Replication code for: **Towards Distributional Ecosystem Accounts**

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This document describes the replication of **Towards Distributional Ecosystem Accounts** by Rufus Panelius. To fully replicate the results, access to Statistic Finland micro level registries is required.

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Software used are QGIS 3.36 and Stata 18. Python code was run in Jupyter Notebook. The following packages are required:

- Stata
  - grc1leg (available through `http://www.stata.com/users/vwiggins/`)
- Python
  - pandas
  - numpy

Code for the spatial analysis is based on work by Jaakko Juvonen, and code for the owner-property link is based on work by Sara Alhola. The author takes full responsibility for any errors in the code.

1 Original data

- The forest datasets used in this study are available from Forest Centre at `https://www.metsakeskus.fi/fi/avoin-metsa-ja-luontotieto/aineistot-paikkatieto-ohjelmille/paikkatietoaineistot` and Natural Resources Institute Finland at `https://kartta.luke.fi/index-en.html`.
- The land cover datasets used are available from the Finnish Environment Institute at `https://ckan.ymparisto.fi/dataset/%7B0B4B2FAC-ADF1-43A1-A829-70F02BF0C0E5%7D`.
- Cadastral index maps are available from National Land Survey of Finland at `https://asiointi.maanmittauslaitos.fi/karttapaikka/tiedostopalvelu/kiinteistorekisterikartta_vektori?lang=fi`.

- The Mikkonen *et al.* (2023) data is available at `https://ckan.ymparisto.fi/dataset/%7BA93CBA25-0B35-41C7-AE73-88C32250CFDD%7D` and the Maes *et al.* (2023) data is available at `https://doi.org/10.5281/zenodo.7016828`.
- Custom table of biomass expansion factors `carboncontent.dta` based on Statistics Finland *et al.* (2024).
- Custom table on timber prices `timber_price2022.dta` based on Luke (2023).
- Custom table of region-municipality link `maakunta_kunta_link.dta`

All of the above are available under the CC BY 4.0 license. Household level administrative data was made available for this study from Statistics Finland, but is not publicly available due to the sensitive nature of the data. To access the data, an agreement with Statistic Finland is required. Expected monetary costs are up to €5,000 and the process can take several months. For more information, visit `https://stat.fi/tup/tutkijapalvelut/index_en.html`.

2 Scripts

2.1 Spatial analysis

Code for the spatial analysis is located in the folder `code_gis`. Run the following scripts in QGIS to combine forest stands, forest harvests, forest characteristics, and land cover with properties. The script assumes stand and harvest data by region. The following datasets are required for step 1:

- `MV_'region'.gpkg` for all regions in Finland available at `https://avoin.metsakeskus.fi/aineistot/Metsavarakuviot/Maakunta/`
- `MKI_'region'.gpkg` for all regions in Finland available at `https://avoin.metsakeskus.fi/aineistot/Metsankayttoilmoitukset/Maakunta/`
- `gridcell.gpkg` available as wfs at `https://geo.stat.fi/geoserver/tilastointialueet/wfs`
- `property_'region'.gpkg` available at `https://asiointi.maanmittauslaitos.fi/karttapaikka/tiedostopalvelu/kiinteistorekisterikartta_vektori?lang=fi`
- `zipcode.gpkg` available as wfs at `https://geo.stat.fi/geoserver/postialue/wfs`

The following datasets are required for step 2:

- `MetZa2018_VMA06` available at `https://ckan.ymparisto.fi/dataset/%7BA93CBA25-0B35-41C7-AE73-88C32250CFDD%7D`
- `ForConInd_2018.tif` available at `https://doi.org/10.5281/zenodo.7016828`
- Volume, height, diameter, and age rasters, available as Atom-feed at `https://kartta.luke.fi/inspireatom/mvmi.xml`. More information at `https://www.luke.fi/fi/luonnonvaratieto/tiedetta-ja-tietoa/metsavarat-vmi/valtakunnan-metsien-inventointi-vmi`

The following datasets are required for step 3:

- `clc2018_FI20m.tif` resampled to pixels of size 5m. Original raster available at `https://ckan.ymparisto.fi/dataset/%7B0B4B2FAC-ADF1-43A1-A829-70F02BF0C0E5%7D`

The following datasets are required for step 4:

- `gridcell.gpkg` available as wfs at `https://geo.stat.fi/geoserver/tilastointialueet/wfs`
- `property_'region'.gpkg` available at `https://asiointi.maanmittauslaitos.fi/karttapaikka/tiedostopalvelu/kiinteistorekisterikartta_vektori?lang=fi`

1. Run `forest_to_property.model3` as a batch process in QGIS, first on forest stand data (MV), and then on forest use declarations (MKI). Save output as `'region'_paikka.csv` and `'region'_mki.csv`
2. Run `biodiv_forcond.model3` as a batch process in QGIS.
3. Run `biodiv_clc.model3` as a batch process in QGIS.
4. Run `property_grid_key.model3`. Save output as `propertygridkey_2022.csv`
5. Run `biodiv_forcond.do` in Stata. This creates the `biodiv_FORCOND.csv` data from the output of step 2.
6. Run `biodiv_clc.do` in Stata. This creates the `biodiv_CLC.csv` data from the output of step 3.

2.2 Property-owner link

Code for the property-owner link is found in the folder `link_property`. Run the following scripts in Stata to create the individual level property-owner link. This requires access to individual level registry data. The following datasets are required:

- `cadastre_omistaja_2022.csv`
- `cadastre_kiinteisto_2022.csv`
- FOLK child - parents - year
  - `folk_laps19702022_1.dta`
- FOLK - Basic data
  - `folk_perus_'year'_1.dta` for years 1987-2022
- FOLK-cohabitation
  - `folk_19872000_tua_aslii2tot_1.dta`
  - `folk_20012010_tua_aslii2tot_1.dta`

- folk_20112020_tua_aslii2tot_1.dta
- folk_aslii_2021_1.dta
- folk_aslii_2022_1.dta

First create auxiliary datasets that link individuals to their descendants by running:

1. folk_child_parent_descending.do
2. folk_deceased.do
3. folk_widow.do

The linking dataset is created in the following steps:

1. Run link_import.do to import and clean data
2. Run link_step_1.do to connect property owners with information of their properties
3. Run link_step_2.do to link deceased owners with their descendants
4. Run link_step_3.do to clean and label data
5. Run link_step_4.do to link property owners to household income

2.3 Merge forest data

Code for merging forest data is found in the folder forest_merge. The code assumes forest data is in .dta format. The following datasets are required:

- 'region'_paikka.dta This is the output of step 2.1 for MV-data
- 'region'_mki.dta This is the output of step 2.1 for MKI-data
- 'region'_treestand.dta
- 'region'_treestandsummary.dta
- 'region'_restriction.dta
- carboncontent.dta (custom table)
- timber_price2022.dta (custom table)
- biodiv_CLC.csv
- biodiv_FORCOND.csv
- Hakkuuaikomukset_2022.xlsx available at https://www.metsakeskus.fi/fi/avoin-metsa-ja-luontotieto/tietoa-metsien-kaytosta/hakkuuaikomukset

Run the following scripts in Stata to create one master file of forest data and link it with owners:

1. Run `forest_merge.do` to combine forest stands with other stand information
2. Run `forest_sumstat.do` to create summary data of forest characteristics by forest type
3. Run `forest_characteristics.do` to summarise forest characteristics for each property
4. Run `volume_coefficients.do` to create harvest volume coefficients
5. Run `forest_fellings.do` to create a dataset of harvest volumes and carbon emissions
6. Run `forest_sumstat_damages.do` to calculate asset values by forest type
7. Run `forest_master.do` to combine all dataset above into a master dataset
8. Run `forest_folk_merge.do` to merge the forest master data with owner data

2.4 Distributional analysis

Code for the distributional analysis is found in the folder `distributional_analysis`. For the distributional analysis, run the following scripts:

1. Run `distribution_landcover.do` to create aggregates of ecosystem ownership across income groups
2. Run `distribution_recreation.do` to calculate access to outdoor recreation across individuals
3. Run `distribution_es.do` to create aggregates of access and ownership of ecosystem services across income groups
4. Run `distribution_depreciation.do` to create aggregates for impacts of ecosystem revaluation across income groups

3 Article figures and tables

3.1 Figures

Code for figures is found in the folder `code_figures`. Article figures are created by running the following Stata scripts:

- Run `figure_2.do`
- Run `figure_3.do`
- Run `figure_4.do`
- Run `figure_5.do`
- Run `figure_6.do`
- Run `figure_7.do`

- Run `figure_B1.do`
- Run `figure_B2.do`
- Run `figure_B3.do`
- Run `figure_B4.do`

3.2 Tables

Code for tables is found in the folder `code_tables`. Article tables are created by running the following Python scripts:

- Run `table_2.ipynb`
- Run `table_3.ipynb`
- Run `table_B1.ipynb`

References

Luke (2023). Volumes and prices in roundwood trade 2022.

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