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Who knocks down the most trees – humans or elephants?

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Abstract

If you push a tree really, really hard, do you think you could make it fall down? You would probably struggle, even if it looks quite small and thin. But it's easy work for an elephant!

We call elephants *ecosystem engineers* because they can have a great effect on their landscape, pushing trees down as they search for food and water. However, humans can also have a big impact on a landscape, cutting trees for fuelwood for cooking or opening space for crops.

We wanted to find out who had the greatest effect on treefall in African woodlands known as *savannas* – humans, or elephants. We collected data on treefall rates and patterns and found that elephants had the greatest effect, but that humans were also responsible for high numbers of treefall. Although this doesn't always kill the trees as they are *resilient* to disturbance, but, combined with other factors humans and elephants can put the woodlands at risk.

Introduction

Humans have lived in the savannas of Africa for almost two million years and these woodlands now support almost a third of the global human population. Scientists have found that humans can have both direct and indirect effects on the savanna woodland, rather like the African elephant does (Fig. 1). Directly, humans alter the structure of vegetation by removing wood, either by chopping down an entire tree, or removing the stump. Indirectly, they can alter it by changing how fires spread through the land. Some of the cut stumps grow again and form dense shrubs.

Both humans and elephants can affect trees of all heights. These changes can then have an impact on *biodiversity* and how the whole ecosystem functions.

We wanted to find out what the impact of humans and elephants is on treefall rates, and explored the following questions:

1. Do elephants and humans have different impacts on trees? Who knocks down the most trees?
2. How important are other factors (e.g. fire, geology, hill slope, differences in the human settlements) in influencing treefall?

Figure 1:
The African elephant (*Loxodonta africana*) is the largest and heaviest land animal and can weigh up to 11 tons. That's one big bulldozer!

Methods

Our study area in the north-east of South Africa covered an area of over 6,500 *hectares* (Fig. 2). That's bigger than Manhattan Island!

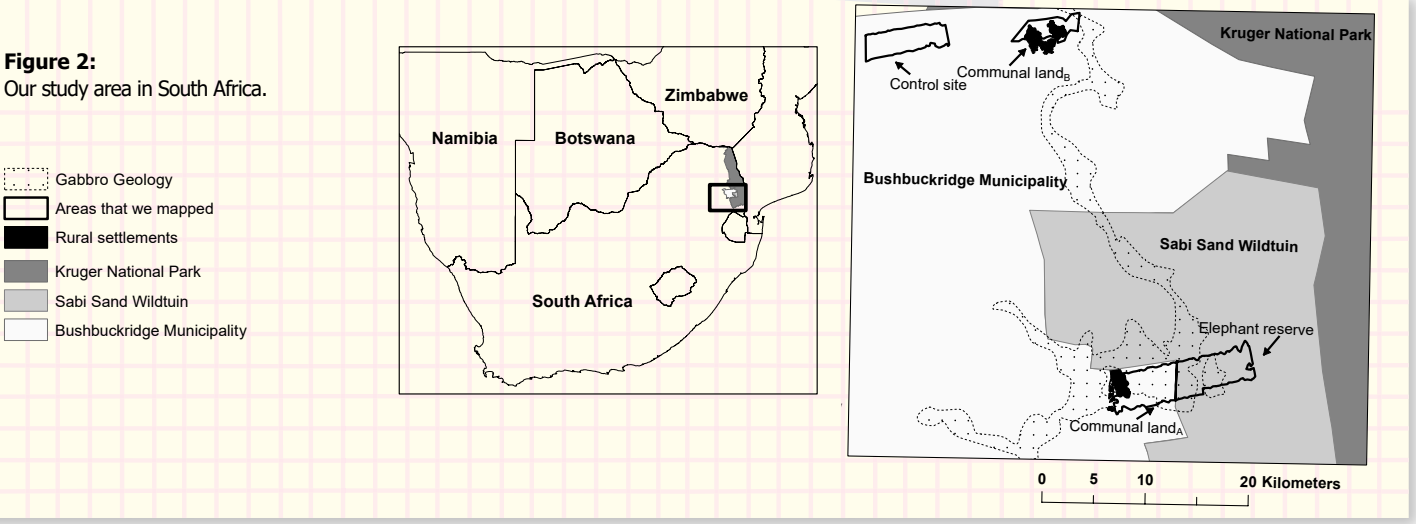
The area is special because it contains separated sites that allowed us to study the independent impact of humans and elephants on rates and patterns of treefall:

- sites only with humans, no elephants (Communal land A & B)
- sites only with elephants, no humans (Reservee)
- and areas *without* both (no humans, no elephants) (Reserve0). This was our *control* site, which we used to compare treefall rates and patterns against.

Over a two-year period, we collected data by flying over the land with a laser imaging technology called *Light Detection and Ranging* (LiDAR). This created high-resolution, 3D maps of the savanna woodlands. Then we used these 3D maps to track each tree's height extremely accurately over two years in the different sites. In this way we could follow the fate of more than 450 000 trees!

We grouped fallen trees into four classes according to their height (1-3 m, 3-5 m, 5-10 m and >10m).

Figure 2:
Our study area in South Africa.



Results

Looking at rates of treefall, we found that:

1) Treefall caused by elephants was 5 times greater than in the control site.

2) Treefall caused by humans was 2 - 4 times greater than in our control area.

3) The two factors that most increased the likelihood of treefall were the presence of elephants and the presence of humans (Fig. 3).

4) There was an interaction between geology and recent fires which also increased the chances of treefall (Fig. 3).

5) When more people lived in the same area, the rates of treefall due to people were almost as high as those of elephants.

We found that the distribution of resources (such as water and nutrients) explained the pattern of treefall for the elephants, while human-caused treefall was more linked to where people extended settlements or cleared land for farming.

Please, see Figure 3 on Page 3

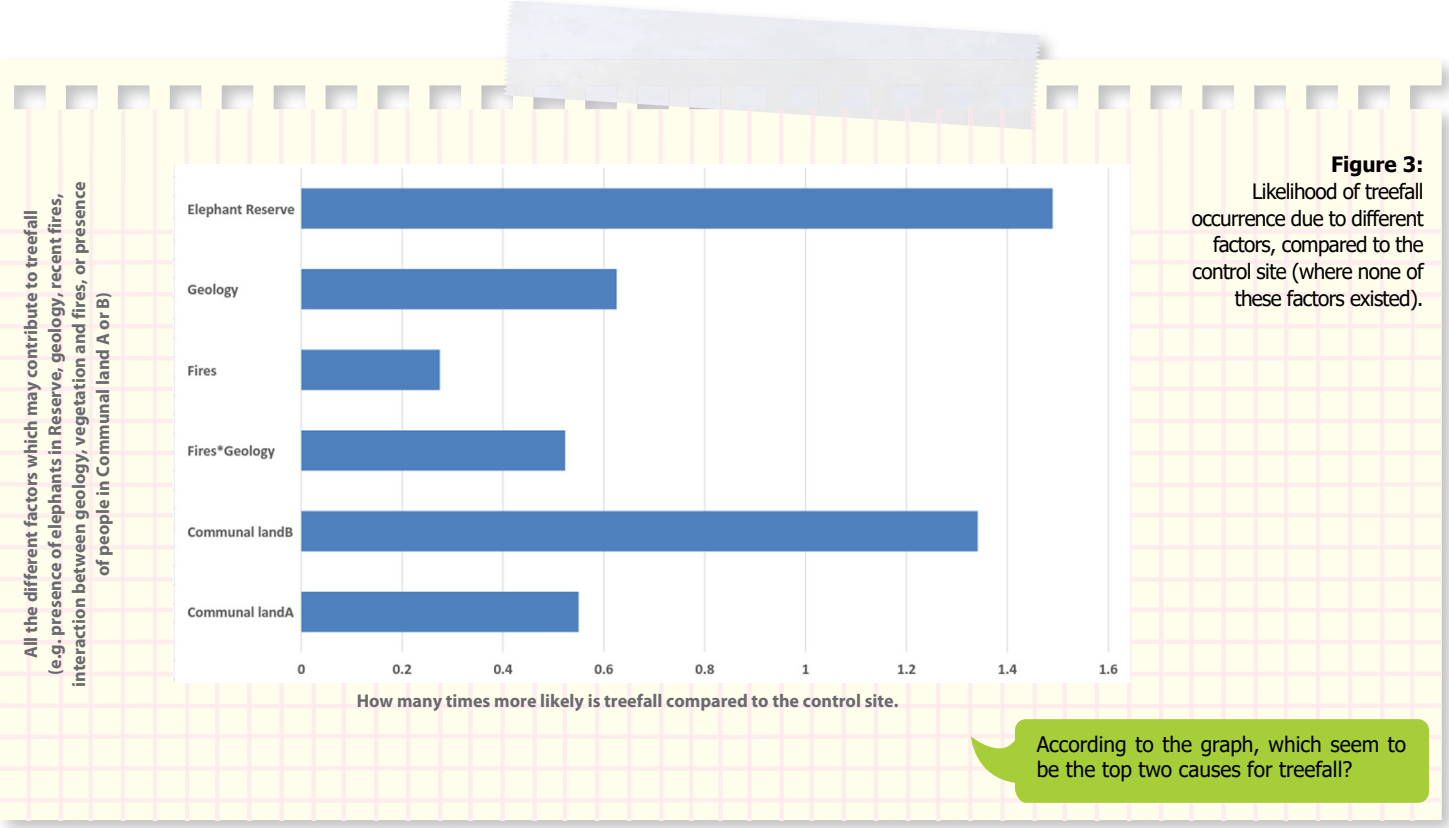


Figure 3: Likelihood of treefall occurrence due to different factors, compared to the control site (where none of these factors existed).

Discussion

Both humans and elephants affect the structure and composition of the savanna vegetation. These effects then ripple down through the ecosystem. They have direct impacts on tree loss as elephants browse or people harvest the wood. They also affect the vegetation indirectly by changing patterns of wildfire.

Interestingly, not all trees died when they fell. In fact, the trees of the savanna are generally able to recover from treefall. This is because they can grow from their stumps or roots. We call this process *coppicing*. It is an important survival skill for savanna trees.

However, we did notice that losing large trees from the landscape may have a negative effect on the ability of the ecosystem to resist and recover from damage (*ecosystem resilience*) because large trees are *keystone* structures in ecosystems. This means they are a crucial part of the ecosystem that many other species depend on.

It is important to monitor savanna woodlands to make sure that they can continue to survive in the future. Particularly it's important to look at the combined effects of large tree loss, lack of trees growing into the tall tree class (over 10m in height), and a low number of seedlings surviving to adulthood. These three factors acting together have very serious consequences for savanna woodlands.

Conclusion

In most of the African elephant's range, humans and elephants live in the same area. This makes it difficult to understand how each species is impacting its environment.

We were able to compare the effects of humans to those of elephants in our study area because we could look at areas where the two species lived separately from each other, and we also had a control site where neither of them lived. Even still, there were other factors that affected our results, like geology and fire.

Think of an experiment that you would like to do. How would you create a control and how would you ensure you were comparing the different factors independently?

Glossary of Key Terms

Biodiversity – The variety of organisms that live in any given ecosystem. We say that there is high biodiversity when there are lots of different types of plants and animals in an ecosystem.

Control – The part of the scientific experiment that is not subject to change of the variables. This provides us with a baseline (in this case the natural rate and patterns of treefall) so that we can compare the results of our experiment against it.

Coppicing – A process where a tree is cut down and new growth comes again from the stump or roots of the tree. This is a traditional woodland management technique to allow for the trees to be harvested regularly. The elephants in our study are actually practicing this technique when they push a tree down – although they don't know it!

Ecosystem – A community of animals that interact with each other, and their physical environment.

Ecosystem Engineer – An organism that significantly changes the ecosystem it lives in. This can have a large effect on the biodiversity and diversity of the landscape in an area.

Ecosystem resilience – The ability of an ecosystem to resist or recover from damage. Here, the ability of damaged trees to regrow is actually a way the savanna ecosystem recovers from harm. If the trees did not grow back, the ecosystem would look and behave differently which would change the biodiversity and the physical environment.

Hectare – A metric unit to measure the size of an area. 1 hectare (ha) equals 10,000 square meters.

Keystone structure – A feature in the landscape that many species depend on. Trees are keystone structures as they support biodiversity and ecosystem resilience.

Savanna – Tropical or subtropical woodlands with few, scattered trees.

Seedling – A young plant or tree that has grown from a seed.

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Check your understanding

1. Why do you think elephants push trees down?
2. What are the main reasons why humans cut trees down?
3. Our research found that if there are less trees of different heights, it would weaken the ecosystem's ability to survive damage, and that it would be devastating if there were also fewer seedlings, or fewer trees that grew to the larger tree heights. Why do you think this would have such a great effect?
4. There were two rock types (granite and gabbro) that made up the composition of the soil in our study area. We found that the geology of the land had an effect on treefall. Areas with gabbro rocks were more nutrient-rich than the granite, and were had more open savanna with fewer scattered trees. The gabbro portions of the study area had higher relative treefall than the granite portions. Why do you think this could be?