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MODELING SPATIAL POPULATION DYNAMICS OF GREEN TURTLE (CHELONIA MYDAS) IN THE SOUTHWEST OF INDIAN OCEAN

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“Understanding green turtle population dynamics using an Individual Based Model”

More than twenty years of active research on green turtle (*Chelonia mydas*) in the South West Indian Ocean (SWIO) have contributed to improve the knowledge of the species biology and ecology. However, lots of gaps still remain regarding the links between the main behavioral processes: alimentation, reproduction and migration, while shifts in these processes at individual scale have major impacts at population scale. On this basis, we have started implementing a spatially explicit individual-based model (IBM) to assess population dynamics of the green turtle in the SWIO. Our simulation experiment aims to unify, in a single model, alimentation, navigation and reproduction constraints as well as potential changes in foraging or breeding sites.

According to the complexity of the biological cycle of *Chelonia mydas*, individual-based modeling appears to be the most suitable method to assess:

- How important is the role played by alimentation, reproduction and migration in green turtle population dynamics
- How these three processes interact and constrain each other
- How sensitive they are regarding environment variability

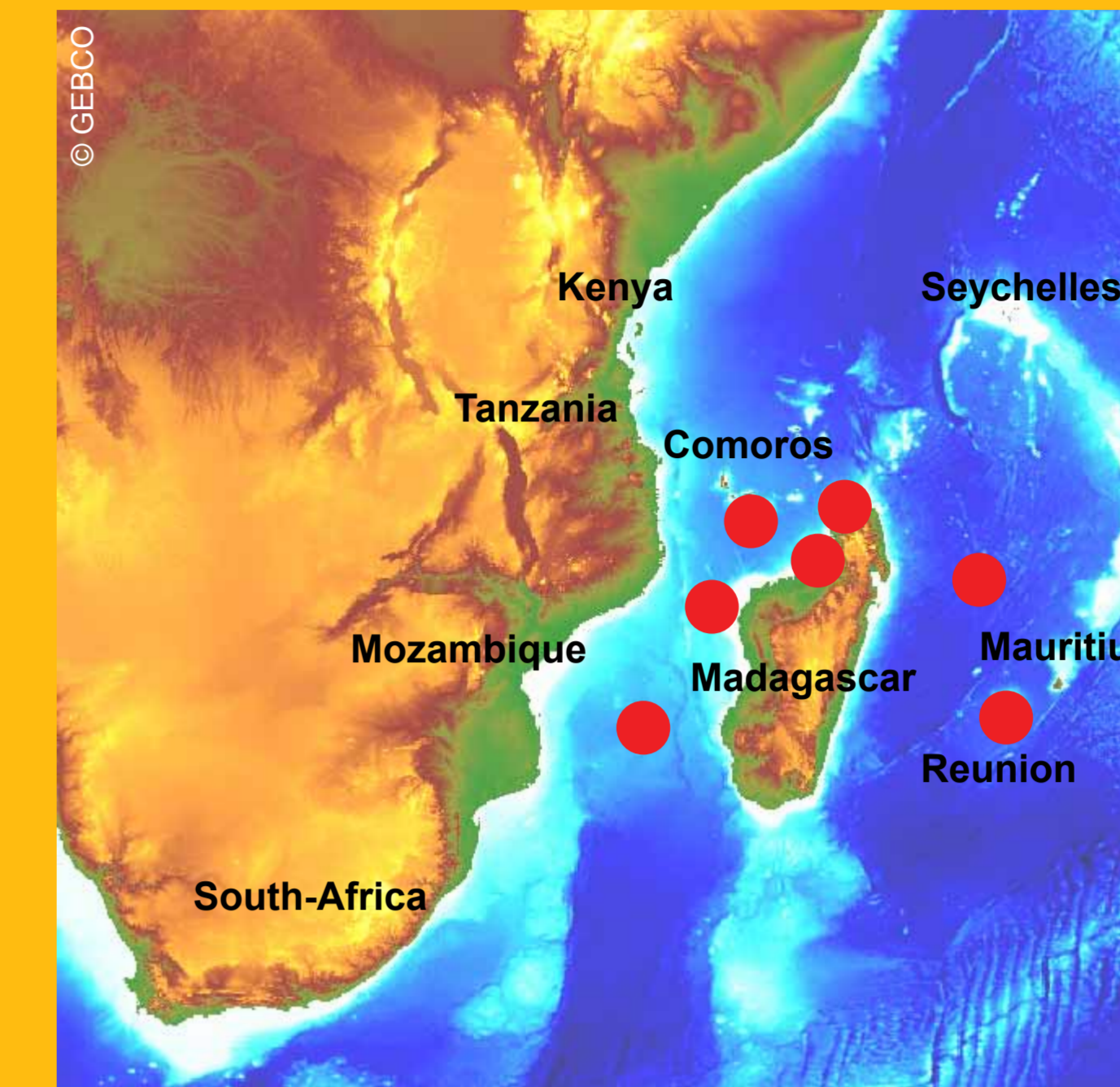
individuals variability and interactions



local environment

> Individual constraints

Local interactions and local environmental conditions constrain the main processes of the biological cycle. Implementing these constraints in an integrative individual-based model will lead to a better understanding of how it affects population dynamics at the end.



> Study area

South West Indian Ocean countries. Main surveyed spots are shown in red (from West to Est) : Europa, Juan de Nova, Mohéli, Nosy Iranja, Glorieuses, Tromelin, Reunion.

1/ An integrative approach

“Field data as the basis for parameterization and validation of the model”

Active research programs in the SWIO have generated and are still generating a large number of data focused on green turtle that are integrated into the model:

- (1) Recent nesting population status and seasonality based on long-term beach tracks monitoring started in 1985
- (2) Nest parameters and activity based on yearly nest monitoring and incubation temperature since 2006,
- (3) Regional genetic structure known for the SWIO
- (4) Physiological studies conducted on captive and free-living individuals since 2007
- (5) Identified adult migration routes and juveniles open sea behavior, using at least 140 satellite tracks deployed from 2004 to 2011
- (6) Oceanographic data such as currents or sea surface temperature retrieved from physical models as well as regional fisheries data from RFMOs.

This entire set of collected data acts as the basis for realistic parameterization and validation of the model.

2/ Individual Based Modeling

“A suitable tool to model green turtle population dynamics in the light of individual traits and local interactions”

Individual-based models aim to understand ecological systems from the properties of individuals that constitute that system. They are helpful when global properties emerge from individual singularities and local interactions. Regarding the complex biological cycle of green turtles and the variability in individual traits, individual-based modeling appears to be a particularly promising tool. Indeed, sea turtles population dynamics are driven by local interactions in between individuals and between individuals and environment at breeding and foraging grounds as well as during migrations. Moreover individuals breeding at the same rookery sites are likely to feed at distinct foraging area. Similarly, individuals from multiple rookeries may be found in the same foraging area or developmental habitat. We believe that sea turtles population dynamics cannot be understood without considering these local interactions.

3/ Expectations

“Viability of green turtles stock in the South West of Indian Ocean”

Main results of our simulation experiment should lead to a fine evaluation of the viability of green turtle population in the region and also to a complete description of the underlying processes. A clear view of the link between these processes could help conservation managers to identify key levels for conservation priorities: habitats conservation and restoration, fishing by-catch, pollution, poaching and so forth.

Acknowledgments

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Clutch and Nest Monitoring



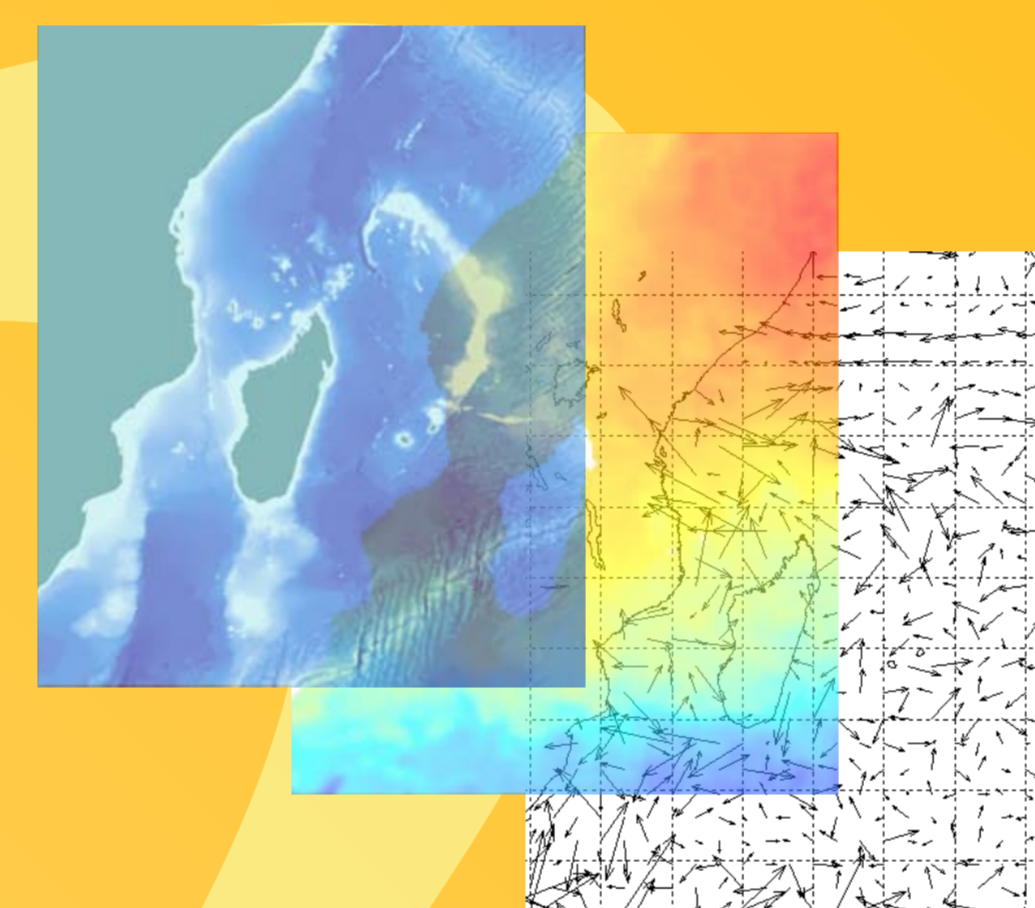
- Egg counts and measurements
 - Hatchling counts and measurements
 - Mark-Recapture of adult females and juveniles
- Project: *TORSOOI*³

Satellite Tagging



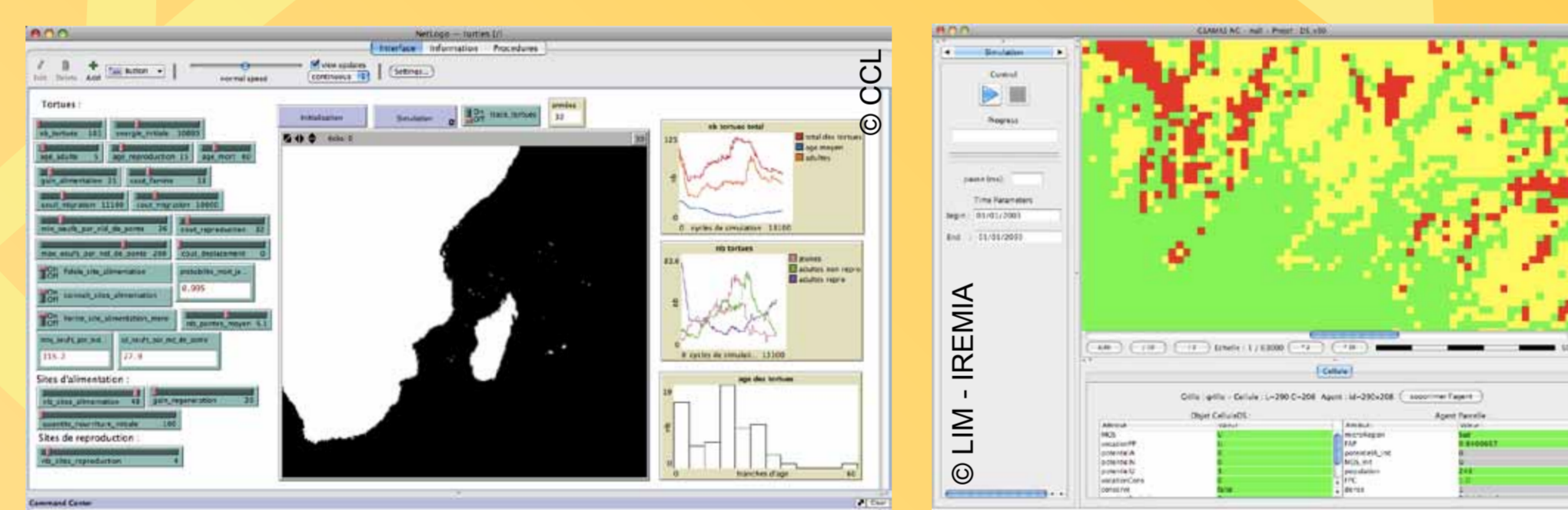
- Post-nesting migration
- Projects: *SWIOFP*¹ and *DYMITILE*²

Environment



- Sea Surface Temperature
- Currents
- Oscillations
- Meteorology

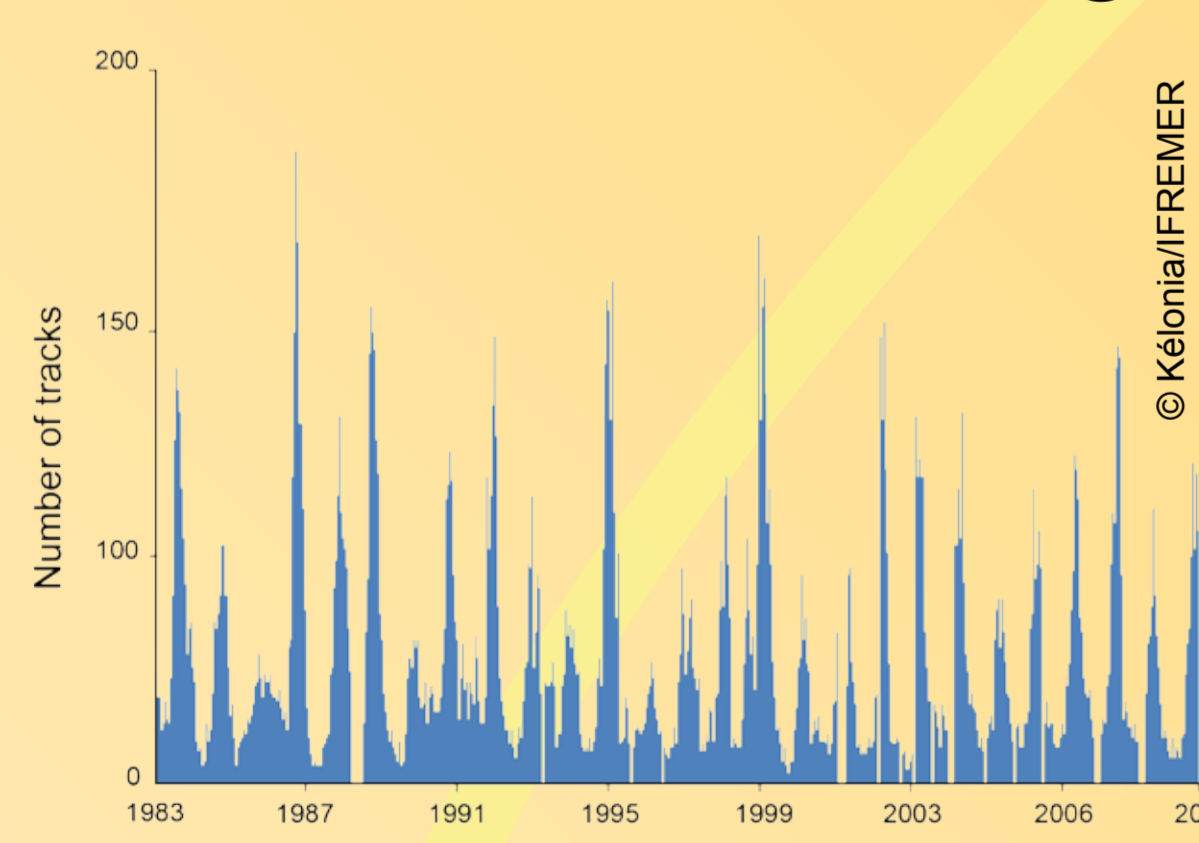
INDIVIDUAL-BASED MODEL



Prototype Platform :
NetLogo⁴

Development Platform :
GEAMAS-NG⁵

Beach Monitoring



- Daily beach tracks count and measurement
- Project: *TORSOOI*³

Fisheries



- Bycatch effort assesment
 - Fishing effort assesment
- Project: *SWIOFP*¹

Physiology



- Respirometry - Accelerometry

References

¹South West Indian Ocean Fisheries Project (SWIOFP). <http://www.swiofp.net>.

²Migratory dynamics of sea turtle in the South-West Indian Ocean (Dymitile). <http://www.ifremer.fr/lareunion>.

³TORSOOI database : regional database and GIS for the conservation of sea turtles and their habitats in the southwest indian ocean.

⁴Wilensky, U. (1999). NetLogo. <http://ccl.northwestern.edu/netlogo>. Center for Connected Learning and Computer-Based Modeling. Northwestern University, Evanston, USA.

⁵Generic Architecture for MultiAgent Simulation - New Generation (GEAMAS-NG).