Food and Agriculture Organization of the United Nations

Climate maps for the Lao People's Democratic Republic

Part of the Land Resources Information Management System (LRIMS)

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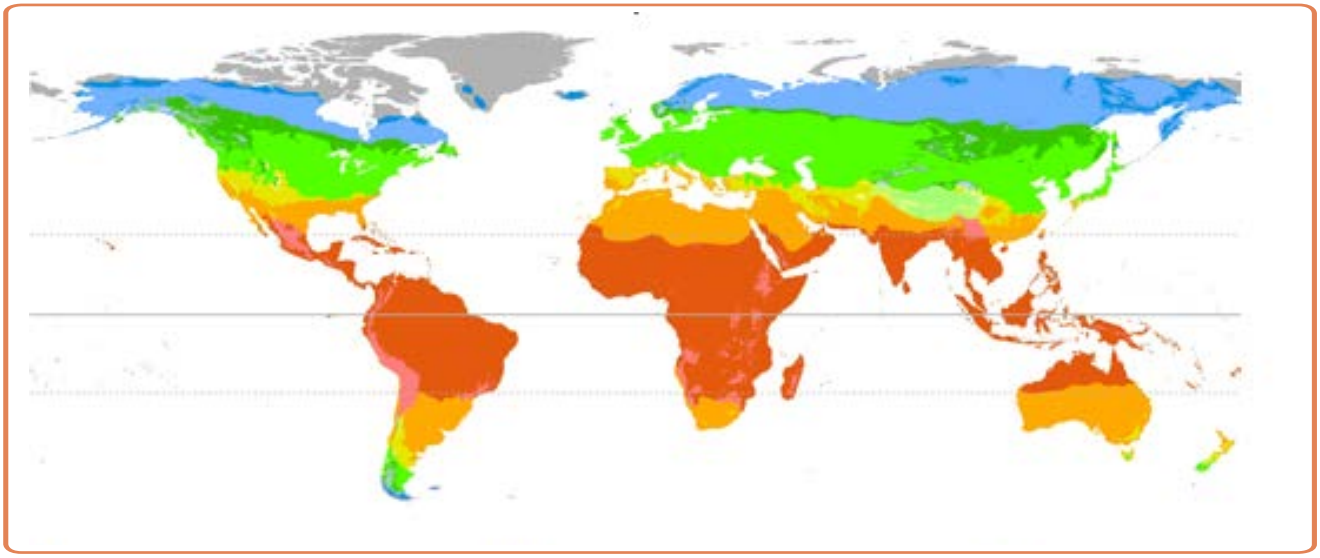
What are climate maps?



Source: Global thermal zones (baseline period: 1961-1990), FAO 2021 International Institute for Applied Systems Analysis (IIASA)

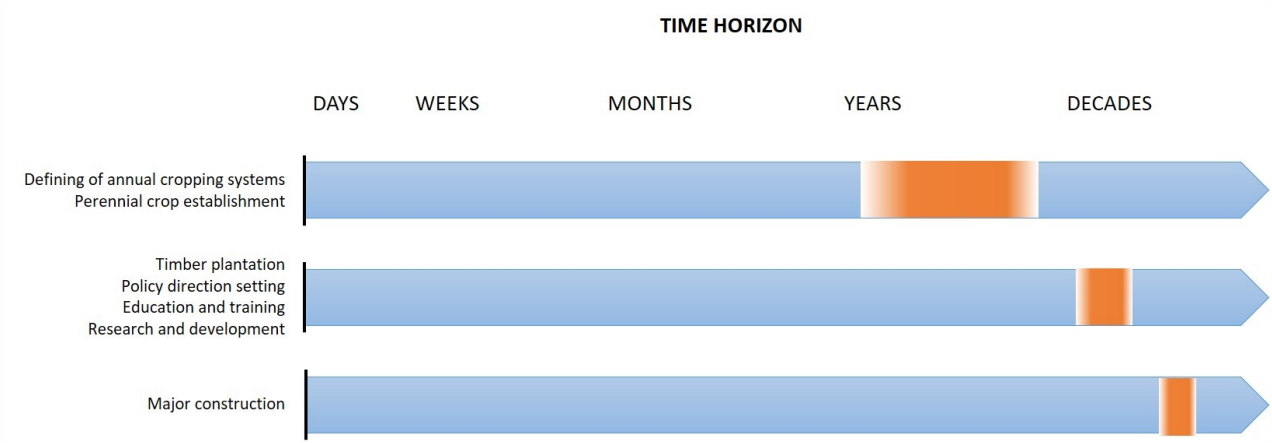
Weather is the state of the atmosphere at a particular place and time with regard to temperature, humidity and precipitation, cloudiness, sunshine, wind, etc. Climate is the sum of weather conditions prevailing in an area in general or over a long period. Thus, weather maps represent weather conditions at a specific point in time, whereas climate maps represent the average weather for a given period, e.g. specific days, months, seasons or a yearly average.

A climate map depicts such averages of climatic variables in a certain geographic area that has been observed over a long period. Each map usually shows one type of variable, most commonly either temperature or precipitation, but in principle all climate related variables can be mapped if data are available (e.g. humidity, atmospheric pressure, wind speed, sunlight hours etc.). While climate graphs can show climate changes over time, maps show climate variations across areas of any chosen size. Computer based interactive maps allow the combination of both features, showing the evolution of climatic conditions across an area over time. This allows for climate modeling and projections of future climate developments, which are powerful tools for predicting deviations of the analyzed variable (e.g. temperature) compared to average years, and to make long-term forecasts about the effects of global climate change.

Why are climate maps needed?

With global climate change affecting many areas of human societies already, sustainable development can only be achieved if countries are able to adjust current policies to future conditions. Especially in developing countries, in which agriculture is usually the major economic engine, climate related changes can have serious impacts and preparedness is essential to prevent hardship or crises. Maps of the present climate help to understand the prevailing conditions. Climate projections help guide crucial decisions, supporting regions, countries, and the global community as a whole in their adaptation efforts. For national and local governance, the analysis and interpretation of climate maps provides the basis for several advanced planning concepts such as agro-ecological zoning (AEZ). This allows for more effective application of agricultural knowledge, and to define impact scenarios for water availability, crop yields and socio-economic factors.

Climate maps enable national institutions to create agro-meteorological information and exchange knowledge on agricultural production, strengthening available land resource information. The outputs will support the development of agro-ecological zoning and feed into agricultural and adaptation policy development. The input data used come from the Lao Climate Service for Agriculture (LaCSA) and the outputs is one of the pillars of the Land Resources Information Management Systems (LRIMS), a collaboration between Government of Lao People's Democratic Republic and FAO.

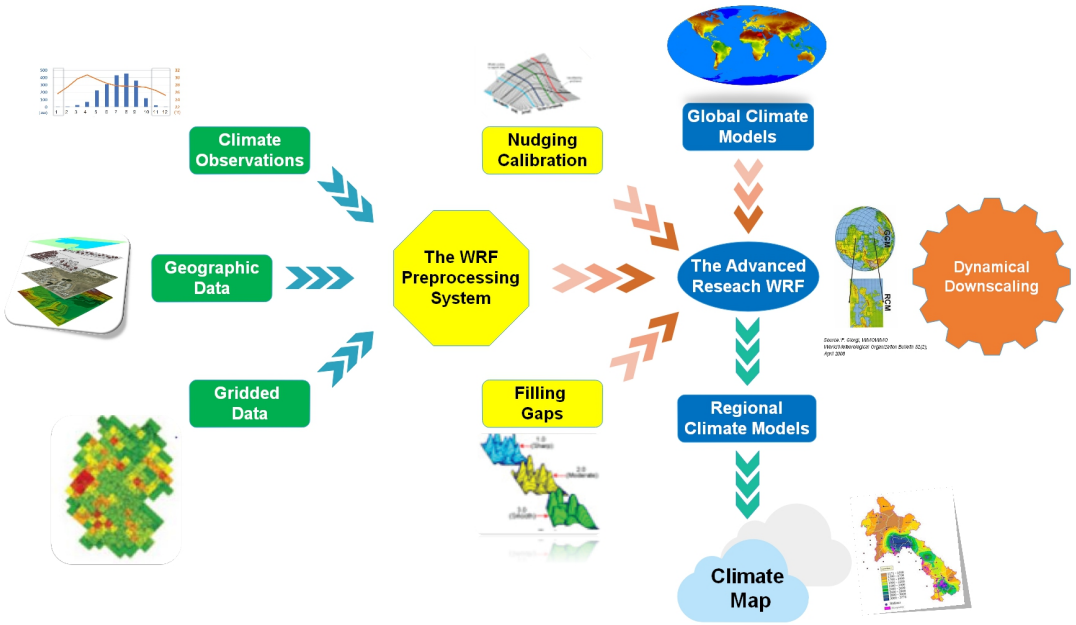


Adapted from Nissan et al, 2018

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

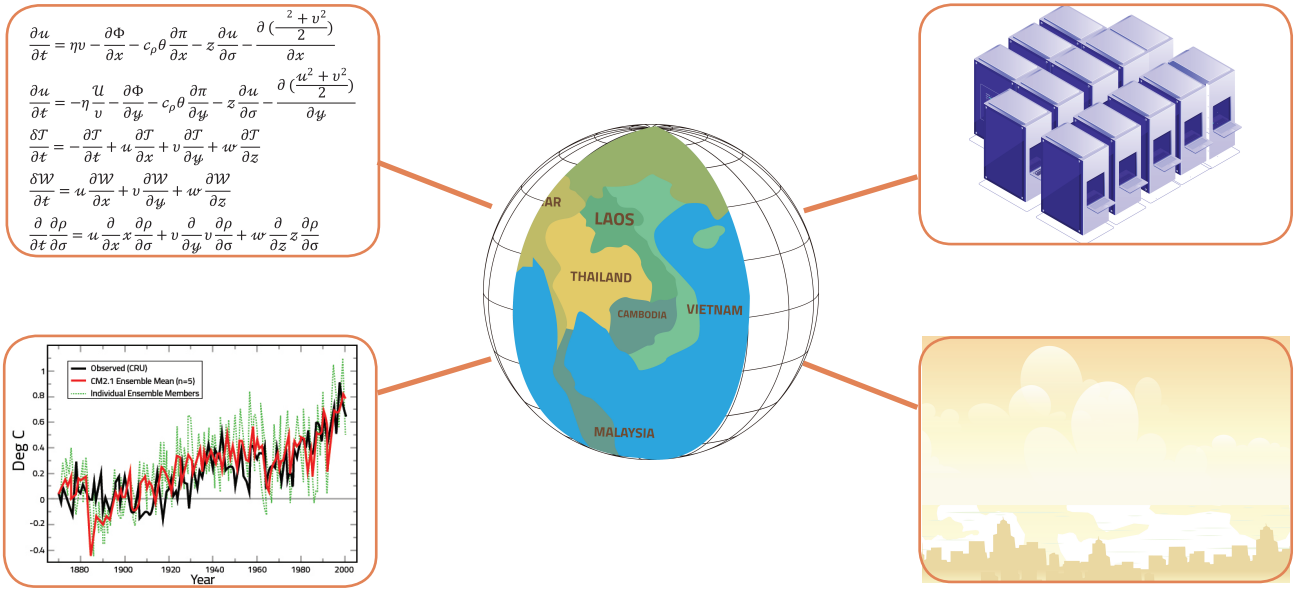
In general, regional climate maps are being generated by feeding local climate observations from weather stations into global climate models (GCMs - General Circulation Models) to create a regional climate model (RCM). This is done through dynamical downscaling, a procedure aimed at increasing map resolution by fitting information taken at different scales and extrapolating observation gaps. This process uses equations of atmospheric physics to model and downscale and is necessary as weather and climate for any locality is to a certain degree linked to a large number of other localities. Thus, observations made in Lao People's Democratic Republic need to be fitted into the global climate model patterns in order to get reliable predictions. The number of weather stations in a certain area and the length and continuity with which they have been operated determines the accuracy of the produced maps.

Lao People's Democratic Republic is the first country in Southeast Asia to have conducted such an extensive study for determining the best set of parameters and to elaborate dynamically downscaled climate maps based on them with their national human resources. It is the most extensive and accurate modeling currently available.



Climate maps generated in this project are based on the Weather Research and Forecasting Model (WRF V4 and WRF-CORDEX), which provides daily minimum and maximum temperature, precipitation, relative humidity, wind speed, and solar radiation. Specific geographical and meteorological data from Lao People's Democratic Republic are first combined in the WRF Preprocessing system (WPS). Then different statistical methods are applied (e.g. Arithmetic method, Normal Ration method, Double mass curve Method, Inverse Distance Weighting, Linear Regression Method) to fill the spatial and temporal gaps between observations so that a consistent map can be generated. After nudging (four dimensional variational data assimilation, Newtonian Relaxation) to adjust uncertainties in the coarser GCM to the finer resolution in the Regional Climate Model, and a circular calibration process of the model parameters, the Advanced Research WRF (ARW) dynamic solver model produces predictive data that can be mapped.

The simulation of 30 years in the past was done by 320 computer cores used in parallel, expending more than 43'200 hours of core computation time and generating a volume of more than 20 TB of data. With the model for past data validated, the downscaling of future climate projection data provided by different Global Climate Models is underway for a range of scenarios for Lao People's Democratic Republic.

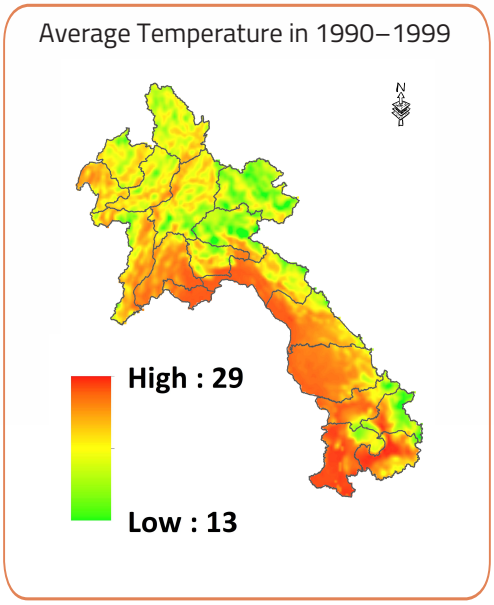


What are the final outputs and who for?

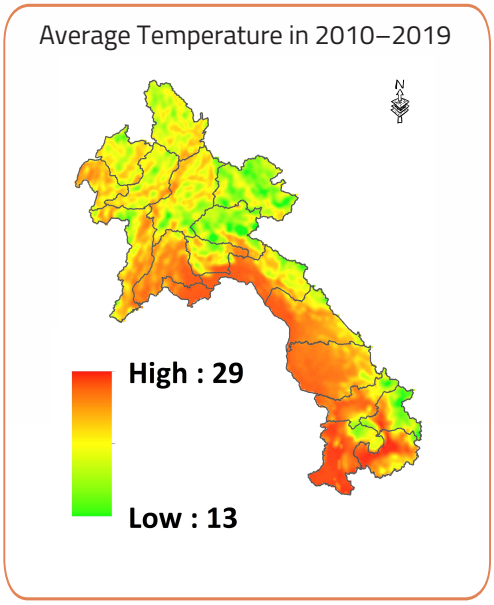
Ultimately, climate data for 30 years in the past have been generated and for at least 60 years in the future will be generated in the near future. They will be the basis of a comprehensive climate atlas for Lao People's Democratic Republic to display national capacities for this sort of work, and an essential part for the Agro-Ecological Zonation (AEZ) program.

Observational data from DMH are not publicly accessible in Lao People's Democratic Republic. The produced standard GIS maps in GRID format are based on point observations from DMH run weather stations and are free to use and downloadable by anyone.

Many government agencies have already indicated interest in these products for reporting to the UN Convention for Climate Change, for disaster risk preparedness, and for planning and construction of infrastructure such as roads or dams, etc. Also, policy makers on all levels, as well as farmers and other entrepreneurs are expected to ultimately benefit from the generated information.



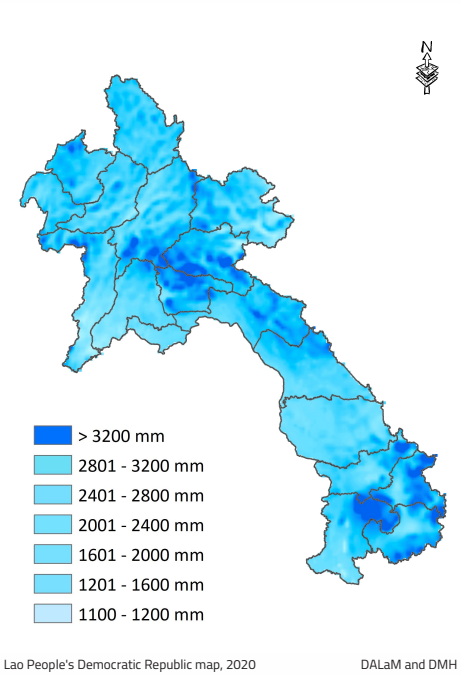
Lao People's Democratic Republic map, 2020 DALaM and DMH



Lao People's Democratic Republic map, 2020 DALaM and DMH

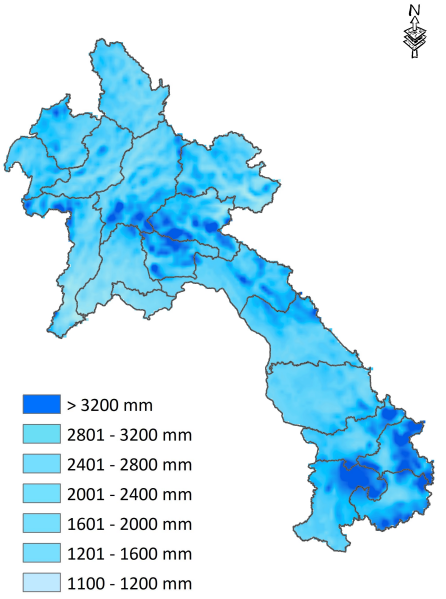
Specifications of the generated maps

Average Accumulated Annual Rainfall in 1990–1999(mm)



Lao People's Democratic Republic map, 2020 DALaM and DMH

Average Accumulated Annual Rainfall in 2010–2019(mm)



Lao People's Democratic Republic map, 2020 DALaM and DMH

List of daily outputs:

- Resolution: 5 km
- Minimum Temperature
- Maximum Temperature
- Accumulated rainfall
- Average short wave radiation
- Average relative Humidity

The climate maps team in the Lao People's Democratic Republic

- Downscaling implementation: DaLAM,
- with the support of DMH
- Data quality assessment and control, model validation data provided by: DMH
- Coordination and financial support: SAMIS, FAO
- Official approvals: DMH at MONRE,
- in collaboration with MAF
- Technical lead and support: Geospatial Information Center, Asian Institute of Technology, Thailand

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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/
FAO Representation in Lao People's Democratic Republic
FAO-LA@fao.org

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Vientiane, Lao People's Democratic Republic

The maps and further information on LRIMS will be retrievable from the LRMIS website Lao People's Democratic Republic, which will go online in 2021.

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.

Concrete inquiries can be directed also at the Department of Meteorology and Hydrology under the Ministry of Natural Resource and Environment (MONRE), which an be reached by telephone under: +865 021 510030.

Detailed information on the generation of the available climate maps are available in Athukorala et al., 2021. https://doi.org/10.1155/2021/6630302

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