

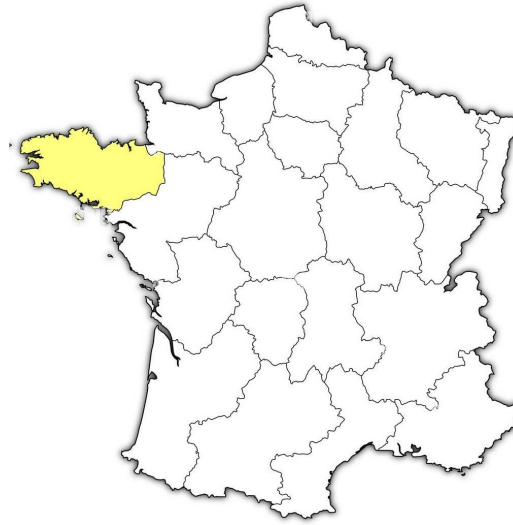
Projection of Thermal Humidity Index (THI) and Frequency of Severe Heat Events for Broilers and Layers in the Context of Climate Change in Brittany, France

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Context - Global Warming

Baseline scenario

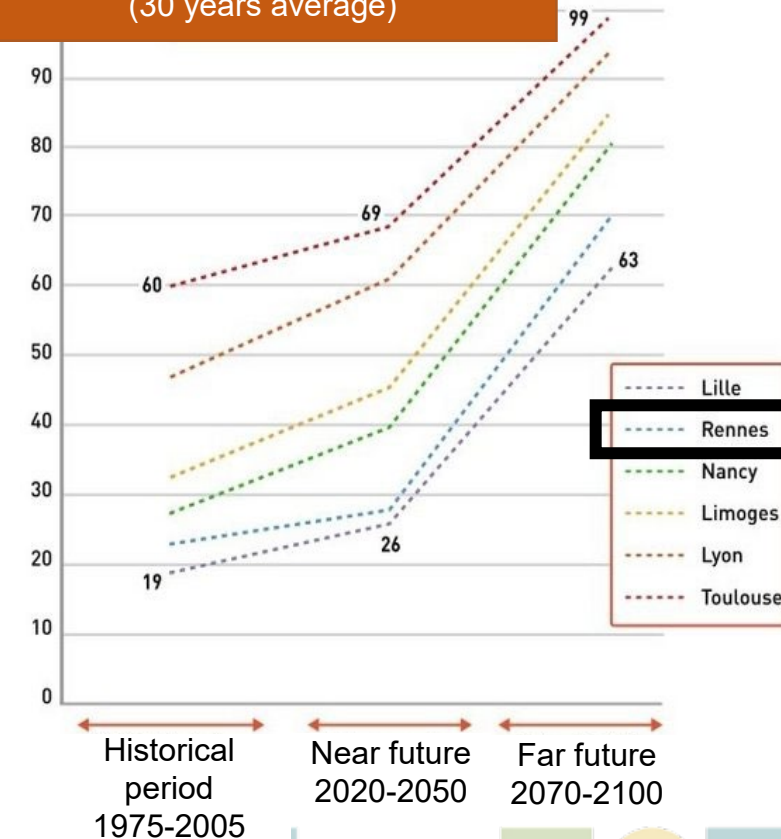
- This scenario reflects the continuation of current global policies, without any additional measures.
- Global warming stabilizes at **+3°C by 2100** compared to the pre-industrial era.
- This represents an average increase of about **+4°C across metropolitan France**.



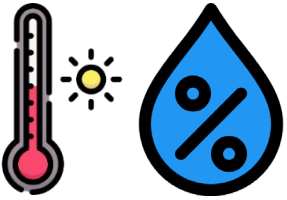
Brittany

- 33% of broilers
- 36% of consumed eggs

Number of hot days from June to Sept (>30°C)
(30 years average)



Context - Heat Stress



Heat stress is the phenomenon where animals are not able to reduce their core body temperature due to high ambient temperature and high humidity



Heat stress has several detrimental effects :

- Discomfort
- Feed intake reduction
- Body weight gain and egg production reduction
- Higher mortality rate

Thermal Humidity Index (THI) combines dry and wet bulb temperatures and are associated to thresholds values corresponding to homeostasis states.

THI > 30 = severe heat stress

$$THI = \alpha T_{db} + (1 - \alpha) T_{wb}$$

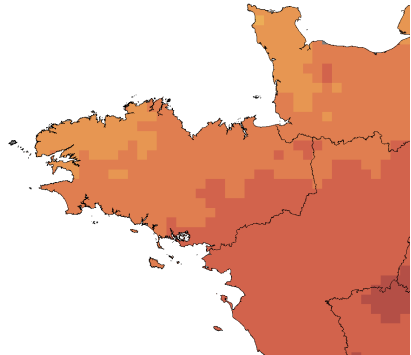
$\alpha = 0.85$ for broilers

$\alpha = 0.6$ for layers

Objective : Quantify the risk related to climate change for poultry via the projection of the amount of days in severe heat stress



Input data & Methodology

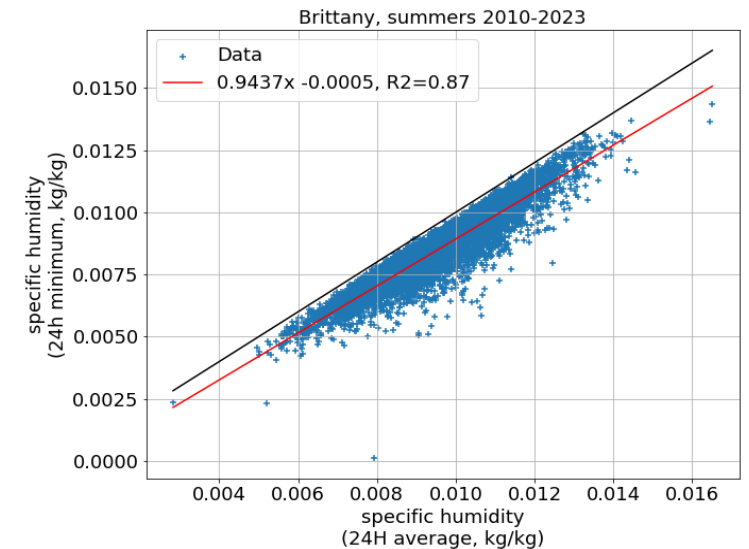


- 8km x 8km regionalised data
- 10 GCM-RCM couplings
- $T_{\max}$ and $\text{spec_hum}_{\text{ave}}$ for each simulations and each day in summer from 1975 to 2100



- Compute maximum THI for each day
- Compute the amount of severe stress days for each year
- Average over 30 years period
- Compute median of the 10 GCM-RCM models

Average to minimum specific humidity relation



What about conventional production with no outdoor access ?



Conventional production - No outdoor access

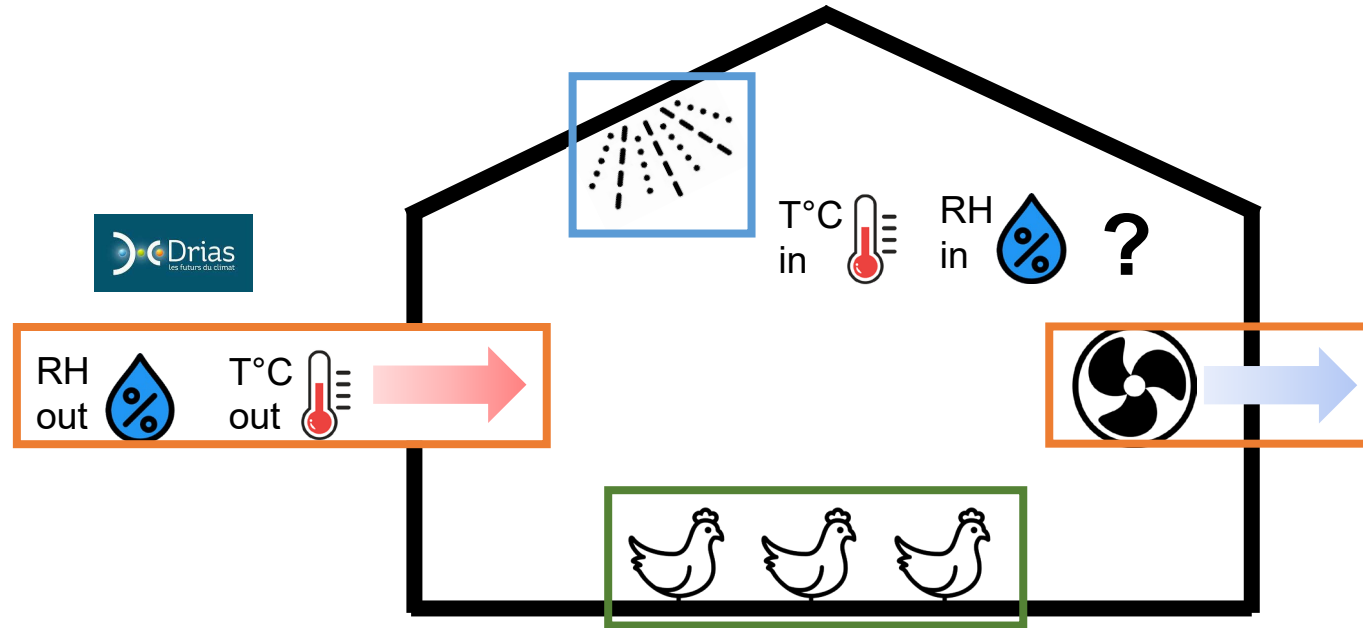


ITAVI

- For conventional productions, animals are kept inside broiler or layer houses
- Good management of the building environment (temperature, humidity, and air velocity) can help to reduce the temperature, thereby limiting heat stress and its harmful effects.
- **A thermodynamic model is necessary to extrapolate external meteorological conditions to indoor THI**



Methodology



Energy balance :

$$V c_v \frac{dT}{dt} = \boxed{n_a q_{sens}} + \boxed{c_v Q_{air} (T_{out} - T)} - \boxed{\dot{m}_{mist} \Delta H_{vap}} = 0$$



Water mass balance

$$\therefore \frac{dW}{dt} = \boxed{n_a q_{lat}} + \boxed{Q_{air} (W_{out} - W)} + \boxed{\dot{m}_{mist}} = 0$$



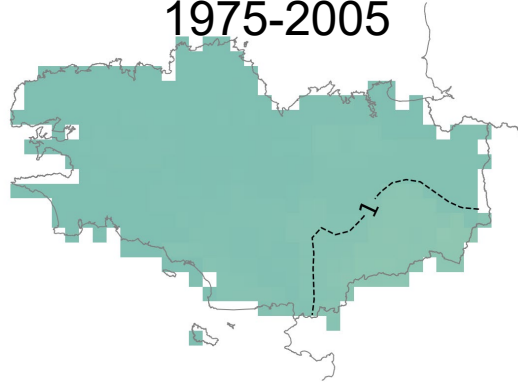
Results - Animals with outdoor access



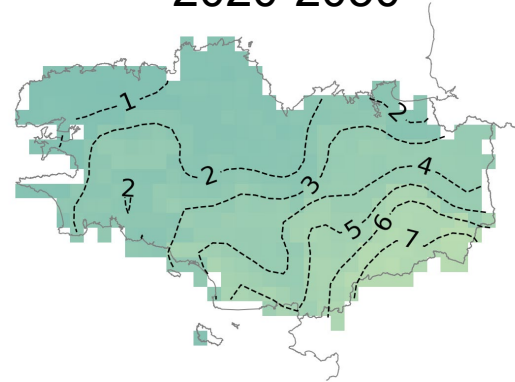
Broilers



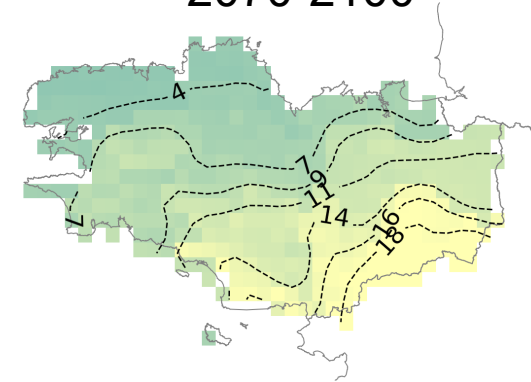
Historical
period
1975-2005



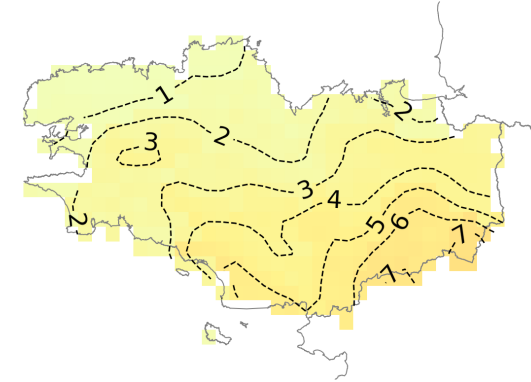
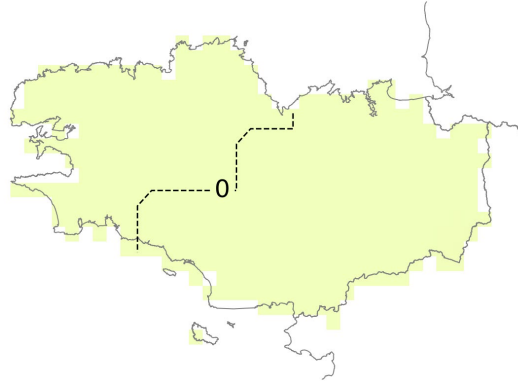
Near future
2020-2050



Far future
2070-2100



Layers



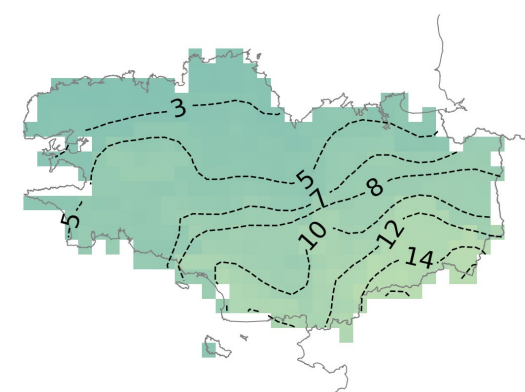
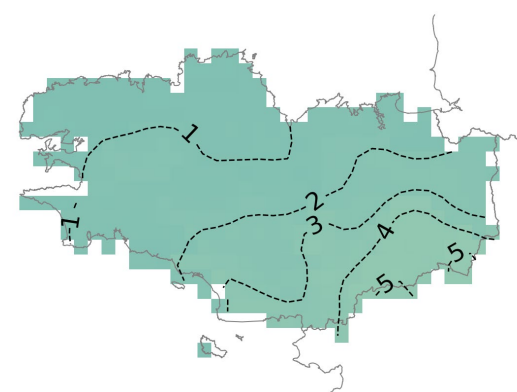
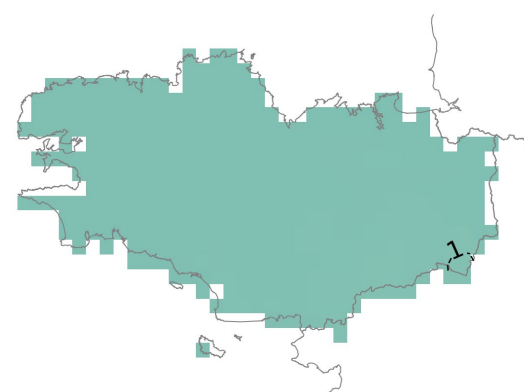
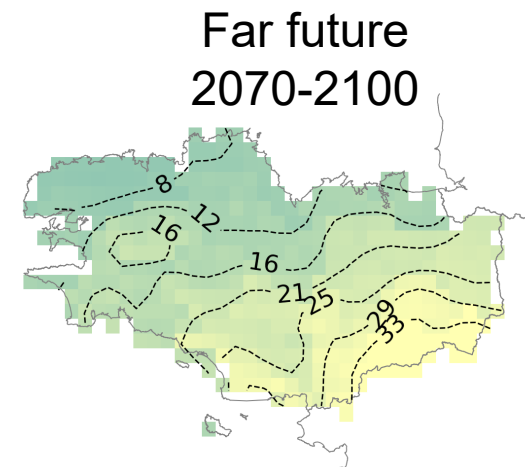
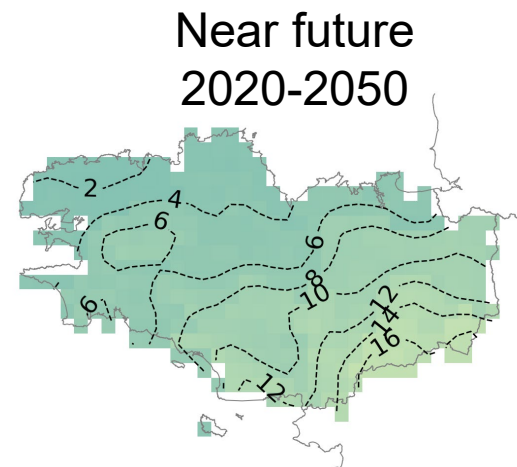
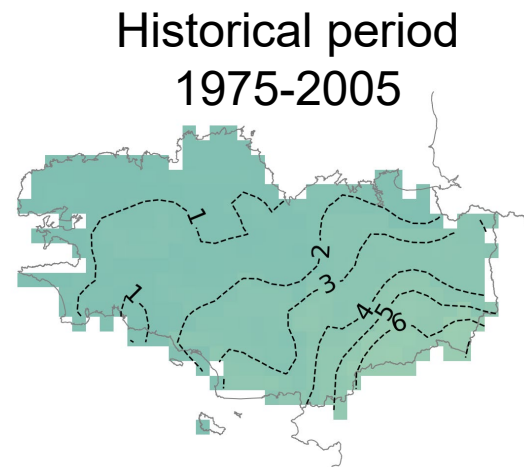
Number of days of severe stress over summer
(June-Sept)



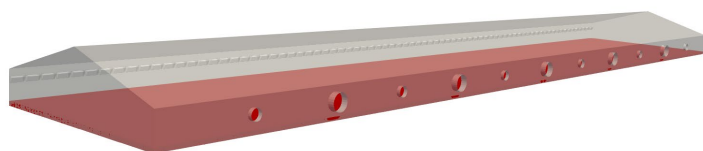
Results - Broilers without outdoor access

Parameters	Values
BW (kg)	1,9
Density (broilers/m ²)	22
Surface area (m ²)	1200
Misting (l/h)	0
Flow rate (m ³ /h/m ²)	250

Parameters	Values
BW (kg)	1,9
Density (broilers/m ²)	22
Surface area (m ²)	1200
Misting (l/h)	500
Flow rate (m ³ /h/m ²)	250



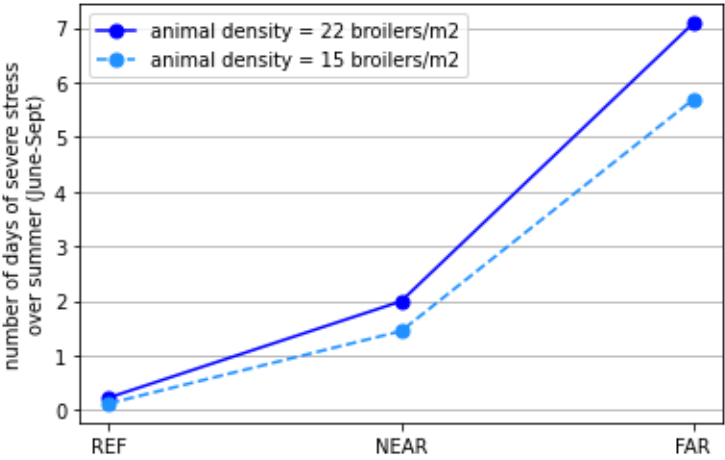
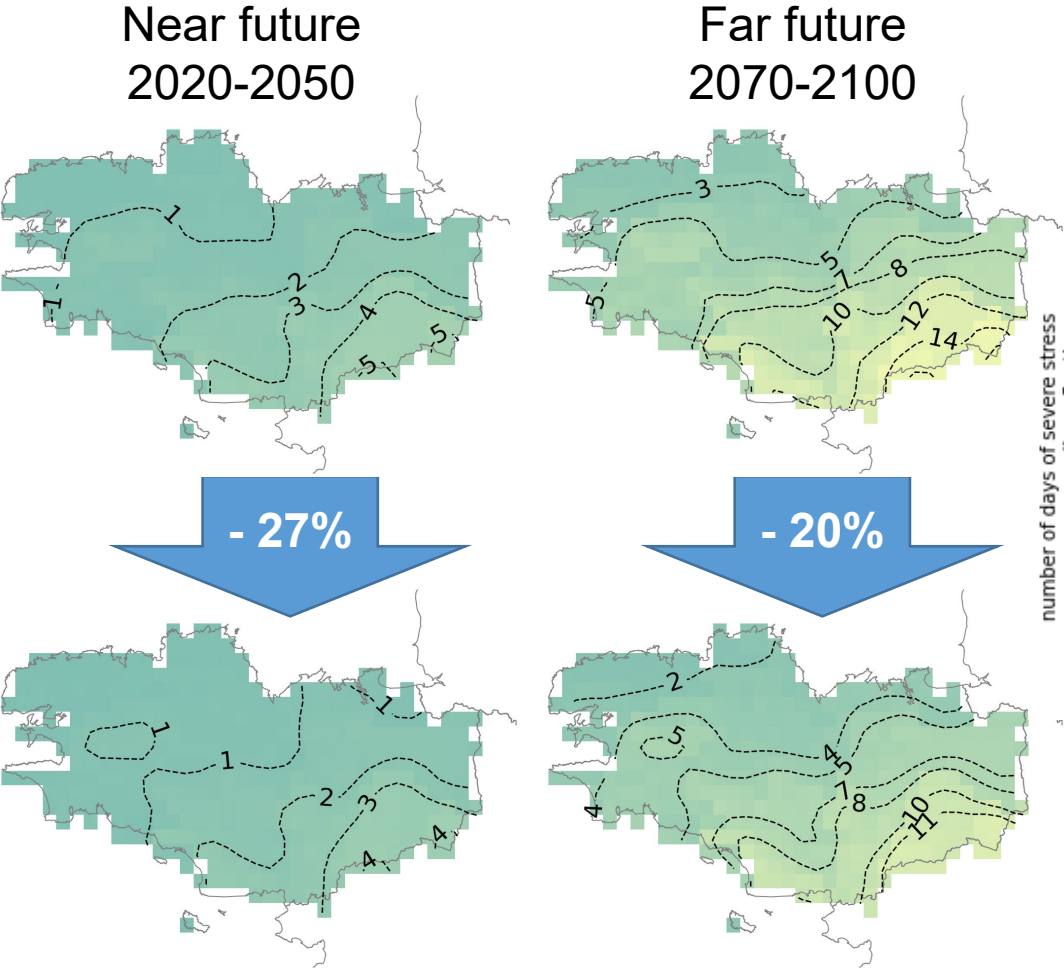
Number of days of severe stress over summer
(June-Sept)





Mitigation strategies - Reduce density

Parameters	Values
BW (kg)	1,9
Density (broilers/m²)	22
Surface area (m ²)	1200
Misting (l/h)	500
Flow rate (m ³ /h/m ²)	250
Parameters	Values
BW (kg)	1,9
Density (broilers/m²)	15
Surface area (m ²)	1200
Misting (l/h)	500
Flow rate (m ³ /h/m ²)	250



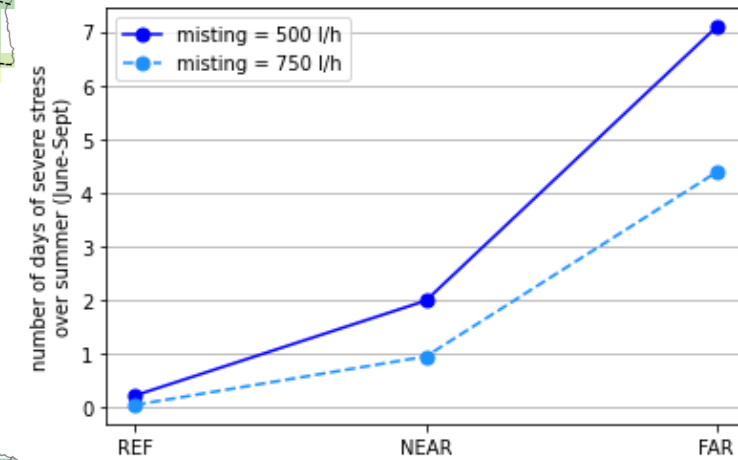
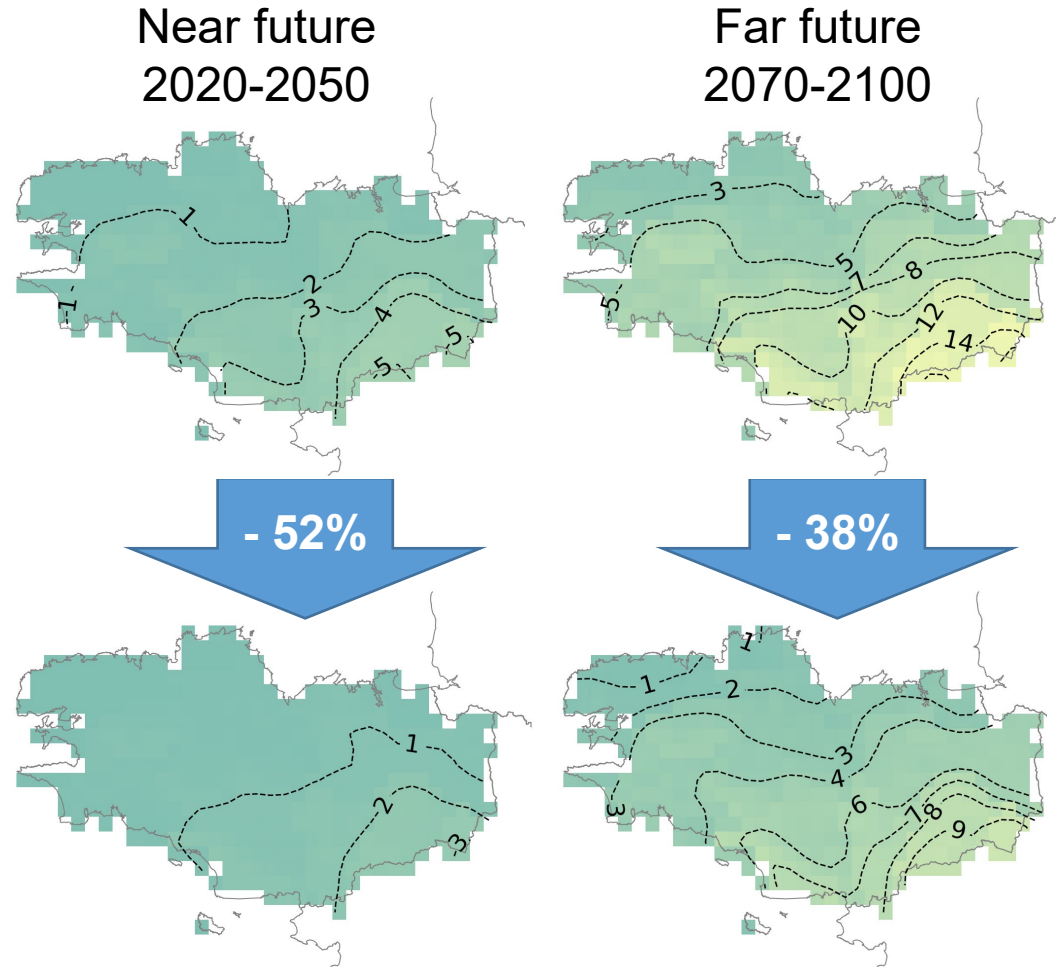


Mitigation strategies - Increase misting



Parameters	Values
BW (kg)	1,9
Density (broilers/m ²)	22
Surface area (m ²)	1200
Misting (l/h)	500
Flow rate (m ³ /h/m ²)	250

Parameters	Values
BW (kg)	1,9
Density (broilers/m ²)	22
Surface area (m ²)	1200
Misting (l/h)	750
Flow rate (m ³ /h/m ²)	250





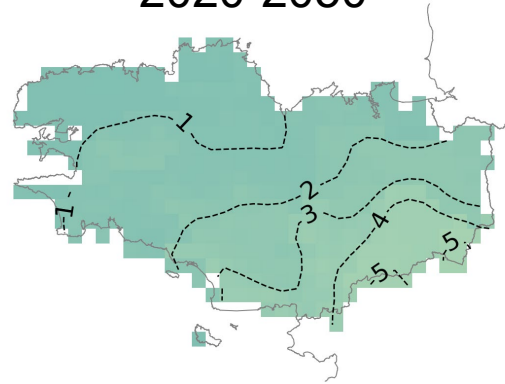
Mitigation strategies - increase misting



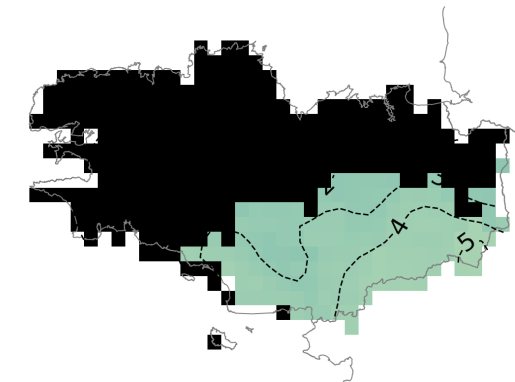
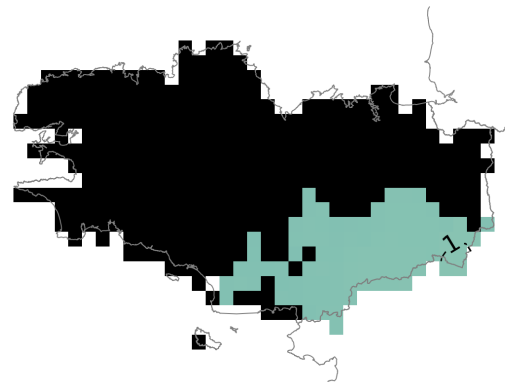
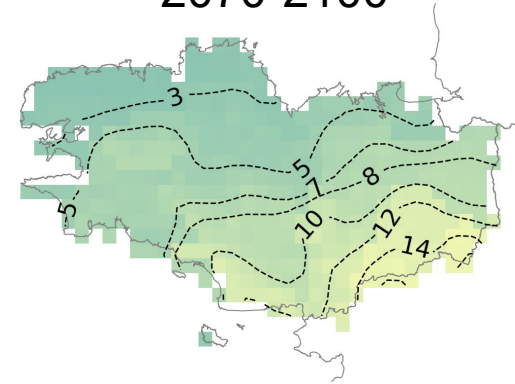
Parameters	Values
BW (kg)	1,9
Density (broilers/m ²)	22
Surface area (m ²)	1200
Misting (l/h)	500
Flow rate (m ³ /h/m ²)	250

Parameters	Values
BW (kg)	1,9
Density (broilers/m ²)	22
Surface area (m ²)	1200
Misting (l/h)	1000
Flow rate (m ³ /h/m ²)	250

Near future
2020-2050



Far future
2070-2100



■ RH > 75%
(on average)



Conclusions

- The present model and simulations can be used to estimate the risk of severe heat stress in the future due to global warming
- Mitigation strategies have to be evaluated in regards of **economic aspects** (lower density) as well **water resource scarcity** (higher misting rate)

Perspectives

- Other regions will be integrated in the model
- Different species can be integrated (as soon as a THI formula is available)
- Effect of long term heat exposure (“critical” load)
- Relationships between heat stress and economical loss
- A user friendly web application is under construction

