

## Causal Inference in Environmental and Social Science – Draft Course Outline

### Content:

In socio-ecological systems, there are many types of human interventions. Some aim for environmental protection and nature conservation. Yet only few things humans do with the environment are systematically designed, such that we can easily infer the effects of such measures. Unintended consequences may occur, and the outcomes may not be planned either. Observational data is thus often noisy. We may have multiple causes and interactions of factors at once. We can nevertheless use these messy real-world observations to learn something about the (socio-ecological) consequences of human actions in the environment.

This short course gives an overview of statistical techniques that are employed in social and environmental sciences to estimate causal effects of interventions such as targeted (environmental) policies from observations. The course starts from gold-standard techniques for controlled experiments and develops an understanding of alternative techniques for settings where experimentation is not feasible or morally justifiable. The course will consist of theoretical lectures and applied showcases in R, replicating seminal studies in lab sessions.

### Intended Learning Outcomes:

- Students understand the theoretical frameworks and can apply quantitative causal inference methods in R
- Students can analyze and evaluate the quality and robustness of causal inference approaches
- Students can create and implement own causal inference research designs

### Credit points: 3

**Requirements:** A basic knowledge of statistical data analysis and (multi-variate) regression is certainly helpful.

**Format:** 5 days with two sessions of 2 hrs each (1 lecture, 1 seminar) + individual 0,5hr consultancy on statistics.

- 1) Introduction: The gold-standard - experiments
  - a. Correlation & Causation
  - b. Randomized Controlled Trials
  - c. Diff-in-Diff
- 2) (Semi) Natural Experiments
  - a. Panel Data Estimations
  - b. Structural Time Series
- 3) Simulated Counterfactuals / Synthetic Controls
  - a. Matching Methods
  - b. Synthetic Controls
- 4) Instruments, Interruptions, and cutting edges
  - a. Instrumental Variables
  - b. Regression Discontinuity Design
  - c. Outlook - A Bayesian Approach of Directed Graphical Models
- 5) Students own research problems / questions / designs

### Related Literature:

Imbens, G., Rubin, D. (2015) Causal Inference for Statistics, Social, and Biomedical Sciences. Cambridge University Press.  
Pearl, J., MacKenzie, D. (2015) The book of why? The New Science of Cause and Effect. Basic Books.

**Suggested Dates:** 2021-05-10 – 2021-05-14