Future-EI

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Preface

This is a guide and reference book for the Future-EI pipeline. To explore future ecosystem services and nature contributions to people (NCP) in the context of climate scenarios, Future-EI (future ecological infrastructure) couples the land use land cover change (LULCC) model for Switzerland (Black et al. 2023, n.d.), state-of-the-art species distribution modelling (N-SDM) (Adde et al. 2023), and NCP calculations (Kuelling and Adde, n.d.).

1 Introduction

This is a book created from markdown and executable code.

- Mayer, Rabe, and Grêt-Regamey (2023), Black et al. (2023), Adde et al. (2023)

2 Overview

Coupling the three models, we need to define how they depend on each other. Figure 2.1 shows the dependencies between the models.
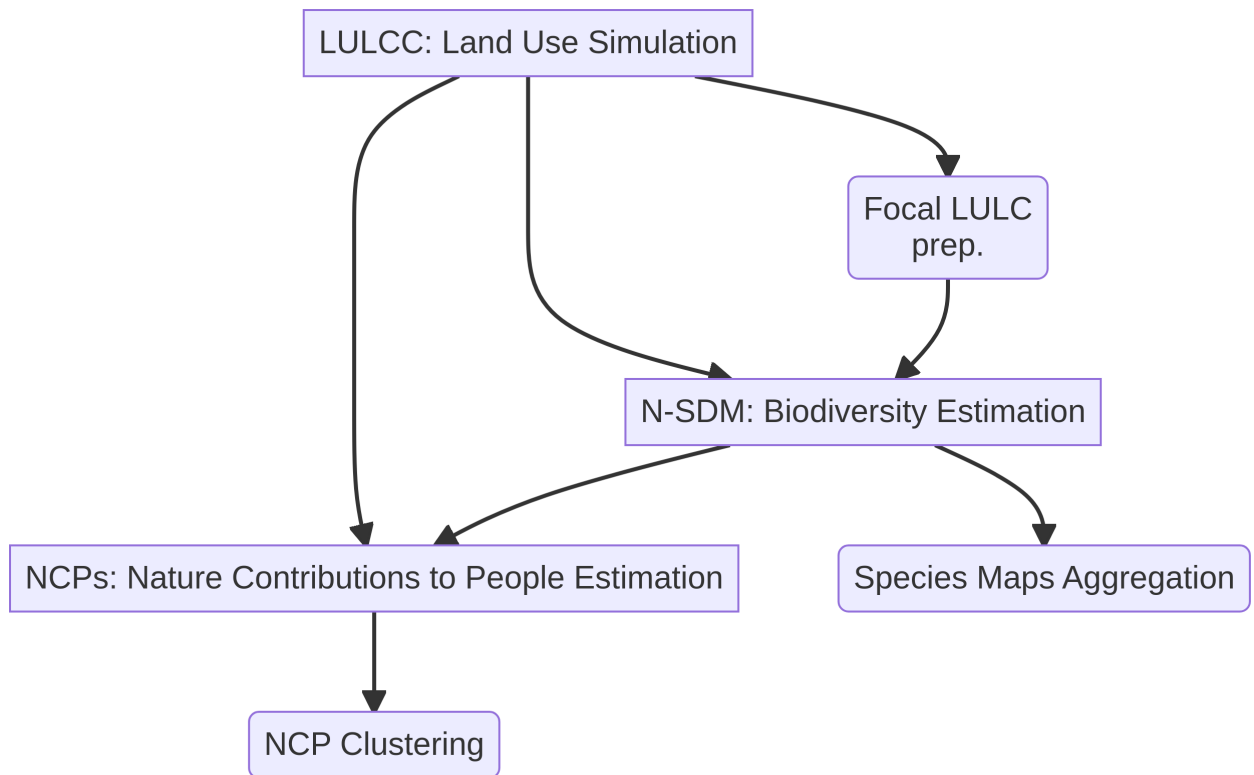

Figure 2.1: Pipeline Overview

From this structure, a clear order of execution can be derived. For each of them there is a short description of the model.

2.1 LULCC: Land Use Simulation

The land use land cover change (LULCC) model for Switzerland (Black et al. 2023, n.d.)
simulates the land use change in Switzerland from 2010 to 2060…

LULCC depends on `R`, CRAN packages and `Dinamica EGO`.

2.2 N-SDM: Species Distribution Modelling

The species distribution modelling (N-SDM) (Adde et al. 2023) uses multiple approaches to
determine species distribution maps for Switzerland…

It mainly uses `Base-R`. As N-SDM is built to be used with HPCs (high performance computers)
, with `bash` scripts `SLURM` is used to submit jobs.

2.3 NCPs: Nature Contributions to People

A range of NCPs are then estimated from the previous models outputs (Kuelling and Adde,
n.d.)…

Additionally to `R` and CRAN packages, `InVEST` is used via the `Python` modules
`natcap.invest`.

Focal…

The job of the Future-EI pipeline is to glue all pieces together for use on HPCs. For this,
a batch job written in `bash` manages multiple climate scenarios and other parameters, while
keeping track of the intermediate results. Such big batch job can be broken down onto steps
from the diagram above, and parallelization through tasks with several cpus. As each step is
different in requirements and execution, resources must be allocated accordingly. The most
computationally expensive step is the N-SDM model. Further details will be given in the
following sections.

3 Pipeline

The pipeline consists out of a `SLURM` batch job as structured in Figure 2.1. To refresh: a `SLURM` *batch job* consists out of one or more *steps*, each consisting out of one or more *tasks*, which of each can use one or more CPU cores.

4 Setup

To set up Future-EI for usage, you need to clone this repository, install the models used in Figure 2.1, and configure the local paths for inputs and parameters. For the `bash` script, environment variables are set in the `src/config.json` file.

4.1 Micromamba/Conda

For some pipeline steps, we use conda environments. For this, we recommend using micromamba, it does the same thing as conda, but resolves dependencies much faster, with the flexibility of miniconda (only command line interface, no GUI). Find the installation instructions here. Using `conda`, the commands work the same, only `micromamba` needs to be replaced by `conda`. The given scripts identify the installed package manager, as can be found in `src/bash_functions.sh`.

4.2 Dinamica EGO

Dinamica EGO is available on the project website, but will be shipped in the LULCC docker image for simplicity.

For a full description of the environments, see the environments:

4.3 Environments

For the steps in the pipeline, different environments and modules are required. These are collected in each step folder. For each, there are scripts to reproduce our used environment. To make all bash scripts in the source executable, give them the permission as follows:

```
# possibly activate globstar: shopt -s globstar
chmod +x src/**/*.sh
```

5 Summary

In summary, this book has no content whatsoever.

References

Adde, Antoine, Pierre-Louis Rey, Philipp Brun, Nathan Külling, Fabian Fopp, Florian Altermatt, Olivier Broennimann, et al. 2023. "*N-SDM* : A High-Performance Computing Pipeline for Nested Species Distribution Modelling." *Ecography* 2023 (6): e06540. https://doi.org/10.1111/ecog.06540.

Black, Benjamin, Antoine Adde, Olivier Broennimann, Daniel Farinotti, Antoine Guisan, Nathan Külling, Manuel Kurmann, et al. n.d. "Broadening the Horizon in Land Use Change Modelling: Normative Scenarios for Nature Positive Futures."

Black, Benjamin, Maarten J. Van Strien, Antoine Adde, and Adrienne Grêt-Regamey. 2023. "Re-Considering the Status Quo: Improving Calibration of Land Use Change Models Through Validation of Transition Potential Predictions." *Environmental Modelling & Software* 159 (January): 105574. https://doi.org/10.1016/j.envsoft.2022.105574.

Kuelling, Nathan, and Antoine Adde. n.d. "NCP Calculation Paper."

Mayer, Paula, Sven-Erik Rabe, and Adrienne Grêt-Regamey. 2023. "Operationalizing the Nature Futures Framework for Ecological Infrastructure." *Sustainability Science*, July. https://doi.org/10.1007/s11625-023-01380-7.