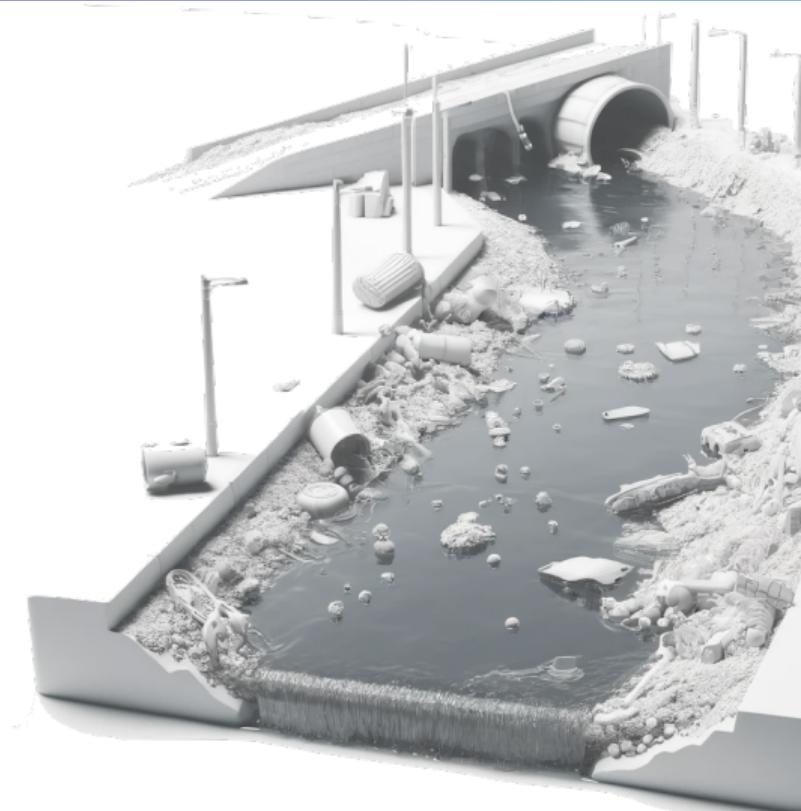
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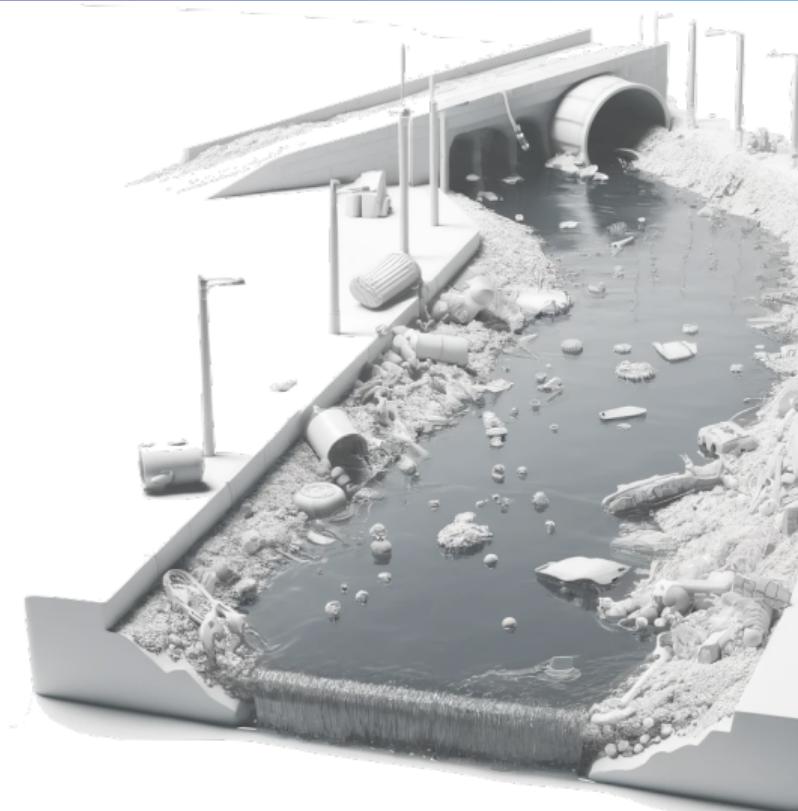
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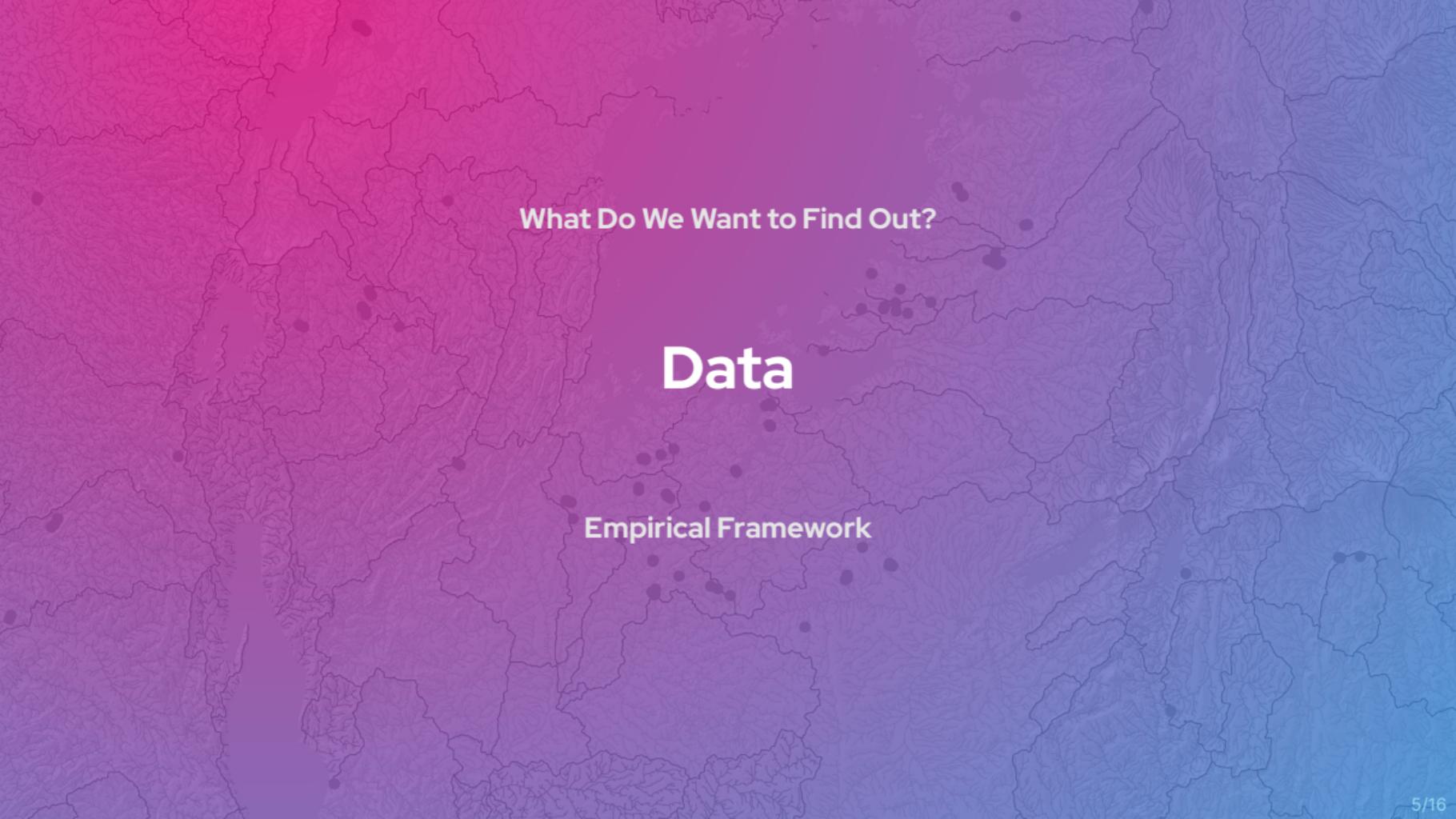
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- This gives us **treated** and **control** areas.



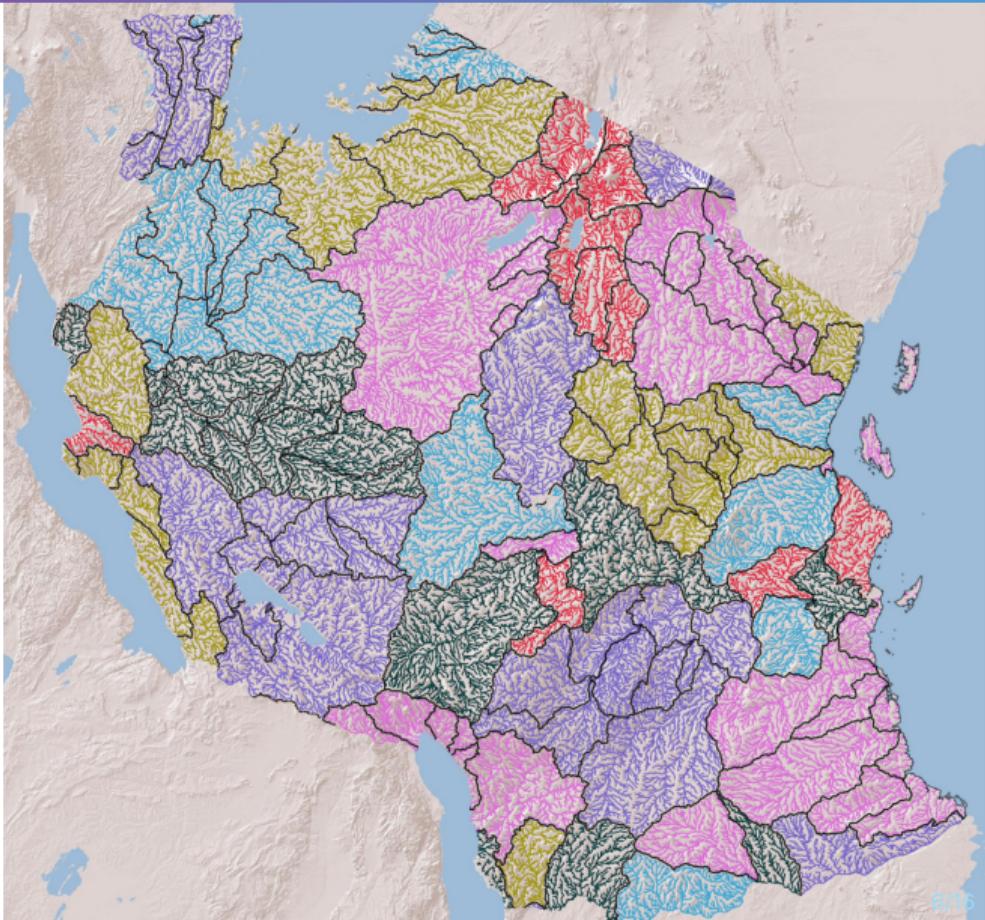


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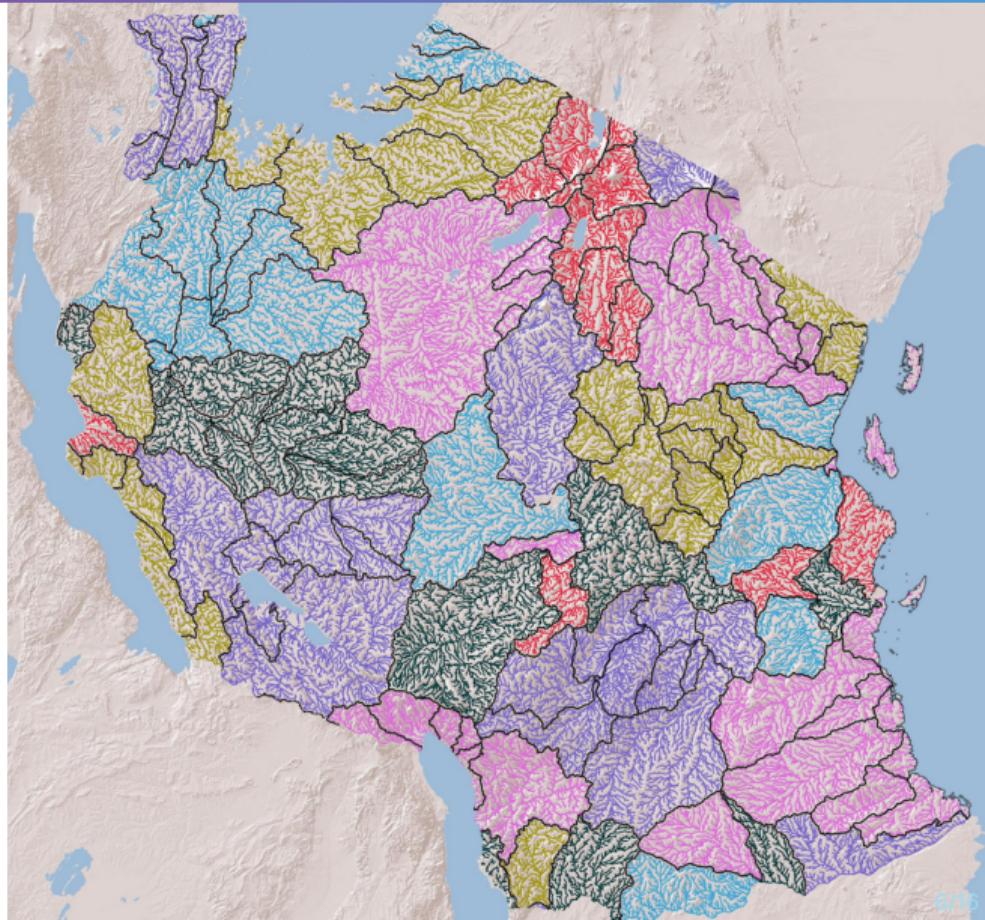
Empirical Framework

Highs, Lows, and Water Flows



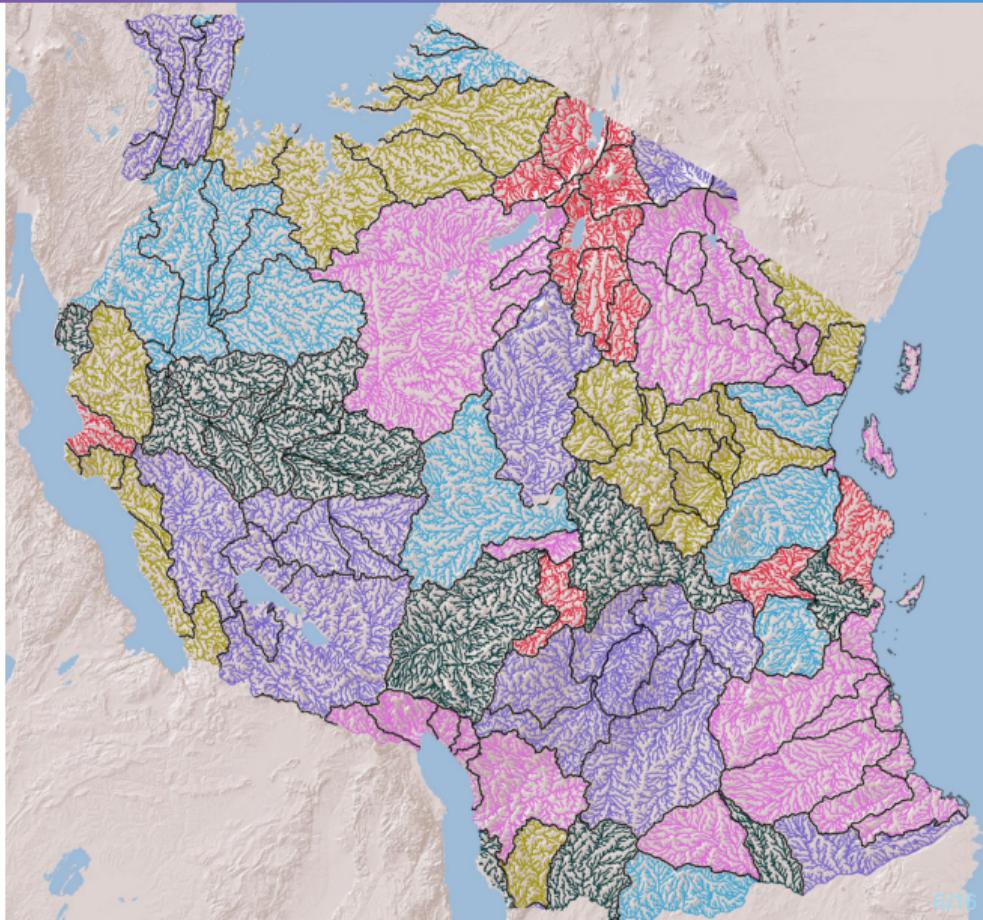
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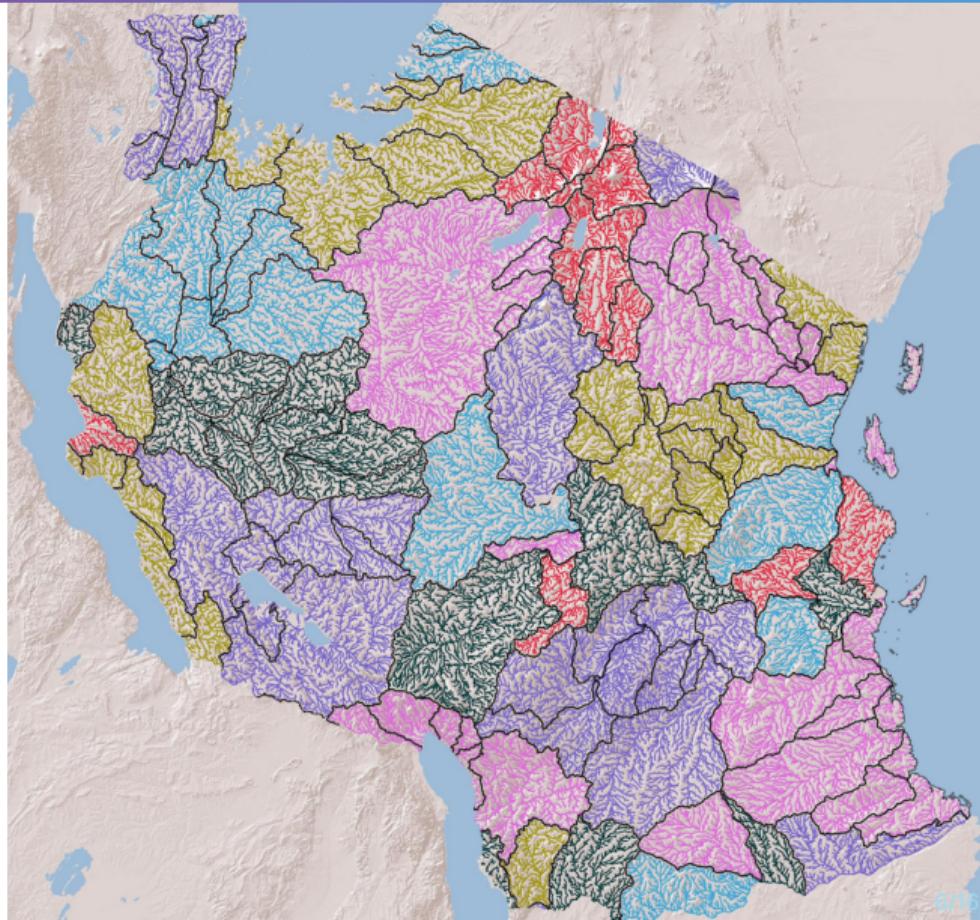
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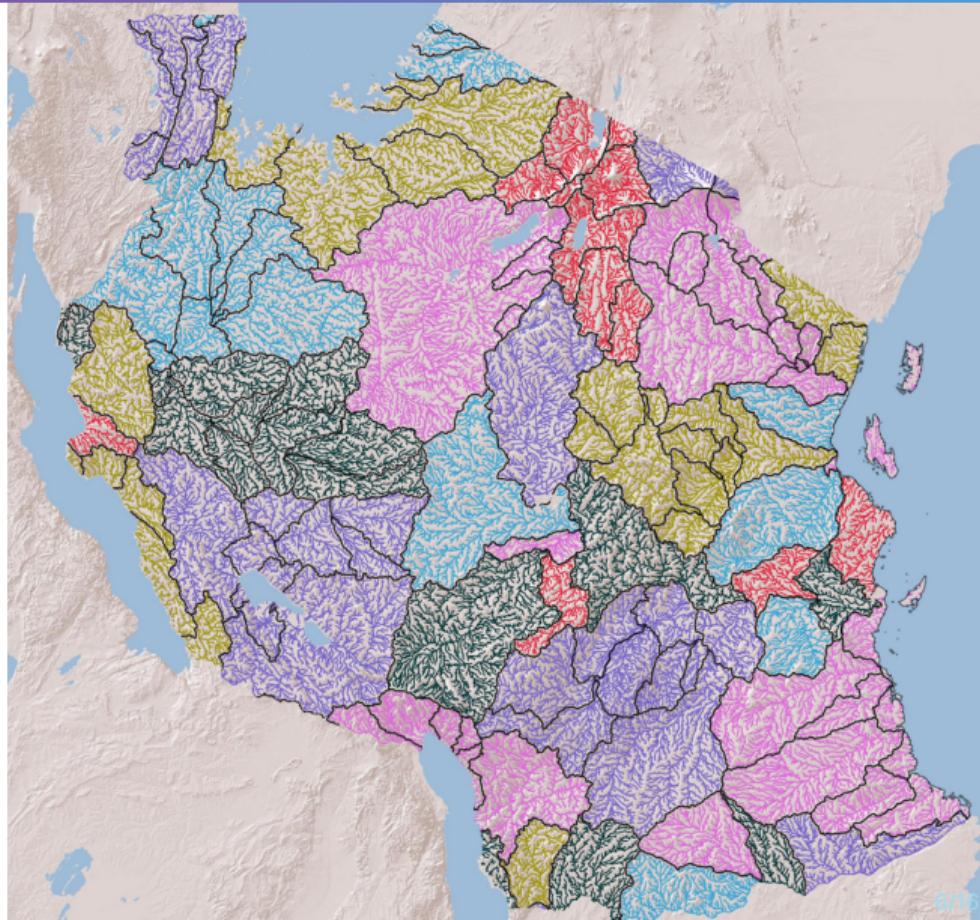
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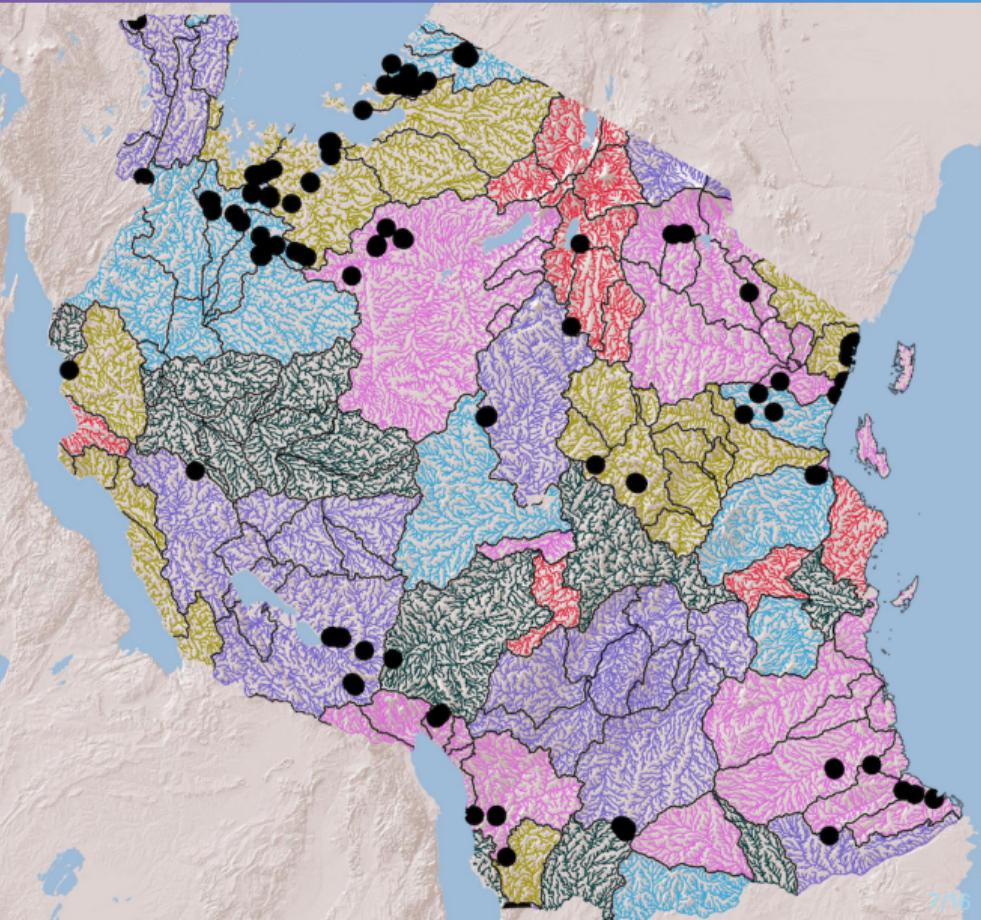


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- This map shows two different levels of **basins** along with **water flows** in them.

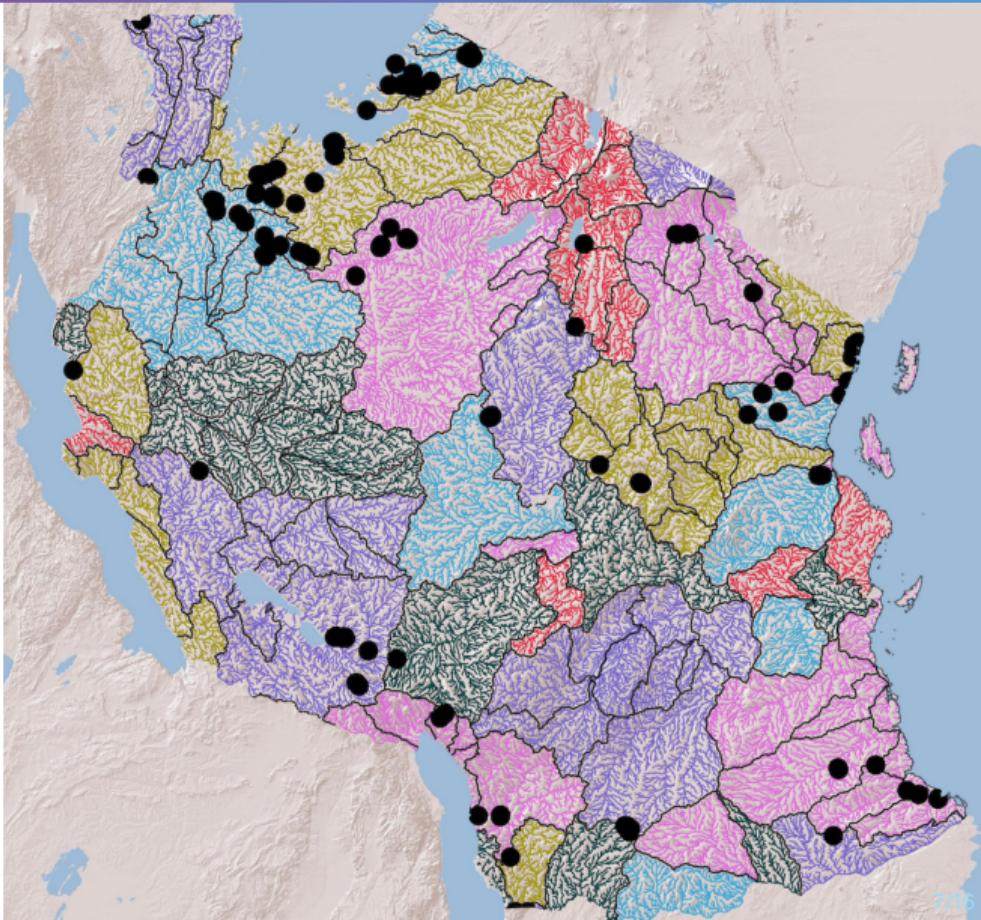


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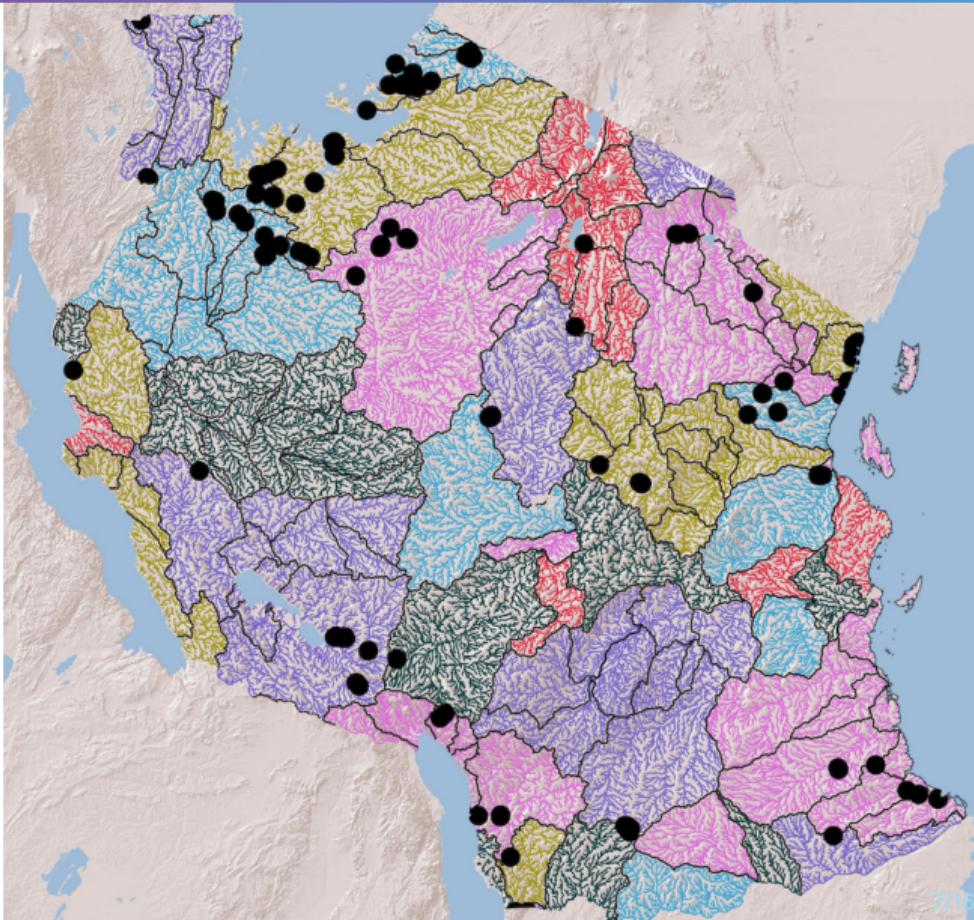
- We can now overlay **centroids of mines**, taken e.g. from Maus et al. (2022) or Kuschnig et al. (2024), over the river basin map.¹



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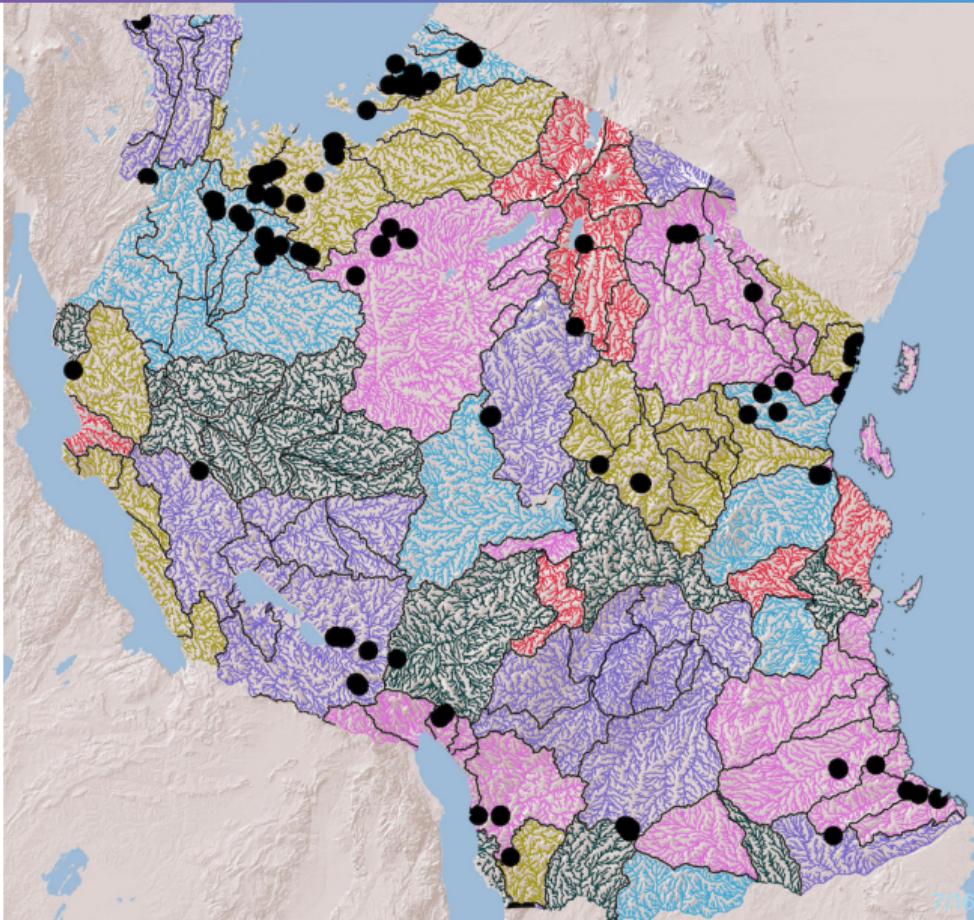
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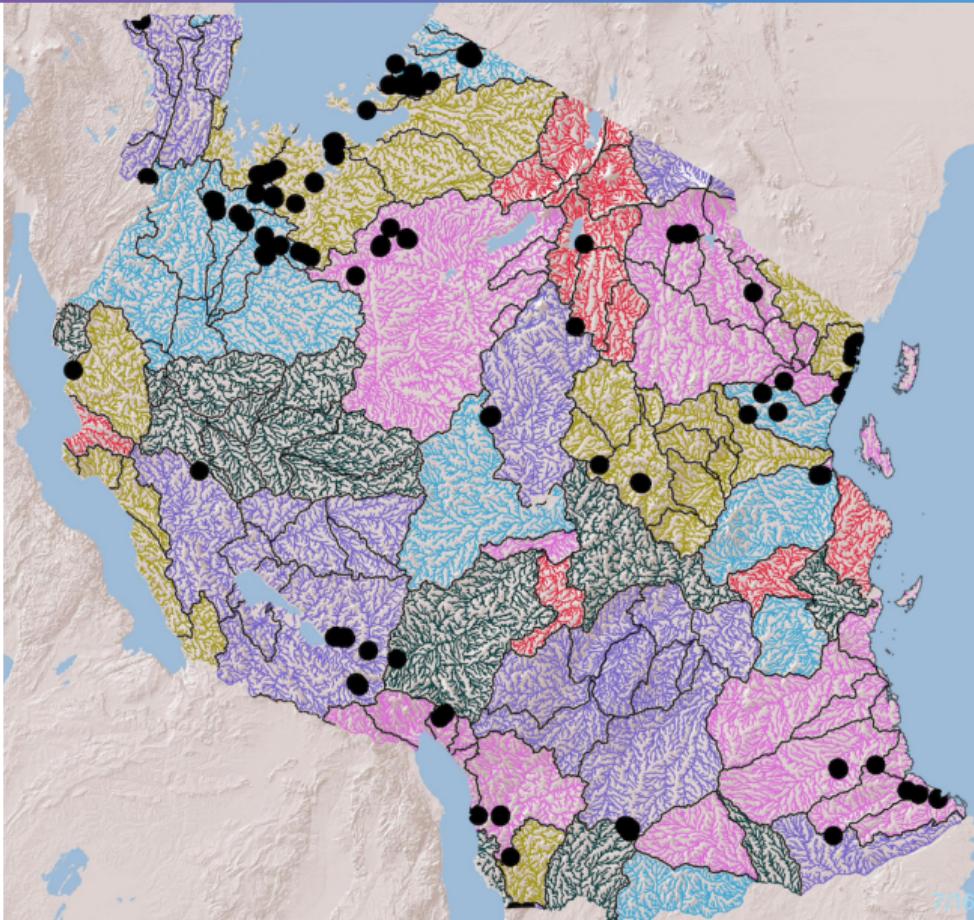
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- Basins are labeled according to a **coding system** which allows identification of **up-** and **downstream** basins.



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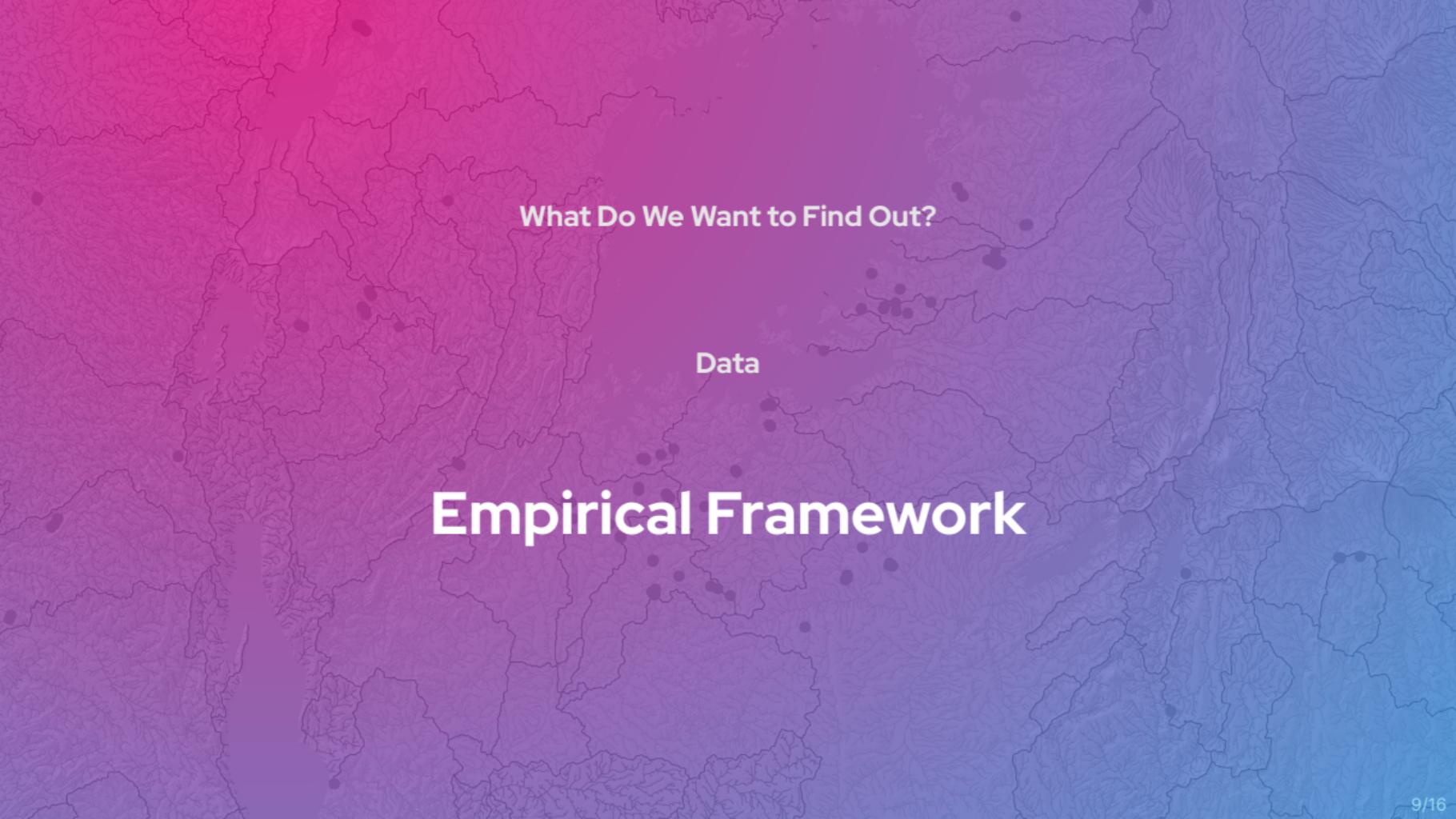


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- We aggregate the proxy for agricultural productivity at the basin level



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Empirical Framework

The Baseline Regression

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which can be interpreted as the average causal effect of treatment at the discontinuity point

$$\tau_{SRD} = E[Y_m(1) - Y_m(0) | X_i = Mine]$$

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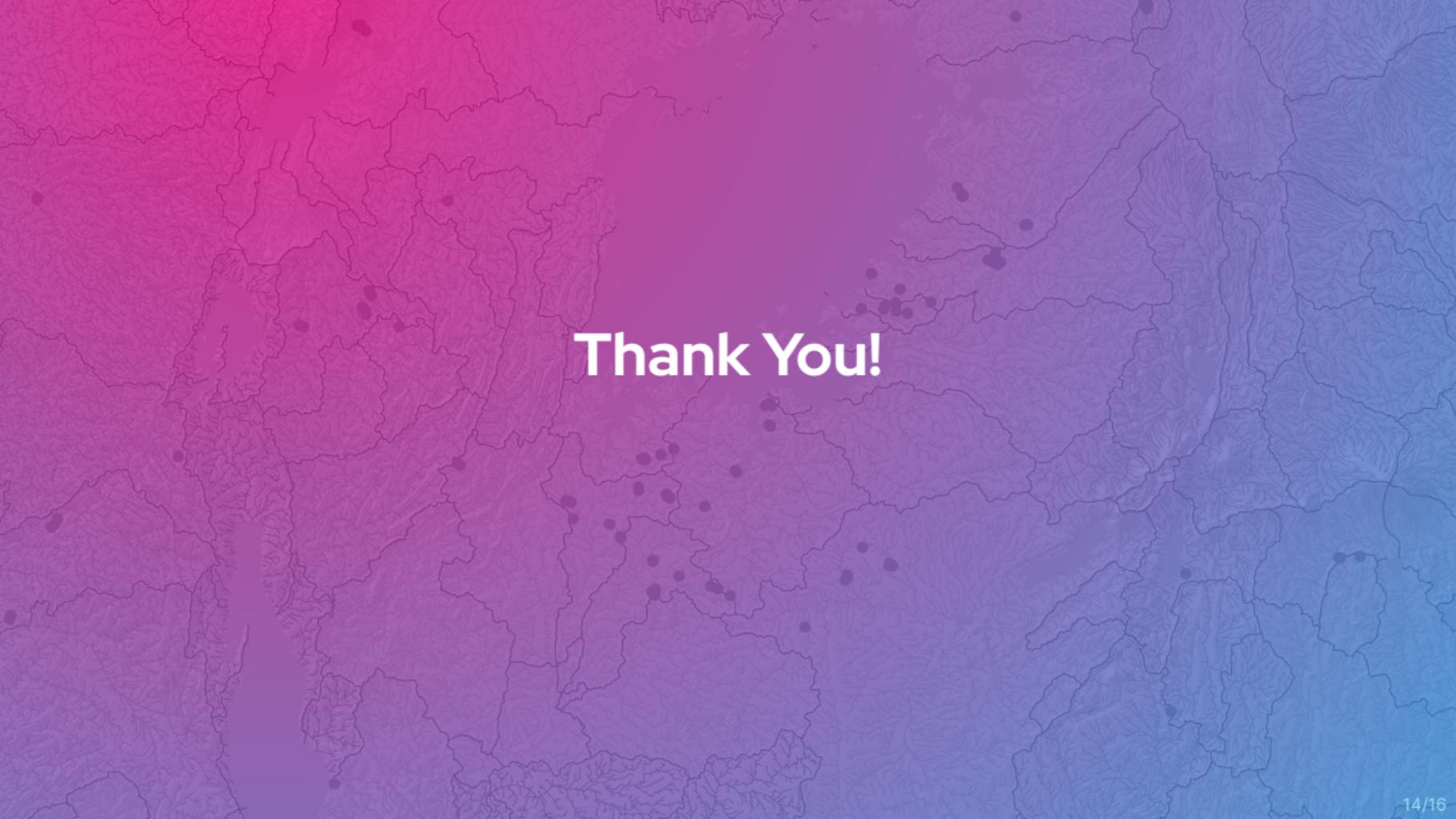
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- We could use **survey data**.



Thank You!

References I

- Aragón, F. M., & Rud, J. P. (2015). Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana. *The Economic Journal*, 126(597), 1980–2011. <https://doi.org/10.1111/ecoj.12244>
- Berman, N., Couttenier, M., Rohner, D., & Thoenig, M. (2017). This Mine is Mine! How Minerals Fuel Conflicts in Africa. *American Economic Review*, 107(6), 1564–1610. <https://doi.org/10.1257/aer.20150774>
- Cattaneo, M. D., Titiunik, R., & Vazquez-Bare, G. (2020). The Regression Discontinuity Design. In *The SAGE Handbook of Research Methods in Political Science and International Relations* (pp. 835–857). SAGE Publications Ltd. <https://doi.org/10.4135/9781526486387.n47>
- Copernicus Climate Change Service. (2020). Crop productivity and evapotranspiration indicators from 2000 to present derived from satellite observations. <https://doi.org/10.24381/CDS.B2F6F9F6>
- Dell, M. (2010). *Econometrica*, 78(6), 1863–1903. <https://doi.org/10.3982/ecta8121>
- Didan, K. (2015). MOD13Q1 MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V006. <https://doi.org/10.5067/MODIS/MOD13Q1.006>
- Kuschnig, N., Sepin, P., & Vashold, L. (2024). *Global mapping and delineation of mining areas*. [Unpublished Manuscript].
- Lehner, B., & Grill, G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. *Hydrological Processes*, 27(15), 2171–2186. <https://doi.org/10.1002/hyp.9740>

References II

- Maus, V., da Silva, D. M., Gutschhofer, J., da Rosa, R., Giljum, S., Gass, S. L. B., Luckeneder, S., Lieber, M., & McCallum, I. (2022). *Global-scale mining polygons (Version 2)* (Dataset). PANGAEA.
<https://doi.org/10.1594/PANGAEA.942325>
- Singh, A. (2022). RDD.