The world's most consistent and transparent Life Cycle Inventory database

OCELOT project

System modelling in the hand of the user

Guillaume Bourgault

Project manager

ecoinvent

Agroscope EMPA EPFL ETH PSI

Introduction

- Why to Ocelot?
- How to Ocelot?
- Summer school

Why to Ocelot?

- Ecoinvent supplies “undefined” datasets:
  - Potentially multi-output datasets (before allocation)
  - Unlinked (demand of inputs from technosphere without known source)
- Allocation, end-of-life and demand distribution are necessary to calculate LCIA scores, but can be done in more than one way
- Ecoinvent v3.X vision: not force users in one direction or the other
- Ecoinvent supplies linked-allocated datasets with 3 system models

Why to Ocelot?

- **In an ideal world…**
- Users should be able to adjust parameters/choices inside a system model and test their sensitivity of an LCA's conclusion
- Users may want to develop new system models and test their effects

Why to Ocelot?

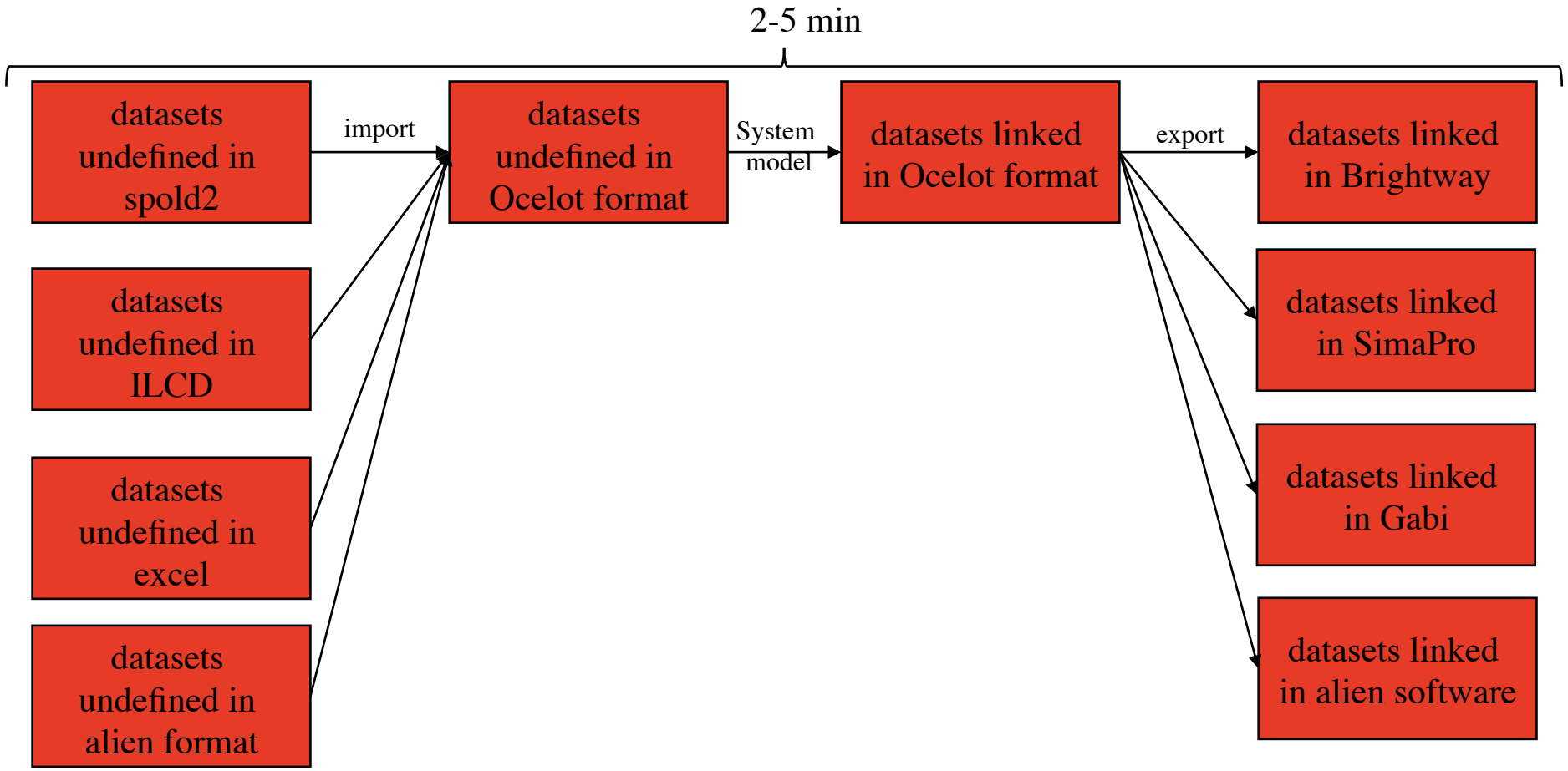
- **Why it has not happened…**
- Data quality guidelines (DQG) document describe the general ideas of the system models, but is not detailed enough to unambiguously rebuild them
- Coding skills and lots of time are required
- Data exchange between output of a system model algorithm and an LCA software have to be taken into account

Why to Ocelot?

- Ocelot's vision: 
  - Build a framework to facilitate creation of new system models
  - Supply ready-made system models to be modified
  - Document the effect of each step of the system model on the datasets (logs)
  - Research-oriented tool, but also for consultant

How to Ocelot?

- Data flow: from data source to LCA software



How to Ocelot?

- Written in Python
  - free
  - one of the easiest language for scientific programing
- Open source, hosted on GitHub. Possibility to:
  - Get updated versions of the code
  - push new code
  - Work with parallel versions (“branch”)

How to Ocelot?

- “Functional programing”: short, “bite-sized” functions
  - Example: allocate a dataset with method X
- Functions successively applied to all datasets
- Each step produces logs

How to Ocelot?

```python
def choose_allocation_method(dataset):

    reference_product_classifications = [exc.get('byproduct classification')
                                         for exc in dataset['exchanges']
                                         if exc['type'] == 'reference product'
                                         and exc['amount'] != 0]
    number_reference_products = len(reference_product_classifications)
    negative_reference_production = any(1 for exc in dataset['exchanges']
                                        if exc['type'] == 'reference product'
                                        and exc['amount'] < 0)
    allocatable_byproducts = any(1 for exc in allocatable_production(dataset)
                                 if exc['type'] == 'byproduct'
                                 and exc['amount'] != 0)
    allocatable_products = any(1 for exc in allocatable_production(dataset)
                               if exc['type'] == 'reference product'
                               and exc.get('byproduct classification') == 'allocatable product')
    has_conditional_exchange = any(1 for exc in dataset['exchanges']
                                   if exc.get('conditional exchange'))

    if number_reference_products == 1 and not allocatable_byproducts:
        return None
    elif dataset['type'] == 'market group':
        return None
    elif dataset['type'] == 'market activity':
        if has_conditional_exchange:
            return "constrained market"
        else:
            return None
    elif number_reference_products > 1:
        if not allocatable_products:
            return "combined production without products"
        elif allocatable_byproducts:
            return "combined production with byproducts"
        else:
            return "combined production"
    elif negative_reference_production:
        # TODO: Should be part of a validation function
        assert len(set(reference_product_classifications)) == 1
        if reference_product_classifications[0] == 'waste':
            return "waste treatment"
        else:
            return "recycling"
    else:
        return "economic"
```

ecoinvent

Gather info about number of reference products, byproducts, their classification

Decision tree: type of allocation depends on info gathered above

Ocelot summer school

- Retreat with 22 students:
  - All with LCA background
  - From “Hello world!” to advanced coding skills
  - Mostly grad students, some post-docs and some researchers
- 2 days crash course about system models and Ocelot
- 3 days team project

Ocelot summer school

- Use the cut-off system model as a baseline
- Modify something of interest
  - Each team decided what to modify and implement it
  - Got coding assistance if necessary
- Export to Brightway
- Compare LCIA results of some datasets: baseline VS modified system model
- Short presentation and report

Ocelot summer school

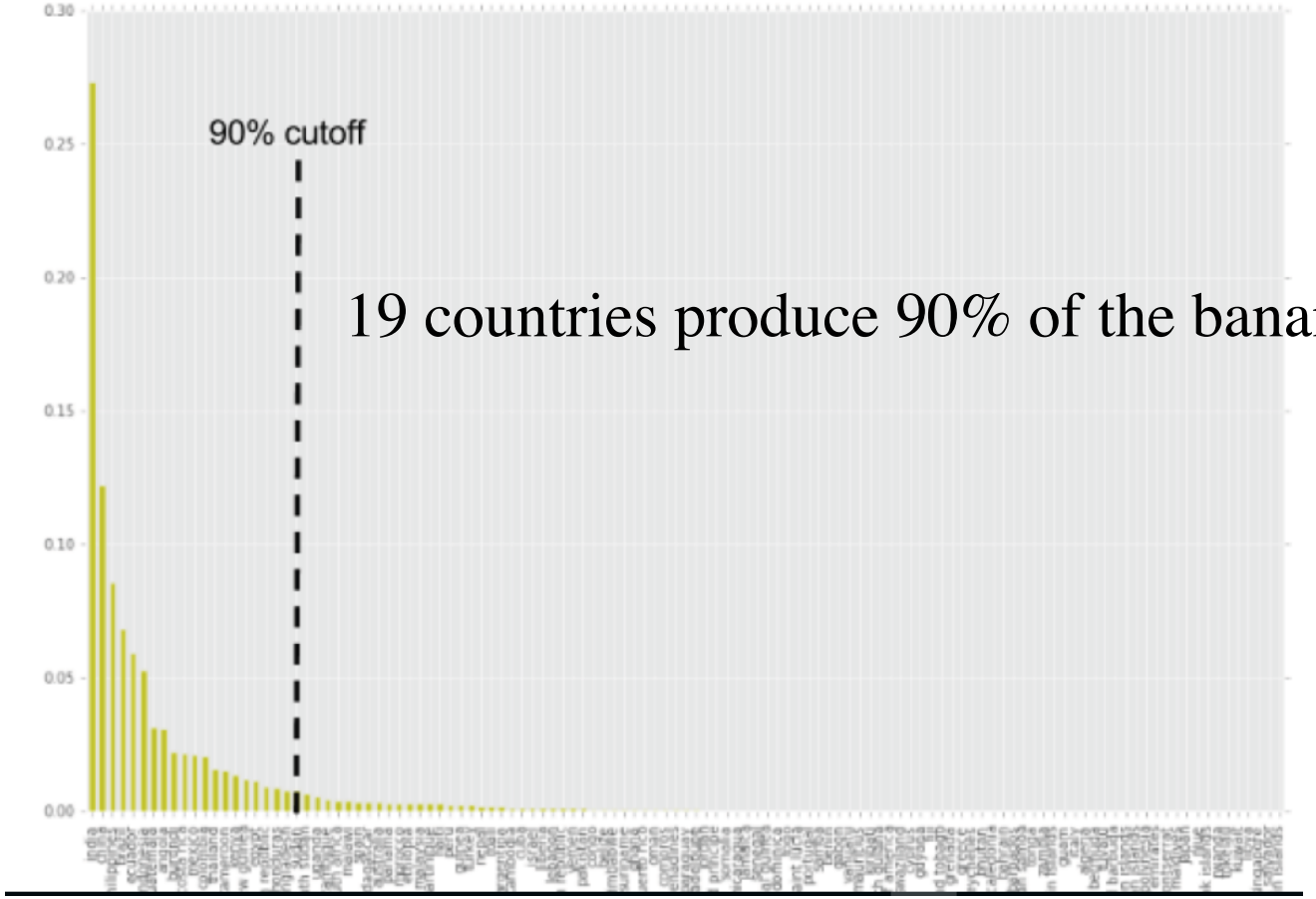
- Crowd-sourcing gone right!
- Project example:
  - International regionalized consequential supply chain model for palm oil production
  - Allocation of some impact to gravel in concrete production
  - Future scenario of electricity production

Ocelot summer school

- João Meirelles de Miranda, Franziska Meinherz and David Turner
- Currently, ecoinvent has banana production in Brazil, China, and RoW
- If banana is a small contributor to the impacts of an LCA, the RoW (rest of the world) is deemed an appropriate average
- If the focus is on the banana, it is safer to test if regional variations might tip the conclusions
- Use of Ocelot as a sensitivity analysis tool
- (disclaimer: student projects were not thoroughly reviewed)

Ocelot summer school

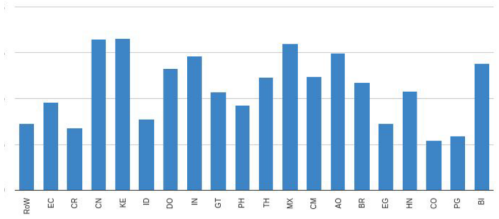
Figure 3: Countries by banana production volume



19 countries produce 90% of the banana

Ocelot summer school

- World Bank data for precipitation per country
- Create 19 datasets with irrigation amount dependant on the annual precipitation
- Let the linking do its job: each dataset gets connected to a regionalized market for electricity and irrigation
- Compare scores of water depletion



- (If regionalized impact assessment methods are implemented, the LCA software would apply the right CFs to each water consumption exchange)

Ocelot summer school

- Easy to see how one can iteratively introduce complexification:
  - Through contribution analysis, identify what appears to be a sensitive parameter
  - Examples for banana: quantity/nature of pesticide, quantity of fertilizer, land use change
  - Apply linking, calculate score, compare scores with previous version
  - Repeat if necessary with another parameter

Future of Ocelot

- Ecoinvent internal use:
  - test of new data
  - test of new features: allocation correction, new geographic linking rules
  - prototype new system models
- Create import/export functions for more data sources and software
- Answer diverse research questions
- Consultants build custom-made system models

Future of Ocelot

- Ocelot is open source
- It will become what all the users need it to become
- Approach Chris or Guillaume if you want to contribute