DAVIS EXPEDITION FUND

REPORT ON EXPEDITION / PROJECT

Expedition/Project Title: Mapping forest aboveground biomass in China

Travel Dates: 17th August 2021 – 15th March 2022

Location: Jilin Province and Yunnan Province, China

Group Members: Wenquan Dong

Aims: To estimate forest aboveground biomass by measuring tree height, diameter at breast height, and wood density.

Outcome (a minimum of 500 words):-

Introduction

Reducing carbon emissions from deforestation and forest degradation, and maximising the rate of uptake of carbon in areas of recovering and restored forest, is of great importance to combating climate change (Bosetti and Rose, 2011). Quantifying the gains and losses of carbon stored in forests can help to implement climate change mitigation policies, and thus it is very important to map forest biomass and biomass change which are direct measurements of carbon stocks and carbon emissions. Without being able to measure the carbon stored in trees, and critically how it is changing, there is no way to design or implement policies to prevent its loss or encourage forest restoration.

In my PhD, I aim to map forest biomass and biomass change between 2007 and 2021 in China using field and earth observation data. This is important because China has experienced extensive deforestation, but also dramatic forest restoration/afforestation over the period (Tan and Li, 2015, Peng et al., 2014). Its forest change is likely contributing greatly to the global carbon cycle, with the net balance probably positive (offsetting much of China's fossil fuel emissions), but with significant regional variation. Existing maps of China's aboveground biomass (AGB) are coarse resolution and from single time points (Su et al., 2016, Santoro and Cartus, 2019, Du et al., 2014, Yin et al., 2015), not enabling the carbon balance to be assessed. I will change this by producing high-resolution maps from 2007 and 2021, time points chosen to coincide with the availability of field data and LiDAR satellite data.

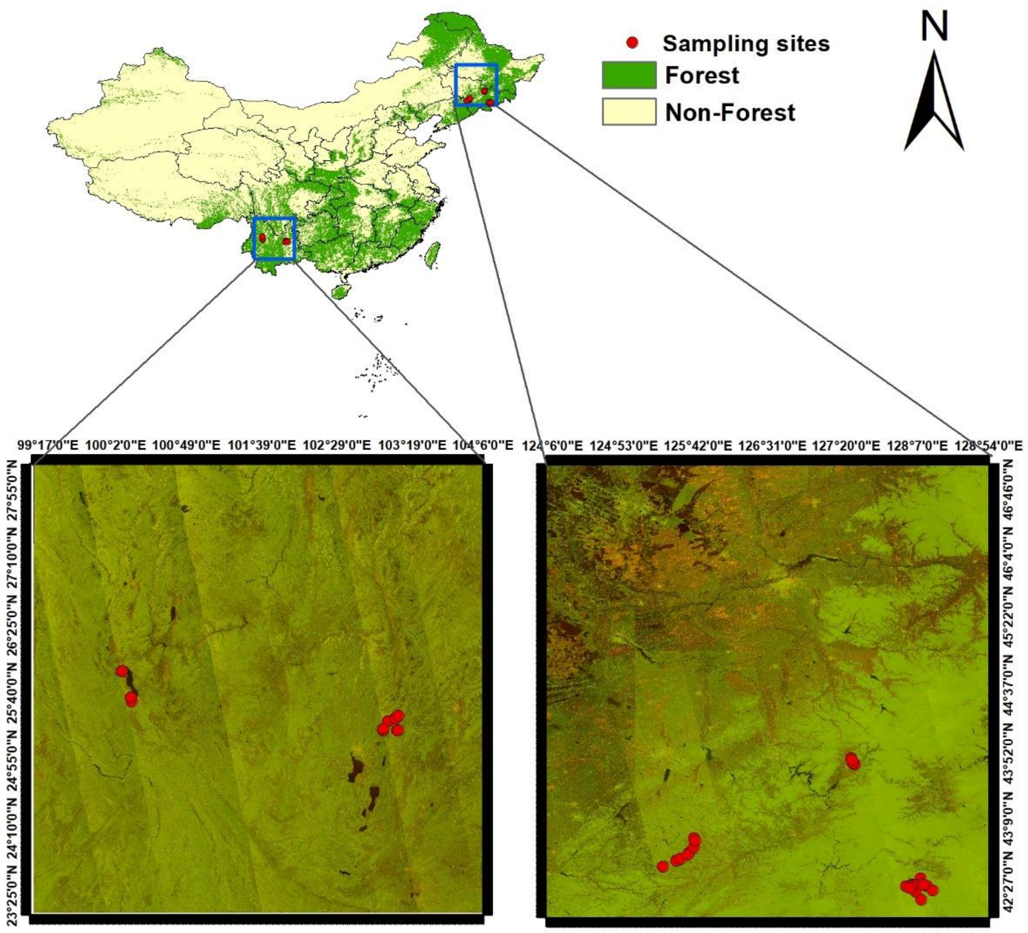
In my research, I will produce forest biomass maps in 2007 and 2021 separately but using similar methods, and then map biomass change by comparing the two maps. In order to map the forest biomass change accurately, field data collected in 2007 and 2021 are needed to train and test the biomass prediction model. While I have managed to obtain good field data in 2007 from collaborators, I have not found any available recent data to calibrate the critical 2021 map. I therefore collected field data in north-eastern and southern China, where we have historical (c. 2007) field data.

I measured tree height, diameter at breast height (DBH), and wood density in Jilin Province and Yunnan Province, China. Most of the sites are under the footprints of the GEDI satellite, a satellite LiDAR that provides information on tree height. I calculated aboveground biomass of each site using allometric functions (Chave et al., 2005, Chave et al., 2014). The field measured aboveground biomass are used to train the biomass prediction model and assess the accuracy of the aboveground biomass map in 2021.

Study area

I collected field data in Jilin Province (northeast) and Yunnan (south) Province in China, and each of the study area is 5 degrees × 5 degrees (~ 550 km × 550 km).
I measured tree height, diameter at breast height (DBH), and wood density in 26 plots of 12.5m diameter in north-eastern China under the footprints of the GEDI satellite. I collected field data in 17 plots in southern China, 15 plots of which are under GEDI footprints.

a)



b) c)

Figure 1. (a) Map shows the locations of the two study areas within ALOS PALSAR-2 Forest / Non-forest Map in 2017 (Shimada et al., 2014). (b) (c) The maps show the locations of the sampling sites within Phased-Array L-band Synthetic Aperture Radar (PALSAR) yearly mosaic mean of 2018, 2019 and 2020 (HH in red, HV in green, and HH/HV in blue).

The north-eastern study area has a temperate continental climate. The dominant trees in this study area are conifer.

Figure 2. The dominant tree species in the north-eastern study area

The southern study area in Figure 1 is in Yunnan Province. This study area has a typical plateau monsoon climate with all the sampling sites in this area over 1500m. Most of the sampling sites are on mountains (Figure 3). The forests in this area are mixed forests.

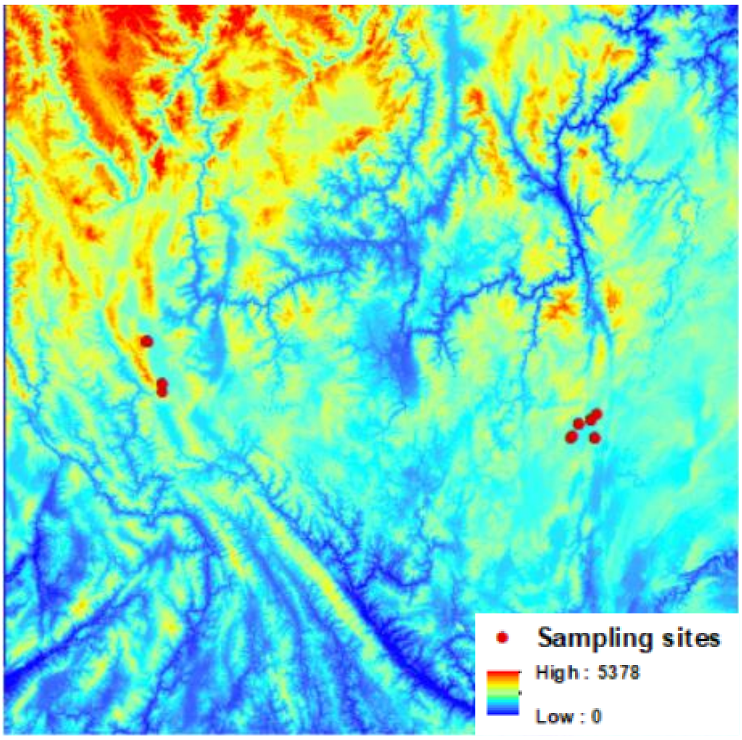


Figure 3. Map shows the locations of sampling sites within the Shuttle Radar Topography Mission (SRTM) digital elevation map.

Materials and methods

All the sampling sites are circular plots of 12.5 m diameter, which have the same size with GEDI footprints. To measure a site, I used a Garmin eTrex 20x to reach the center of the GEDI footprint and setup the plot using a 15m tape. I measured the tree height and diameter at breast height of each tree in the plot. In addition, I took cores of each tree species to calculate wood density.

a) Tree height

I measured tree height using clinometer and Vertex (Figure 4). For clinometer, find a place to stand at around 15m from the tree where I can see the top of the tree. Secondly, look through the clinometer, and read off the instrument the height from the horizon to the tree top, then from the horizon to the tree base. Then tree height is the sum of the length from the horizon to the tree top and the horizon to the tree base.

For Vertex, I measured the distances from the tree and the standing point. Aim at the height of 1.3 m and press the button ON until sight cross disappears. And then, aim at the tree top with the cross hair blinking. Keep pressing ON until the cross disappears. Then the tress height is displayed.

Figure 4. Measuring tree height using Vertex

b) Diameter at breast height

With the measuring tape, measure 1.3 m up the trunk of the tree from the ground. Use a thumbtack to mark the height on the tree. And then wrap the DBH tape around the tree trunk at 1.3 m. Make sure the DBH tape is straight and tight around the trunk, and read the number on the DBH tape (in pi cm). The number is the DBH of the tree – no need to convert.

Figure 5. Measuring diameter at breast height

c) Wood density

Wood density is based on two measured values, dry weight and volume. I extracted cores from trees using a tree corer. Firstly, screwing the borer of the tree corer into the tree. Secondly, pulling out the extractor along with the core. And then Gently unscrewing the borer auger from the tree. The volume of the cores will be estimated using core length and the bore diameter of the increment borer. The dry weight will be measured by a mini Digital Scale.

a) b)

Figure 6. (a) Extracting core from the tree, (b) The cores.

Initial results

I calculated aboveground biomass of each plot. For the plots in north-eastern area, I calculated AGB using Lorey's height, a basal area weighted average height known to be closely correlated with AGB Lefsky (2010). I analysed the relationship between field AGB and GEDI RH 98 (Figure 7).

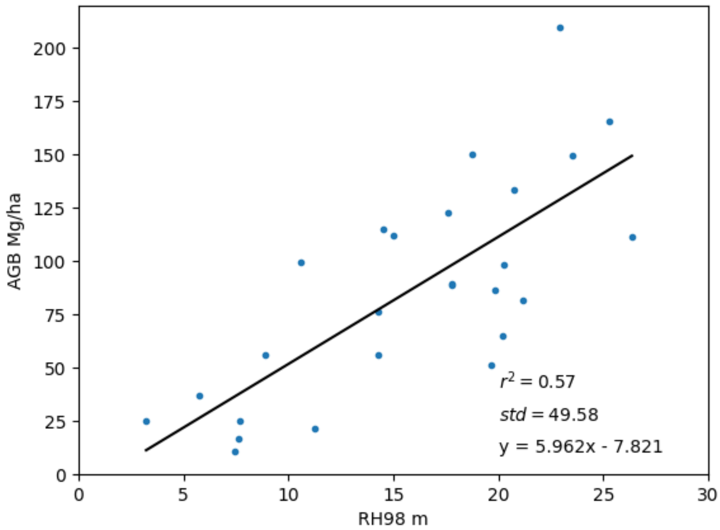


Figure 7. Field AGB against GEDI RH98 in north-eastern study area

Then, I used field AGB to train the predict model, and I produced an AGB map for China in 2021 (Figure 8).

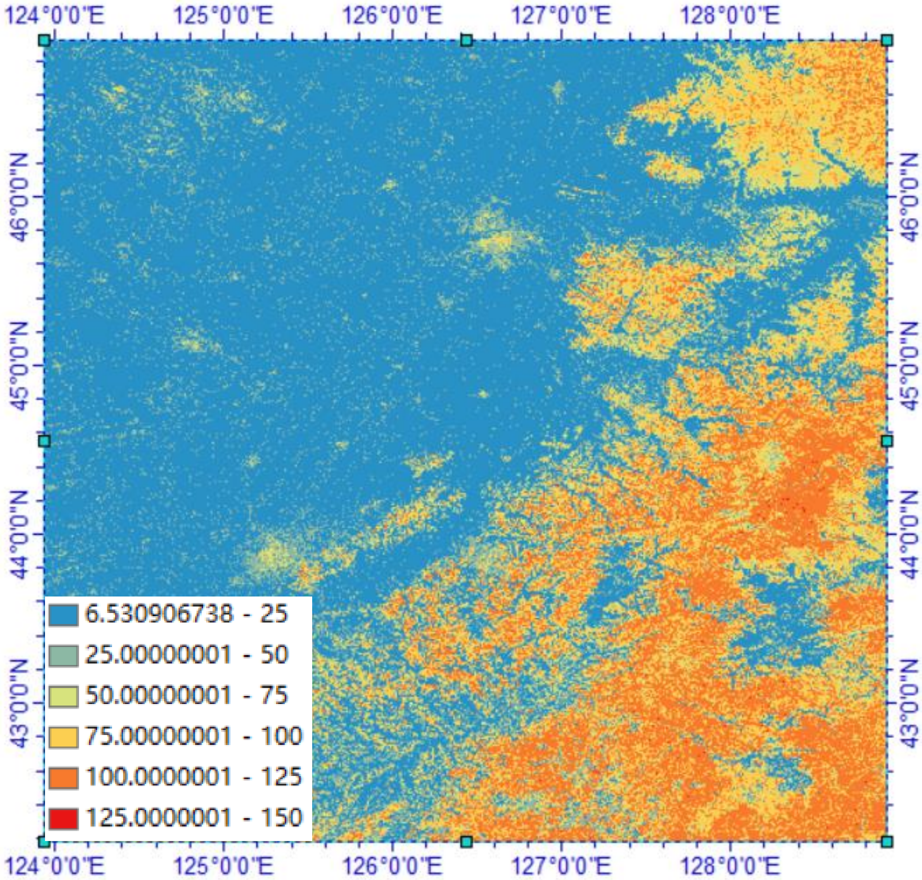


Figure 8. AGB map of north-eastern study area, generated using field AGB data

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