Pasture Ecosystem Services Indicators : an expert based set of indicators of ecosystem services

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Abstract

Many recent studies show that grassland biodiversity is linked to ecosystem functioning (BEF Theory) and to its capacity to deliver a large diversity of ecosystem services (ES). However, till now no methods allow an easy diagnosis of the level of ES produced, neither a concomitant evaluation of these services (i.e. forage production, biodiversity conservation and pollination or carbon sequestration). Our goal was to develop indicators of ES using botanical surveys (as a proxy of biodiversity), because botanical survey is quite easily accessible and is integrative of the spatiotemporal variability of grassland ecosystems. We used a multicriteria analysis tools to aggregate different criteria calculated from botanical survey to assess ES scores (ranged from 0 to 1). This tool used a set of indicators, which mixed academic knowledge and expertise. The first step was to develop a set of indicators (selection of the botanical survey criteria and the way to aggregate them) based on literature survey. Then, they were discussed with 20 experts during a workshop to produce a more finalized version of the indicators. 6 ES, i.e. forage production and quality, flexibility of forage production, nitrogen availability for vegetation, biodiversity conservation, resilience hazards and pollination, were selected.

Introduction.

Grassland especially permanent grassland provided many ecosystem services (ES). Forage to feed the animals, carbon sequestration in the soil, conservation of biodiversity, pollination… Grasslands are presented in many different climates and under many different management (grazing, cutting, fertilization...). This variability of conditions impact strongly the flora composition of grassland and so the provision of ecosystem services. Indeed, many studies show for grassland a link between vegetation characteristic especially biodiversity and ecosystem functioning and so services(de Bello *et al.*, 2010).

Some studies proposed to use this link between vegetation and ecosystem services develop indicators of services(Lavorel *et al.*, 2011).

We developed indicators of ecosystem services using the actual knowledge between grassland vegetation and ecosystem services. We used a multicriteria analysis tool to aggregate vegetation variables to produce score for ecosystem services. The choice of the vegetation variables and the way to aggregate the different variables were defined by expert knowledge. One of the main constraints was that the variables can be calculated only from a botanical survey.

Materials and Methods

We used the Tatale tools to develop the indicator (https://umr-selmet.cirad.fr/en/products-and-services/proposed-products/tatale) (Taugourdeau and Messad, 2017). This construction is based on two principles: (1) expertise on variation ranges and key relationships between variables (2)

normalization and aggregation of variables for calculating summary scores. These scores that can be considered as latent variables. The variables from the botanical survey are so first transform into score between 0 and 1 based on expert knowledge. Secondly, these scores are successively aggregated to propose intermediate score (here ecosystem processes and function) and thus aggregate these intermediate score into a final score (here ecosystem services).
We choose to work on six different ecosystem services: Forage provisioning in quantity and in quality, forage production stability, nitrogen availability, Biodiversity conservation, resistance of the community to extreme events and pollination. To be able to propose ecosystem services indicators, we had first to decompose these services into several ecosystems functions and processes. For example, forage provisioning was decomposed into forage annual production, forage quality and the percentage of the biomass available for animals feeding.
Finally, we selected vegetation variable related to the different functions and processes. Finally, we proposed transformation and aggregation coefficients. For example, we chose the percentage of cover in the survey of species with pastoral value equivalent to 0 to evaluate the percentage of biomass available for animals feeding.
The creation of the indicators were made using literature surveys and expert meeting. We made a meeting with 20 experts in June 2018.The different indicators and the explanation for the different choices we made are presented on a website (https://pesi-travail.cirad.fr/en).
We used the indicators develop on this work on the 1754 botanical surveys from the eflorasys dataset. (Plantureux and Amiaud 2010). The survey cover mostly France and range from 1973 to 2018. Functional traits were obtained on the TRY database (www.try-db.org).

Results and Discussion

The figure 1 represented the PCA obtained for the 6 scores of ecosystem services and with latitude longitude and year of the survey as supplementary variables.
Nitrogen availability was positively correlated with the robustness to extreme events and negatively with pollination .Forage provisioning and forage flexibility were correlated together but independent from the other services. The average nitrogen availability seems to be increasing with time at the opposite of pollination and conservation of biodiversity.
This example shows the possibility to use our indicators on large datasets to evaluate the trade-off between services and see change over time.
These indicators are first prototypes of ecosystem services and are available on the website https://pesi-travail.cirad.fr/en.

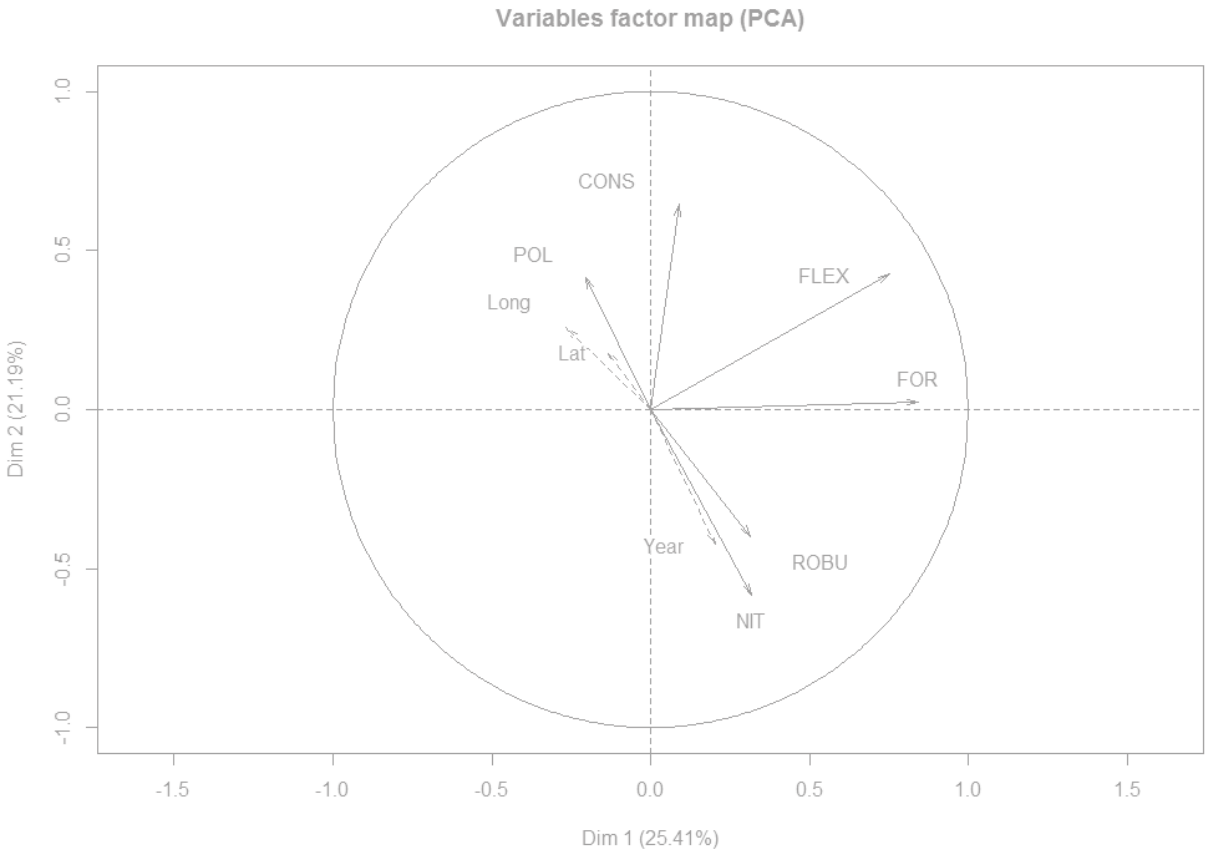

Figure 1 PCA on the score of ecosystem services (FOR forage provisioning , Flex for flexibility in forage production , CONS for conservation of biodiversity , ROBU for Robustness to extreme events, NIT nitrogen availability , Pol pollination) and latitude (Lat) Longitude (Long) and the year of the survey(Year) that were as use a supplementary variable.

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