MoFuSS visualization tool – extended

All results displayed here are linked to MoFuSS global outputs and are updated each time the model is run. You can also access the data here.

How to query and interpret the results in the visualization tool?

MoFuSS was originally designed to calculate avoided CO2e emissions by comparing aboveground biomass dynamics with (ICS) and without (BaU) a clean cooking intervention. This approach diverges from currently approved methodologies, such as AMS.II.G, and requires information on both past and future deployment of woodfuel-saving devices. The strength of comparing BaU vs ICS scenarios lies in attributing the differences in AGB (avoided losses and augmented gains) directly to the intervention, without needing to define woodfuel sheds or summarize raster data by administrative divisions. However, this method is not applicable for carbon credits accounting, and currently, the fNRB parameter in the baseline must be used.

Raster results from the BaU simulations are aggregated at different administrative levels to provide estimates for various regions. You can access each administrative unit by zooming in and out while displaying the vector layers (Figure 1). However, caution is needed in interpreting these results. The woodfuels harvested in each administrative unit may be supplied to demand centers in other units, especially if the units are small. Therefore, unless you have a clear understanding of the maximum distance woodfuels are sourced for your project area, it is strongly recommended to use national values to account for all possible woodfuel transportation.

You can also use the left side menu and upload or draw your area of interest, considering the same previous recommendation, and a few essential statistics will be calculated on the fly and showed in the right side of your screen (Figure 2).

Figure 1. Vector layers at three different zooms

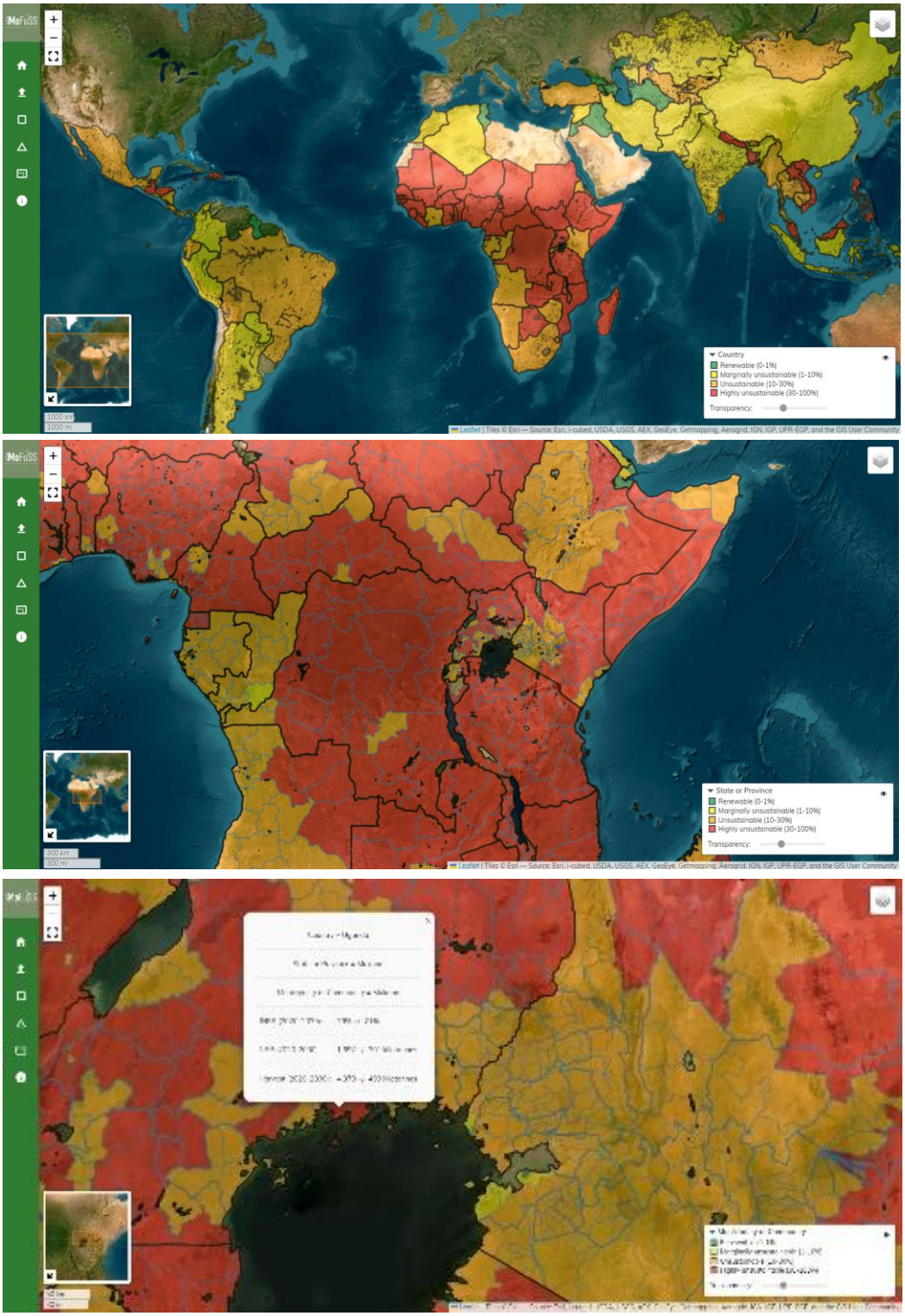
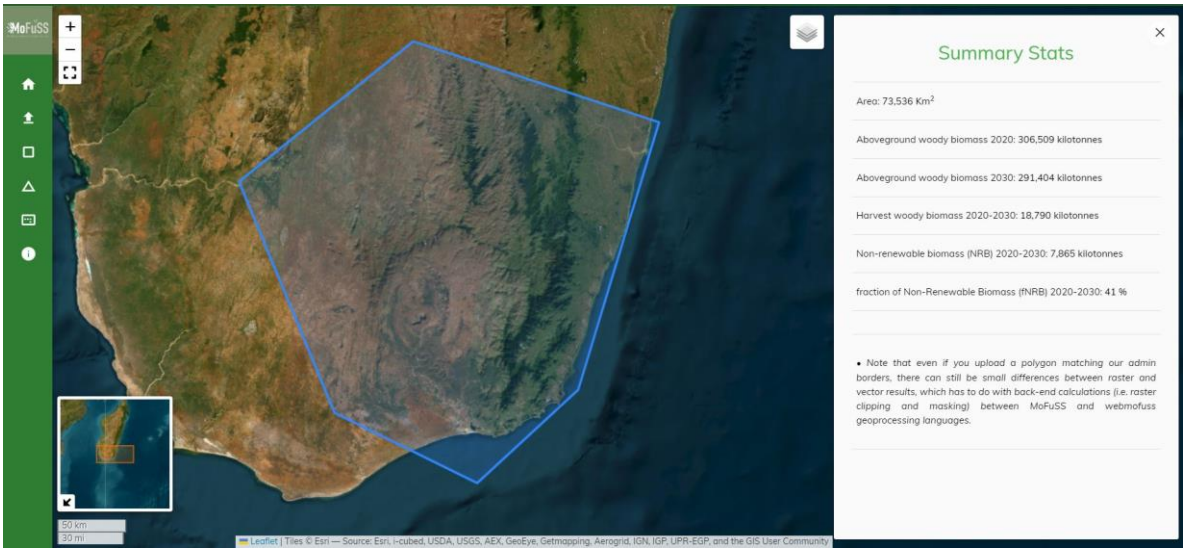


Figure 2. Summary statistics for area of interest draw or uploaded by the user.



Understanding MoFuSS at different resolutions

In geospatial analysis and modeling, the resolution of map layers being processed, and the time of analysis are of paramount importance. Even though results are presented by administrative units, all input, temporal, and output layers in MoFuSS are invariantly a rectangular matrix of pixels, or so called “raster maps.” The size of each pixel or cell becomes important because they represent features in the real world. In the present analysis, all input layers at 30, 90, and 100, 300 and 500m were resampled using appropriate procedures into 1km.

Regarding temporal resolution, MoFuSS operates with annual increments from 2010 to 2050. The summary results for the current decade (2020-2030) are provided. MoFuSS is a dynamic geospatial model, which means it reflects temporal changes in land use. For instance, an area cleared for charcoal production in the first year is recorded as deforested during that year but may experience regrowth in subsequent years. Employing decadal intervals to report data is a conservative approach (towards higher values of fNRB) as revegetation can often extend beyond a decade, particularly in regions where woodfuel demand is projected to decrease to zero by 2050.

The global model at 1km can overestimate fNRB values

The 1km analysis tends to overestimate woodfuel-driven aboveground biomass (AGB) losses (i.e. NRB and fNRB) because of five reasons. Depending on the region, each of these will have a different importance.

1.- Non-energy anthropic pressure

The non-energy anthropic pressure in MoFuSS comprises a set of parameters designed to calibrate the natural regrowth potential of forests and woodlands, accounting for non-energy drivers of forest degradation. These drivers include selective logging for timber and pulp, extensive grazing, altered fire regimes, edge effects, and more (C. Bourgoin et al. , 2024, Li et al. , 2023). The 1km model assumes that these non-energy drivers are prevalent everywhere, implying that even if all woodfuel demand were eliminated, woodlands would not fully regrow to their biophysical potential due to the ongoing pressure from an unknown mix of non-energy anthropic activities.

As MoFuSS simulations progress, woodfuel harvest reduces aboveground biomass (AGB) stocks during the analysis period, with natural regrowth occurring, based in part on the spatial intensity and temporal trajectories of harvest and collection events. In many parts of the world where AGB stocks are below their biophysical potential and gains are scattered, this assumption seems valid. However, there are numerous regions where AGB gains are widespread and even have outpaced losses over the past two decades (Yude Pan et al. , 2024). When running high-resolution versions of MoFuSS over specific areas with significantly more AGB gains than losses, and calibrating the non-energy anthropic pressure accordingly, fNRB simulations show a significant drop compared to global results.

2.- Resolution

The AGB map used in the global analysis (NASA, 2020) fails to account for all woody resources utilized for fuelwood and charcoal, mostly in arid or highly degraded areas such as Haiti (Ghilardi et al. , 2018). When running high-resolution versions of MoFuSS using 30m to 100m AGB maps in arid or degraded regions, there is more biomass available compared to the 1km version, with a drop in fNRB values (Miro Demol et al. , 2024).[1] These high-resolution maps are currently a bottleneck for running MoFuSS at 100m as they are not freely available and can be quite expensive from private providers. So far, we have used selected areas of high-resolution, multitemporal AGB maps to calibrate and validate MoFuSS between 2010 and 2022. The comparison with the 1km estimates shows lower fNRB values.

3.- Deforestation

Many areas around the world are experiencing deforestation due to non-energy drivers, resulting in land use and cover changes (e.g. Haddad et al. , 2024). When there is demand for woodfuel, the wood from land clearing operations is often used as fuelwood or for making charcoal. Occasionally, using this wood as fuel can be seen as a catalyst of change rather than the underlying driver, as the profits from selling charcoal or fuelwood can finance the land clearing for conversion to cropland or grazing areas. In any case, we couldn't model this on a global scale due to site-specific circumstances governing these patterns. When the "deforestation submodule" is activated in

[1] Note that ecosystems with higher-than-previously-estimated carbon levels result in more credits for conservation and restoration projects. However, the opposite is true for cookstove projects; as more carbon is stored per areal unit, the impact is diminished due to inelastic demand.

MoFuSS and calibrated to simulate land clearing events into the future, fNRB values tend to decrease because a tunable percentage of the felled wood is assumed to be used as fuelwood and/or converted into charcoal depending on their demand trends.

4.- Elasticity in demand scenarios

We assume woodfuel demand scenarios are inelastic, which is rarely accurate. In situations of acute scarcity, driven for example by the expansion of land clearing operations or by tightening enforcement on woodfuel access, production, or trade, people simply use less wood and switch to lower forms of biomass such as crop straws (Jagger and Shively, 2014). It is worth noting that inelastic demand can also underestimate fNRB values in woodlands with higher-than-previously-estimated AGB. MoFuSS has yet to incorporate elasticity of demand, not due to modeling challenges, but because of the significant lack of information on the subject. A first indicator could be the correlation between unitary woodfuel usage and availability at the landscape level (Ghilardi et al. , 2007).

5.- Carbon accumulation potential from natural regrowth

MoFuSS uses IPCC default values (Dong H et al. , 2019) to derive the intrinsic growth rate of AGB for various ecosystems and ecological zones. It has been published that these rates “may underestimate aboveground carbon accumulation rates by 32 per cent on average and do not capture eight-fold variation within ecozones” (Cook-Patton et al. , 2020). An essential aspect of the ongoing calibration and validation efforts, as briefly mentioned earlier, involves adjusting regrowth parameters using observed datasets.

Woodfuel harvesting occurring within Protected Areas could underestimate fNRB values

The global model estimates that woodfuel harvested within protected areas is about 10% of the expected harvest without protection, predominantly near the boundaries. However, discussions with project developers reveal that in areas with weak enforcement, people enter deeper into protected zones for fuelwood and charcoal production, effectively ignoring protections. The porosity of protected areas is one of many parameters in MoFuSS and should be adjusted in regions with insufficient enforcement. When protected areas are mostly surrounded by low-AGB density supply zones such as croplands or rangelands, and their porosity is increased, the fNRB tends to be higher.

In conclusion, a higher-resolution version of MoFuSS, specifically parameterized for a given site and calibrated with independent data on AGB dynamics, could potentially yield significantly lower fNRB values in the baseline compared to the global 1km results. This hypothesis can only be confirmed through further analyses in selected case studies across the Global South.

Willing to push the envelope?

If you have information for your project on past and/or future deployment of woodfuel-saving devices and would like to compare how avoided emissions look like when considering not only a reduction in losses, but also the expected gains in aboveground biomass, please get in touch.

References

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Publications

A handful of peer-review papers and commissioned reports on MoFuSS and WISDOM.

Ghilardi, A, Bailis R. Updated fNRB Values for Woodfuel Intervention. UNFCCC commissioned study. 2024

This commissioned report presents up to date values of fNRB for many countries in the Global South using the MoFuSS model

Bailis R, Drigo R, Ghilardi A, Masera O. The carbon footprint of traditional woodfuels. Nat Clim Change. 2015;5:266-72.

This paper describes the 2015 global WISDOM model

Bailis R, Wang YT, Drigo R, Ghilardi A, Masera O. Getting the numbers right: revisiting woodfuel sustainability in the developing world. Environ Res Lett. 2017;12.

This paper describes the 2015 global WISDOM model

Ghilardi A, Bailis R, Mas JF, Skutsch M, Elvir JA, Quevedo A, et al. Spatiotemporal modeling of fuelwood environmental impacts: Towards improved accounting for non-renewable biomass. Environ Modell Softw. 2016;82:241-54.

This paper describes the original MoFuSS model in detail. Some steps have changed, but the underlying concepts are very similar to those described here.

Ghilardi A, Tarter A, Bailis R. Potential environmental benefits from woodfuel transitions in Haiti: Geospatial scenarios to 2027. Environ Res Lett. 2018;13.

This paper describes an early application of the MoFuSS model. It demonstrates how comparing BAU to alternate scenarios can result in an estimate of net biomass stock change and wrestling carbon emission reductions.