« Lolly », a Gama tool to study the Senegalese artisanal fisheries dynamics

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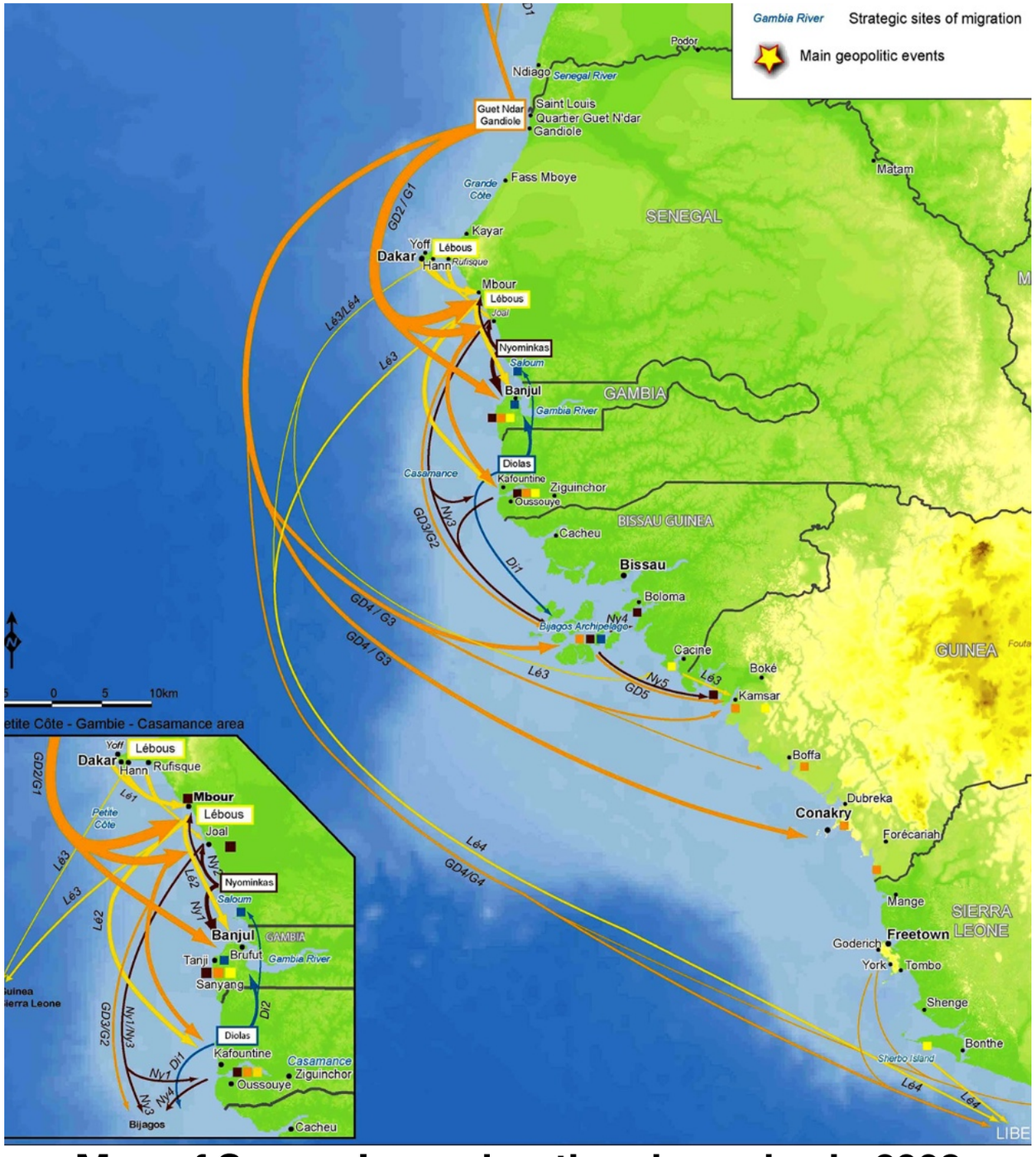
Summary

- 1 - The scientific question motivating the onset of the model
- 2 - Methodology for model construction
- 3 - The Lolly Gama simulator and Preliminary results
- 4 - Conclusions and Perspectives

How to simulate the effect of climate change on the Senegalese Artisanal Fisheries ?

- **Processes in interaction :**
  - Ocean temperature
  - Fish distribution
  - Fishers Mobility
- **We gathered data on :**
  - Climate models
  - Target fish species parameters
  - Senegalese artisanal fishery



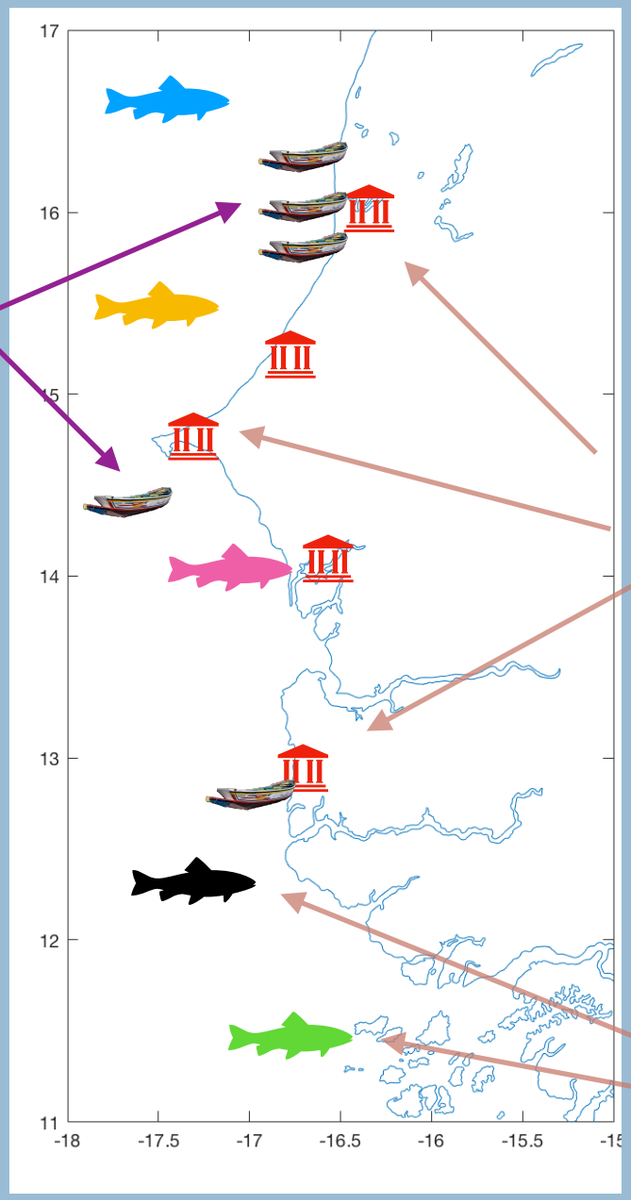
Map of Senegalese migration dynamics in 2008 (Binet et al., 2012)

Conceptual model : Parameters and processes

Forcings :

Climate scenario
—> species distribution

Landing site infrastructures
—> fishing effort distribution



Output :

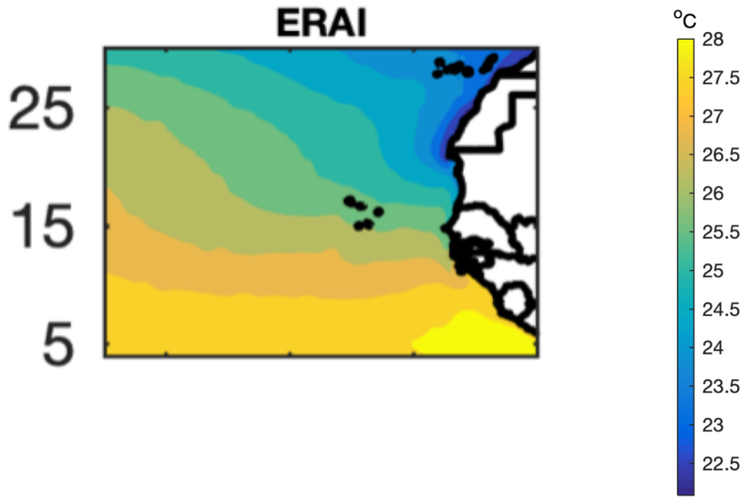
Landings of the Senegalese artisanal fishery

- The conceptual model was described following the ODD protocol (Overview, Design concepts, Details) protocol for describing individual- and agent-based models (Grimm et al. 2006).

Climate Forcing

Sea Surface Temperature in Climate models

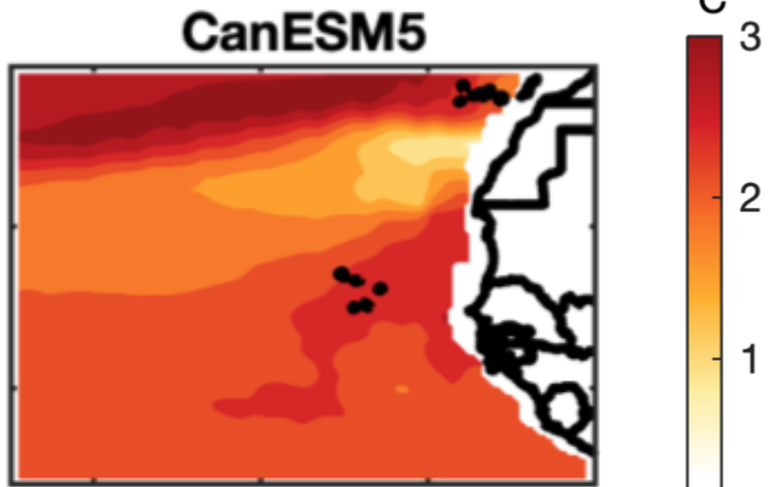
Reference state



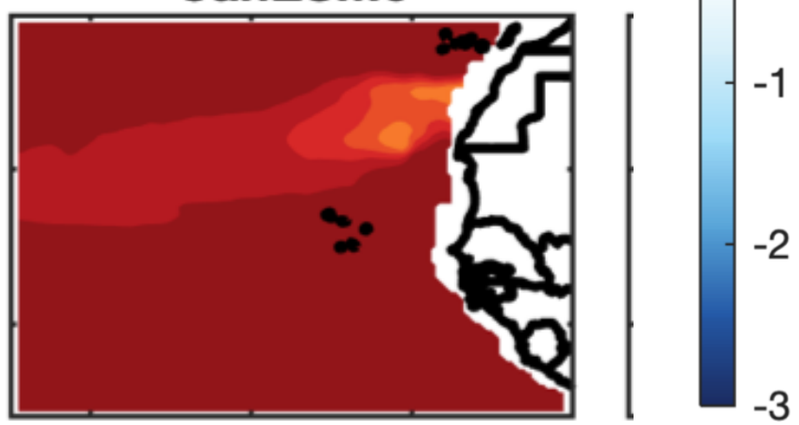
Monthly files netcdf files containing SST at 1/4° resolution

Climate projections

Scenario « optilistic » (ssp2-4.5)



Scenario « pessimisctic » (ssp5-8.5)



—> Downscaled to 10km grid, 12 month x 36 years stored in TiFF files (readable by Gama)

Fish distribution

Target Species Parameters

We defined **four « model-species »** representing pelagic and demersal species with cold or warm temperature preferences

Model-Species	**species represented**	**Temperature range**	**Bathymetry range**	**K (Tons)**	***K* (tons/ km2)**	**r (year^{-1})**
Coastal demersal "Guinean affinity"	*Arius spp., Sepia officinalis, Pomadasys jubelini, Dentex*	24-29°C	0-100m	300 000	30	0.5
Coastal demersal "Saharan affinity"	*Octopus vulgaris, Pagrus spp, Pagelus bellotii, Galeoides decadactylus*	18-25°C	0-100m	500 000	50	0.5
Coastal pelagic "Guinean affinity"	*Sardinella maderensis, Ethmalosa fimbriata, Caranx rhonchus*	24-29°C	0-100m	1M	100	1.5
Coastal pelagic "Saharan affinity"	*Sardinella aurita, Scomber colias*	18-25°C	0-300m	3M	100	1.5

Each model species biomass is distributed in 10km2 patches and randomly move inside its habitat defined by SST and bathymetry

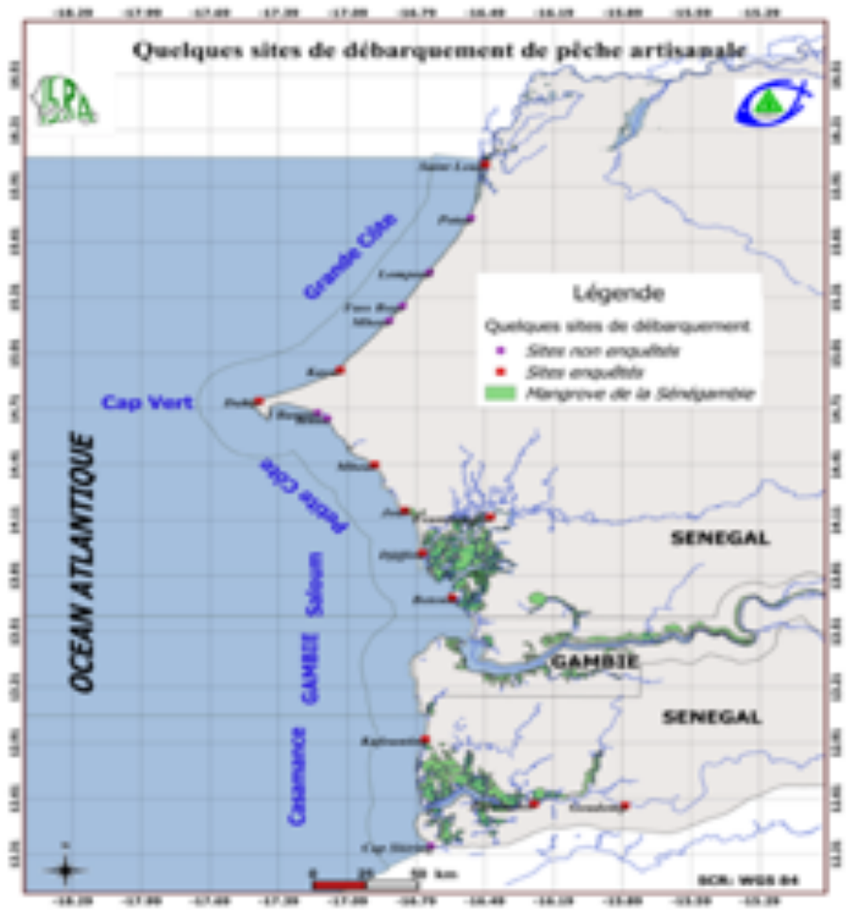
Fishers Mobility

Fisheries Parameters

Fishing units characteristics

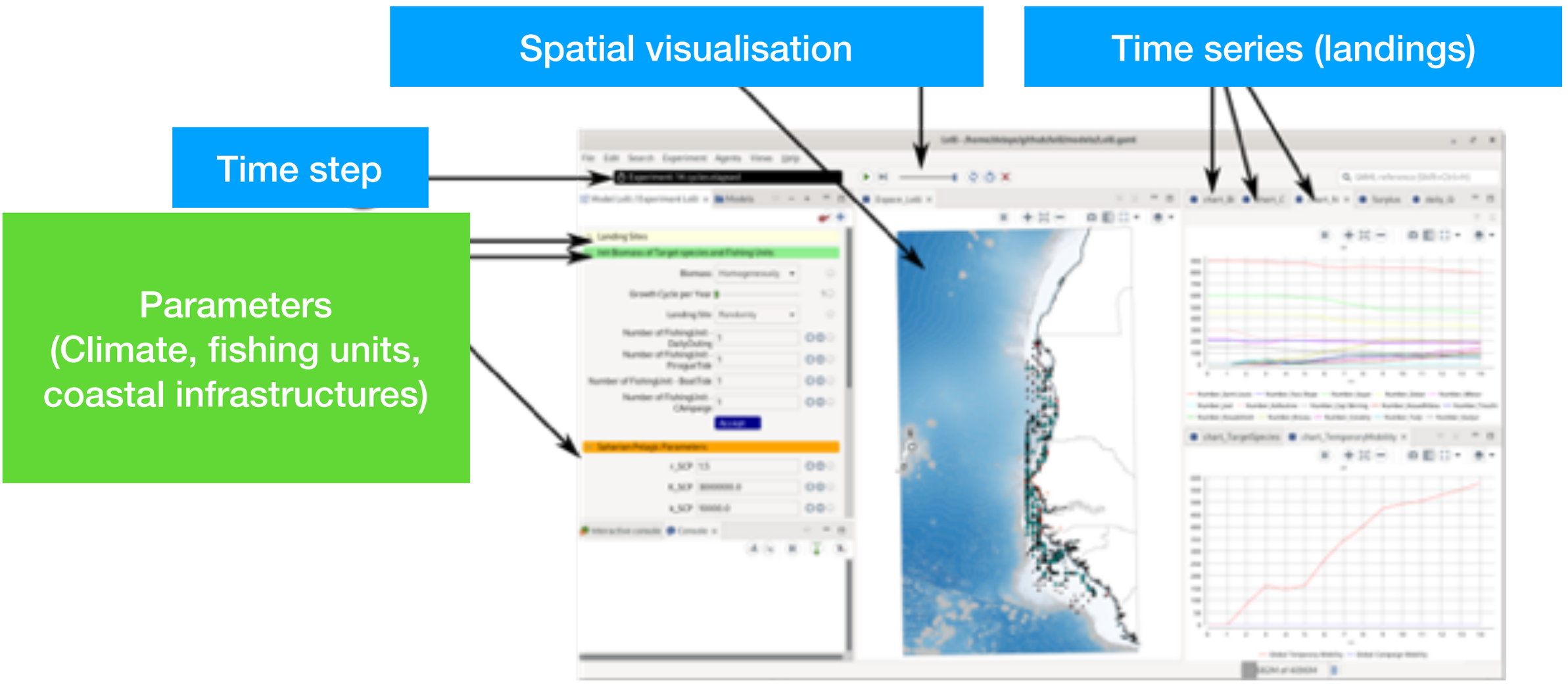
	Cat I	Cat II	Cat III
Storage capacity	500 kg	5000 kg	30 000 kg
Fishing Radius	50 km	100 km	1000 km
Maximum time at sea	1 day	15 days	15 days
Catchability	10^{-4}	10^{-3}	10^{-2}
Campaign Probability	0.1	0.2	0.3
Campaign Maximum Duration	4 months	8 months	12 months
Homeport	Initial landing zone		

Landing sites position and processing capacities



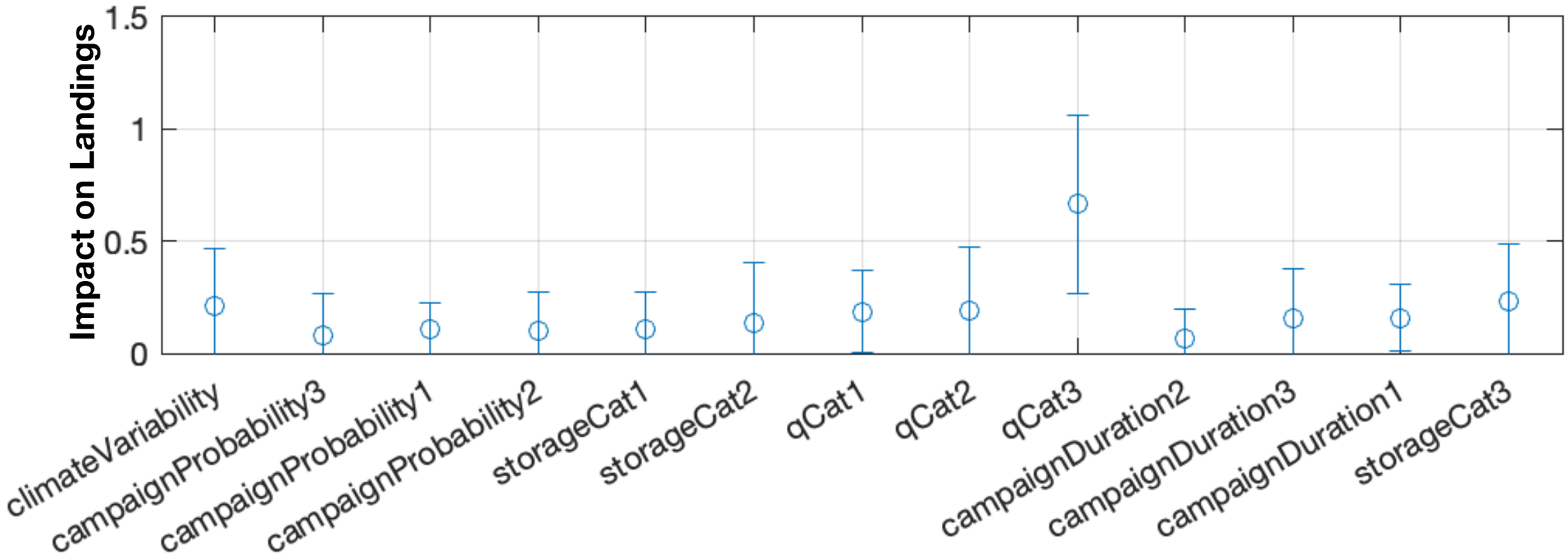
The Lolly Gama Simulator

- The lolly simulator was implemented based on the ODD conceptual model description



Preliminary results

Saltelli sensitivity analysis : effect of parameters on fish landings



—> Major effect of the larger fishing units' parameters

Preliminary results

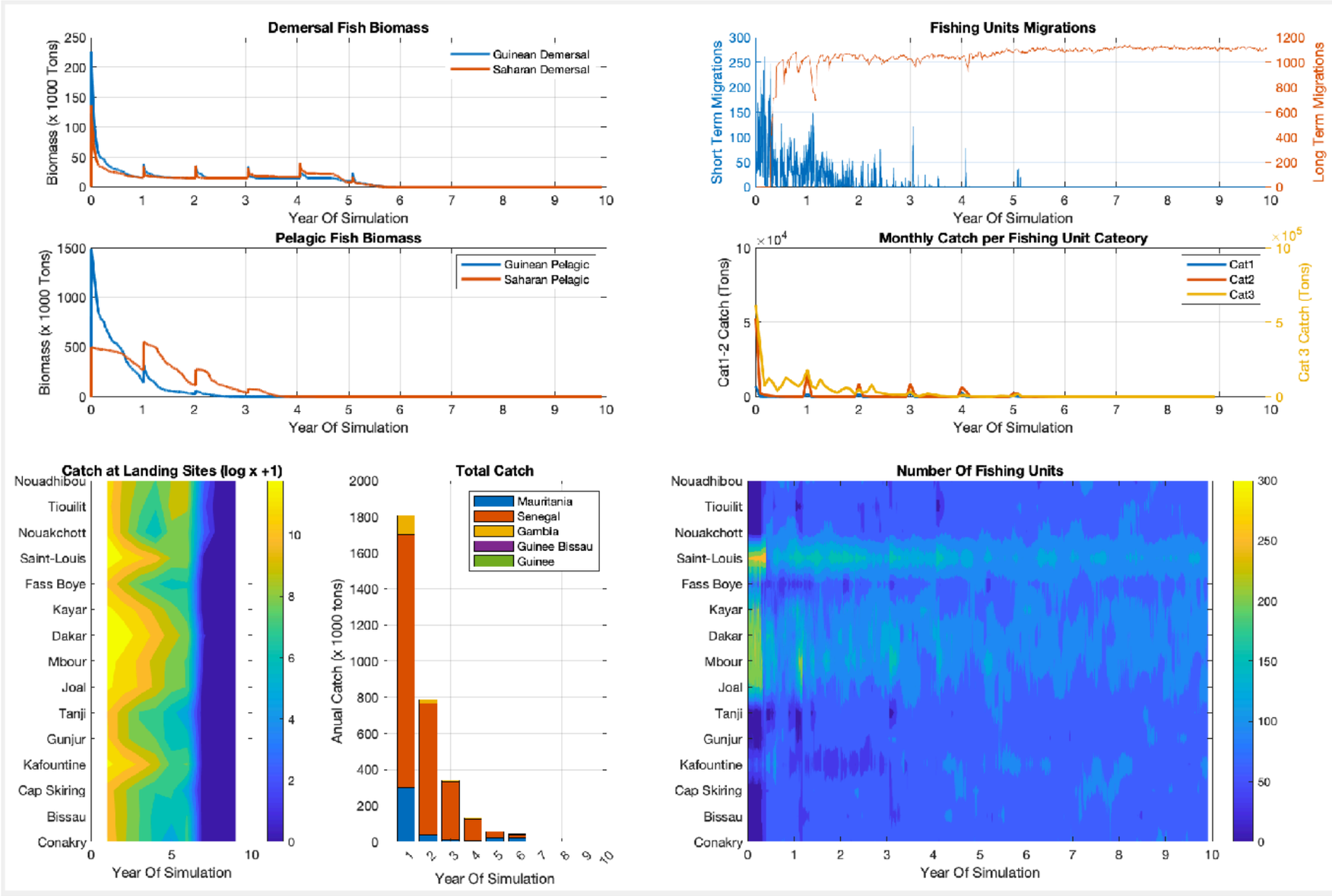
Evolution of the catch in different scenarios :

		Fishing Effort	
		actual	reduced
Climate	Present		X
	+1,5°C	X	X
	+3°C	X	X

Preliminary results

Exemples of simulation results visualisation

Reference Simulation

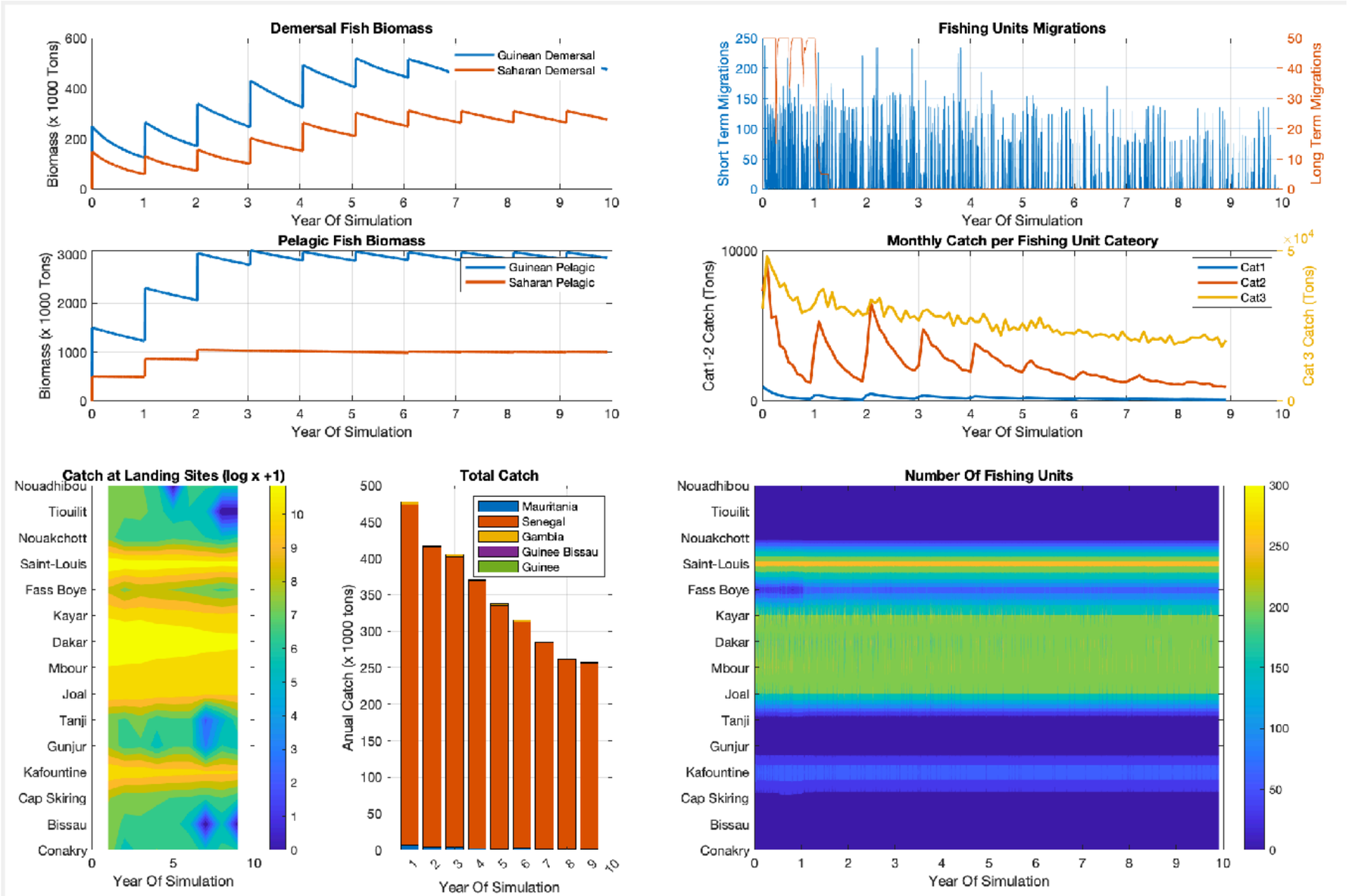


—> Fishery collapse after 10 years

Preliminary results

Exemples of simulation results visualisation

SST+3°C, reduced fishing effort



—> Total Catch stabilise at 250 000t per year

Preliminary results

Summary of scenario's simulation results

Climatee	Fishing Capacity	Predicted Landings at t+10y
Present	actual	**0**
+3°C	actual	**0**
Present	reduced	**249 000 tons**
+3°C	reduced	**253 000 tons**

Conclusions & Perspectives

- **Main working hypothesis :**
  - Fish species distribution depends on sea surface temperature, which change seasonally and is impacted by climate change
  - Fishers can migrate (Change landing site)
  - Fish processing capacity at each landing site is a proxy for market.

Conclusion based on preliminary model predictions

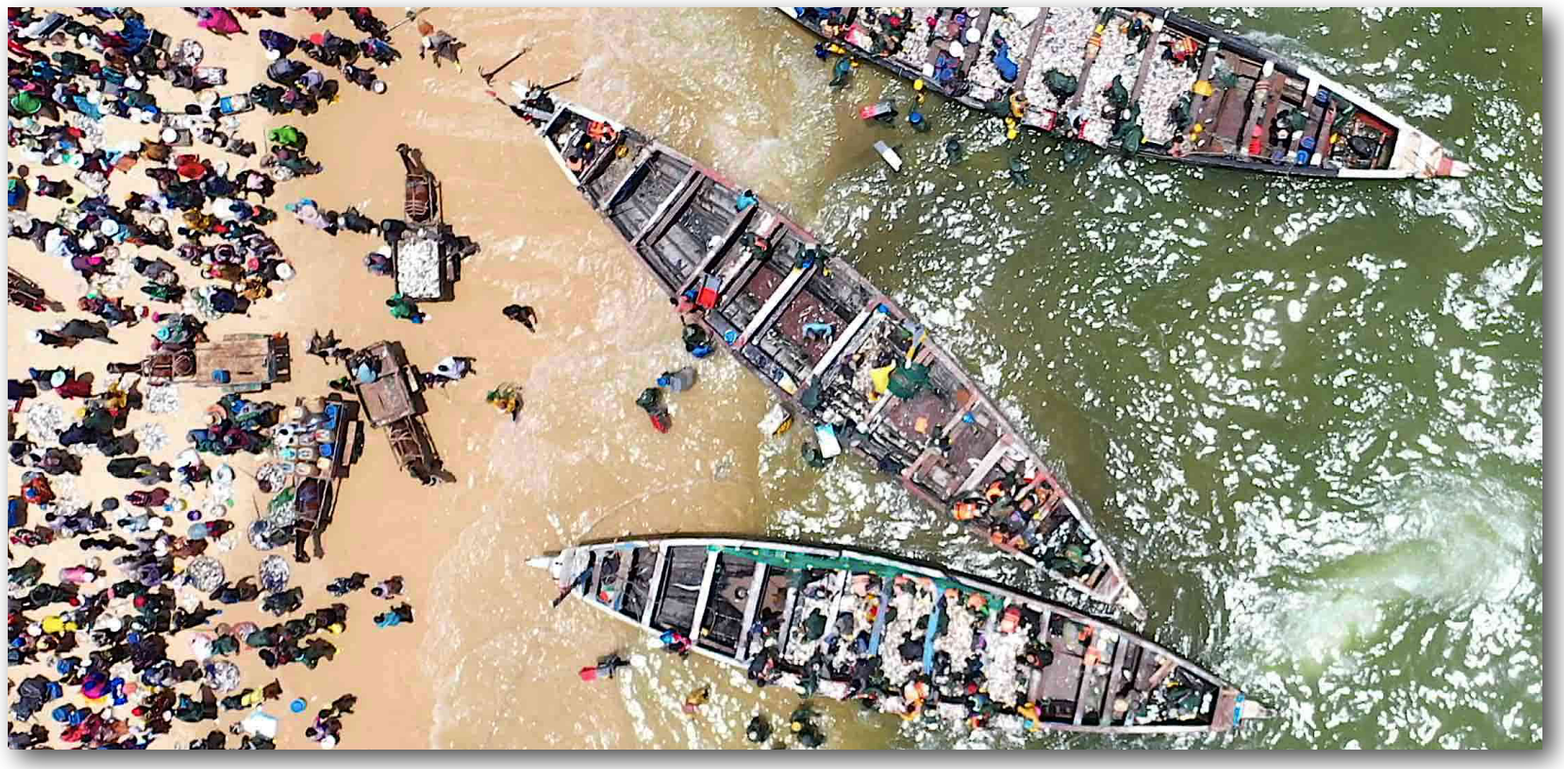
Fishing effort determine The fisheries trajectory in all climate scenarios

—> Need for a complete sensitivity analysis to explore all scenarios combination

Challenges : code optimisation, calcul distribution, patterns analysis

Acknowledgements

Fishers, CRODT, LPAO-SF, LOCEAN, ESEA, Students



Senegalese artisanal fishing units landing in Kayar