# Is there solid evidence of widespread landscape disturbance in the Azores before the arrival of the Portuguese?

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Raposeiro et al. (1) conclude that human occupation of the Azores islands began between 700 and 850 CE, causing widespread landscape disturbance and raising doubts about the islands' presumed pristine nature when the Portuguese arrived. However, previous paleoecological studies from Flores, Pico, and São Miguel Islands (Table 1) show that permanent changes in the vegetation occurred only after the early 15th century. The authors' work also shows the permanent decline, to the lowest levels, in arboreal pollen on Corvo and Flores occurring during Portuguese occupation, not before. So, how would cereal cultivation, livestock grazing, and settlements be possible without deforestation—the hallmark of Norse settlements elsewhere (2)?

The authors argue that these early settlements were extensive. Citing Nogué et al. (6), who never mention such early settlements, they argue that these led to profound environmental and ecological disturbance. Nevertheless, they do recognize that such extensive occupation, persisting up to the 15th century, should have 1) been detected by the arriving Portuguese and mentioned in historical reports and 2) left clear archeological evidence.

**Table 1. Evidence of major permanent vegetation changes around sites located on Flores, Pico, and São Miguel Islands**

| Site | Time of major vegetation change (approximate) | Evidence (decline of the dominant tree pollen and increasing abundance of light-demanding taxa) | Ref. |
|---|---|---|---|
| Lagoa Rasa (Flores Island, 530 m a.s.l.) | 1500 CE | Decline of trees<br>Decline of *Juniperus*<br>Increase of Poaceae and Ericaceae | 3 |
| Lagoa do Caveiro (Pico Island, 903 m a.s.l.) | 1550 CE | Decline of *Juniperus* and *Ilex*<br>Increase in Poaceae and Ericaceae<br>Presence of *Sphagnum* | 3 |
| Pico Bog (Pico Island, 873 m a.s.l.) | 1600 CE | Great decrease of *Ilex*<br>Decline of *Juniperus*<br>Increase in Poaceae, Ericaceae, and *Pteridium*<br>Presence of *Sphagnum* | 3 |
| Alagoínha (Flores Island, 270 m a.s.l.) | 1515–1680 CE | Decline of *Juniperus*<br>Disappearance of *Picconia* | 4 |
| Lagoa Azul (São Miguel Island, 260 m a.s.l.) | 1420 CE ± 40 | Disappearance of *Juniperus* and *Picconia*<br>Increase in Ericaceae | 5 |

*Juniperus* = *Juniperus brevifolia* (Seub.) Antoine; *Ilex* = *Ilex azorica* Gand.; *Picconia* = *Picconia azorica* (Tutin) Knobl. a.s.l., above sea level.

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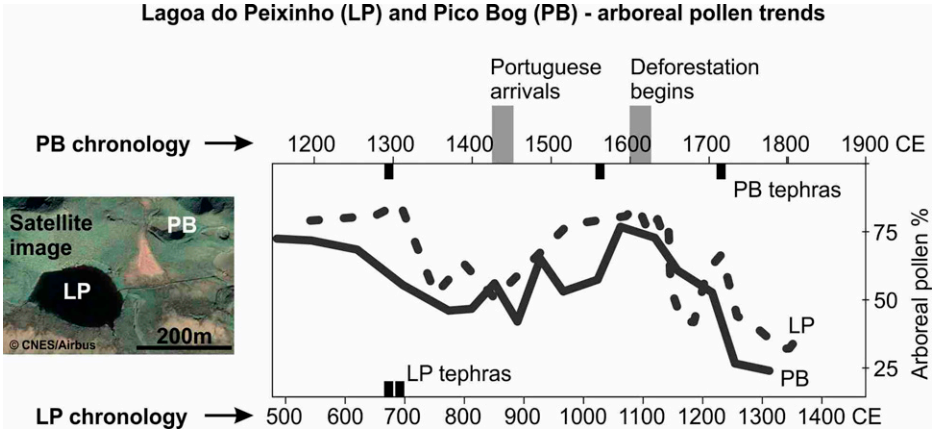


**Fig. 1. Arboreal pollen trends and tephra layers at Lagoa do Peixinho (LP, ref. 1) and Pico Bog (PB, ref. 3) showing the mismatch between chronologies based on pollen concentrates (LP) and macrofossils/bulk dates (PB).**

A major discrepancy also exists between ages assigned to the arboreal pollen decline at Lagoa do Peixinho and the same decline in a neighboring peat bog (Fig. 1). Radiocarbon dates from Azorean crater lake sediments are potentially contaminated with "old" volcanic carbon (7). Pollen concentrates, as used by the authors, are known to produce dating anomalies (8). If the authors' dates are anomalously old, evidence for early colonization crumbles.

*Secale* pollen is interpreted as evidence of cultivation, but *Secale* disperses significantly more pollen than other cereals (9). With dominant winds blowing directly from Europe, occasional *Secale* pollen likely reached the Azores. However, the authors do not provide any raw data and the datasets lack sample depths. Were enough cereal pollen recorded to indicate local cropping? Were other exotic pollen blown from the continents (e.g., *Alnus*, *Betula*, or *Artemisia*) (3)? The authors use *Plantago* pollen as an anthropogenic indicator, but it likely indicates the indigenous *Plantago coronopus*, a common species of coastal and high-altitude vegetation.

Could lightning fires or volcanic eruptions (3) explain some of the early charcoal peaks? Could these and other natural disturbances explain some of the pre-Portuguese declines in arboreal pollen? Furthermore, why are fecal biomarkers in L. Peixinho before 700 CE, between tephra layers? Could biomarkers be related to the presence of large bird colonies (as reported by the first Portuguese colonizers)?

Based on the available information, not denying the possibility of earlier human presence (10), we argue that there is no solid empirical evidence for a widespread landscape disturbance caused by pre-Portuguese settlers. Additional multidisciplinary work is required to deny the historical records that the islands were occupied by dense native forests in the 15th century. Until more convincing evidence emerges, Norse presence remains an "intriguing possibility" (10). Not merely an academic question, the assumption of extensive human impact on the Azores, from as early as the eighth century, may lead to a decrease in current conservation efforts to preserve endemic species and unique habitats.


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