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How to model moving farming systems?
The case of transhumant breeders in northern Senegal.

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1 – Introduction

Extensive livestock farming is the dominant type of production system in the Sahelian regions of West Africa. Each year, when the scarcity of rains impedes the regeneration of pastures, millions of ruminants leave the Sahelian semi-arid regions towards harvested fields and rangelands further south. Back from transhumance, when grass starts growing, animals move daily within their territory looking for water and forage resources. This type of farming system is thus intrinsically mobile and entirely dependent on its environment.

The understanding of herds' mobility in relation to available resources and landscape configuration is essential to better take into account these types of farming systems for landscape planning or support policies. Many studies had recourse to computing models to simulate herds' mobility (Bah et al., 2010), however they remains limited to small extents, due to the difficulty of manipulating fine resolution spatial data and multiscale processes on large areas.

We propose an approach able to reproduce herd mobility according to vegetation dynamics and landscape changes, using a spatially explicit modeling platform and remote sensing images, on a large territory.

2 – Materials and methods

The study area is the Senegal River valley, covering 4000 km². It has seen a rapid expansion of irrigated areas at the expense of pastoral lands and rainfed crops areas, so that mobility on this territory is becoming more and more complicated. We carried out an exhaustive census to characterize the 1103 breeders ‘camps of the valley. We then conducted about 400 surveys with breeders to understand their mobility strategies. We selected 20 of them for semi-directive interviews. We completed these surveys with a data set collected by H. Assouma, from June 2014 to October 2015 in the service area of the Widou Thiengoly, in northern Senegal, where 5 steers grazing behavior was monitored monthly (Assouma et al., 2017).We then built a model that reproduced daily herd motility over one year, using the Ocelet modeling platform. The model calculate the biomass dynamics from remote sensing images, and reproduces the landscape structure changes (access or not to plots depending on the season). The model describes relations between five entities: the Herds, the Camps (center of decisions), the Plots (seen as obstacles during the rainy season, and food during the dry season), the Watering places and the Pasture. The model represents each day by a succession of five actions describing the herds' mobility behaviors. The duration and implementation of each action varies according to the herd and its environment (Fig. 1).

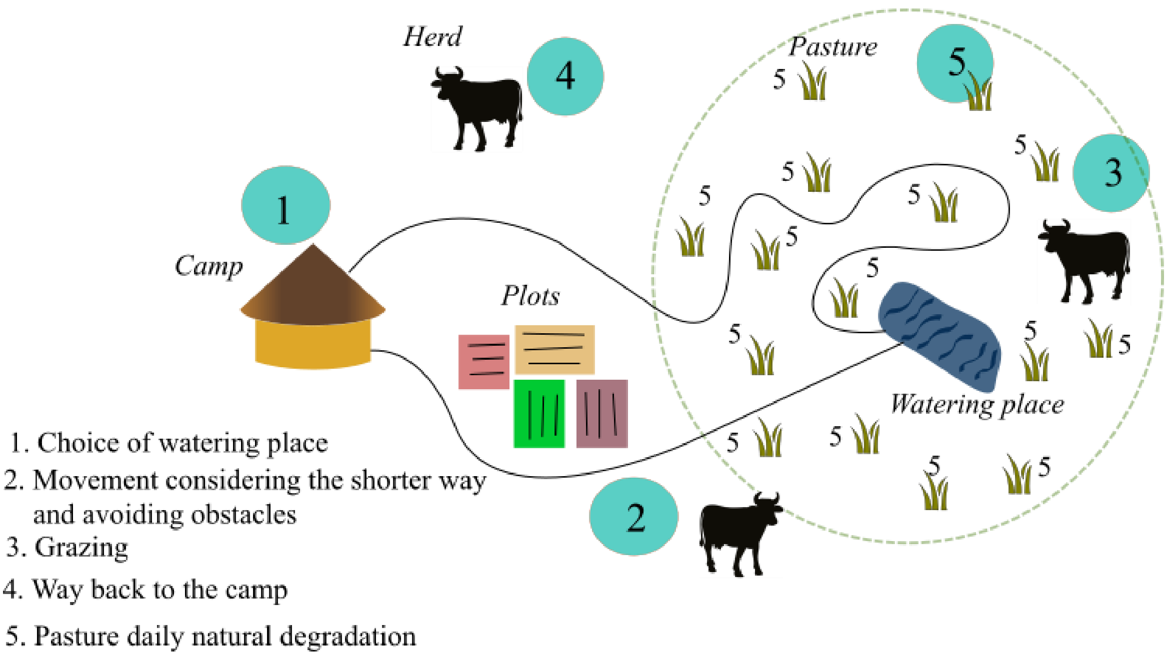

Figure 1. The five daily actions in the model.

We calibrated the model with the five steers monitoring of grazing behavior data set (time spent at the watering place, displacement speed, daily food intake according to the period, etc.). We then validated the model by comparing the simulated movements with maps of herds’ mobility drawn by 50 breeders in the valley.

3 – **Results – Discussion**

Model was able to reproduce the herd mobility spatial dynamics and their evolution during a year. Figure 2 shows that herds go further and further as the season progresses, and as the pasture decreases.

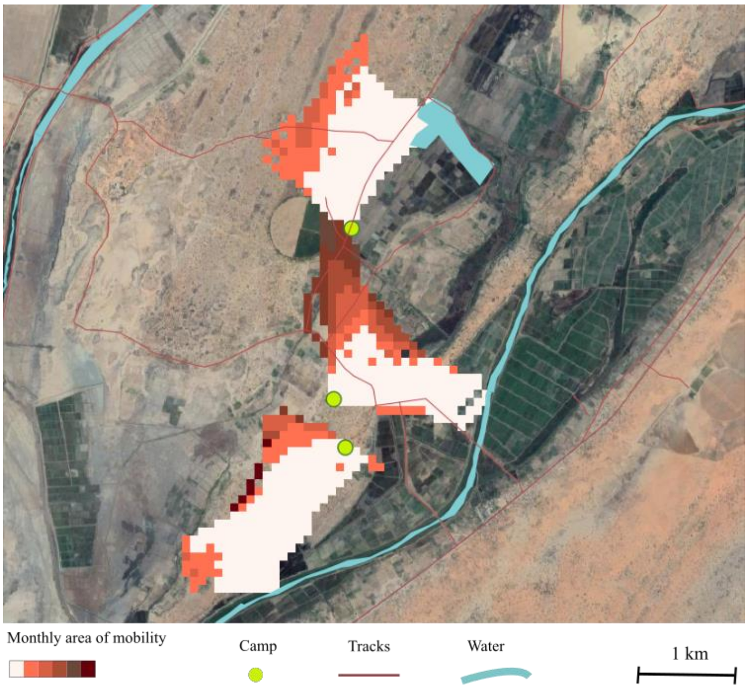

Figure 2. Simulated map of monthly herd mobility evolution during one year (zoom on three camps and 60 herds before calibration).

We then run the model for the next ten years, with several hypothesis of environment change and compared their results considering four simulated indicators: the distance covered by herds, the pastures intakes, the weight evolution and the occurrence of contacts between herds. These scenarios enabled to assess the impact of environment changes on farming system performances and risks of disease spread.

4 – Conclusions

Modeling herds' mobility at large scale with fine spatial resolution is essential for understanding the impact of environment on such moving farming systems, and the risks of disease spread between herds. Such modeling requires integrating processes at different scales, from grass to landscape level including breeder decision level, and fine spatial information. The novelty of our approach is to use interaction graphs to represent and assess relations between herds and their environment on a large area.

Work is now underway to use the results to propose land-use measures that support livestock systems in the valley.

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