The Effects of the Spatial Resolution of Airborne Lidar Data on Aboveground Biomass Estimation

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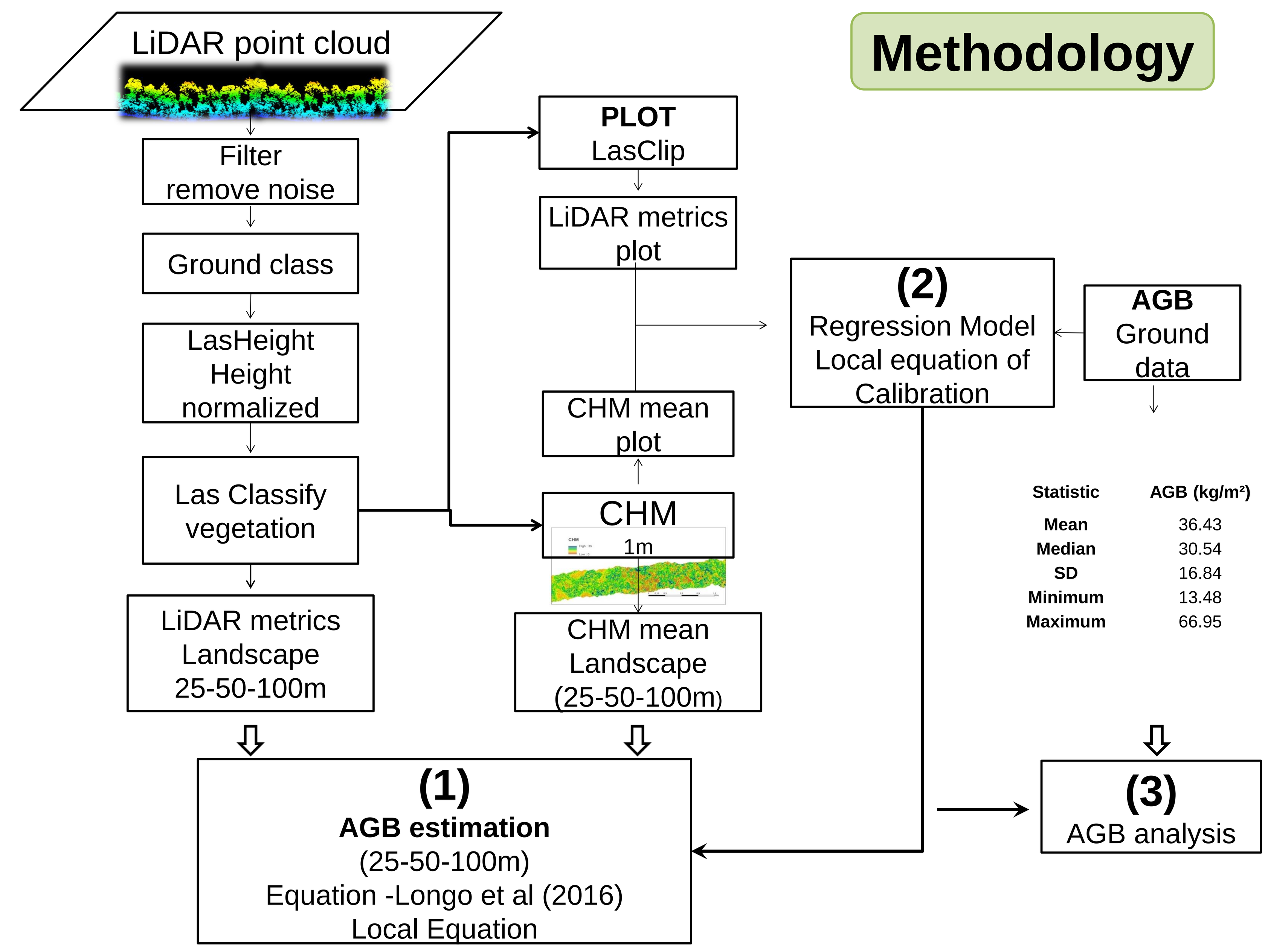
Abstract: The amount of aboveground biomass (AGB) held in vital components of vegetation play a significant role in the carbon cycle of tropical forests. Reducing uncertainty of terrestrial carbon cycle depend strongly on the accurate estimate of AGB. Lidar remote sensing provides the most precise methodology to quantify AGB at large scales, but the effects of the spatial resolution of airborne lidar data on AGB estimation is unknown. Here we examine the impact of the minimum spatial resolution threshold of lidar data to reduce the uncertainty of AGB estimations in tropical forest. For that we used a sizeable airborne lidar data from Tapajos National Forest (TNF) and ten permanent field plots. We compared two approaches: (1) we used general lidar allometric equation of AGB estimation developed for the Amazon, testing the best spatial resolution of lidar measurements at 25, 50 and 100 meters and compared with our ground data of forest inventory from TNF; (2) we developed and tested a new local lidar allometric equation to quantify AGB in TNF. Although the use of lidar cloud cover at 50 m provides unbiased estimates of AGB, our results demonstrated that local forest structure plays a significant role in this general allometric equations. Our results underscored three conclusions. First, the effects of the spatial resolution of airborne lidar data on AGB estimation were significant. We found that a minimum size-area of 50 meters of lidar is necessary to produce an unbiased estimate of AGB in a local tropical forest of Central Amazon. Second, our adjusted allometric equation for TNF, which was based in mean canopy height model, reduced the uncertainty of AGB from RMSE%: 36.8% to RMSE%: 26.2% (local model). Finally, this study highlights the need of lidar allometric equations based on local forest structure to reduce the uncertainty of AGB estimations.

Objectives

To examine the impact of the minimum spatial resolution threshold of lidar data on AGB estimations we:

1. Investigated the best spatial resolution of lidar data at 25, 50 and 100 meters of spatial resolutions using a general AGB lidar allometric equation developed for the Amazon;
2. Develop and tested a new local lidar allometric equation for Tapajós National Forest (TNF);
3. Compare the AGB estimates with ground data of forest inventory from TNF.

Methodology

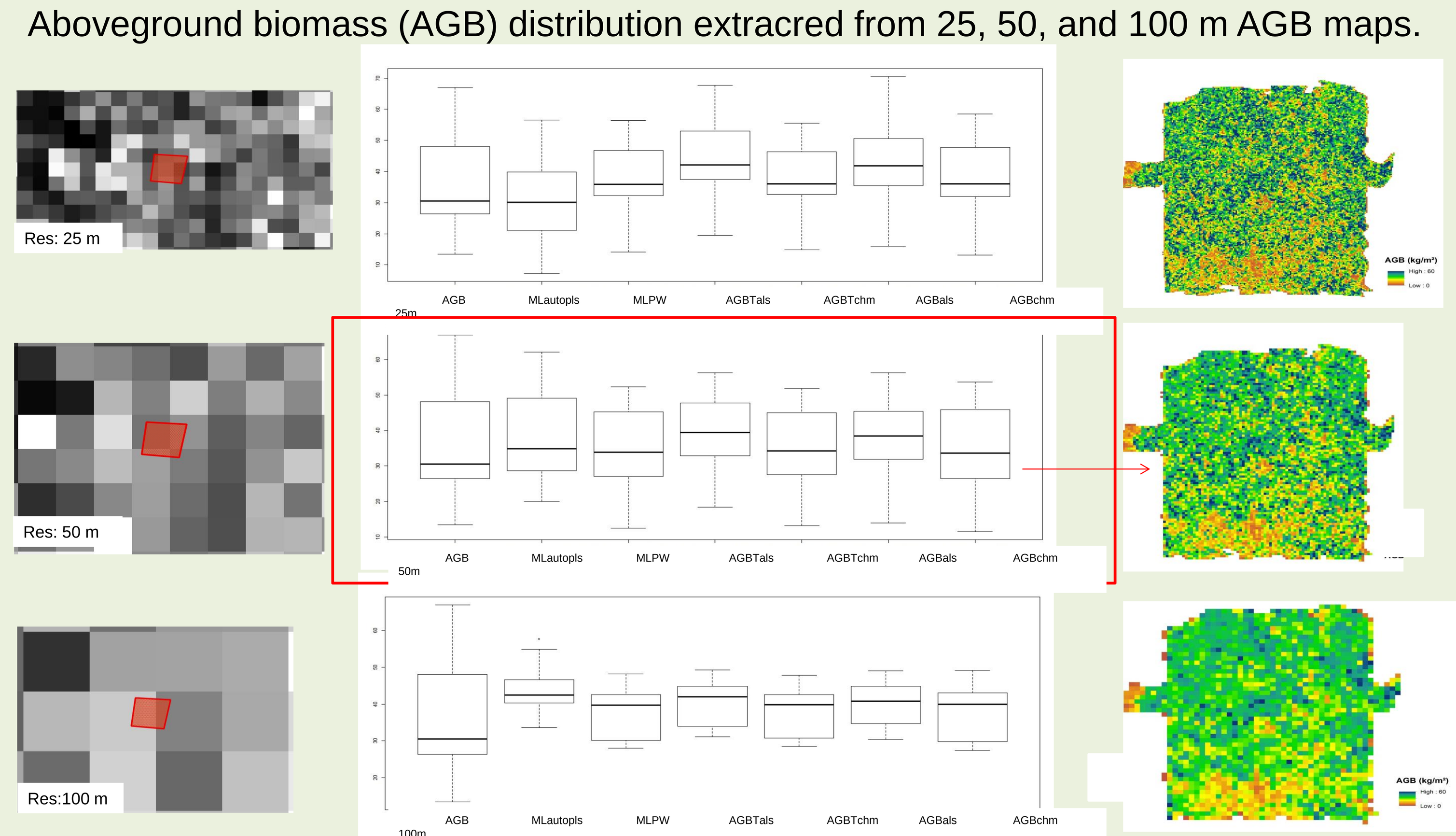


Statistic	AGB (kg/m²)
Mean	36.43
Median	30.54
SD	16.84
Minimum	13.48
Maximum	66.95

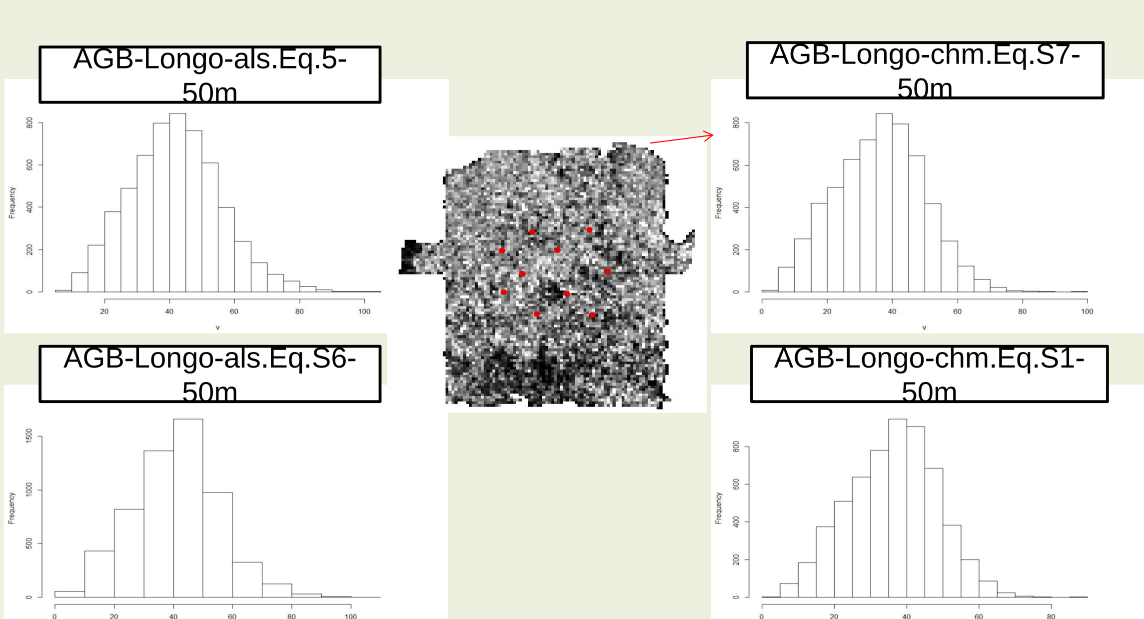
Results

1

Aboveground biomass (AGB) distribution extracred from 25, 50, and 100 m AGB maps.



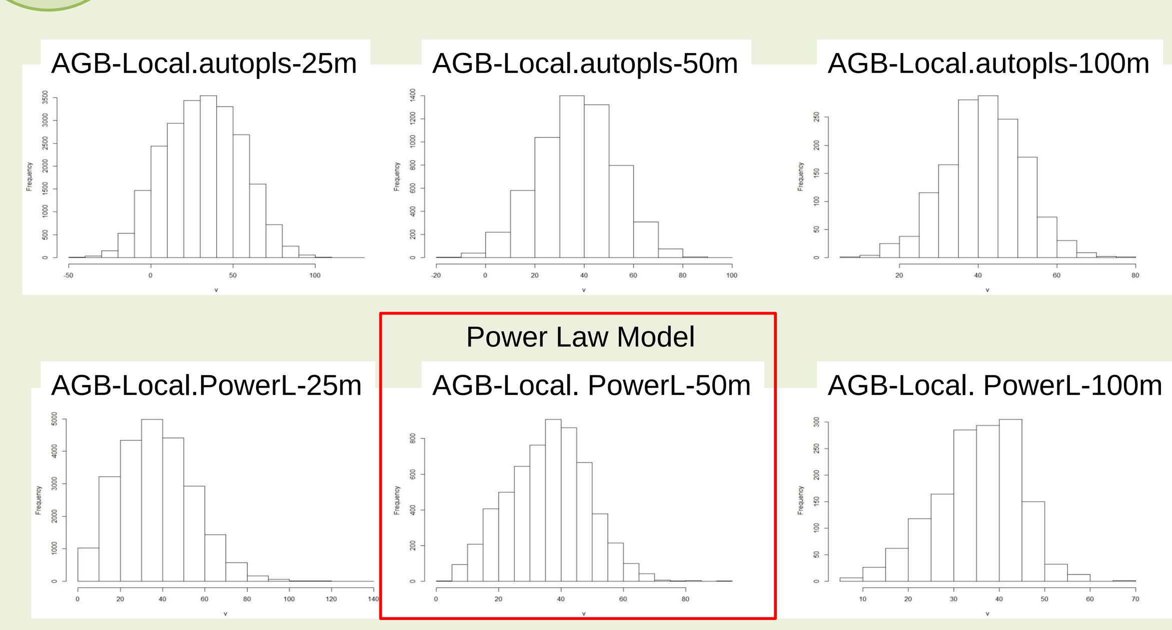
AGB
MLpls = AGB-Local.autopls-25m
MLPW = AGB-Local.PW-25m
AGBTals = AGBT-Longo-als.Eq.5-25m
AGBTchm = AGBT-Longo-chm.Eq.S1-25m
AGBals = AGB-Longo-als.Eq.S6-25m
AGBchm = AGB-Longo-chm.Eq.S7-25m

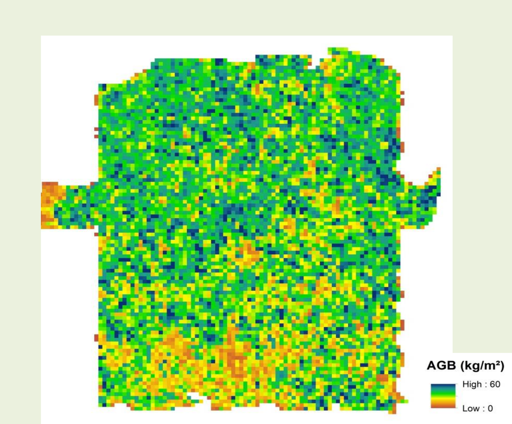


AGB maps was produced using a regional LiDAR allometric equation (Longo et al., 2016)

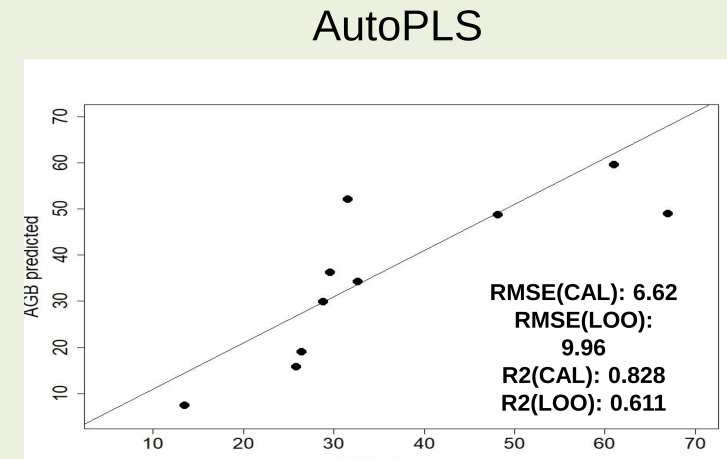
2

AGB map using a local LiDAR allometric equation

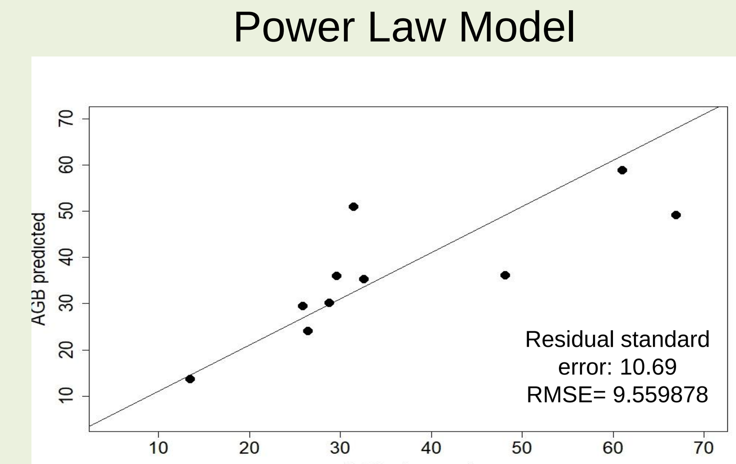




AutoPLS

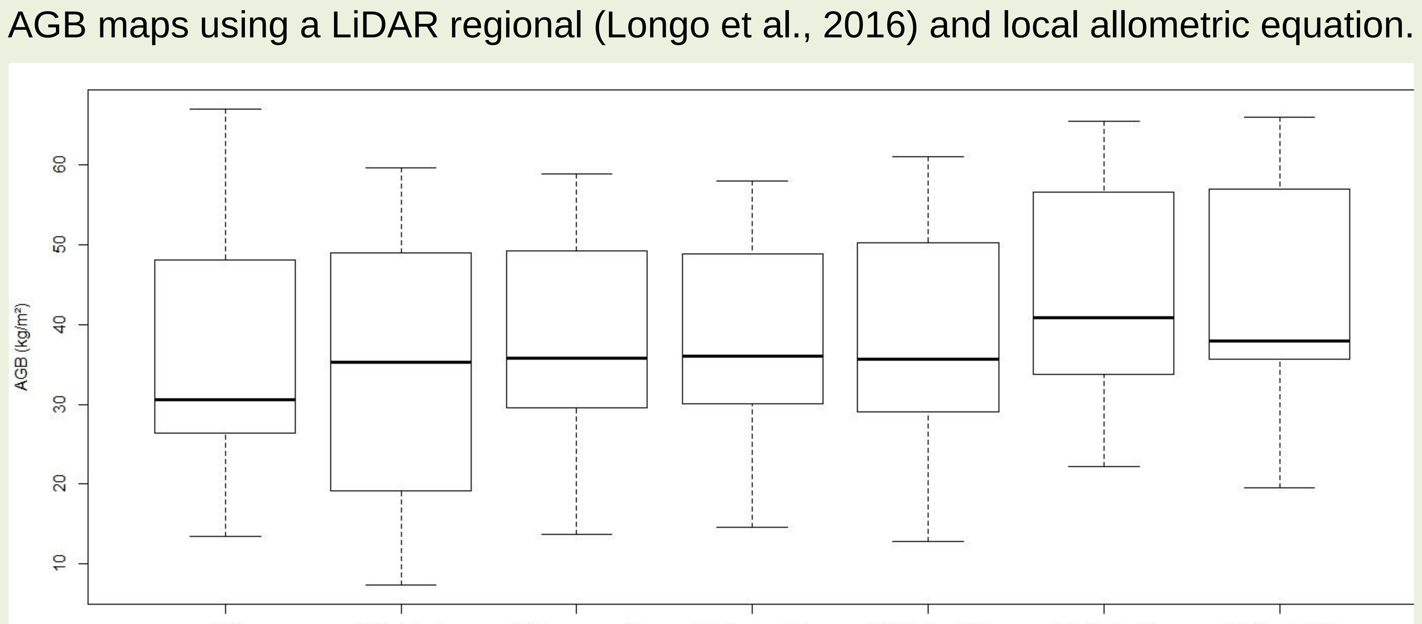


Power Law Model



3

AGB maps using a LiDAR regional (Longo et al., 2016) and local allometric equation.



Conclusions

The effects of the spatial resolution of airborne lidar data on AGB estimation were significant. We found that a minimum size-area of 50 meters of lidar is necessary to produce an unbiased estimate of AGB in a local tropical forest of Central Amazon. Our adjusted allometric equation for TNF, which was based in mean canopy height model, reduced the uncertainty of AGB from RMSE%: 36.8% to RMSE%: 26.2% (local model).This study highlights the need of lidar allometric equations based on local forest structure to reduce the uncertainty of AGB estimations.

Acknowledgment: