Informal Roads in the Peruvian Amazon: An Ucayali Case Study

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Negative Impact of Roads on the Amazon Rainforest

Environmental

- 95% of all deforestation in the Amazon occurs within 5.5 km of roads (Barber et al., 2014)
- Roads reduce biodiversity by introducing invasive species and fragmenting habitat (Koga et al., 2022; Vilela et al., 2020)
- By providing access to remote areas, roads facilitate the unsustainable extraction of natural resources by local agents (Ibisch et al., 2016; Perz et al., 2007; Arima et al. 2005)
- Both formal and informal roads often lack environmental feasibility assessments to determine potential damages (Vilela et al., 2020)

Fig. 1 (above): A road cuts through the Peruvian Amazon (LaRocca, 2022).

Indigenous Communities

- Roads bring disease, exploitation, and cultural change to Indigenous communities (Koga et al., 2022; Ferrante et al., 2020)
- Roads endanger Indigenous communities by increasing competition for land and resources with new settlers (Vilela et al., 2020; Perz et al., 2010)
- Continued road development sets a dangerous standard of frontier development for threatened Indigenous communities (Ferrante et al., 2020; Perz et al., 2007)

Fig. 2 (above): Road construction along the interoceanic highway (Salisbury, 2007).

Roads in Acre, Brazil

- Roads expanded in Acre, Brazil by 590 km per year between 2007 and 2019 (Nascimento et al., 2021)
  - 2019 saw the largest growth, with 1050 kilometers of roads built (Nascimento et al., 2021)
  - Settlement projects were the administrative territories where the largest growth of roads occurred (Nascimento et al., 2021)
  - Conservation units saw the greatest percentage of road expansion (Nascimento et al., 2021)
- Nascimento et al. (2021) finds a correlation between deforestation and road construction

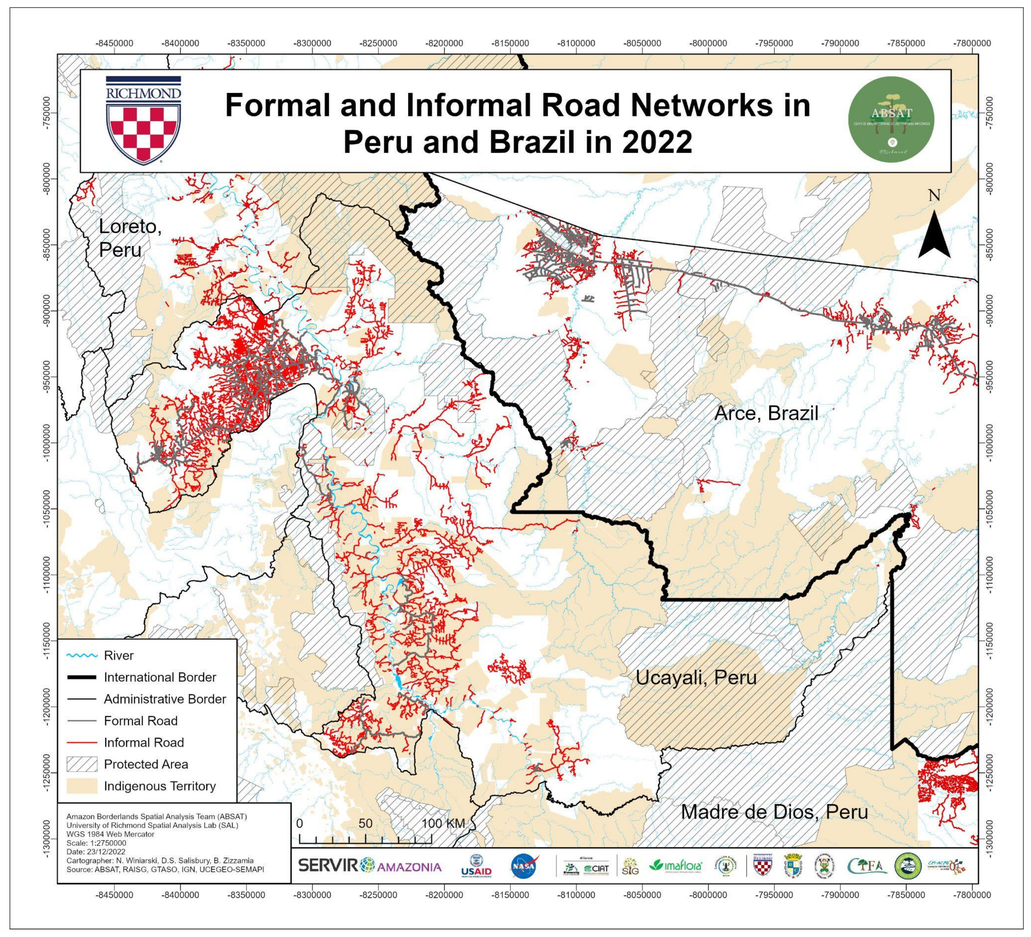


Fig. 3 (above): Map of informal roads in Ucayali, Loreto, and Madre de Dios, Peru and Acre, Brazil as seen in 2022.

Methodology

- Employed ESRI ArcGIS Pro (Version 3.0) and 4.77 meter resolution satellite data from Planet's monthly mosaics
  - Used September imagery to identify cumulative roads on an annual basis between 2017 and 2021
  - Used monthly imagery to identify cumulative roads on a monthly basis between August 2022 and November 2022
- Expanded data previously collected by ABSAT, ACCA, UFAC LabGama, and others
- Quantified road data by metrics such as year built, imagery date, and length in kilometers
- Created a grid of 10 KM² areas to focus analysis and more accurately record rural road presence, expansion rate, and contraction/reclamation by the tropical forest
- Analyzed road growth in central Ucayali, Peru to identify annual and monthly trends (excludes Pucallpa-Lima road corridor and Purus River basin)

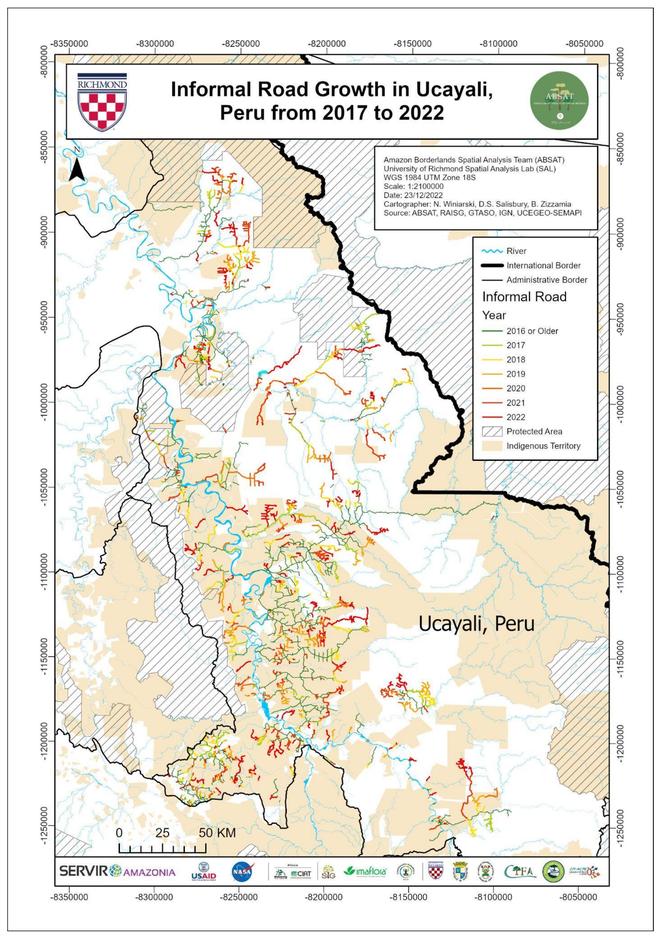


Fig. 4 (above): Map of formal and informal road networks from 2017 to 2022 in central Ucayali.

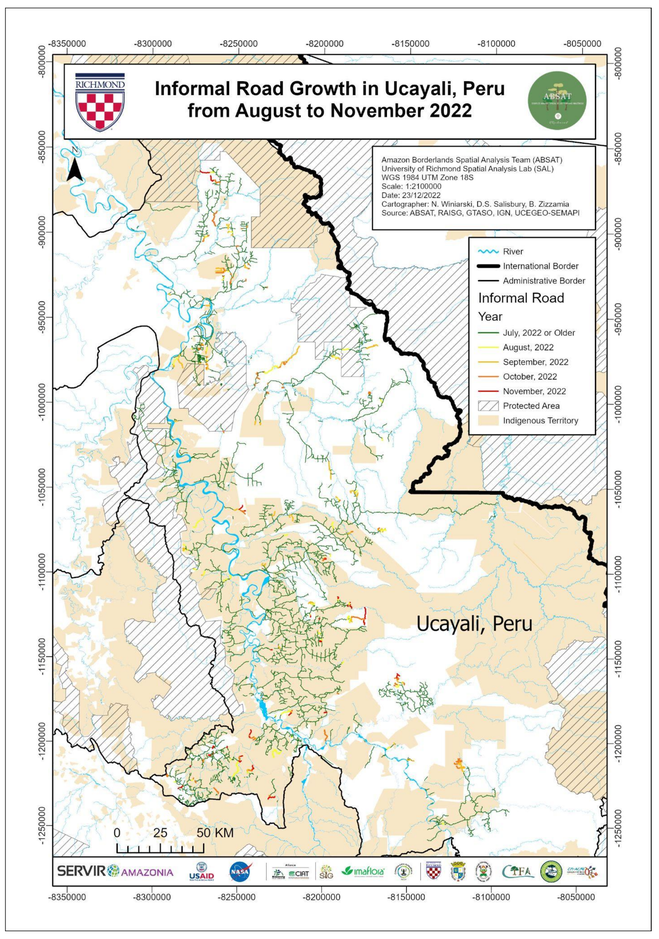
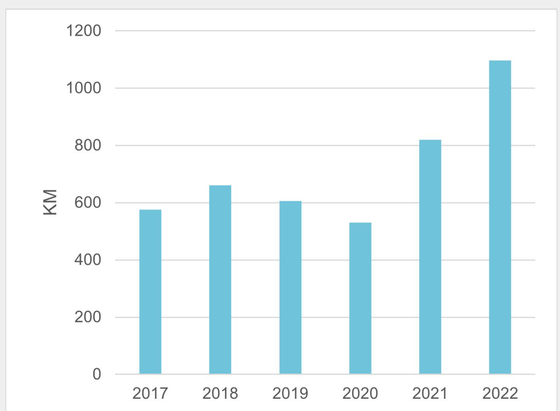


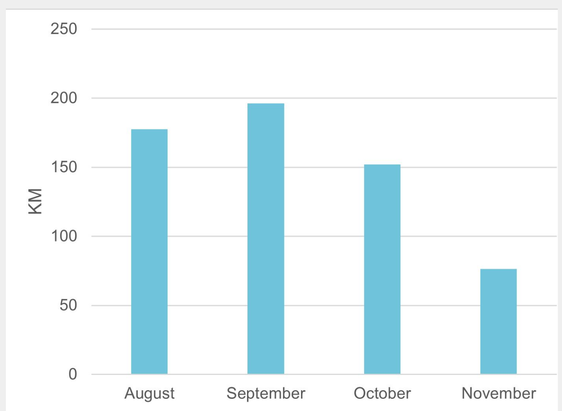
Fig. 5 (above): Map of informal road growth from August-November, 2022 in central Ucayali.

2022 Road Growth Data



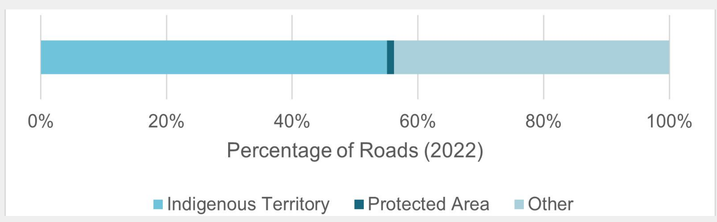
2017	2018	2019	2020	2021	2022	Total	Avg.
576.05 KM	660.67 KM	605.54 KM	530.34 KM	820.56 KM	1096.73 KM	4289.89 KM	*714.9 KM*

Fig. 6 & Table 1 (above): Annual informal road growth from 2017 to 2022 in central Ucayali, Peru.



August	September	October	November	Total	Avg.
177.46 KM	196.11 KM	152.05 KM	76.40 KM	602.02 KM	*150.51 KM*

Fig 7 & Table 2 (above): Informal road growth per month in 2022 in peak dry season (August-November) in central Ucayali, Peru.



Indigenous Territories	604.11 KM
Protected Areas	12.07 KM
Other	480.55 KM
Total (2022)	1096.73 KM

Fig. 8 & Table 3 (left): Percentage and length of informal roads inside protected areas and indigenous territories in 2022 in central Ucayali, Peru.

Discussion

Literature Analysis

- Limiting the expansion of informal road networks in the Amazon Basin will protect local biodiversity and support global sustainability objectives (Koga et al., 2022; Ibisch et al., 2016)
- Understanding and communicating the impacts of road development on ecosystem services in the region will create opportunities for more informed decision making at multiple scales (local, regional, national, and international stakeholders)

Limitations

- Imagery obstructions, such as cloud cover and imagery processing errors, can limit the effectiveness and accuracy of informal road data analysis
- ABSAT's current methodology only monitors the expansion and presence of the informal road system, and does not easily account for road contraction/reclamation by tropical forest
- Time required for data collection and quality control, language barriers, and inconsistent internet connectivity limits agile and timely communication to threatened territories and communities

Future Actions

- Improve transboundary compatibility by updating UFAC LabGAMA's (Nascimento et al., 2021) Acre, Brazil dataset (currently limited to 2020)
- Improve dataset accuracy by switching to month-by-month analysis, rather than year-by-year analysis
- Improve ABSAT methodology to more accurately measure temporal expansion, contraction, and presence of roads
- Analyze ACCA machine learning techniques to improve data collection speed and accuracy
- Continue to monitor the expansion of the informal road network into areas of rich cultural and ecological diversity (indigenous territories, conservation units, and adjacent landscapes)

Scan this QR Code for more information and references:

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