

Open geodata of the LaForeT project landscapes in Ecuador, the Philippines and Zambia

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Abstract

The LaForeT (Landscape Forestry in the Tropics) project has been conducted by the Thünen Institute of Forestry in close collaboration with partners in Ecuador, the Philippines and Zambia in the years 2016 to 2023 with the main objective to analyze the impact of policy instruments on deforestation and reforestation processes as well as land-use dynamics and sustainability in a landscape context. The project relied on an extensive field campaign to collect research data from different scientific domains related to tropical land use. Even though that more than 20 scientific publications have in the meantime become available based on the data sets, the scientific data potential is far from being fully exploited. New scientific and political questions are to be expected to which the data sets can provide answers; in addition, the data can provide a baseline for future studies to assess land use change dynamics on a pan-tropical scale. Therefore, the aggregated field data are now made publicly accessible. Terms of use require a correct citation of the data sets as well as a specific requirement for commercial use. This Working Paper provides a general description of the project and links to the data sets in order to facilitate further use of the data by the scientific community and other land users. Annexes to this Thünen Working Paper are available with specific technical descriptions of the single data sets.

Keywords

deforestation, tropics, landscapes, livelihoods, forest inventory, land use, governance, open data

Zusammenfassung

Das LaForeT Projekt (Landscape Forestry in the Tropics) wurde vom Thünen-Institut für Waldwirtschaft in enger Zusammenarbeit mit Partnern in Ecuador, den Philippinen und Sambia in den Jahren 2016 bis 2023 durchgeführt. Das Projekt analysiert Auswirkungen von Politikinstrumenten auf die Entwaldung und auf Aufforstungsprozesse sowie die Nachhaltigkeit der Landnutzung im Landschaftskontext. Das Projekt stützte sich auf eine umfangreiche Feldkampagne, welche Forschungsdaten aus verschiedenen Bereichen tropischer Landnutzung generierte. Auch wenn mittlerweile mehr als 20 wissenschaftliche Publikationen auf Basis der Datensätze vorliegen, ist deren wissenschaftliches Potenzial noch lange nicht ausgeschöpft. Es sind neue wissenschaftliche und politische Fragestellungen zu erwarten, auf die die Datensätze Antworten geben können. Darüber hinaus können die Daten eine Grundlage für zukünftige Studien zur Dynamik von Landnutzungsänderungen auf pantropischer Ebene liefern. Daher werden die aggregierten Felddaten nun öffentlich zugänglich gemacht. Die Nutzung der Daten setzt ein korrektes Zitieren der Datensätze voraus. Für die kommerzielle Nutzung gelten spezielle Bedingungen. Dieses Thünen Working Paper beschreibt das Projekt im Allgemeinen und enthält Links zu den Datensätzen, um die weitere Nutzung der Daten durch die Wissenschaft und andere Landnutzer zu erleichtern. Die Anhänge enthalten spezifische technische Beschreibungen der einzelnen Datensätze.

Schlagworte

Entwaldung, Tropen, Landschaften, Lebensgrundlagen, Waldinventur, Landnutzung, Governance, offene Daten

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1 Introduction

Tropical deforestation is continuing at a reduced pace but is still reported to amount to 10 mio ha/year for the years 2015 – 2020 (FAO, 2020). Globally, forest disturbance is mainly attributed to land use change for the production of agricultural commodities, as well as to forestry, shifting agriculture, wildfires and urbanization (Curtis *et al.*, 2018). Ongoing deforestation often results in dramatic impacts on livelihoods and ecosystem services including climate and biodiversity. Multiple policies and programs have been and are currently deployed to reduce and even halt tropical deforestation. Sound scientific knowledge on the underlying drivers, their interactions with direct causes (Geist and Lambin, 2002) and their effects on forest ecosystems in a landscape context (Sayer *et al.*, 2013) is needed as a basis for the multiple policy approaches.

The LaForeT project (Landscape Forestry in the Tropics; www.la-foret.org) has been conducted by the Thünen Institute of Forestry in close collaboration with partners in Ecuador, the Philippines and Zambia in the years 2016 to 2023. It integrates different scale levels for the analysis of the deforestation drivers, land use and land use change, ecosystem service provision, socio-economic conditions as well as governance and policy frameworks and relies on modelling tools to capture the complex dynamics of previous, present and anticipated land use changes. During this research project, a comprehensive field data set has been collected in 36 study landscapes, i.e. 12 landscapes per each of the three partner countries. The data have already been the basis for over 20 scientific publications (Section 5). Yet, the potential of the data sets in terms of scientific evaluations may not be fully exploited, as new scientific and political questions are to be expected to which the data sets can provide answers. In addition, the high temporal dynamics of land use change in the tropics make it seem worthwhile to publish these data sets as a baseline for future studies focusing on temporal changes in the LaForeT study landscapes. Geopackages of the aggregated data are now available under the links given in Section 4, the data are as well published on the Thünen Atlas (<https://atlas.thuenen.de>) where they can be visualized interactively with or without data download. This Working Paper provides a general description of the project as a background to the data sets as well as the links for open data publications. Annexes to this Thünen Working Paper are available with specific technical descriptions of the single data sets.

2 The LaForeT Project

The core objective of the LaForeT (Landscape Forestry in the Tropics) project is to

- Analyze the impact of policy instruments on deforestation and reforestation processes as well as land-use dynamics and sustainability in a landscape context.

More specific objectives are related to six work packages (WP, see Figure 1). These work packages cover spatial scales from single land users to the national level and are related to different drivers of land use change. They include:

- (1) Multitemporal analysis of re- and deforestation patterns (WP 1)
- (2) Sustainable forestry and agroforestry land-use (WP 2)
- (3) Land use, livelihoods and opportunity costs (WP 3)
- (4) Barriers for sustainability due to governance structures (WP 4)
- (5) Ecosystem services and payments for ecosystem services (PES), especially carbon/REDD+ (WP 5)
- (6) Modelling the consequences of incentive systems and controlling tools on forests, landscapes and livelihoods of the local population (WP 6)

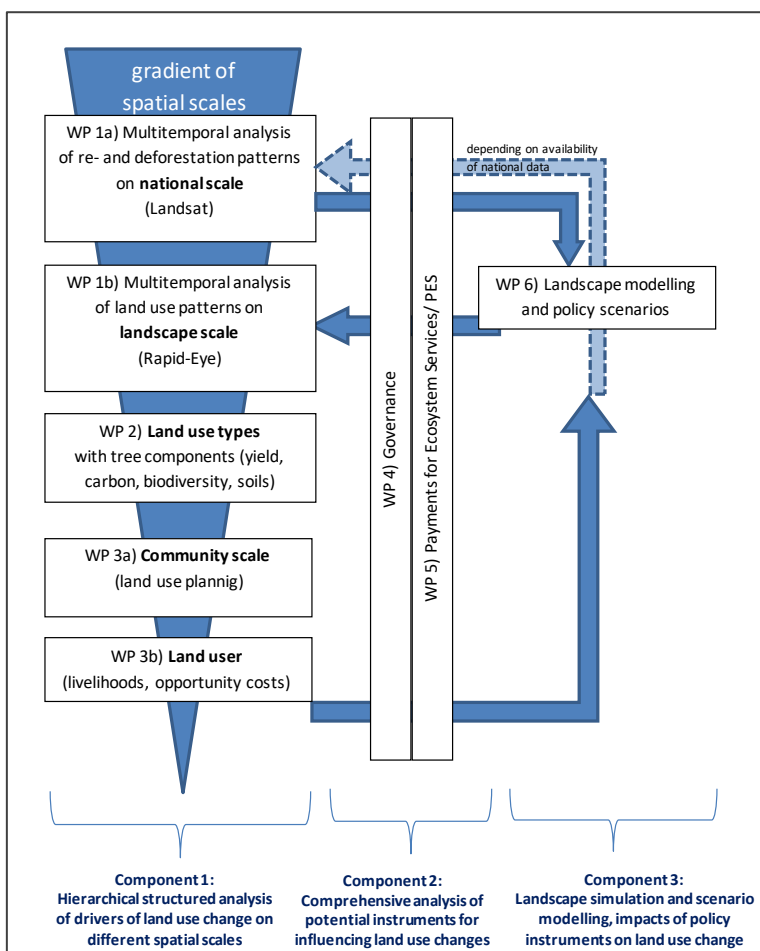


Figure 1: The conceptual project approach is based on three components and six work packages: the analysis of drivers of land use change on different spatial scales (left, WP1-3), the comprehensive analysis of governance structures, environmental valuation and payments for ecosystem services „PES“ (middle, WP 4-5), as well as landscape simulation and scenario modelling (right, WP 6).

The project has been designed as a pan-tropical field study on landscape level. The study countries of the LaForeT project were selected to cover different phases in the forest transition framework. The forest transition hypothesis specifies phases from a declining to an expanding forest cover (Mather, 1992; Angelsen, 2007; Hosonuma *et al.*, 2012; Angelsen and Rudel, 2013). Forest transition usually starts in core forests areas, where deforestation rate is low and the forests are relatively undisturbed. A second phase refers to areas within so-called deforestation frontiers where deforestation rate is high, followed by a phase that refers to areas within forest/agricultural mosaics with reduced forest cover and low levels of forest loss. The late transition phase comprises areas with increasing forest cover, i.e. forest restorations and reforestations. Zambia was selected as a study country as national deforestation rates and temporal development indicate the country as representing an early transition stage. Ecuador was selected as country in a middle transition phase and the Philippines as country in a post transition situation (see Tab. 1). At the same time, the project countries were selected across the major global tropical forest regions in Latin America, Africa and South East Asia in order to provide for a pan-tropical perspective. Different transition phases can as well occur within each specific country. Within each LaForeT country, three regions were thus selected to again cover initial, middle, and advanced deforestation contexts. In each of the resulting nine regions, four landscapes of approx. 10*10 km size were selected. This resulted in 36 study landscapes (Figure 2). The landscapes were selected in pairs, in each case comprising one landscape without restrictions to use and access and one landscape that contained governance arrangements with restrictions, such as e.g. the Socio Bosque program or nationally protected areas in Ecuador, the community-based forest management programme in the Philippines or national forests in Zambia. Each of the landscapes was positioned within the boundaries of an independent jurisdictional unit (chiefdom, parish or municipality in Zambia, Ecuador and Philippines, respectively) to ensure homogeneous formal administration. They were all selected as multifunctional landscapes, thus capturing a diversity of forest and land-use types and to represent typical land-use, socioeconomic, demographic, and biophysical attributes of their respective regions.

Table 1: Forest cover dynamics of the study countries at the start of the project in 2016 (FAO, 2015). Values indicate that the countries represent early (Zambia), middle (Ecuador) and post (Philippines) forest transition stages

Attributes	Zambia	Ecuador	Philippines
Forest cover in 2016 (%)	65.2	50.2	27.8
Annual forest cover change 2010-15 (%)	-0.34	-0.62	3.29

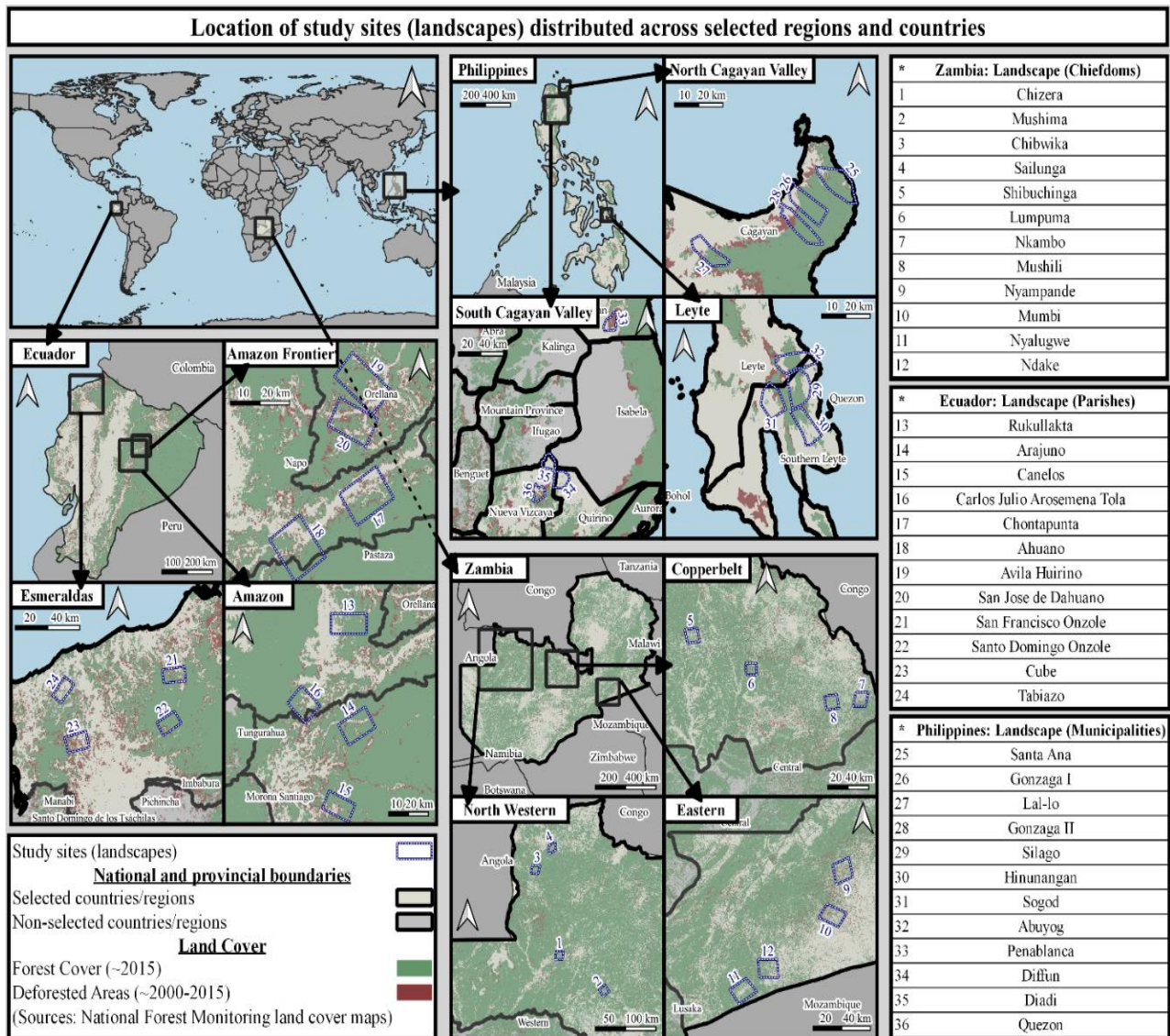


Figure 2: Location of LaForeT study landscapes within the selected countries.

The LaForeT project has been carried out by the following partners

- Thünen Institute of Forestry, Hamburg, Germany
- Amazon State University, Puyo, Ecuador
- Technical University Luis Vargas Torres, Esmeraldas, Ecuador
- Center for International Forestry Research (CIFOR), Lusaka, Zambia
- Copperbelt University, Kitwe, Zambia
- Visayas State University (VSU), Baybay City, The Philippines
- Isabela State University (ISU), Cabagan, The Philippines
- College of Forestry and Natural Resources of the University of the Philippines Los Baños College, Los Baños, The Philippines

The project has been financed by the German Federal Ministry of Food and Agriculture, by the German Federal Office for Agriculture and Food, as well as by the Thünen Institute and project partners in Ecuador, the Philippines and Zambia.

3 Data overview

Data within the LaForeT project have been collected in different surveys conducted under different work packages. With the exception of data for external drivers, national governance and payment for ecosystem services (PES), all data have been collected in the project landscapes in extensive field campaigns mostly organized by the partners in Ecuador, the Philippines and Zambia in the years 2016 – 2019 (Figure 3).

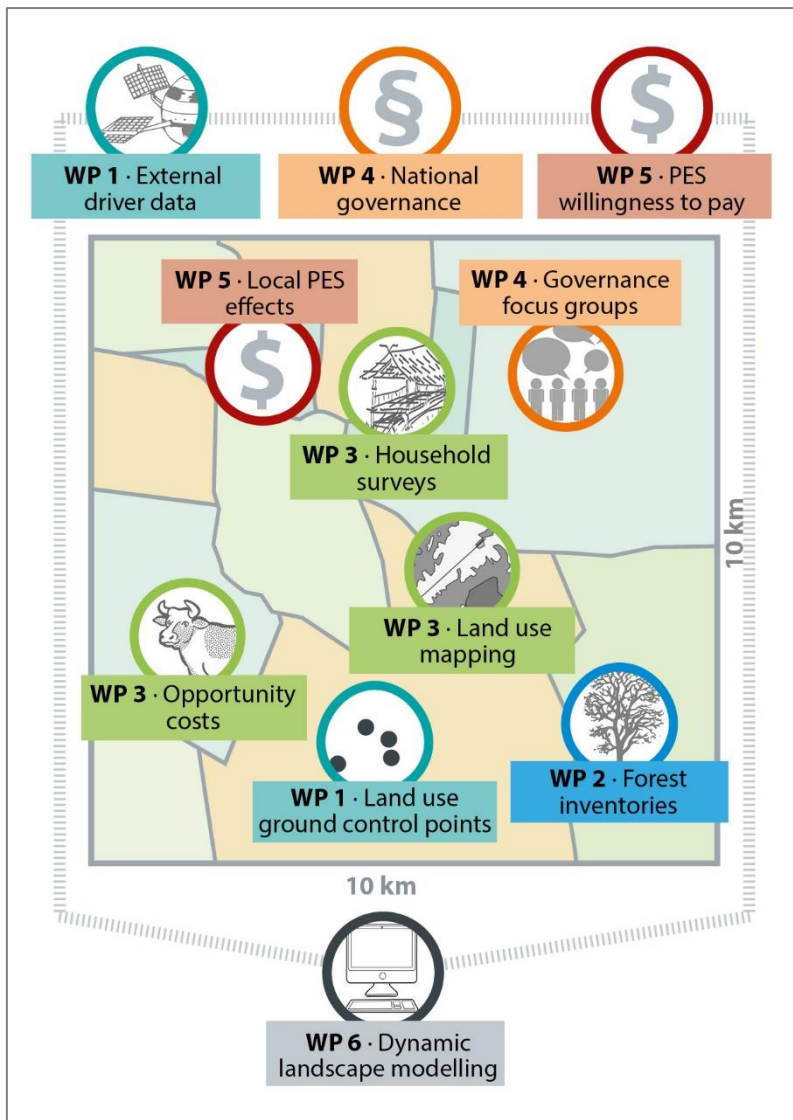


Figure 3: Surveys carried out in LaForeT under different work packages (WP) within project landscapes of approx. 10*10 km and on national level.

Aggregated field data from the landscape level are now available for open access, whereas raw data and national level data might be requested by the authors and the LaForeT project team. This section provides an overview on the open data sets and how they are interrelated (Table 2).

WP 1: Multitemporal analysis of re- and deforestation patterns

The collection of reliable figures on deforestation and its spatial and temporal distribution are of utmost importance in order to be able to develop efficient and targeted countermeasures for the affected countries and regions. The work package relies on the analysis of publicly available and commercial satellite data. In addition,

terrestrial ground truthing of land use has been carried out between 2016 and 2019 on over 16.000 georeferenced ground control points. Ground truthing was based on a pre-stratification through scoping visits, key informant interviews, community workshops, participatory mapping exercises, household interviews, and forest inventories, in order to capture the main forest and land cover/land use types in each landscape. In the field, control points were classified into land use categories based on a project specific and four-tiered land cover and land use classification scheme.

WP 2: Sustainable forestry and agroforestry land-use

Based on the selected landscape sections and satellite images from WP 1, the second work package aims to investigate the influence of land use on forest area and forest structure. For this, parameters on carbon stocks, tree species diversity and soil fertility were collected. Primary and secondary forests, forest plantations and agroforestry areas were taken into account. In each LaForeT landscape, approx 12 forest inventory plots were selected with pre-stratified random selection to cover the different forest types. Each plot contains four satellites on which all trees and partly palms with a diameter at breast height (dbh) ≥ 10 cm as well as deadwood components were measured. Soil samples were analyzed for a subsample of inventory plots.

WP3: Land use, livelihoods and opportunity costs

In order to be able to influence land use decisions through policy approaches, an analysis of the relevant land use types, their users and associated land use decisions is necessary. The work package thus analyzed the land use as well as the socio-economic conditions of land users in the landscapes based on a large-scale household survey of approximately 3.400 households in Ecuador, Zambia and the Philippines. An identical, structured questionnaire was applied for household interviews covering socio-demographics, land use, forest use, income activities, and contextual factors as well as other aspects of rural livelihoods.

In addition, land use has been mapped in more than 70 community workshops in the LaForeT landscapes in 2017-2019. Participatory mapping was used to produce maps at the landscape level from the perspective of individuals. Mapping was carried out in workshops assembling representatives from the research landscapes. Polygons were classified into land use categories based on the same project specific and four-tiered land cover and land use classification scheme which was applied in WPs 1 and 2.

WP 4: Barriers for sustainability due to governance structures

Governance structures are assigned a crucial role in the context of tropical forest management including conservation. Their consideration is of fundamental importance in international forest policy processes. Governance has been assessed and mapped together with property rights in more than 70 community workshops in the LaForeT landscapes in 2017-2019. Mapping was carried out in workshops assembling representatives from the research landscapes. Polygons of single governance arrangements were delineated. Subsequently, governance quality as well as property rights were scored in focus group discussions for selected polygons by the participants. Aggregations of these landscape level data are now available publicly. On national level, 224 key informant interview have been carried out to cover capture perceptions on drivers of deforestation and on effectiveness of different policy instruments by different stakeholder groups. These national level data are not included in the open access publication.

WP 5: Ecosystem services and payments for ecosystem services (PES)

The "Payments for Ecosystem Services" (PES) approach aims to place greater value on the services of natural ecosystems and thus create income opportunities for land users, which offer an incentive to preserve these ecosystems. In the LaForeT project, the assessment relied on a willingness to pay questionnaire distributed to

976 households in Ecuador. This data set is not included in the open access platform. PES related evaluations on the landscape level relied on data sets from other WP with additional data collection.

WP 6: Modelling the consequences of incentive systems and controlling tools on forests, landscapes and livelihoods of the local population

Landscape simulation models are effective instruments for GIS-based information and decision support and serve various additional applications. In LaForeT, no specific data collection was included for the modelling exercises, as the models rely on data from all other WPs.

Technical descriptions of the single data sets are available in additional open access publications (Section 4).

For most of the data sets, scientific publications are available in addition (Table 2 and Section 5); these publications tackle specific scientific research questions on one side but on the other describe the methodology of data collection and treatment for single surveys and WPs.

Table 2: LaForeT data sets and publications for different countries and work packages. In green: open access data. References as listed in Section 5

Work package		WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	All WP
Name WP		Drivers and de-/reforestation patterns	Forestry land use	Livelihoods	Governance	Payment for ecosystem services	Modelling	
Ecuador	sampling units	7167 land use ground control points; 1136 land use/cover polygons	156 inventory plots	mean livelihood indicators for 12 landscapes based on 1255 households	governance and property rights scores for 201 polygons	976 household interviews	all project and external data	
				participatory land use maps for 12 landscapes	participatory governance maps for 12 landscapes			
	year	2018/19	2016/17	2017	2017/18	2017		
	results publication	LIPPE et al. 2022	EGUIGUREN et al. 2019	OJEDA LUNA et al. 2020a	FISCHER et al. 2021	GORDILLO et al. 2019	LIPPE et al. 2022	TORRES et al. 2020
			EGUIGUREN et al. 2020	OJEDA LUNA et al. 2020b	SARKER et al. 2022	GORDILLO et al. 2021		
Philippines	sampling units	6577 land use ground control points; 507 land use/cover polygons	232 inventory plots	mean livelihood indicators for 12 landscapes based on 1179 households	governance and property rights scores for 40 polygons			
				participatory land use maps for 12 landscapes	participatory governance maps for 7 landscapes			
	year	2016-18	2017/18	2017/18	2017/18			
	results publication		VERIDIANO et al. 2020 (external data)	WIEBE et al. 2022				
				ZHUNUSOVA et al. 2022				

Zambia	sampling units	2932 land use ground control points; 998 land use/cover polygons	119 inventory plots	mean livelihood indicators for 12 landscapes based on 1148 households	governance and property rights scores for 74 polygons			
				participatory land use maps for 12 landscapes	participatory governance maps for 12 landscapes			
	year	2018/19	2018/19	2018/19	2017/18			
	results publication			KAZUNGU et al. 2020	NANSIKOMBI et al. 2020a			
				KAZUNGU et al. 2021a	NANSIKOMBI et al. 2020b			
				KAZUNGU et al. 2021b				
trans national	sampling units				224 key informant interviews			
	year				2018/19			
	results publication	FERRER VELASCO et al. 2020 (with external data)	PETERS et al. 2023	SADEGHI et al. 2023	FERRER VELASCO et al. 2023			
		FERRER VELASCO et al. 2022			FISCHER et al. 2023			
		FERRER VELASCO et al. 2023						
	data publication							
	data incl. metadata							

4 Data access

Data are open for public, non-commercial use on the condition of correct scientific citation.

The following LaForeT geodata packages are available

Ferrer Velasco, R., Lippe, M., Günter, S., Jany, C., Mfuni, T., Rebuyas, R.S., Tamayo, F., Fischer, R., Eguiguren, P., Kazungu, M., Nansikombi, H., Ojeda-Luna, T., Wiebe, P., 2023. Geospatial open data for ground control points and landscape borders of the LaForeT project. Annex 1 to Thünen Working Paper 236. Braunschweig, Germany
<https://doi.org/10.3220/DATA20240213131557-0>
https://www.openagrar.de/receive/openagrar_mods_00092843

Lippe, M., Ferrer Velasco, R., Yang, A., Caraan, R., Gayagay, R., Günter, S., Kabwe, G., Mangabat, C., Nansikombi, H., Sales-Come, R., Tamayo, F., Fischer, R., 2023. Geospatial open land cover and land use data of the LaForeT project. Annex 2 to Thünen Working Paper 236. Braunschweig, Germany.
<https://doi.org/10.3220/DATA20240213131637-0>
https://www.openagrar.de/receive/openagrar_mods_00092852

Peters, F., Fischer, R., Günter, S., Eguiguren, P., Jany, C., Mfuni, T., Schröder, J.M., Veridiano, K., 2023. Open forest inventory data of the LaForeT project. Annex 3 to Thünen Working Paper 236. Braunschweig, Germany.
<https://doi.org/10.3220/DATA20240213131425-0>
https://www.openagrar.de/receive/openagrar_mods_00092849

Zhunusova, E., Kazungu, M., Ojeda-Luna, T., Wiebe, P., Sadhegi, A., Ferrer Velasco, R., Günter, S., Kabwe, G., Jany, C., Lippe, M., Mangabat, C., Sales-Come, R., Torres, B., Fischer, R., 2023. Open livelihood data of the LaForeT project. Annex 4 to Thünen Working Paper 236. Braunschweig, Germany.
<https://doi.org/10.3220/DATA20240213131502-0>
https://www.openagrar.de/receive/openagrar_mods_00092842

Fischer, R., Caraan, R., Gayagay, R., Günter, S., Kabwe, G., Mangabat, C., Nansikombi, H., Tamayo, F., 2023. Geospatial open governance data of the LaForeT project. Annex 5 to Thünen Working Paper 236. Braunschweig, Germany.
<https://doi.org/10.3220/DATA20240213131340-0>
https://www.openagrar.de/receive/openagrar_mods_00092841

Interactive visualization of the research data is possible on the Thünen Atlas under <https://atlas.thuenen.de>.

Data download is as well possible through the Thünen Atlas.

In addition, data from the inquiry among over 3.500 households in all three countries are available. For privacy reasons, these are not included in the set of open research data, but can be requested in anonymized formats from the authors or the Institute of Forestry. Also, requests for any other additional data, specifically raw data or data for commercial use should be directed to the authors or to the Institute of Forestry, Hamburg, Germany (<https://www.thuenen.de/de/fachinstitute/waldwirtschaft>).

5 Results and LaForeT publications

Based on the project data as well as on additional publicly available data scientific results have become available and publication of related results is still ongoing. Results are accessible on the project webpage (www.la-foret.org) and have been published in numerous scientific publications. They include the following (as per December 2023).

- Eguiguren, P., Fischer, R., Günter, S., 2019. Degradation of Ecosystem Services and Deforestation in Landscapes With and Without Incentive-Based Forest Conservation in the Ecuadorian Amazon. *Forests* 10.
- Eguiguren, P., Ojeda Luna, T., Torres, B., Lippe, M., Günter, S., 2020. Ecosystem Service Multifunctionality: Decline and Recovery Pathways in the Amazon and Chocó Lowland Rainforests. *Sustainability* 12.
- Ferrer Velasco, R., Köthke, M., Lippe, M., Gunter, S., 2020. Scale and context dependency of deforestation drivers: Insights from spatial econometrics in the tropics. *PLoS One* 15, e0226830.
- Ferrer Velasco, R., Lippe, M., Fischer, R., Torres, B., Tamayo, F., Kalaba, F.K., Kaoma, H., Bugayong, L., Gunter, S., 2023. Reconciling policy instruments with drivers of deforestation and forest degradation: cross-scale analysis of stakeholder perceptions in tropical countries. *Sci Rep* 13, 2180.
- Ferrer Velasco, R., Lippe, M., Tamayo, F., Mfuni, T., Sales-Come, R., Mangabat, C., Schneider, T., Günter, S., 2022. Towards accurate mapping of forest in tropical landscapes: A comparison of datasets on how forest transition matters. *Remote Sensing of Environment* 274.
- Fischer, R., Lippe, M., Dolom, P., Kalaba, F.K., Tamayo, F., Torres, B., 2023. Effectiveness of policy instrument mixes for forest conservation in the tropics – Stakeholder perceptions from Ecuador, the Philippines and Zambia. *Land Use Policy* 127.
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- Lippe, M., Rummel, L., Günter, S., 2022. Simulating land use and land cover change under contrasting levels of policy enforcement and its spatially-explicit impact on tropical forest landscapes in Ecuador. *Land Use Policy* 119.
- Nansikombi, H., Fischer, R., Ferrer Velasco, R., Lippe, M., Kalaba, F.K., Kabwe, G., Günter, S., 2020a. Can de facto governance influence deforestation drivers in the Zambian Miombo? *Forest Policy and Economics* 120.

- Nansikombi, H., Fischer, R., Kabwe, G., Günter, S., 2020b. Exploring patterns of forest governance quality: Insights from forest frontier communities in Zambia's Miombo ecoregion. *Land Use Policy* 99.
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