# DO PLANT BIO-INDICATORS REFLECT CHANGES IN FOREST SOIL CHEMICAL PROPERTIES OVER TIME?

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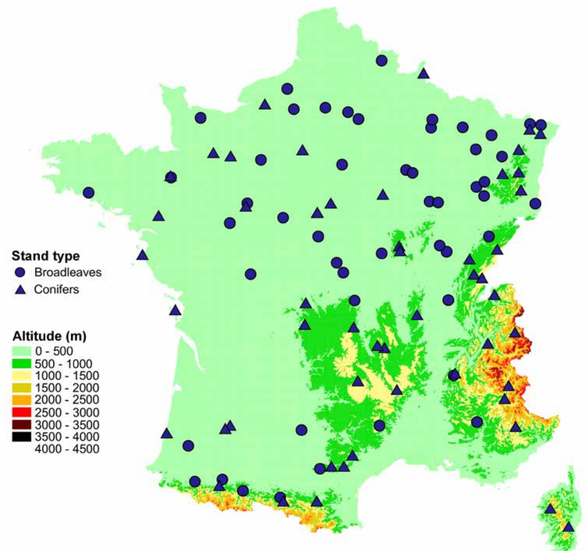


## APPARENTLY NOT!

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## INTRODUCTION:

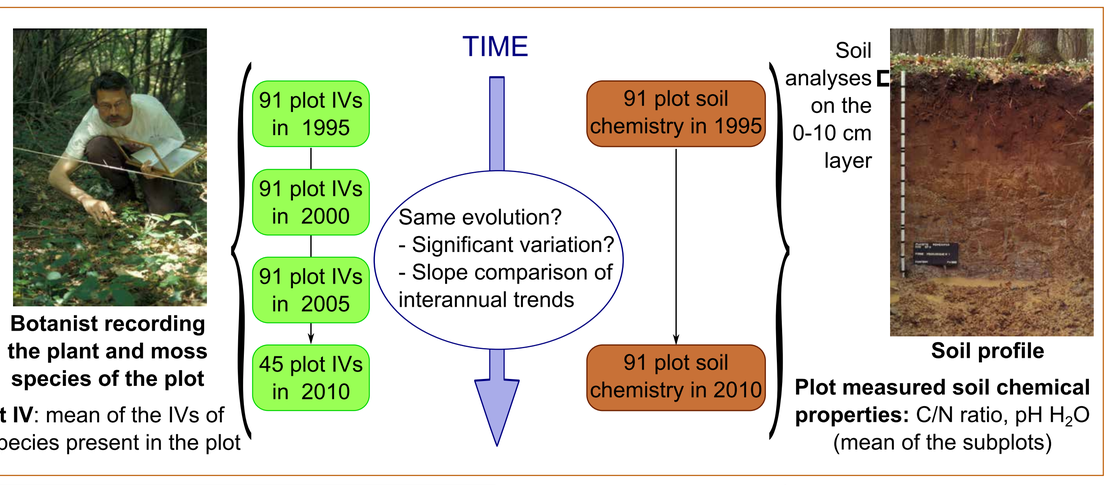
Tracking long-term environmental changes is particularly difficult due to:
- limited historical data on soil chemistry,
- high cost of soil chemical analyses.

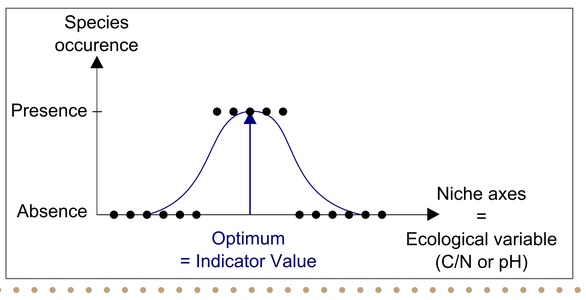
Bio-indication by plant communities has therefore become an option to determine the values of environmental parameters and to monitor their change[1]. **Niche modeling** allows researchers to attribute **Indicator Values (IVs) to specific plant species**. Then, by averaging the IVs of the species from a local community, they can estimate the environmental parameters of the site[2].

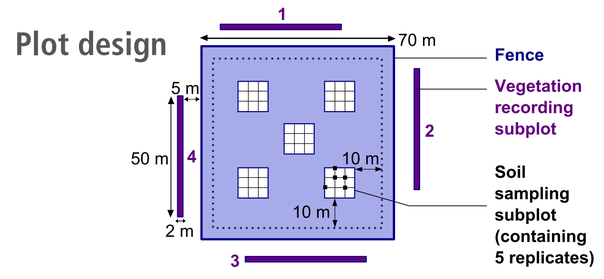
The reliability of bio-indicators to show **spatial variations** has been proven[3]. Yet, on the supposition that species change their distribution in accordance with changes in soil chemistry, it is sometimes taken for granted that that the correlation between IVs and soil properties **remains valid through time**. IVs are being widely employed to study temporal trends even though the relevance of this transposition **has not been clearly proven**.

We used data from 91 forest plots in the RENECOFOR monitoring network over 15 years. We tested to what extent **plant community dynamics reflect changes in soil chemistry**:
- for **two chemical properties**: soil pH $H_2O$ and C/N ratio,
- at **two different scales**: national (whole network level) and local (among plots).

## METHODS:



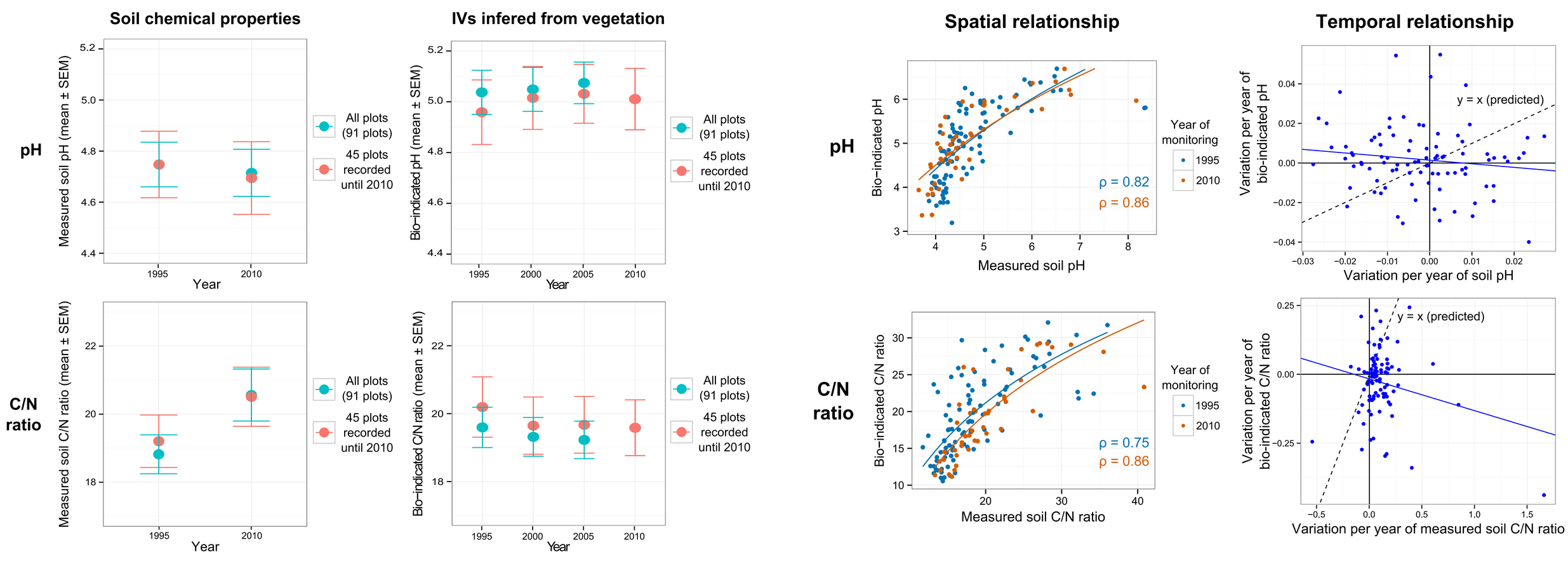




## RESULTS:

**1)** At the network scale, soil chemistry and their corresponding IVs varied in **opposite directions**. The measured C/N ratio increased while the bio-indicated C/N ratio decreased (significant variations), and the measured soil pH decreased while the bio-indicated pH increased (non-significant variations).

**2)** Among plots, there was a strong spatial correlation between IVs and soil chemical properties at each survey date which confirmed the **relevance of plant bio-indicators**. Yet, variations per year of measured soil chemistry did not correlate with variations per year of IVs. Temporal variations in soil chemistry **cannot be predicted** by those of IVs.




**3)** We found **no satisfying bio-geographical factor** influencing the plant bio-indicator/ soil chemistry relationship over time.

Table: Results of the regressions between variations per year of soil measured chemical properties (pH and C/N ratio) and variations per year of their corresponding IVs within the different levels of environmental factors (number of plots out of 91).

p: level of significance, * $p < 0.01$ with Bonferroni's post hoc test

| | | pH | | | | C/N ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Intercept | Slope | $R^2$ | p | Intercept | Slope | $R^2$ | p |
| CLIMATE | Continental (29) | -0.0012 | -0.34 | 0.055 | 0.2 | -0.015 | 0.18 | 0.012 | 0.6 |
| | Mountain (27) | 0.0030 | -0.29 | 0.065 | 0.2 | -0.040 | 0.40 | 0.17 | 0.04 |
| | Oceanic (35) | 0.0043 | -0.0095 | 4.2e-05 | 0.9 | -0.054 | -0.14 | 0.15 | 0.02 |
| STAND TYPE | Conifers (46) | 0.0052 | -0.14 | 0.0081 | 0.6 | -0.043 | -0.09 | 0.045 | 0.2 |
| | Broadleaves (45) | -0.00095 | -0.21 | 0.032 | 0.2 | 0.0026 | 0.14 | 0.011 | 0.5 |
| INITIAL pH | pH $H_2O$ < 4.5 (49) | 0.0038 | -0.23 | 0.025 | 0.3 | -0.059 | 0.0033 | 1.5e-05 | 0.9 |
| | pH $H_2O$ in 4.5-5.5 (31) | 0.00029 | -0.16 | 0.02 | 0.5 | -0.018 | 0.30 | 0.15 | 0.03 |
| | pH $H_2O$ > 5.5 (11) | -0.0034 | 0.12 | 0.0060 | 0.8 | 0.046 | -0.27 | 0.67 | 0.0011* |

## CONCLUSION:

In our study, **temporal changes in IVs** inferred by vegetation **did not reflect** the measured changes in soil chemistry over a 15-year period. The correlation between soil and bio-indication may not be strong enough to bring out such **subtle changes**. As understorey species are mainly perennials, this lack of correlation could also be due to a **delayed response** of vegetation. There are numerous examples of lagged responses from vegetation to soil changes[4,5]. Nevertheless, the median study period is 18 years in the papers published on the temporal changes in plant species richness[6]. This may be **far too short a time-period**. Monitoring the impacts of environmental changes on forest ecosystems through plant bio-indication might require longer term studies. There is no such thing as quick adaptation of plants to their edaphic niche.

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