Impacts of insect-driven tree mortality on land-surface water and energy exchanges

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Introduction

Forest disturbances can **affect** land-surface **temperature**, **heat fluxes,** and alter the **carbon** and **water** budgets. **Only in 2022, bark beetles killed 1.36 million ha of forest** - nearly half of all insect-related damage in the United States[1].

Fig 1: Forest affected by bark beetles. Credits: Collective crunch

Is it possible to estimate the response of the land-surface water and energy exchanges to bark beetle-induced tree mortality?

We focus in the area of the USA where there are detailed tree mortality information provided by the USDA[1].

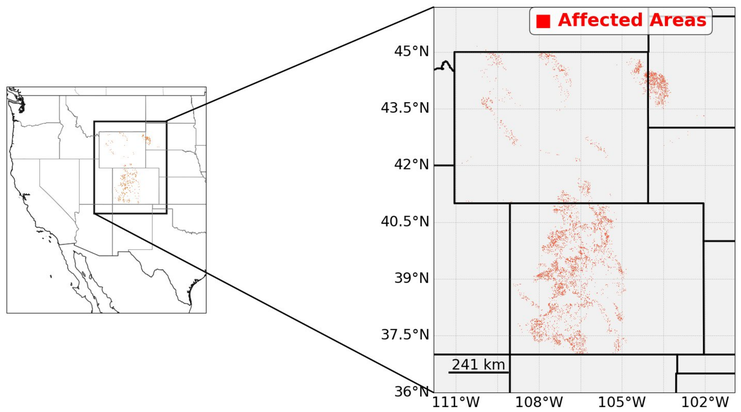

Fig 2: Bark beetle tree mortality between 2012 to 2022 in the study area.

Material and Methods

We used the tree canopy cover (TCC) provided by the NLCD[2] and the MODIS products below to estimate the influence of bark beetle on land-surface water and energy exchanges.

Data	Horizontal Resolution (m)	Temporal Resolution	Data used
Tree Canopy Cover	1000 and 500	Yearly	2000 - 2022
Tree Mortality Data	1000 and 500	Yearly	2012 - 2022
LST Day (11A2)[3]	1000	8-day averages	2000 - 2022
ET (16A2GF)[4]	500	8-day sum	2002 - 2022
Albedo (43A3)[5]	500	daily	2000 - 2022
Snow Cover (10A1)[6]	500	daily	2002 - 2022
LAI (15A2H)[7]	500	8-day composite	2000 - 2022

Table 1: MODIS and NLCD data used between 2000-2022.

The pipeline diagram below shows the process followed to generate the anomalies.

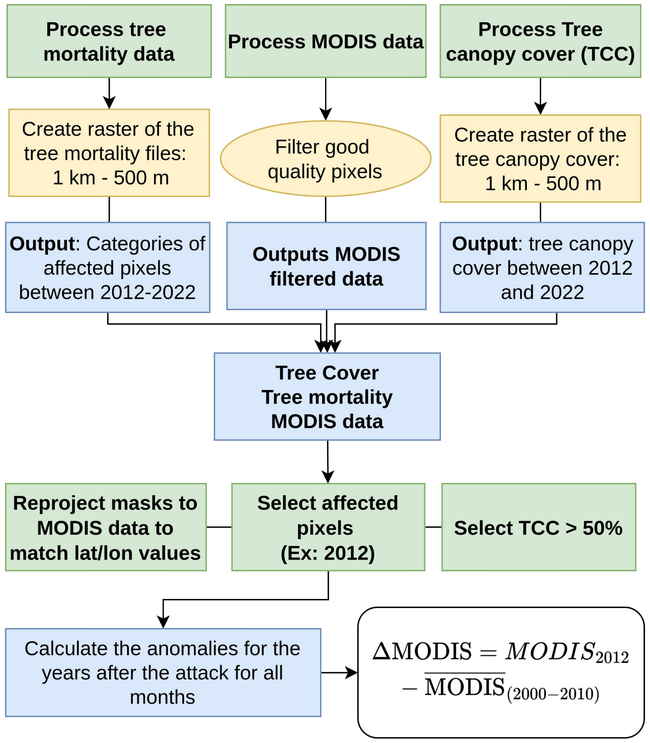

Fig. 3: Pipeline of the process followed to generate the anomalies.

Results

Winter land-surface responses to bark beetle-caused tree mortality:

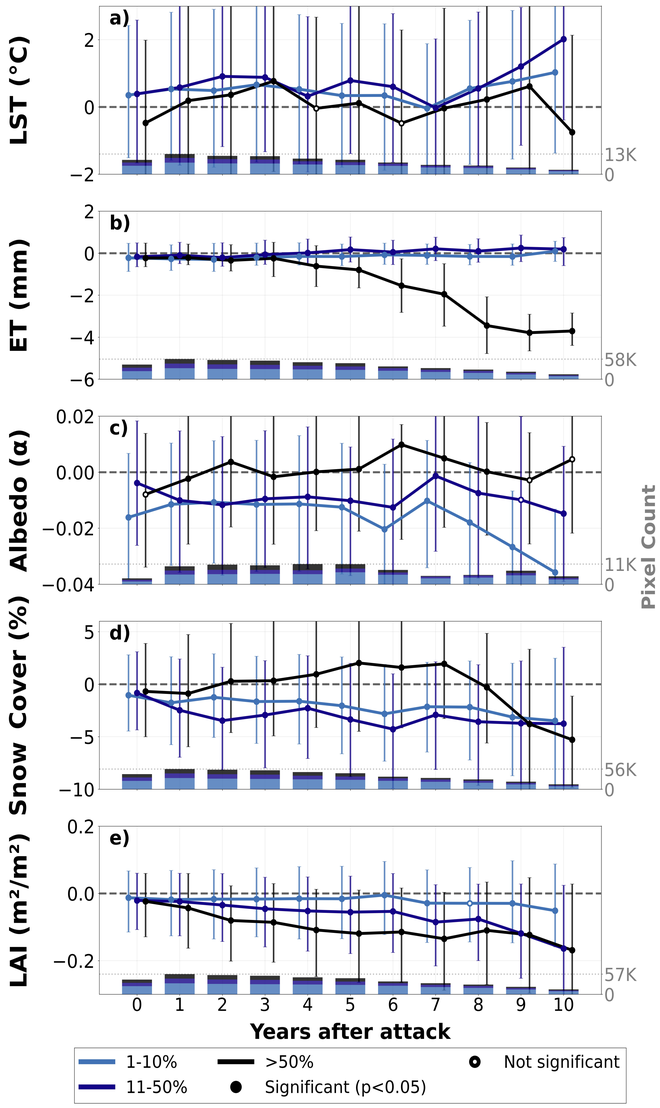

Fig. 4: Winter anomalies in the years after bark beetle attacks. Pixels selected were attacked only once between 2012 and 2022. LST – Land Surface Temperature, ET - Evapotranspiration, LAI – Leaf area index

Key findings

The **decrease** in **ET** is linked to the high tree mortality level.

The **increase** in **LST** does not depend on the tree mortality level.

Snow cover and **albedo** show **similar patterns**.

LAI decreases in the years after the attack following the tree mortatliy levels.

The Wilcoxon-test shows that the anomalies are significant in most years after the attack.

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