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Deliverable reference number and full title: *D13.1 "Report on modelling artisanal fisheries in Senegal and Cabo Verde"*

Lead beneficiary for this deliverable: CAU

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Project co-funded by the European Commission within the Seven Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the Consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	X

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THE CONTENT REPORTED HERE IS PART OF A PhD THESIS THAT HAS NOT YET BEEN SUBMITTED, AND IS ALSO PART OF TWO MANUSCRIPTS FOR PEER-REVIEW PUBLICATION. THIS DELIVERABLE IS TO BE MADE PUBLIC AS SOON AS THE MANUSCRIPTS ARE ACCEPTED, WITH PLANNED DATE IN 2018.

PhD Thesis for candidate Kira Lancker in the field of «Factor inputs in resource economics: Example from fisheries and energy production» at the Department of Economics, Christian Albrechts University of Kiel, Wilhelm-Seelig-Platz 1, 24118 Kiel, Germany.

Manuscript 1: "Empirical bio-economic modeling of artisanal fisheries under climate change: A new approach and application to the Senegalese purse-seine fishery". Submitted to «World Development». (The manuscript mostly demonstrates the model itself and what it can do)

Manuscript 2: "The economic consequences of bias correction in climate modeling: An application to the Senegalese artisanal fishery". In preparation for submission in June-July 2018. (The manuscript contains modelling (fuel and biomass dynamics), and impact assessment)

Contribution to project objectives – with this deliverable, the project has contributed to the achievement of the following objectives (from Annex I / DOW, Section B1.1.):

N.º	Objective	Yes	No
1	Reduce uncertainties in our knowledge of the functioning of Tropical Atlantic (TA) climate, particularly climate-related ocean processes (including stratification) and dynamics, coupled ocean, atmosphere, and land interactions; and internal and externally forced climate variability.		X
2	Better understand the impact of model systematic error and its reduction on seasonal-to-decadal climate predictions and on climate change projections.		X
3	Improve the simulation and prediction TA climate on seasonal and longer time scales, and contribute to better quantification of climate change impacts in the region.		X
4	Improve understanding of the cumulative effects of the multiple stressors of climate variability, greenhouse-gas induced climate change (including warming and deoxygenation), and fisheries on marine ecosystems, functional diversity, and ecosystem services (e.g., fisheries) in the TA.		X
5	Assess the socio-economic vulnerabilities and evaluate the resilience of the welfare of West African fishing communities to climate-driven ecosystem shifts and global markets.	X	

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Comments on deviations: As reported in the 2nd Periodic Report (01.05.2015-31.10.2016), MS49 – collection of data and MS50 – model development suffered a delay when an interim decision among partners was taken, to not use a generic model framework for all West African fisheries, but instead to use individual models for each region to account for different circumstances. However, a later survey among project partners on availability of data lead to revising this decision and the FISHRENT model was chosen for all case studies. This caused a delay in D13.1, as did the delay in achievement of MS36 – Updated climate projections, with new parameterizations and flux correction (also reported in the 2nd Periodic Report). The extension granted to the project however has now ensured that D13.1 could be delivered as originally planned, MS49, 50 and 36 having been achieved.

Executive Summary:

This deliverable belongs to the PREFACE project WP13: *Evaluating environmental and socio-economic effects of climate change on small scale fisheries* and contributes to the overall project objective of "assessing the socio-economic vulnerabilities and evaluating the resilience of the welfare of West African fishing communities to climate-driven ecosystem shifts and global markets". The deliverable is a report describing modelling activities carried out as part of WP13.

The objective was to develop single species coupled bio-economic models to understand the threats climate change poses to fisheries with focus on small scale fisheries. The models are meant to enable simulation of future climate development consequences and a comparison of optimal and realized harvest, and their impact on consumer and producer welfare. The final models are now ready for use and can be made available once this work is published open access in a scientific journal.

Due to their importance for local communities and data availability, we focused on the artisanal purse seine fishery for *Sardinella aurita* in the four major Senegalese fishing regions (see Figure i) and the artisanal hand line fishery for Yellowfin tuna in three island regions of the Cabo Verde archipelago: The southern Sotavento islands (SV), and the more northern Barlavento islands, which for the subject of artisanal fisheries are divided into an eastern Barlavento (BE) and western Barlavento (BW) area. We model for each of the three regions the fishery of the island with the most important Yellowfin tuna hand line fleet, namely Sal for the Barlavento east region, São Nicolau for Barlavento west and Maio for Sotavento.

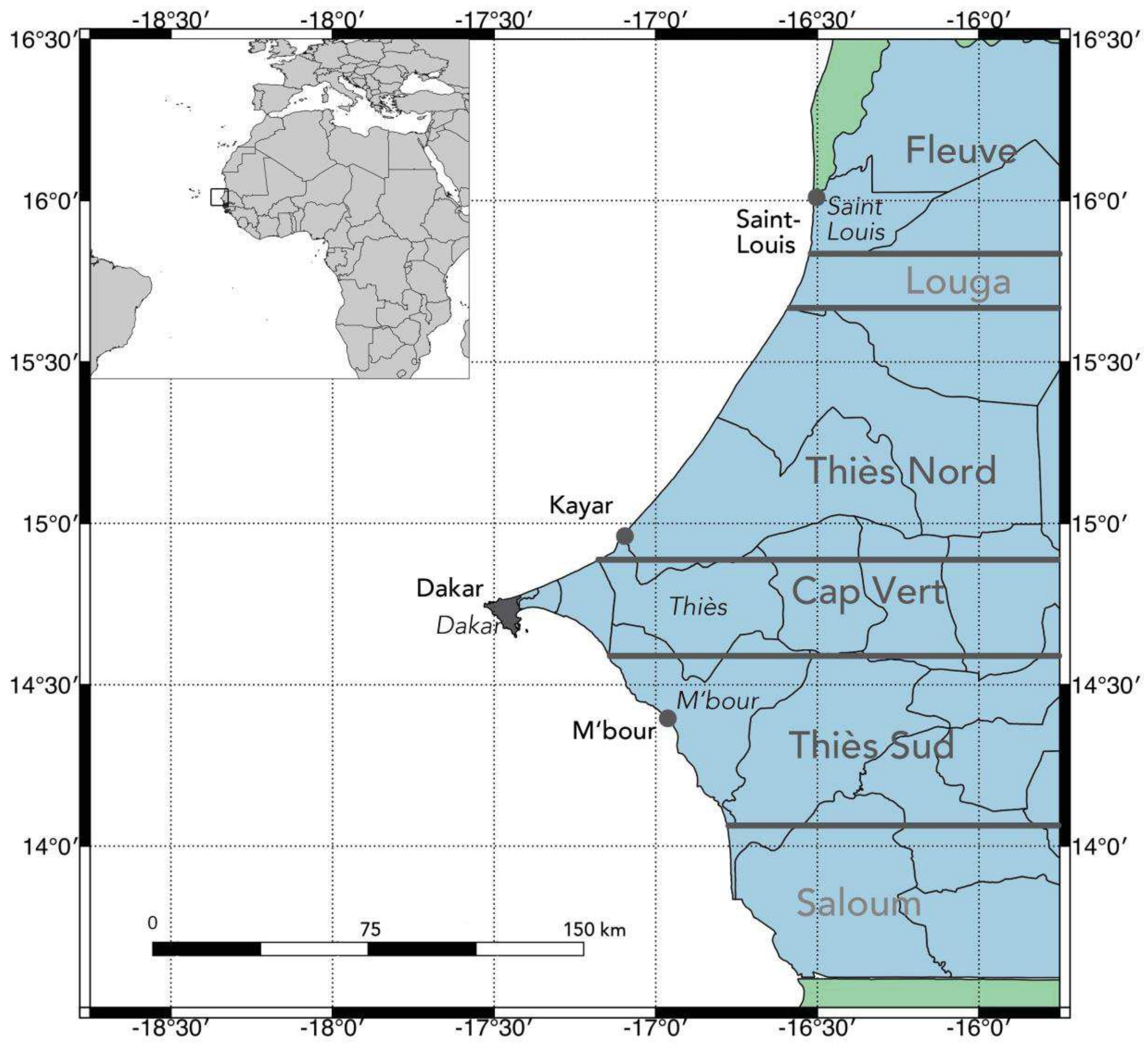

Figure i: Major Senegalese landing areas

In the following report, we will briefly present the data and background for each of the two modelled fisheries (see sections 1 and 2). In addition, we present the climate data used for the parameterization of the models via estimation in section 3. Afterwards, we present models and model results. Both models consist of two parts: A biological part determines how the yearly biomass develops based on the climatic and biological situation of the habitat. We present the biological model for Senegal in section 4.1, while we will rely on the biological model presented in PREFACE WP12 for Cabo Verde[i]. Using yearly biomass as input, a second, economic part forms the core of our modelling exercise. Climate impacts not only determine the outcome of this economic part via yearly biomass growth as taken from the biological part. Weather also influences the accessibility of the resource to fishermen and intra-annual biomass growth. This part determines harvest, fish prices as well as consumer and producer welfare and is presented in section 4.2. Only small changes are made to adapt the model to the Cabo Verde fishery (see section 5.1). The last section concludes and provides an outlook on future plans (section 6).

Briefly, the models developed under WP13 can be used for simulation to generate results on welfare consequences of climatic developments. Climate data is now available to use from the bias reduction models of the climate Core Themes (CT3&CT4) of the PREFACE project. The modelling for Cabo Verde is finalized. The severe lack in price and other data renders any deeper analysis difficult. For Senegal, the model is currently being expanded to include fuel prices as this study revealed that one of the most important drivers during the study period was the increase in fishing cost, attributed to a sharp increase in fuel cost. The model is therefore being expanded to include this important factor of production.

[i] In collaboration with Heino Fock (Thuenen Institute, Germany), related to D12.2: «Bioclimatic modelling». A manuscript is in preparation on "Catch opportunities of Yellowfin tuna (*Thununnus albacares*) in Cabo Verde", where WP13 contributes with data on artisanal fisheries (the main data used so far having been those available from industrial fisheries).