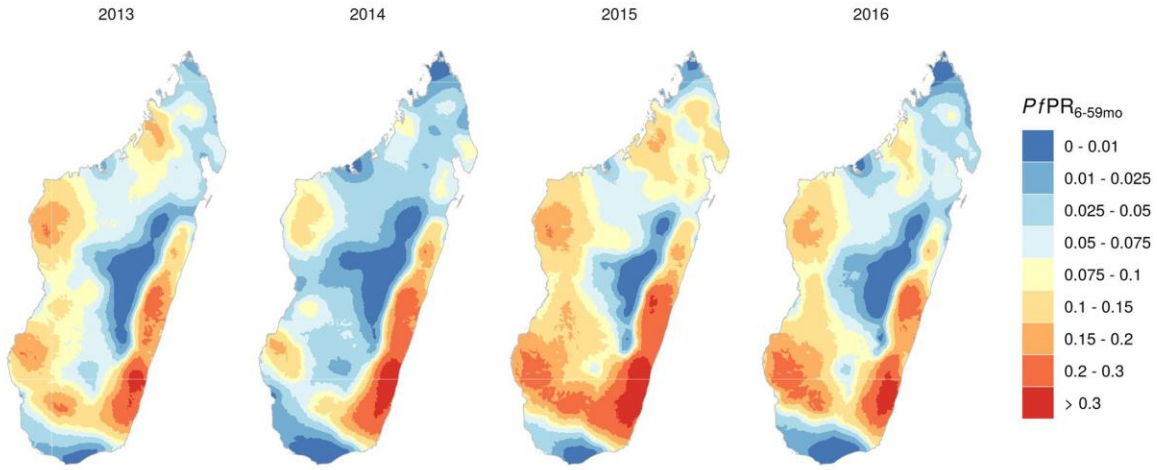
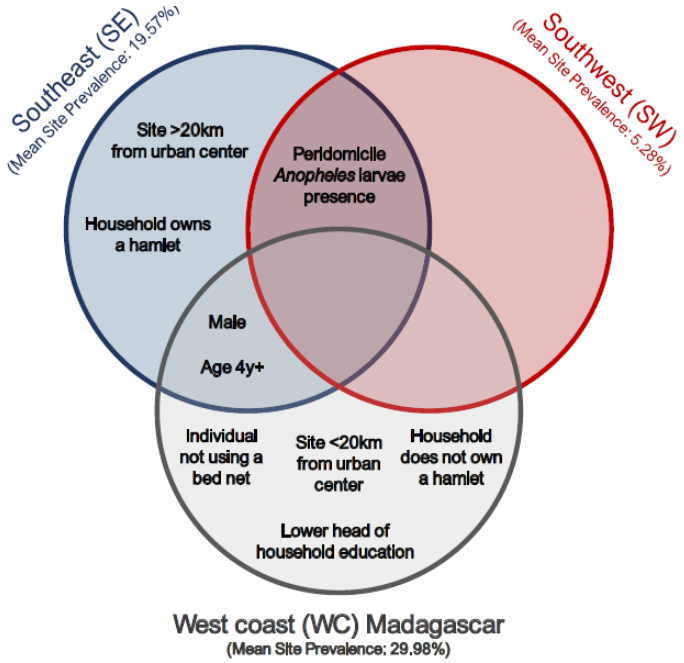
Ecology of *Anopheles* mosquitoes under climate change in Madagascar

- Research background : Malaria distribution is changing and It is mainly caused by the distribution of the vector.
- Statistical research question : What is the relationship between climatical conditions and *Anopheles* spp. occurrence in Madagascar?
- Mechanistic research question : How rainfall affect *Anopheles* spp. density?
- Acknowledgments : Fabrice, Mirana (Readers)





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Statistical question : What is the relationship between climatical conditions and *Anopheles* spp. occurrence in Madagascar?

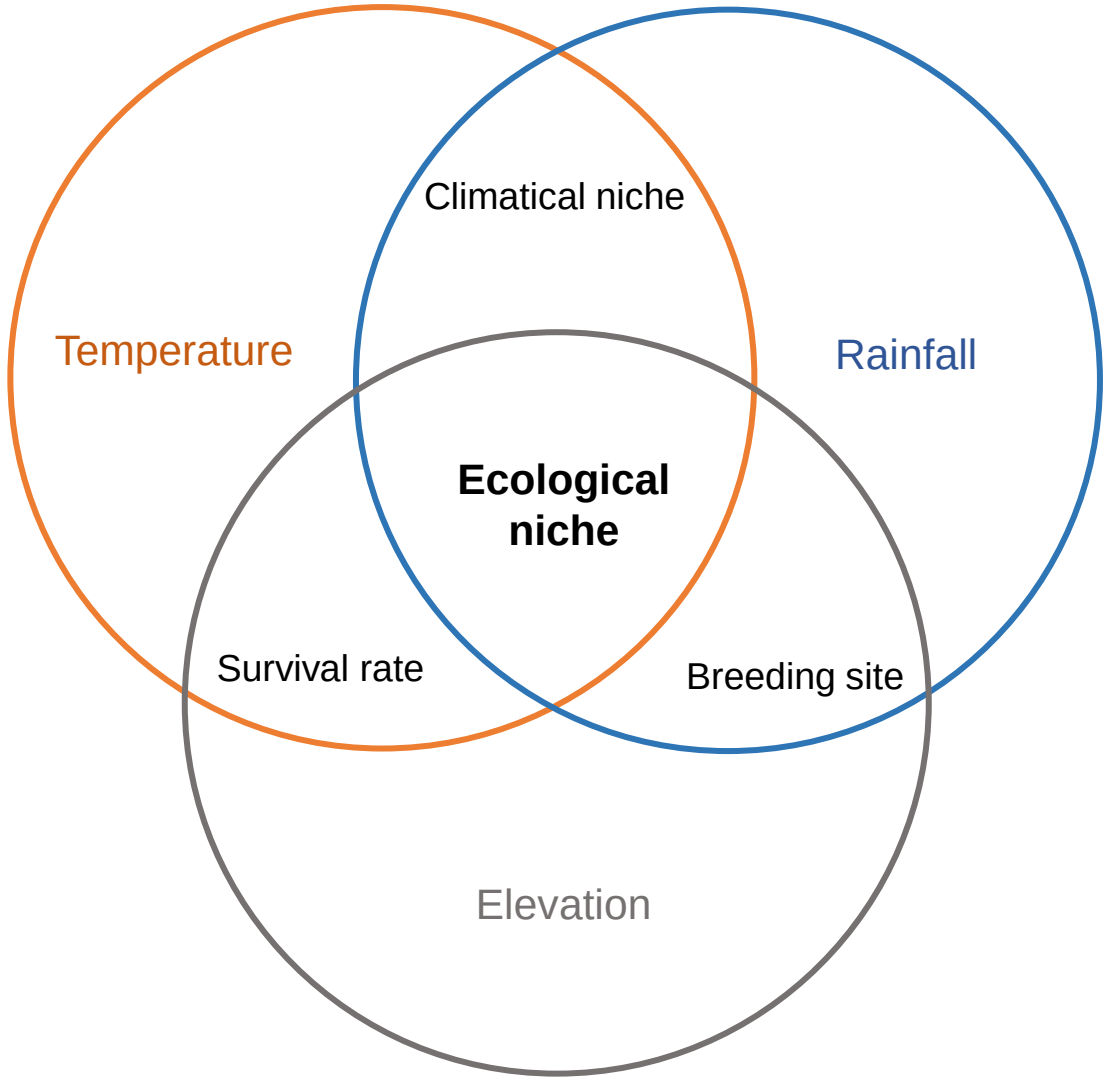
- Response variable : occurrence of *Anopheles* spp. (Family : binomial) -> Ancient mosquito collections digitization

- Predictor variables
  - Time
  - Elevation
  - Temperature
  - Rainfall
  - Species (random effect)

- Hypothesis : *Anopheles* spp. will be more occurrent with increasing temperature and rainfall

- R code

```
glmer (an.occurrence ~ time + elevation +
temperature + rainfall + (1|species) ,
family = 'binomial' , link = 'logit' )
```



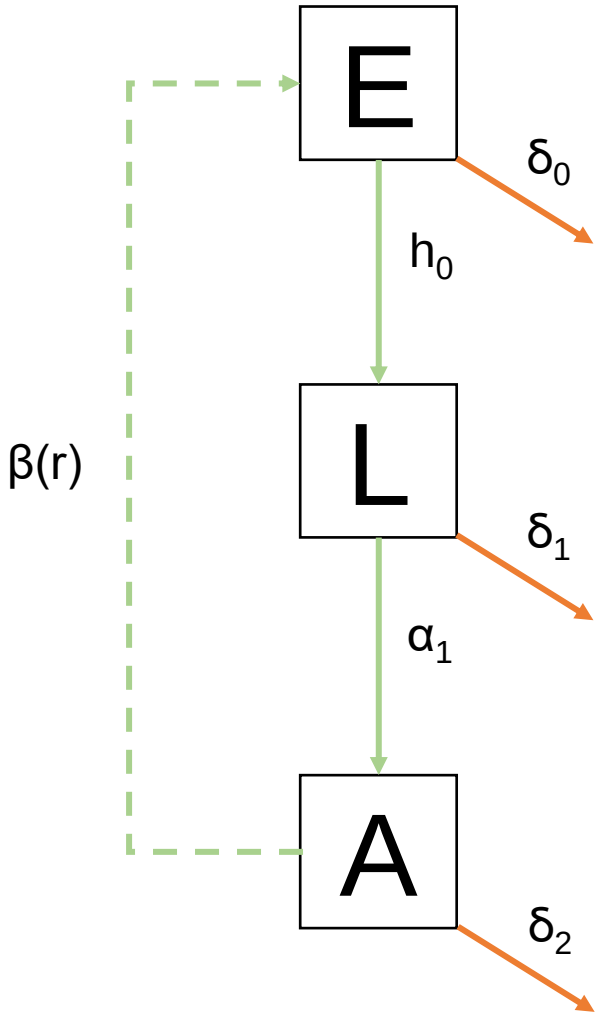
Mechanistic question : How rainfall affect *Anopheles* spp. density?

States (Field data)

E = Egg density
L = Larvae density
A = Adult density

Parameters

α_1 = Theorical growth rate of the larval stage
h_0 = Theorical hatch rate of the eggs
δ_0 = Eggs death rate
δ_1 = Larvae death rate
δ_2 = Adults death rate
β = Breeding success
r = Rainfall



From where to begin?

1. **Get support**, write a research proposal based on the known and published state of *Anopheles* spp. distribution in Madagascar.
2. **Do a meta analysis** of published and unpublished data about *Anopheles* spp. ecology, and get the precise location of mosquitoes collection related to these manuscript from different institutions.
3. **Build research convention** tying each institutions and get access to these collections.
4. **Begin the digitization,** data recovering and re-identification of collected specimens.
5. **Get a statistical prediction,** *Anopheles* spp. occurrence under climate change.
6. **Refine causation** behind climate dependent distribution of the vectors with fieldworks and mechanistic model.