International Workshop AWA-PREFACE "Socio economic impact of climate change in West Africa: insight from modeling and questionnaires"

The 17th February 2014,
*at the **S**ub **R**egional **F**isheries **C**ommission,*
Dakar, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Time and Venue

The 17th February 2014.

SRFC; Secrétariat Permanent de la CSRP. Villa 4430, Karack, Rue KA-38 (Rue Mère), Dakar, Sénégal. Adresse postale : Secrétariat Permanent de la CSRP, BP 25485, Dakar-Fann, Sénégal

Tél. : +221 33 864 04 75
Fax : +221 33 864 04 77

Courriel : spcsrp@spcsrp.org

Web: www.spcsrp.org

ToR Term of reference

The aim of the whole work shop is to set the final basis in order to determine the optimal management of key fish species, taking into account economic (including profits by fleet) and ecological drivers and needs. A special focus will be on the effects of environmental variability and climate change on economic performance and indicators. Variability and long-term trends in abiotic environmental conditions have been recorded in the area, e.g. changes in the oxygen minimum zone, and will further be analyzed within the AWA project (WP 1). Such changes will influence the distribution and concentration of fish stocks according to their preferred habitat (WP 2) and will therefore change economically important parameters like catchability or catch per unit of effort. Presently, the assessments models are run with biomass and catches as only input parameters, and significant improvement will be obtained by advancing towards two-stage Bayesian models with an explicit modelling of recruitment as appropriate tools for short lived and early maturing species . Stock-recruitment relationships have in many cases been demonstrated to be strongly mediated by environmental conditions, ranging from extremely rich year-classes under positive conditions to complete year-class failure under environmental shocks. Knowledge of variability and long-term trends in oceanographic conditions (WP 1) can be included via environmental-sensitive stock recruitment relationships (WP 3) into ecological-economic modelling. Optimal management strategies will be calculated, taking these effects into account. Two different species are considered, one (*Sardinella aurita*) caught by artisanal domestic

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

and industrial international fisheries in large quantities, and the other (*Ethmalosa Fimbriata*) at lower quantities in inshore areas by artisanal fleets only.

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Program

Chair Jörn Schmidt (CAU, Germany) and Patrice Brehmer (IRD, France)

9h00: Welcoming and opening speech by SRFC.

Her excellence Marième Diagne Talla (CSRP)

9h15: Dr Jörn Schmidt (CAU)

Title**:** Socio-economic approaches to investigate artisanal fisheries in West Africa.

09h30: Key note Speaker: Pierre Auger (UMMISCO)

Title: Mathematical modeling of fishery: Effect of price variation.

09h45: Aliou Ba (IUPA-IRD-CRODT)

Title: Evolution of the small scale Senegalese fishery.

10h00: Timothée Brochier

Title: Cross-shore Sardinella aurita population structure: consequences for industrial and artisanal fisheries dynamics.

10h15: coffee break

10h30: Sidy Ly (UCAD-UMMISCO)

Title: A model of a multi-site fishery with variable price: Number of sites optimizing the total capture.

10h45 : Fulgence Mansal (UMMISCO)

Title: Control of a multi-site fishery model.

11h00: Mathieu Rouault (UCT)

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Title: Coastal Climate change and variability around Southern Africa.

11h15: Asberr Mendy (FD)

Title: Overview of Gambia fishery.

11h30 : Moustapha SALL

Title: Simulating the effects of Marine Protected Areas in Senegales coast.

12h00: Lunch break

13h00: Workshop about AWA PhDs (Asberr Mendy, Gambia) and (Aliou Ba Senegal)

14h00: Link with the EU project PREFACE

15h00: Opening discussion (round table)

16h15: coffee break

17h30: End of meeting, closing by Mika Diop

17h30-18h30: AWA Administration meeting

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Participants list

Senegal :

Hamady Diop (CSRP), Adama Mbaye (ISRA-CRODT), Aliou Ba (UCAD, IRD-CRODT), Fulgence Mansal (UCAD), Moustapha Sall (UCAD), Sidy Ly (UCAD), Mouhamadou Makhtou Seck (CSRP), Ismaïla Baldé (AIMS), Dienaba Beye Traore (CSRP), Amadou Oumar Toure (CSRP), Mika Samba Diop (CSRP), Abdou Khadir Diakhaté (CSRP), Marième Diagne Talla (CSRP).

Excused: Massal fall, Djiga Thiao and Mustapha Deme (ISRA-CRODT)

Gambia:

Asberr Mendy (FD).

France:

Patrice Brehmer (IRD-CRODT, AWA), Pierre Auger (IRD, Ummisco), Timothée Brochier (IRD-CRODT, AWA), Mathilde Vienne (IRD, AWA), Didier Jouffre (IRD-IFAN, Ecosym).

Excused : Philippe Estrade and Amadou Gaye (UCAD/ESP-LPAOSF)

Germany:

Joern Schmidt (CAU), Linda Kleenmann (CAU).

South Africa:

Mathieu Rouault (UCT).

Institutions:

CSRP, ISRA/CRODT, IRD, UCAD (ESP/LPAOSF and IFAN/Labep), AIMS, FD, CAU, UCT, UMMISCO, Lemar, Ecosym, ESP.

Bundesministerium für Bildung und Forschung

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

Technical committee

Amadou Touré (CSRP)

&

Mathilde Vienne (IRD-AWA)

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Book of abstracts

Subject: Mathematical modeling of fishery: Effect of price variation.

Author: Pierre Auger.

Address: UMI 209 IRD & UPMC UMMISCO

Centre IRD de l'île de France, Bondy, France

UMMISCO-UCAD, Dakar, Sénégal

E-mail : pierre.auger@ird.fr

I present classic dynamical models of fishery describing the time evolution of the resource and of the fishing effort. In this model the market price of the fish is assumed to remain constant. According to parameters, two cases can occur, either stable fishery equilibrium or a stable fishery free equilibrium. In a second model, we still consider the classic model but we add a new equation governing the market price varying according to supply and demand. We consider a linear decreasing demand function with price. We show that according to parameters values, three positive equilibria can coexist, two of them being stable. One equilibrium can be interpreted as a case of over-exploitation while the second stable one corresponds to an equilibrium with a durable exploitation or artisanal fishery. To finish, I will say a few words about modelling multi-site fisheries.

References

Auger P., Lett C., Moussaoui A. and Pioch S.. Optimal number of sites in artificial pelagic multi-site fisheries. Canadian Journal of Fisheries and Aquatic Sciences. 67, pp. 296-303, 2010.

Auger P., Mchich R., Raïssi N. and Kooi B. Effects of market price on the dynamics of a spatial fishery model: Over-exploited fishery/traditional fishery. Ecological Complexity, 7, pp. 13-20, 2010.

Subject: Evolution of the small scale Senegalese fishery.

Author: Aliou Ba.

Address: IRD UMR Lemar, BP1386 Dakar, Sénégal.

E-mail aliouba81@gmail.com

The small scale fishery plays an important part in food security, the decrease of the poverty, the economic development and the sustainable development. A lot of countries, and especially the ones in development, can't have a correct socioeconomic balance without this kind of fishery (FAO 2010). The

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Senegal isn't an exception. Nowadays the Senegalese fisheries have to be faced with the increasing scarcity of some fisheries resources, the decrease of the income of fishermen and the competition of other types of exploitation, as the industrial fishery (Fontana and Samba, 2013). In addition to these general issues, the small scale fishery is characterized by a free access regime, making it hard to know exactly the number of actors. This is considered as the main reason for the over exploitation and over fishing, according Gréboval and Catanzano (2005). In order to diagnose quickly the small scale fishery, we will present the evolution, the fishing capacity state and a zoom over the fishery of Round sardinella and Bonga shad. In another hand, we will show you some runways modeling.

Keys Words

Small-scale fisheries; Fishing capacity; modeling; bioeconomics; pelagic

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Subject: Cross-shore *Sardinella aurita* population structure: consequences for industrial and artisanal fisheries dynamics.

Authors: Timothée Brochier, Pierre Auger, Philippe Estrade, Ismaïla Baldé, Patrice Brehmer.

Address: IRD UMR Lemar, BP1386 Dakar, Sénégal**.**

E-mail timothee.brochier@gmail.com

Small scale fisheries are a major part of the Senegalese socio-economic system, an heritage of a long fishing tradition. Although the techniques are artisanal (i.e. outboard motor, wooden canoe), the total amount of fish landed largely out-pass local industrial fleet, and is more or less equivalent to the foreign industrial fleet catch level. Round sardinella (*Sardinella aurita*) is one of the main small pelagic fish species exploited in Senegal. Round sardinella juveniles are found near the coast while mature fish are usually located offshore, a population structure that is typical to a number of others small pelagic fish species. The cross-shore structure of the coastal upwelling has been described analytically (Estrade, 2006) and displays three main regions with distinct levels of enrichment by nutrients, which determines primary production and thus small pelagic fish carrying capacity. The near shore area has the highest carrying capacity all the year round, while the mid-shelf and shelf break area display more seasonal variability. The offshore area has a poor carrying capacity. Industrial fisheries have legal limitations that prevent them to fish near the coast, and thus operate only offshore, where the mature fish are. By contrast, artisanal fisheries operate from the shore and suffer no legal restrictions, but the fishing costs increase with distance from shore. Therefore most of the artisanal fisheries efforts concentrate near shore, where the juveniles are. In this context, we propose a mathematical approach to model this complex system. A set of eight differential equations describe the evolution of (1) the fish population, structured in adults and juveniles; (2) the industrial fishing effort; and (3) the artisanal fisheries effort. The possible equilibriums between fish population and artisanal and industrial fisheries will be explored. The conditions for solution existence will be defined following the parameters of the systems as (1) the natural mortality and the catchability 'q' of the juvenile and adult fish, or (2) the costs of the fishing effort for artisanal and industrial fisheries.

References

Estrade P (2006) Mecanisme de decollement de l'upwelling sur les plateaux continentaux larges et peu profonds d'Afrique du Nord-Ouest. These doctorat, Universite de Bretagne Occidentale, Brest, France, 135pp.

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

Subject: A model of a multi-site fishery with variable price: Number of sites optimizing the total capture.

Authors: Sidy Ly, Pierre Auger, Moussa Baldé

Address: UMI IRD 209 UMMISCO and UCAD

E-mail : lysidyly@gmail.com

We present a mathematical model of a fishery on several sites with a variable price. The model takes into account the evolution during the time of the resource, fish and boat movement between the different sites, fishing effort and price that varies with respect to supply and demand. We suppose that the movements of the boats and resource as well as the variation of the price go on at a fast time scale. We use methods of aggregation of variables in order to reduce the number of variables and we derive a reduced model governing 2 global variables, respectively the biomass of the resource and the fishing effort of the whole fishery. We look for the existence of equilibria of the aggregated model. We show that the aggregated model can have 1, 2 or 3 non trivial equilibria. We study local and global stability. We show that a number of sites that optimizes the total capture to the fishery exist.

Keys Words

dynamical systems, Multi-site fishery, variable price, demand function, equilibrium, stability, optimum capture.

Subject: A model of a multi-site fishery with variable price: Number of sites optimizing the total capture.

Authors: Fulgence Mansal

Address: UMI IRD 209 UMMISCO and UCAD

E-mail : fulgence.mansal@ucad.edu.sn

We present a mathematical model of a fishery on several sites with a variable price. The model takes into account the evolution during the time of the resource, fish and boat movements between the different sites, fishing effort and price that varies with respect to supply and demand. We show that the fishery can be controlled by a variation of the total number of sites inducing a switch from over-exploitation to sustainable fisheries. In another model, we generalize the bio-economic model of a fishery with a variable price to the case where there are no time scales. We obtain a generic Market Price Equation (MPE) which has to be

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

solved to calculate non trivial equilibria of the model. This Market Price Equation (MPE) can have 1, 2 or 3 equilibria. The MPE is extended to two cases: an age-structured fish population and a fishery with storage of the resource.

Key words

Dynamical systems, multi-site fishery, variable price, demand function, equilibrium, stability, optimum capture, sustainable exploitation/overexploitation.

References

Ly S., Mansal F., Balde M., Nguyen Huu Tri, Auger Pierre. A model of a multi-site fishery with variable price : from over-exploitation to sustainable fisheries. Mathematical Modelling of Natural Phenomena, 2013, 8 (6), p. 130-142. ISSN 0973-5348.

Mansal F., Balde M., Nguyen Huu Tri, Auger Pierre. A mathematical model of a fishery with variable market price Sustainable fishery/over-exploitation. Acta biotheoretica.

Subject: Coastal Climate change and variability around Southern Africa

Author: Mathieu Rouault

Address: Nansen Tutu Center for Environmental Research and Dept of Oceanography, University of Cape Town

E-mail : mathieu.rouault@uct.ac.za

Over the last century, Southern Africa has experienced dramatic interannual changes in climate. The impact of climate variability on coastal marine ecosystem and fisheries of the Agulhas Benguela Angola Current system (Angola, Namibia and South Africa) has drawn less effort in Southern Africa than the study of the impact of climate variability on rainfall and agriculture. For instance, the most severe droughts happen in Southern Africa during the mature phase of El Niño while it is wetter during La Nina. This offers predictability at the seasonal scale. El Nino and La Nina have also an impact on streamflows, vegetation and the fluxes of nutrients into the ocean. They also change wind patterns and upwelling along the coast. Closer to Africa the Agulhas Current, southern Boundary of the Benguela Current system, has significantly warmed up since the 1980's. It has warmed up by up to 1.5 °C since the 1980's. This warming was due to an intensification of the Agulhas Current system in response to an augmentation of wind stress curl in the South Indian Ocean. A coastal cooling of an up to 0.5°C per decade is also present in the Cape Peninsula upwelling in late summer. The potential impact of

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

the intensification of the Agulhas Current on the ecosystem has not yet been studied and provides also a new paradigm to explain the observed changes in the marine ecosystem. Further north, Namibia and Angola water has considerably warmed up by up to 1.5 C. Such warming may be a symptom of an intrusion of low-nutrient, low-oxygen tropical water into the Benguela upwelling system and potentially having a detrimental effect on the marine ecosystem. Those regions are influenced by the variability of the Tropical Atlantic Ocean and warm events there are called Benguela Niños by analogy to the Peruvian El Nino. These warm events had a strong impact on the ecosystem when low-oxygen, nutrient-poor tropical water was advected into the upwelling system.

Subject: A model of a multi-site fishery with variable price: Number of sites optimizing the total capture.

Authors: Moustapha Sall, alassane Bah, Pierre Augier.

Address: UMI IRD 209 UMMISCO and UCAD

E-mail : taphasall@gmail.com

Experience has demonstrated the relevance of the use of marine protected areas (MPAs) as a management tool. However, it raises the question of what fraction of a marine region should be allocated to these areas to maximize catches, while ensuring the sustainability of the resource. Also, would it make more sense to protect a single large area rather than several smaller ones? In this paper, we present a simulation model designed with the GAMA platform. The model uses as input a map representing the Senegalese coast which we divide into multiple cells where a cell may be a reserve. We perform several simulations of this model with various parameters of size and number of MPAs and we note their impact on the density of fish and catches. From these simulations, we observe that catches at equilibrium admit a maximum for a certain percentage of area dedicated to marine protected areas.

Subject: Socio-economic approaches to investigate artisanal fisheries in West Africa

Authors: Joern Schmidt

Address: University of Kiel

E-mail : jschmidt@economics.uni-kiel.de

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

In Africa, fisheries play an important economic, social and environmental role. Historically, in South Africa and other countries, research and data collection pertaining to the oceans mainly focused on exploited fish populations and their management. In recent years, however, uncertainty associated with effects of changing environmental conditions on marine ecosystems has prompted scientists to suggest the adoption of a precautionary approach with a shift in policy focus towards an ecosystem-based approach (Bottsford et al. 1997; Link, 2002; Pikitch et al. 2004). Although distant water fleets are currently a major pressure on stocks in West Africa and thus the local fisheries, global warming will be an important and likely irreversible additional pressure (Sumaila et al. 2011, Lam et al. 2012).

The main objective of the socio-economic work within the AWA and PREFACE projects is to understand the effect of climate change on small scale fisheries and coastal communities and to derive an understanding of the effect of uncertainty in projections and possible implications for management and fishing communities. The aim is to develop coupled ecological-economic models for key species and investigate perceived and realised threats for coastal fishing communities.

Refernces

Botsford, L.W., Castilla, J.C., and C.H. Peterson (1997). The management of fisheries and marine ecosystems. Science, 277: 509–515.

Lam VWY, Cheung WWL, Swartz W, Sumaila UR (2012). Climate change impacts on fisheries in West Africa: implications for economic, food and nutritional security. African Journal of Marine Science, 34(1)103-117.

Link, J.S. (2002). What Does Ecosystem-Based Fisheries Management Mean? Fisheries 27(4):18-21.

Pikitch, E.K., Santora, C., Babcock, E. A., Bakun, A., Bonfil, R., Conover, D. O., Dayton, P.,Doukakis, P., Fluharty, D., Heneman, B., Houde, E.D., Link, J., Livingston, P., Mangel, M., McAllister, M., Pope, J. & K.J. Sainsbury (2004). Ecosystem-based fishery management. Science 305 (5682):346-347.

Sumaila UR, Cheung WWL, Lam VWY, Pauly D, and S Herrick (2011). Climate change impacts on the biophysics and economics of world fisheries. Nature Climate Change, 1:449-456.

Subject: Overview of Gambia fishery.

Authors: Asberr Mendy,

Address: Fisheries department, Banjul, Gambia

E-mail : asberr.mendy@gmail.com

No abstract

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal

AWA

www.awa-project.org

In association with

PREFACE

www.preface-project.eu

How to cite this document

"Socio economic impact of climate change in West Africa: insight from modeling and questionnaires", 2014. Book of proceedings International Workshop AWA-Preface, Sub Regional Fisheries Commission, 17th February 2014, Dakar, Senegal

Acknowledgements

This work has been done inside the tripartite AWA project (BMBF, MESR-MAEE/IRD) and the PREFACE project which is funded by the European Commission's Seventh Framework Programme (2007-2013) – Cooperation, under grant agreement number 603521. We would like to thank the Sub Regional Fisheries Commission, for the organization

Bundesministerium für Bildung und Forschung

Benin, Cabo-Verde, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal