Ecological Classification of Soils and Pristine Premontane Vegetation in the Alto Mayo Valley, North Peru

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Objective

Classification and mapping of intact tropical forest areas is often difficult due to limited access in the field and low availability of spatial data.

Mapping of tropical vegetation types was performed in a remote premontane tropical landscape of Peru. A four step approach was chosen which combined 1) field studies,

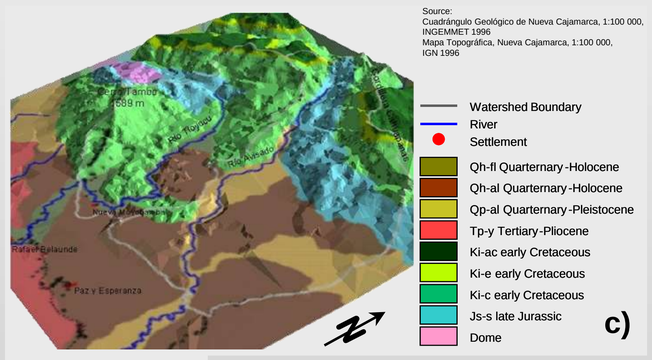
2) statistical data analysis,

3) landscape analysis and

4) remote sensing techniques.

The ecological vegetation classification is based on the observation that pristine forest structure is closely correlated with edaphic conditions which are mainly driven by topography, climate and geology. While potential vegetation classification can be done *a priori*, disturbance is unpredictable and must be detected directly by remote sensing.





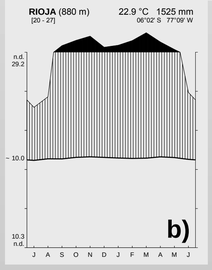


Fig. 1: Study area:

a) Location in north central Peru on the eastern slopes of the Andes
b) Climate diagram for Rioja, Alto Mayo Valley
c) Geological conditions
d) Panoramic view of the study area

Study Area

The study was conducted in the Río Avisado and Río Tioyacu watersheds on the left banks of the Upper Río Mayo in north central Peru (Fig. 1 a). The climate is tropical moist with one pronounced dry season per year (Fig. 1 b). The area divides into three different geomorphological regions:

a) montane region (1100 to 1600 m a.s.l.) over Cretaceous and Jurassic sandstones,
b) eroded hill areas (900 to 1100 m a.s.l.) on sandy Quaternary deposits and
c) floodplains below 900 m a.s.l. (Fig. 1c).



Field Work

In the field biometrical data of the forest stands, structural characteristics and soil samples were collected on > 200 plots to describe the spatial variation of forests in the region.

Analysis

Data was screened, reduced by principal component analysis and consequently submitted to a hierarchical cluster analysis (Fig. 2). Resulting classes were examined for common characteristics in terms of edaphic (soil, nutrients), biometric (above ground stand biomass) and structural properties.

Mapping

A panchromatic aerial photograph was merged with contour lines and geological information (Fig. 3). A decision tree for the image analysis was developed (Fig. 4) which lead to the forest type map of the study area shown in based on six forest types derived from cluster analysis (Fig. 5).

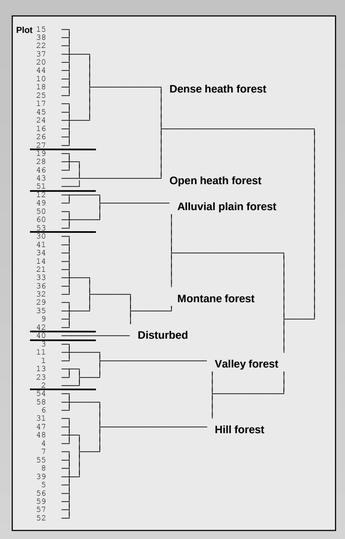


Fig. 2: Result of a hierarchical cluster analysis using Ward's method performed on 60 plots yielding seven different clusters.

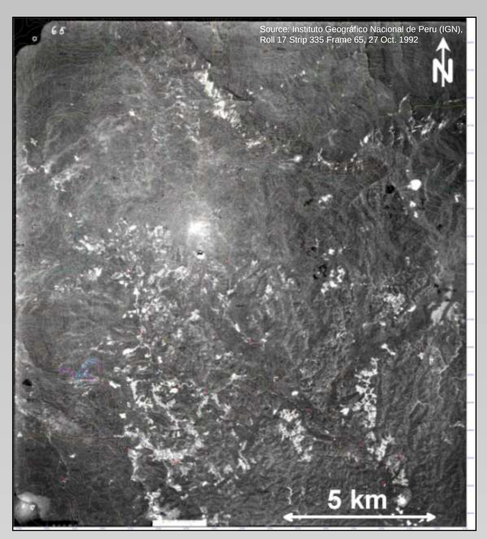


Fig. 3: Panchromatic aerial photograph of the study area with contour lines, geology and plot locations superimposed by GIS.

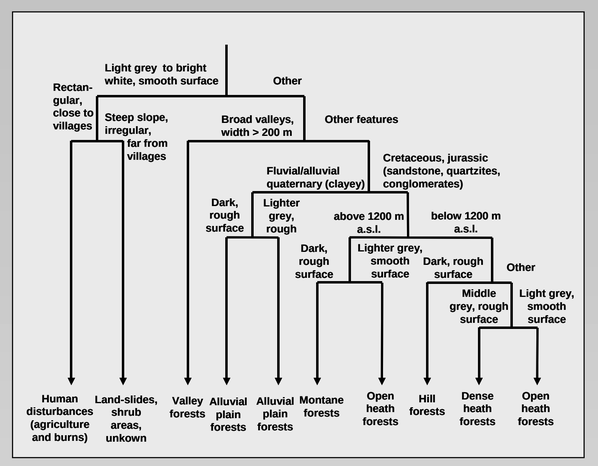


Fig. 4: Decision tree developed for the mapping of the classified forest types. It combines biometrical, geological and topographical information with optical texture derived from the aerial photography.

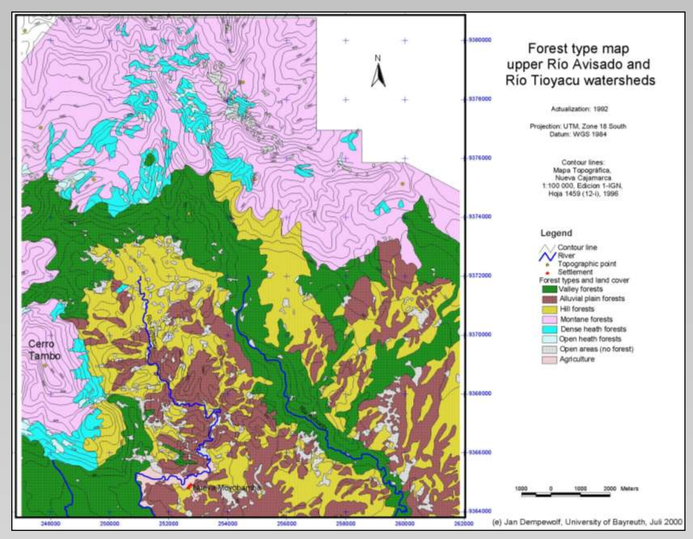


Fig. 5: Vegetation map of the study area with eight different land cover classes. This map was derived from the aerial photograph (Fig. 5) by applying the criteria shown in Fig. 6.

Results

Ten forest types were identified in the study area. The ecological classification is based on edaphic, biometric and structural parameters. The forest types vary not only by structural aspects and soils but also in terms of their biomass allocation (cf. Tab. 1). Heath forests of three types were classified between approx. 1000 and 1400 m a.s.l. showing least above-ground biomass. Fern woodlands ("*shapumbal*") are connected to naturally disturbed sites on steep slopes.

The forest variation could also be ascribed to topographic situations such as palm rich types in ravines, heath forests ("*chamizal*") on plateaus and dry rainforests on upper slopes (Fig. 6).

Tab. 1: Biomass parameters for ten vegetation types that were classified in the study area.

Vegetation Type	Biomass[a] t ha^{-1}		Basal Area[b] m^2 ha^{-1}	Growth Density stems ha^{-1} dbh > 3.2 cm	Growth Density stems ha^{-1} all stems
Palm forest	**197**	(62)	**32**	**462**	-
Ficus swamp	**216**	(59)	**33**	**700**	-
Alluvial plain forest	**192**	(58)	**33**	**2126**	-
Valley forest	**240**	(103)	**40**	**4287**	-
Montane rainforest	**245**	(147)	**40**	**5225**	-
Semi-deciduous hill forest	**113**	(45)	**27**	**3305**	**4392**
Fern woodland*	**36**	(14)	**7**	**1241**	**1337**
Slope heath forest	**69**	(46)	**20**	**5883**	-
Dry heath forest*	**25**	(17)	**9**	**2262**	**8966**
Peat heath forest*	**14**	(6)	**6**	**1284**	**17806**

[a] Standing above ground biomass after OGAWA 1965 * Biomass estimation supported by biomass harvest
[b] Determined with relascope by BITTERLICH

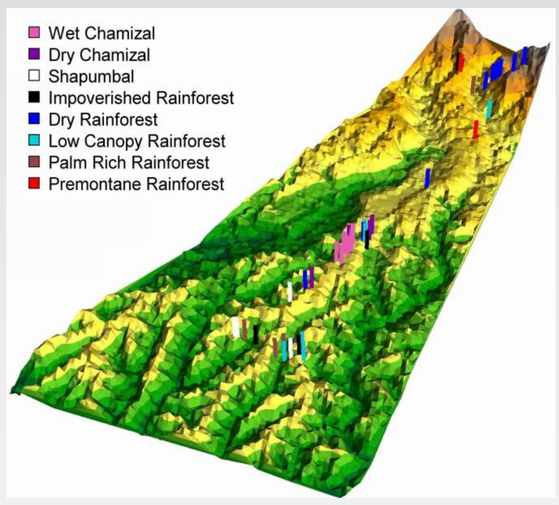


Fig. 6: Topographical locations of different forest types on a digital elevation model derived from stereoscopic aerial photography.

Conclusion

The presented method of combining a descriptive with a functional classification proved to be a robust tool for the ecological characterization and mapping of inaccessible tropical forest areas with sparse existing data.

This study is a joint Peruvian-German project for the development and implementation of an Environmental Monitoring System in the Margen Izquierda (Bosque de Protección) of the Alto Mayo Region.
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