LEAP-RE

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User guide for the modelling platform on Github

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Summary

This report accompanies the fifth scientific deliverable of the RE4AFAGRI project (or WP12 of LEAP-RE). This deliverable is the second official deliverable of Task 12.2 ?Integration of modelling infrastructure? (coordinated by IIASA), albeit also being tightly linked to Task 12.3 ?Field data collection, calibration and validation? (coordinated by UCT), which are two of the core research tasks in the development of the nexus modelling platform for RE4AFAGRI. It follows the first official deliverable of Task 12.2, i.e. the ?Integrated platform source code on GitHub as main deliverable of Task 12.2?. The deliverable consists of the WIki user guide accompayning the GitHub code and Zenodo data repositories of the RE4AFAGRI platform, and it is presented in this short introductory note.

Approval

Date	By
2023-06-11 12:39:27	Dr. Manfred HAFNER (HEAS)
2023-06-12 12:11:36	Mr. Léonard LéVêQUE (LGI)

LEAP-RE

Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

User guide for the modelling platform on Github as second deliverable of Task 12.2

Accompanying document

Deliverable D12.4

WP12 of LEAP-RE (RE4AFAGRI)

www.leap-re.eu

https://www.leap-re.eu/re4afagri/

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Acronyms

IIASA: International Institute for Applied Systems Analysis

LEAP-RE: Long-Term Joint Research and Innovation Partnership on Renewable Energy between the European Union and the African Union

M-LED: Multisectoral Latent Electricity Demand assessment tool

MESSAGE: Model of Energy Supply Systems And their General Environmental Impact

NEST: NExus Solutions Tool

OnSSET: Open Source Spatial Electrification Tool

POLITO: Politecnico di Torino

RE4AFAGRI: Renewable Energy for African Agriculture – Modelling Excellence and Robust Business Models

SSA: Sub-Saharan Africa

UCT: University of Cape Town

WaterCROP: Water Crop assessment model

1. Background

The RE4AFAGRI project seeks to support sub-Saharan African (SSA) smallholder farmers and communities to grant community-wide access to energy services and water for crop irrigation and human use with the ultimate goal of fostering rural development. It will provide African research institutions and public and private decision makers with the tools and expertise necessary to operate a multi-scale modelling platform that can support the design and implementation of integrated solutions for the energy and water nexus in rural areas. In parallel, RE4AFAGRI will set the ground for a multi-stakeholder discussion platform about the business models and enabling environment (policy and regulation) to promote the involvement of the private sector in water-energy-agriculture integrated solutions.

This report accompanies the fifth scientific deliverable of the RE4AFAGRI project (or WP12 of LEAP-RE). This deliverable is the second official deliverable of Task 12.2 "*Integration of modelling infrastructure*" (coordinated by IIASA), albeit also being tightly linked to Task 12.3 "*Field data collection, calibration and validation*" (coordinated by UCT), which are two of the core research tasks in the development of the nexus modelling platform for RE4AFAGRI. It follows the first official deliverable of Task 12.2, i.e. the *"Integrated platform source code on GitHub as main deliverable of Task 12.2".*

The RE4AFAGRI platform is a multi-model framework to analyse deficits, requirements, and optimal solutions for integrated land-water-agriculture-energy-development nexus interlinkages in developing countries.

A more comprehensive background on the design and principles behind the RE4AFAGRI platform is found in Falchetta, G., Adeleke, A., Awais, M., Byers, E., Copinschi, P., Duby, S., ... & Hafner, M. (2022). *A renewable energy-centred research agenda for planning and financing Nexus development objectives in rural sub-Saharan Africa*. Energy Strategy Reviews, 43, 100922. https://doi.org/10.1016/j.esr.2022.100922

The deliverable consists of the WIki user guide accompayning the GitHub code and Zenodo data repositories of the RE4AFAGRI platform, and it is presented in this short introductory note.

2. The RE4AFAGRI Wiki user guide

This supporting document accompanies the Wiki user guide for the GitHub code and Zenodo data repositories (which are the main objects of the deliverable) containing the source code of the RE4AFAGRI nexus modelling platform (WaterCROP, M-LED, OnSSET and MESSAGE-NEST; see Figure 1). For a more detailed characterisation of the RE4AFAGRI models and platform development, the user is invited to refer to Deliverable 12.5 *"Joint EU-AU report on the platform testing and validation activity as a deliverable of Task 12.3 Field data collection, calibration, and validation"* and Deliverable 12.2 "*Joint EU-AU report on agreed project vision*", both retrievable on the official LEAP-RE website at https://www.leap-re.eu/.

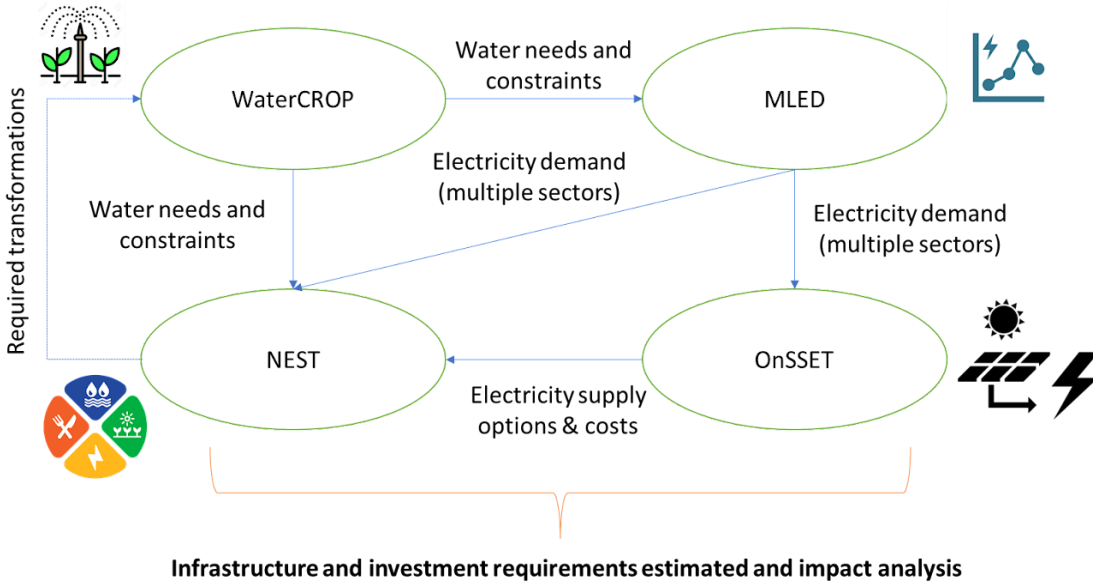


Figure 1: Schematic diagram of the RE4AFAGRI modelling platform

The user guide is accessed through https://github.com/iiasa/RE4AFAGRI_platform/wiki, which host a landing page for the different sub-section of the guide (Figure 2). The user guide is then structured into ten different pages (described below), which guide the user through the different components and steps of the modelling platform. The key purpose is enabling the user to autonomously operate each of the four RE4AFAGRI platform models, as well as to soft-link them through outputs and inputs sharing. In addition, the user guide also includes a page of examples and exercises and a page dedicated to the interactive visualisation dashboards. Finally, a capacity building page will host materials such as slides and scripts for the upcoming trainings throughout and beyond the project duration. Each Wiki page – and chiefly the four model pages – contains explicit references to the scripts and specific code

lines under discussion, and it is thus written in tight integration with the Github repository hosting the code of the four models.

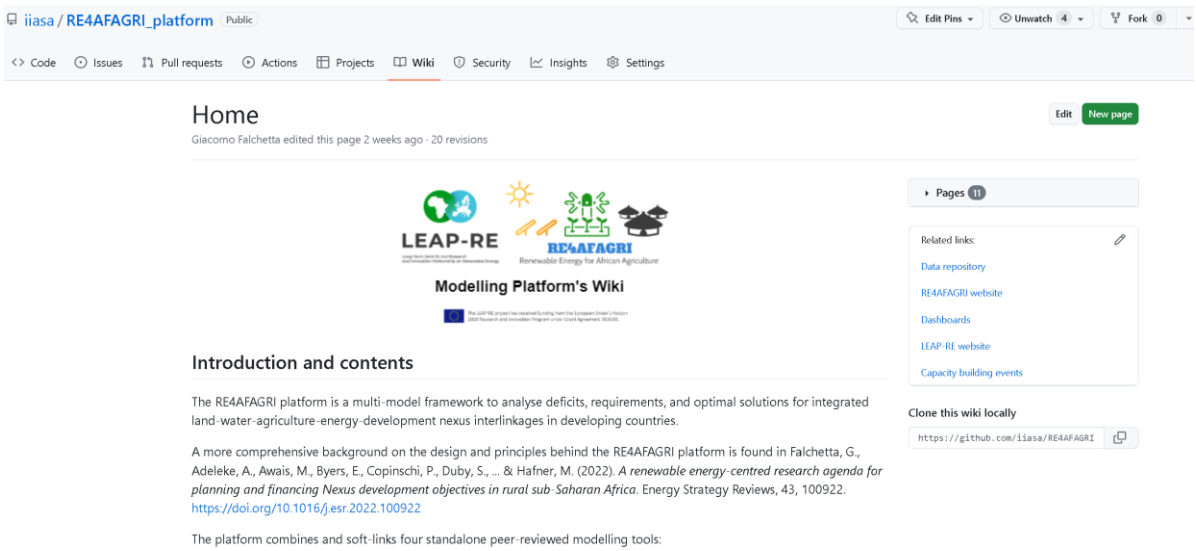


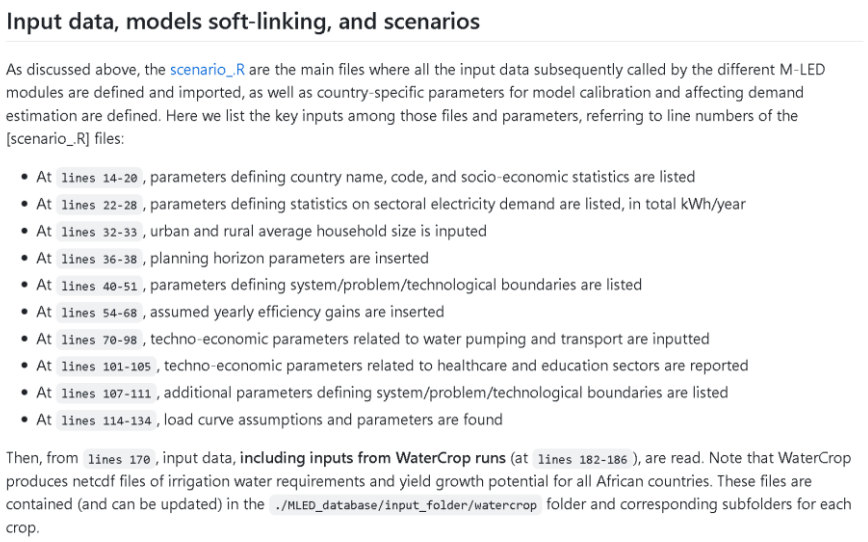
Figure 2: Screenshot of the RE4AFAGRI modelling platform's Wiki landing page

The ten pages included in the Wiki user guide are the following:

- Data download: this page instructs the user on how to retrieve the input data to replicate the RE4AFAGRI base scenarios in the four models, I.e. SSA-wide for WaterCROP, Zambia, Rwanda, Nigeria, Kenya, and ZImbabwe for M-LED; and Zambia only for OnSSET and MESSAGE-NEST. It details how to access the Zenodo repository and how to update the database path folders into the four models.
- Scenarios and their customisation: this page describes the key assumptions characterising the three base scenarios for the RE4AFAGRI platform, I.e. the baseline, improved access, and ambitious development scenarios and how these assumptions are coded into each model.
- WaterCROP: this page is dedicated to the WaterCROP crop evapotranspiration model, describing all the necessary steps to run the model. From data preparation, to scenario definition, model run, and outputs analysis.
- M-LED: this page is dedicated to the M-LED electricity demand assessment platform, describing all the necessary steps to run the model. From data preparation, to scenario definition, model run, and outputs analysis.
- OnSSET: this page is dedicated to the M-LED electricity access planning local optimisation model, describing all the necessary steps to run the model. From data preparation, to scenario definition, model run, and outputs analysis.
- NEST: this page is dedicated to the MESSAGE-NEST Nexus integrated assessment model, describing all the necessary steps to run the model. From data preparation, to scenario definition, model run, and outputs analysis.

- Models-linking: this page specifies how the soft-linking of output occurs across each of the four models, and which files and code lines specifically are responsible for such model interlinkages.
- Interactive-dashboards: this page illustrates the functioning of the interactive dashboards accessible under www.re4afagri.africa, including accessing the raw, high-resolution output data for each scenario, and a brief description of how the dashboards are developed in their backend.
- Examples-and-exercises: this page hosts different examples and exercises, such as replicating the Zambia country study analysis in the four models, developing a new country study, or developing a new scenario.
- Capacity-building-events: finally, this page includes information and access links to materials related to the in person and online capacity building events scheduled for 2023-2024 (as well as for continuous learning after the project's end).

Please note that any future update will be published directly on the repository and the corresponding Wiki page, and therefore this short accompanying note is only meant to introduce the Wiki as of early June 2023.



Input data, models soft-linking, and scenarios

As discussed above, the scenario_.R are the main files where all the input data subsequently called by the different M-LED modules are defined and imported, as well as country-specific parameters for model calibration and affecting demand estimation are defined. Here we list the key inputs among those files and parameters, referring to line numbers of the [scenario_.R] files:

- At `lines 14-20`, parameters defining country name, code, and socio-economic statistics are listed
- At `lines 22-28`, parameters defining statistics on sectoral electricity demand are listed, in total kWh/year
- At `lines 32-33`, urban and rural average household size is inputed
- At `lines 36-38`, planning horizon parameters are inserted
- At `lines 40-51`, parameters defining system/problem/technological boundaries are listed
- At `lines 54-68`, assumed yearly efficiency gains are inserted
- At `lines 70-98`, techno-economic parameters related to water pumping and transport are inputted
- At `lines 101-105`, techno-economic parameters related to healthcare and education sectors are reported
- At `lines 107-111`, additional parameters defining system/problem/technological boundaries are listed
- At `lines 114-134`, load curve assumptions and parameters are found

Then, from `lines 170`, input data, **including inputs from WaterCrop runs** (at `lines 182-186`), are read. Note that WaterCrop produces netcdf files of irrigation water requirements and yield growth potential for all African countries. These files are contained (and can be updated) in the `./MLED_database/input_folder/watercrop` folder and corresponding subfolders for each crop.

Figure 3: Screenshot of the M-LED wiki page

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