Food and Agriculture Organization of the United Nations

State of the art agricultural land cover maps for the Lao People's Democratic Republic

Part of the Land Resources Information Management System (LRIMS)

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A first crop cover maps for the Lao People's Democratic Republic

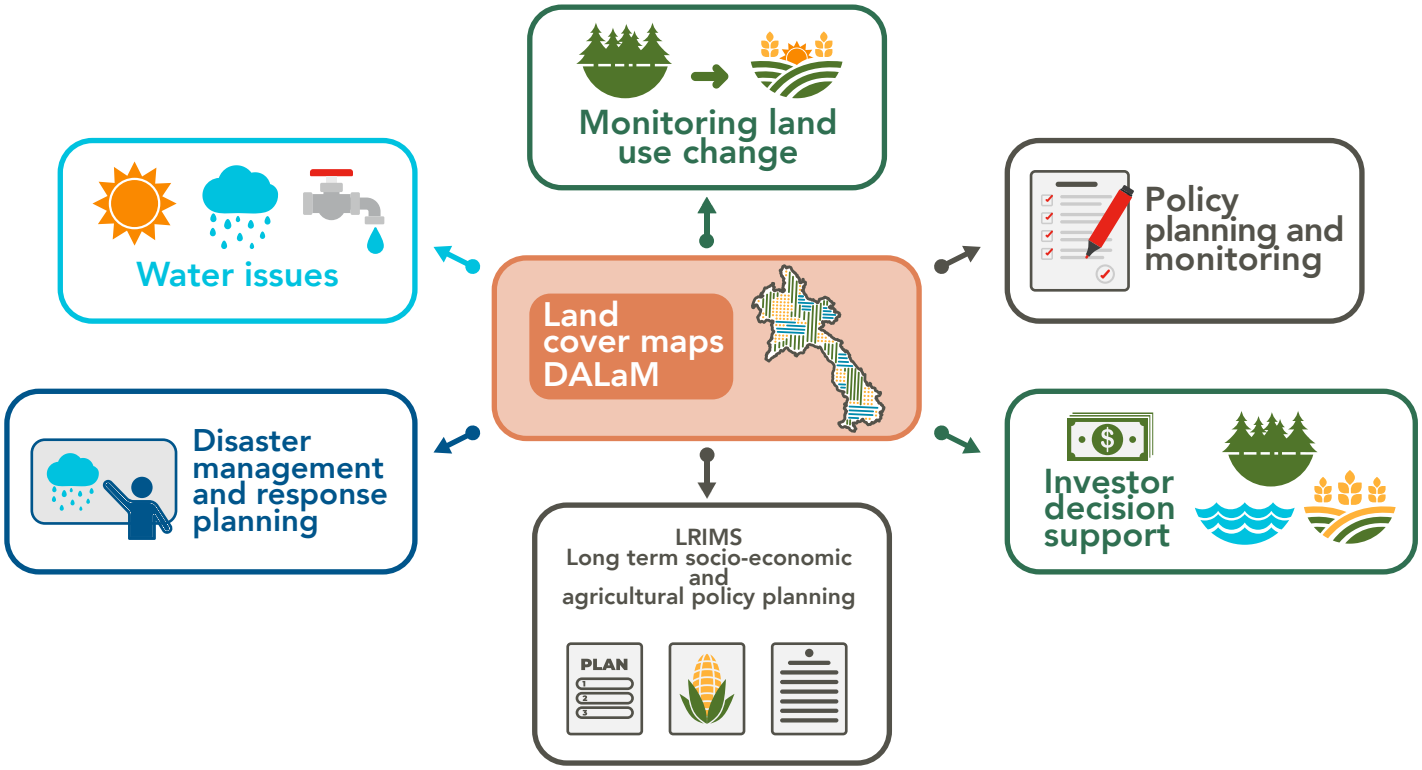
The Department of Agricultural Land Management (DALaM) under the Ministry of Agriculture (MAF) has, with financial support of FAO and technical support from international experts, produced the first national agricultural cover map in the country. It has been generated using a random forest machine learning approach to identify different cropland from satellite imagery and is in both, technical standard and accuracy, state of the art.

The Lao People's Democratic Republic is thus the first country in its economic class to produce a map of this kind using machine learning and one of the first countries in the world to use Google's Earth Engine for this purpose. DALaM's team now manages the production and further development of high-quality outputs independently.

The map includes major production systems of Lao People's Democratic Republic, including shifting cultivation. In its first released version, the following land cover classes are depicted: paddy rice, annual crops, steep slope agriculture (shifting agriculture), maize, cassava, sugarcane, tea plantations, coffee plantations, orchards and other plantations, sparse natural vegetation, dense natural vegetation, bare areas, built-up areas, and water surfaces. The pixel resolution of the map is 10 meters, while for temporal resolution images across the whole year of analysis are used. It is calibrated with 2 740 field observation data and has currently an estimated accuracy of 90 percent, the acceptable norm based on FAO expertise.

The map has been approved as official national crop cover map of Lao People's Democratic Republic, is suitable for agricultural land use assessment and environmental planning.

How can this map be of use?



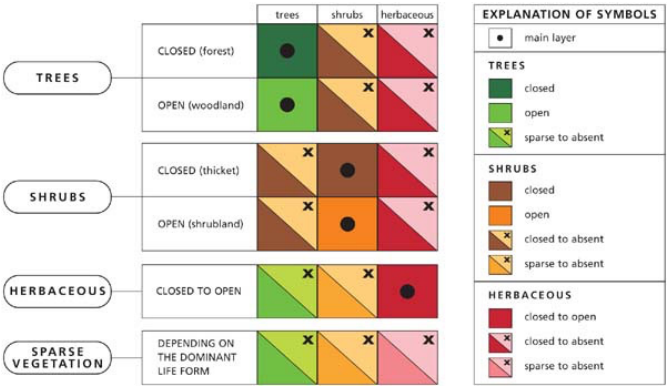
Land cover maps provide an overview of the current landscape, in this case with a specific focus on agricultural land. It can provide managers, researchers and decision makers with high-quality, data-based information to support their tasks. The map will be used by DALaM for calculating yearly crop productivity and will feed into the Land Resource Information Management System (LRIMS), a support tool for socio-economic and agricultural policy planning that provides crop modeling at least 20 years into the future.

But also other uses can be envisioned, such as monitoring environmental change, or supporting disaster management and emergency response planning, where prediction of drought and flood risks, wildfires, or future climate change risks and effects need to be assessed. Being easy to update now, it can support the monitoring of production plans on a seasonal, yearly or 5-year basis for District Offices for Agriculture and Forestry (DAFO) or at higher levels.

But DALaM's team aims at providing still more, such as the location of suitable arable land for different purposes. With land cover maps for a number of years, past management decisions could be assessed, and predictions for possible effects of future decisions or impacts can be made (e.g. natural or man-made disasters, changes in land use, etc.).

How are the Lao People's Democratic Republic's crop cover maps generated?

The process of generating land cover maps is based on discriminating the response of different surfaces to to optical bands or to pulses emitted from a satellite (radar images). Every surface reflects specific proportions of different wavelength, which is called surface spectral reflectance (SSR). SSR is much more detailed and specific than what we perceive as colors. If measured from space, it can be used to identify different surfaces such as water, leaves, roofs or roads. As natural surfaces are rarely pure (e.g. soil in water, different plant parts, different soils) and due to atmospheric interference (vapor, dust), computer programs need to be trained to interpret the SSR of different surfaces so they can be attribute to defined categories, including specific (crop) plants, or recognize clear and muddy rivers both as water-bodies. To support this process ground observations need to be collected which confirm vegetation and surface types. Using a random forest classifier, algorithms are now able to interpret land cover classes more efficiently than the past.



The generation process included several major steps:

1. Assembling the raw map of the area of interest (AoI) (Lao Peoples Democratic Republic with a 5km buffer to the borders) from available satellite images;

2. Defining land cover categories based on data collected in an ancillary database;

3. Applying an object-based image analysis (OBIA) to get more realistic land cover representations;

4. Interpreting the information and attribute land cover categories to map features;

5. Verifying the accuracy of the finalized map through field observations.

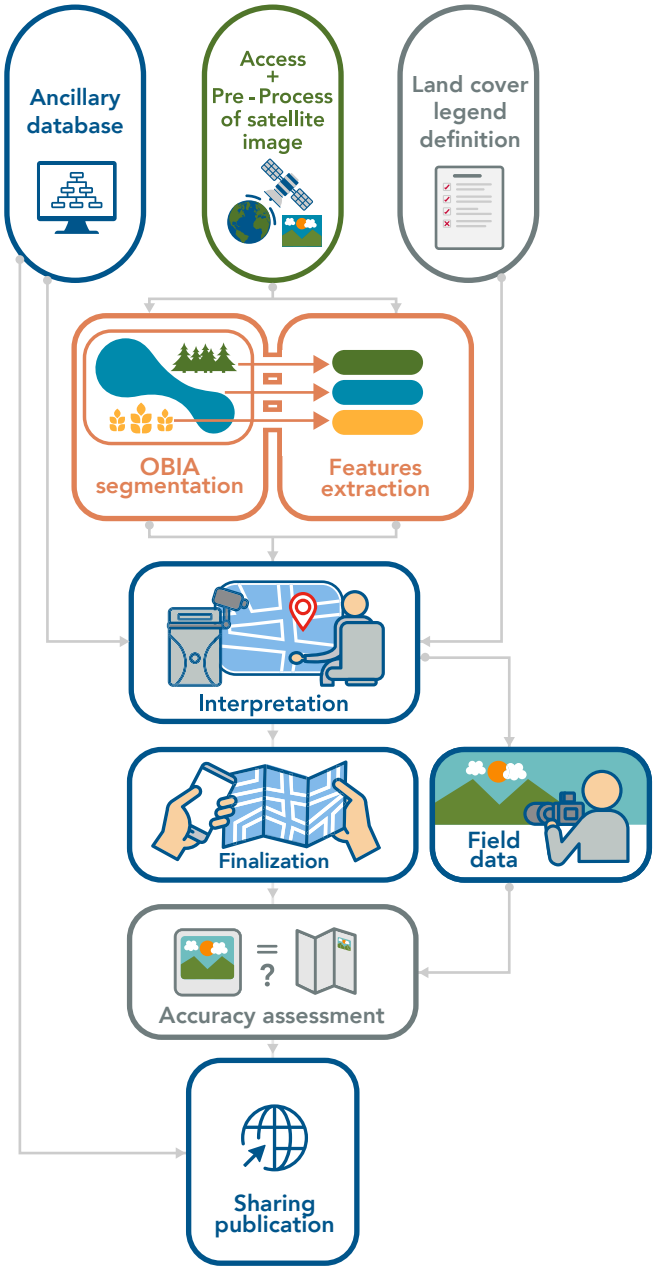
For the crucial step of image interpretation, a hybrid approach is employed, combining photo interpretation and automatic classification.

1. Plantations and built-up areas were classified with photo interpretation from very high resolution (VHR) reference images (Google, Bing and ESRI);

2. To the remaining polygons, an automatic, machine learning based classification was applied to get an initial differentiation of the main classes: natural vegetation, bare soils, water and generic agricultural land;

3. An initial quality control was carried out to guarantee thematic and topographic consistency of results;

4. A second automatic classification on agricultural land was applied specifically to differentiate main crop types based on collected field data.



Who is this map for?

While primarily developed for the needs of DALaM, further expected users will be several other departments under the Ministry of Agriculture and Forestry (MAF) including the Departments of Agriculture, Forestry, Irrigation, Planning and Finance (and here especially the Center for Agricultural Statistics), Livestock and Fisheries, Policy and Legal Affairs, Technical Extension and Agro-Processing and the National Agriculture and Forestry Research Institute, as well as the Land Department under the Ministry of Natural Resources and Environement (MONRE).

Provincial ad District Offices of the MAF and of the MONRE and other entities and other entities engaging with farmers, but also universities and colleges are expected to benefit from the information displayed in this map for both analytical and educational purposes.

Allowing for faster response to requests for alternative land uses, such as mining or other land concessions, its potential value for companies and investors is predicted to be high.

Funding uncertainties

Continuous updating, improvement and maintenance require resources. Even though the needed yearly budget is comparatively small and despite its great value for planning and analysis, funding is currently not secured. If you are interested in supporting this long-term project or get involved, we would be glad to provide further information. Please find contact details at the back-cover of this booklet.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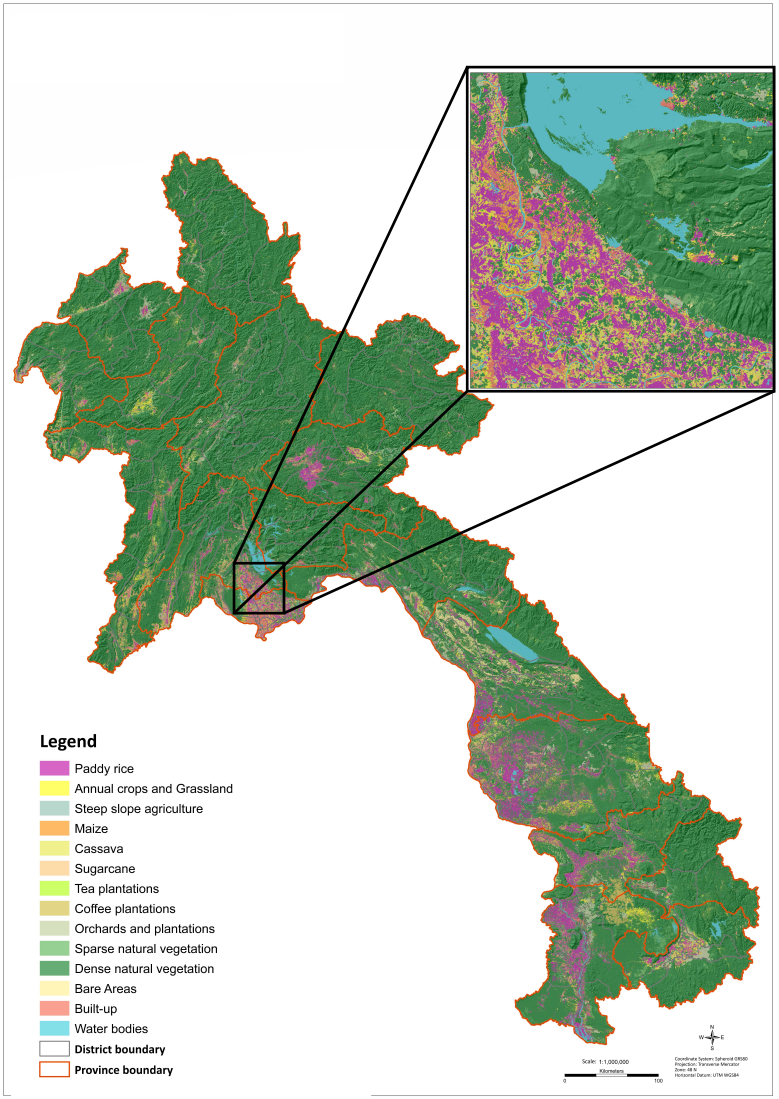
Specifications for the generated maps

1. Type: Topographic, land cover
2. Scale: Up to 1:20 000
3. Imagery sources: Sentinel 1, Sentinel 2, level 1B&1C, 48 tiles; Resolution: S1 imagery: 10 m, monthly, S2 Images: 13 bands in 3 resolutions (10/20/60m);
4. Final map: 10 m
5. Land cover classes: Paddy rice, annual crops, steep slope agriculture, maize, cassava, sugarcane, tea plantations, coffee plantations, orchards and plantations, sparse natural vegetation, dense natural vegetation, bare areas, built-up, water
6. Coordinate System: Spheroid GRS80
7. Projection: Transverse Mercator
8. Generation method: Hybrid
9. Tools used:
   - LCCSv3: LCML land cover legend definition
   - SEPAL: Selection of satellite images (S2)
   - Google Earth Engine: Download satellite imagery, pre-processing of S1 images, ancillary data, charts of NDVI profiles
   - QGIS\ArcGis: GIS editing, photo interpretation, clipping.
   - eCognition Developer and Server: Segmentation and feature extractions
   - Erdas Imagine: Image processing (mainly mosaics and dicing of images)
   - KoBo toolbox: Field data collection tool
   - Python: Batch processing, data management
   - R Studio: Machine learning



Source: GIS unit, DALaM of MAF, 2020.

The crop cover maps team in Lao Peoples Democratic Republic

- Overall implementation: Department of Agricultural Land Management
- Coordination and financial support: SAMIS, FAO
- Official approvals: Ministry of Agriculture and Forestry
- Technical expertise and support: FAO Rome

Further information

Further information on the generated land cover maps and the SAMIS project under which they were developed can be found on the respective FAO page: http://www.fao.org/in-action/samis/en/
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Vientiane, Lao People's Democratic Republic

Funding proposals and concrete inquiries can be directed at the Department of Agricultural Land Management (DALaM, www.dalam.org.la) under the Ministry of Agriculture and Forestry (MAF), which can be reached by telephone under: +865 21 770201

Detailed information on the generation of the available land cover maps can be found in FAO & MAF, 2020. *Practical handbook for agricultural land cover mapping in the Lao People's Democratic Republic.* http://www.fao.org/3/-ca9960en/CA9960EN.pdf