TECHNICAL ASSISTANCE TO IORA FOR THE IMPLEMENTATION AND COORDINATION OF IORA ACTION PLAN ON FISHERIES, AQUACULTURE AND MARINE ENVIRONMENT

Webinar on utilization of satellite services for fish stock assessment and a climate warming system

30 November 2021

REPORT

A. INTRODUCTION.

Existing Geographical Information Systems (GIS) and Remote Sensing (RS) technologies can be better used for planning and management of fisheries[1]. They play an important role in monitoring the current condition of fishery resources providing information for optimal harvesting strategies in some fisheries[2]. A good understanding of fishing effort both spatially and temporally has become increasingly important in stock assessment. The Southeast Asian Fisheries Development Centre (SEAFDEC) has been using these tools in assessments of transboundary species such as anchovies and mackerels in the Gulf of Thailand and the Andaman Sea. The technologies are important in the early detection and monitoring of harmful algal blooms[3] and are also increasingly used in Marine Spatial Planning (MSP). MSP has had an unsettled relationship with capture fisheries and greater technical effort is required to ensure their proper integration[4].

Climate change already has observable impacts on fisheries throughout the Western Indian Ocean (WIO). Evidence exists of climate change causing tuna species to shift spatial distributions and range as well as knock-on effects on coral reef fisheries. Monitoring, information dissemination and awareness of vulnerabilities to climate change are currently weak and should be strengthened[5]. An international study bringing together specialists in marine ecosystems has defined the essential biological variables

[1] Wanchana and Sayan 2018. Application of GIS and Remote Sensing for Advancing Sustainable Fisheries Management in Southeast Asia. Fish for the People, Vol 16: 1.

[2] Meaden and Aguillar-Manjarrez, 2013. Advances in geographic information systems and remote sensing for fisheries and aquaculture. FAO Fisheries and Aquaculture Technical Paper No. 552.

[3] Remote sensing and GIS integration. https://archimer.ifremer.fr/doc/00172/28330/26615.pdf

[4] Integration of fisheries into marine spatial planning: Quo vadis? Holger Janßen et al. Estuarine, Coastal and Shelf Science 201 (2018) 105-113

[5] H Moustahfid, F Marsac, A. Gangopadhyay, 2018. Climate change impacts, vulnerabilities and adaptations: Western Indian Ocean marine fisheries. Chapter 12 of FAO Fisheries and Aquaculture Technical Paper No. 627

to be measured so as to assess the impact of climate change and human pressure on marine biodiversity. These variables are already collected or reasonably easy to collect and consist of components of the marine environment such as plankton, fish, coral reefs and mangroves[6].

The proposal was to organise a webinar showcasing existing examples of latest developments that have been undertaken in GIS and RS with application to stock assessment and fisheries management for the IORA Member States. The webinar was open to presentations from commercial interests having appropriate technical software and hardware applications. It was also an occasion to provide information dissemination and awareness of the vulnerabilities of climate change and some of the options for long-term monitoring.

B. Objectives

The specific objective of the webinar was to share improved knowledge on stock assessment and sustainable fisheries management practices through utilization of satellite services for fish stock assessment and a climate warming system.

The entire recording of the webinar can be accessed by clicking below:
https://www.dropbox.com/s/2pxbm7qxm2voem3/IORA-AFD Webinar 2021-11-30-11-11-38.mp4?dl=0

C. OPENING AND SPEAKERS

Opening: **Mr. Daroomalingum Mauree**, Main Resident Expert for the AFD technical assistance to IORA implemented by COFREPECHE and SOFRECO

Moderators: Dr. Francis Marsac Oceanographer and fisheries biologist, IRD and **Mr. Daroomalingum Mauree**, Main Resident Expert for the AFD technical assistance to IORA implemented by COFREPECHE and SOFRECO

The flyer of the speakers for this webinar can be accessed from:
https://www.dropbox.com/s/qvvww88a8w7nix1/Flyer.pdf?dl=0

Speakers:

1. **Dr. Francis Marsac** (Oceanographer and fisheries biologist, IRD)
2. **Mr. Nicolas Vuillaume** (Representative in the SWIO area, CLS)
3. **Dr. Amos Barkai (**Fisheries Management Consulting divisions, OLSPS)
4. **Dr. Anna Conchon** (SEAPODYM-LMTL development, CLS)
5. **Dr. Amos Barkai (**Fisheries Management Consulting divisions, OLSPS)

The webinar agenda and the profiles of the speakers are presented in Annex.

[6] Contact: francis.marsac@ird.fr / yunne-jai.shin@ird.fr (LMI ICEMASA)

D. ATTENDEES

A total of 167 persons pre-registered for the webinar.
There was a total of 59 participants who attended the webinar, and 56 active connections were recorded one hour after the start of the webinar. On the response to the question "Where are you working": They were 38% from Research Institutions; 29% from Government; 24% were from private sector; 5% each were from international organisation/agencies and other sectors. This is indicated in pie chart below.

F. PRESENTATION BY SPEAKERS

1. Presentation by **Dr Francis Marsac** (Oceanographer and fisheries biologist, IRD)
"A review on the utilization of satellite services to manage fisheries and to monitor the marine environment"

Dr Francis Marsac provided an overview of the multiple uses of remote sensing products in the ocean space, with emphasis on fisheries and marine environmental monitoring. Firstly, he highlighted the remarkable ocean features that can be detected from satellites, and how it is linked with delineating habitat preferences of marine organisms and informing marine spatial planning. Secondly case studies in fisheries management in the IORA region were presented, covering fishery-aid services, conservation purposes and the control and surveillance of the fleets to combat IUU fishing. The third component of the presentation focussed on environmental monitoring, addressing the issues of harmful algal blooms, climate trend detection and the usefulness of satellite services in the development of early warning system.

A copy of the presentation can be accessed at:
https://www.dropbox.com/s/uxnvaoqbc1qasq5/Presentation%20No1.pdf?dl=0

2.Presentation by **Mr. Nicolas Vuillaume** (Representative in the SWIO area, CLS)
"How can Satellite Technology make our fisheries more sustainable? "

The second presentation focused on the Monitoring Fisheries activities in very large areas such as EEZ/ocean is a cost/benefit calculation where satellites can offer the most efficient answer. CLS have been designing and operating VMS terminals for over 30 years and is the leading software manufacturer of a FMC turnkey solution, called Themis. Over 15.000 fishing vessels are equipped with

CLS VMS/ERS equipment's and 39 countries has chosen Themis to monitor their fishing activities. In just 10 years, Industrial Fisheries Management benefited from various major technological improvements, such as the switch from the paper logbook to the electronic format (ERS, Electronic Reporting System). At the same time, the AIS data (Automatic Identification System) has started to be collected by Satellites, allowing tracking and mapping of Fisheries at a global level. The fishing vessels are getting more and more connected thanks to gears sensors and cameras. The sudden raise of the number of nanosatellites is offering more data to enhance our Fishery and Marine Resources understanding. Even Small-Scale Fisheries can now take advantage of affordable solutions. Combining these several sources of Fishery Data (VMS, ERS, AIS, SAR and Oceanography data), can lead to a new approach of the Fisheries Management with an automatization of the Monitoring Surveillance and Control operations. And these are only the first steps of Big Data applied to the field of Fisheries management, that will also very soon rely on Machine Learning models. This talk described the latest features of each of these technologies, with some concrete examples of their application in the Indian Ocean Area.

A copy of the presentation can be accessed at:
https://www.dropbox.com/s/9vf1ipnbnxvyzru/Presentation%20No2.pdf?dl=0

3.Presentation by **Dr Amos Barkai** (Fisheries Management Consulting divisions, OLSPS
"Use and Abuse of Data in Fisheries Management-Data technology: The way forward for the efficient and effective management of commercial fish resources"

The third presentation covered the use of modern data technologies as the way forward as it allows for the efficient and effective management of commercial fish resources. Dr Amos Barkai highlighted some of the shortcomings of current recording & management measures, while presenting the software solution developed by OLSPS. This solution was developed with the aim of dramatically improving the entire data management process which is needed for modern and effective management of commercial fisheries

A copy of the presentation can be accessed at:
https://www.dropbox.com/s/83386vq8ot8akna/Presentation%20No3.pdf?dl=0

4.Presentation by **Dr Anna Conchon** (SEAPODYM-LMTL development, CLS)
"Using micronekton modelling to sustainably manage fish stocks in the context of climate change"

The fourth presentation highlighted on using micronekton modelling to sustainably manage fish stocks and study top predators originally created at the SPC in the 90's. SEAPODYM – Spatial Ecosystem and population dynamic Model – has been developed by the SPC and CLS since 2006. SEAPODYM is a unique spatially explicit population dynamic model. The predator component of this model has been used to simulate both historical and future spatial distribution of tuna (and tuna like) populations in every ocean of the globe. This presentation described SEAPODYM-LMTL modeling framework. The challenges and opportunities arising from the difficulty to observe micronekton organisms was also discussed. Different applications illustrated how such a model can be used to sustainably manage fish stocks. This model is also a tool to study climate change and its impact on ecosystems. An overview of the progress made regarding this aspect has also been presented.

A copy of the presentation can be accessed at:
https://www.dropbox.com/s/j1dqai6ulx7u0wg/Presentation%20No4.pdf?dl=0

5. Presentation by **Dr Amos Barkai (**Fisheries Management Consulting divisions, OLSPS
"Olrac Real-time Incentives (RTI): A complete and novel approach that considers biological, ecological, and economic effects in wide-ranging Ecosystem-Based Fisheries Management"

The presentation covered the development of marine spatial planning management techniques as a means of facilitating the implementation of ecosystem-based fisheries management. The real-time incentives (RTI) solution is a complete and novel fisheries management approach that aims to avoid unsustainable fishing mortality, minimize ecosystems damage, improve economic efficiency, and empower fishers through technology and data-collection, via a single platform. The RTI management approach makes use of spatiotemporally explicit management schemes to incentivize skippers to fish in a way that achieves a range of fisheries and ecosystem objectives. At the core of this approach are credit-point allocations and spatiotemporally varying tariffs that reflect the various impacts of fishing on commercial stocks and ecosystems.

A copy of the presentation can be accessed at:
https://www.dropbox.com/s/0oiw6hszce4pnkl/Presentation%20No5.pdf?dl=0

G. QUESTION AND ANSWERS

1) Question from Khulood AlBulushi :
How is the data obtained from satellite image linked with fisheries species? I mean how we can know the fisheries or species existing?

Answer from Dr. Francis Marsac IRD:
We cannot directly identify the fish species from satellite sensors. The technology is the information collected on board vessels by Electronic Monitoring System. This system is composed of cameras disposed at different places on the vessel that can deliver information on the main species caught, and even the size of the fish.

2) Question from Clivy Lim Shung:
Thank you for the interesting presentation. Can you please give us an idea on the type of accessible tools which can be developped to help in the decision-taking process?

Answer from Dr. Francis Marsac IRD:
To make good decisions in management, it is necessary to identify if we are in normal or anomalous ocean/climate regime and as shown in the first presentation, the main environmental cues defining fish habitat can be measured by satellite (temperature, salinity, productivity, wind, eddy kinetic energy…).

The other aspect of essential information is to control the activity of the fleets, through various means (AIS, VMS), which can also transmit the amount of catch (at least a national fleet to its fisheries authorities). Nicolas Vuillaume referred to this in his presentation.

Scientific information, adjustment of regulations if needed and fishing zones where vessels are operating must be integrated alongside satellite technology to deliver value-added information for the decision-making process.

3) Question from Clivy Lim Shung to Nicolas Vuillaume CLS:
Thank you Nicolas for your presentation. The plug and play satellite terminal is quite interesting. May be used to monitor the local FADs fishery in Mauritius. Can you please give us a rough idea on the requirement and cost involved in implementing such a project?

Answer from Nicolas Vuillaume CLS to Clivy Lim Shung:
To monitor the FADs, either drifting or anchored, we do have dedicated solutions. We have surface tracking terminals but also submersible terminals depending on the use needed. A pamphlet/ brochure will be forwarded to you to get familiar with the plug and play satellite terminal.
Note →, the cost implication was not spelt out.

Comment from Dr. Francis Marsac IRD:
Yes, the plug and play satellite terminal may be used to monitor anchored FADs and such devices will exactly show what is happening around the FADs, including estimates of the aggregated biomass.

4) Question from Helène Gobert, AFD:
Chla is often used as an indicator of a productive zone that can be directly obtained from remote sensing data. Could you unveil a strong correlation between Chla and micronecton presence through SEAPODYM?

Answer from Anna Conchon CLS:
There is a correlation between Chla and micronekton but both fields are different. Basically, the model transports Chla with added recruitment and mortality so you will have "patchy" maps of micronekton compared to spatially-smoothed maps of Chla.

5) Question from Hélène Gobert, AFD:
How is this model used by the authorities and/or fishermen and how do you measure the accuracy of the model?

Answer from Anna Conchon to Helene Gobert AFD:
The accuracy of the model is estimated indirectly as there is not a lot of accurate data of micronekton. As there are a lot of zooplankton data we are validating this component and assuming that the process are well put into equations. We also have a lot of predator data and by successfully calibrating a predator model using the micronekton model as an input we are confident in the quality of the micronekton model.
Concerning the usefulness of the model for fisheries authorities, the model can be used to focus your control effort on small area where the probability of presence of fishermen is high. We could also support small scale fisheries by providing micronekton maps.

6) Question from Daroomalingum Mauree AFD TA MRE to Mr Nicolas Vuillaume CLS:
How are IOC countries implementing the ERS?

Answer from Nicolas Vuillaume CLS to everyone:
Seychelles is fully implementing the ERS. Mauritius is about to start implementing ERS shortly.

7) Question from Daroomalingum Mauree MRE to Dr Anna Conchon CLS:
Can you please provide an example of any fishery or species being affected by climate warming using SEAPODYM-LMTL?

Answer from Dr Anna Conchon CLS:
Apart from tuna, research activities are presently underway on other species using Ocean Global Circulation model (currents & temperature) and Chlorophyll- and hopefully by next year a PhD research student will provide us with his/her findings.

8) Question from Dr Francis Marsac IRD to Dr Amos Barkai OLSPS:
Following the presentation on Olrac Real-time Incentives (RTI), is it a brand-new approach? Is it already in use in fisheries? Is it affordable for developing countries?

Answer from Dr Amos Barkai OLSPS:
Yes, it is a brand-new system. It is 10 years old. There is need to convince fisheries authorities to use it. Only a smartphone is needed on board of the vessel. This facilitates the interaction between scientists and fishers as it enables anyone to see how much time is spent in each grid. This was to be implemented in Indonesia, however budgetary constraint is hampering implementation.

9) Question from Dr Francis Marsac IRD to Dr Amos Barkai OLSPS:
To design the map, a good knowledge of the ecosystem properties is a big challenge. How can you design the system when real information on the environment is lacking most of the time?

Answer from Dr Amos Barkai OLSPS:
Yes, this is a challenging issue. However, the system is only using available knowledge. Based on available information, this is therefore qualitatively used regarding the zones for fishing and for conservation/protection of the sensitive areas.

10) Question from Dr Francis Marsac IRD to Dr Amos Barkai OLSPS:
Does the device require an update of the software?

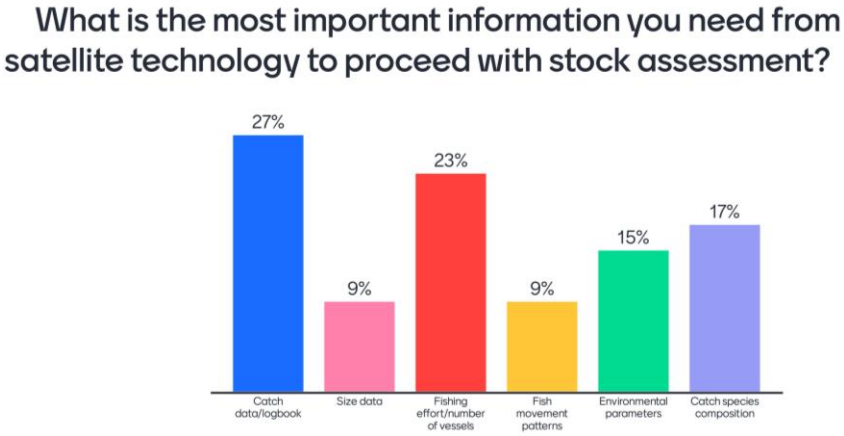
Answer from Dr Amos Barkai OLSPS:
You need access to internet. The software is a simple mobile application. Internet is needed to display the map with its coloured grid designed by scientists, and of course the availability of a budget for the update.

11) Question from Dr Francis Marsac IRD to Dr Anna Conchon CLS:
Regarding the use of micronekton modelling, have you been able to simulate a posteriori maps and compare them to the forecasting model. In other words, a retrospective analysis of the model ?

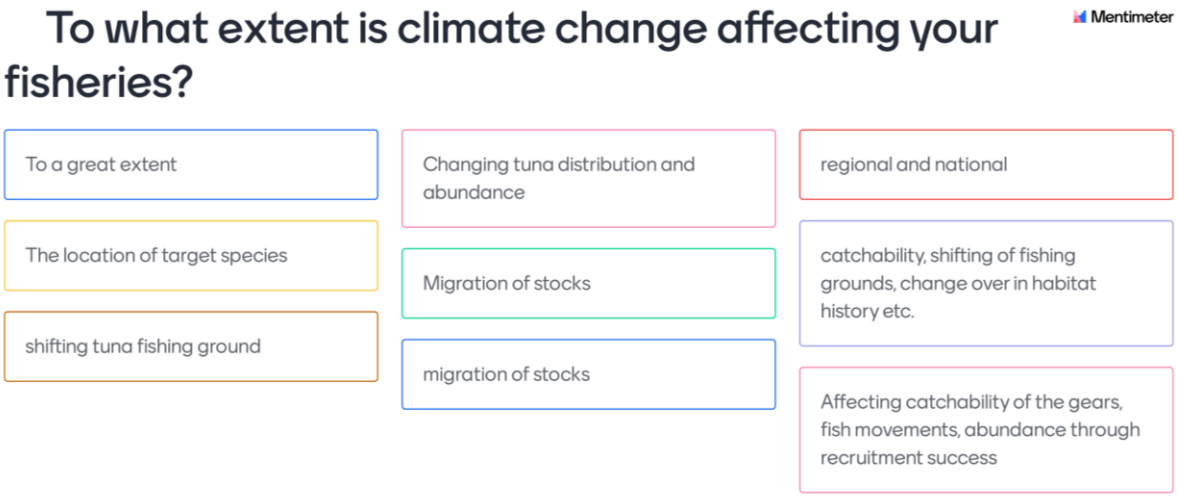
Answer from Dr Anna Conchon CLS to everyone: The model is only based on forecast. Updating is needed for comparative analysis between forecast and posteriori. Only 7 days forecast are presently available.

H. GROUP EXERCISE AND RESULTS

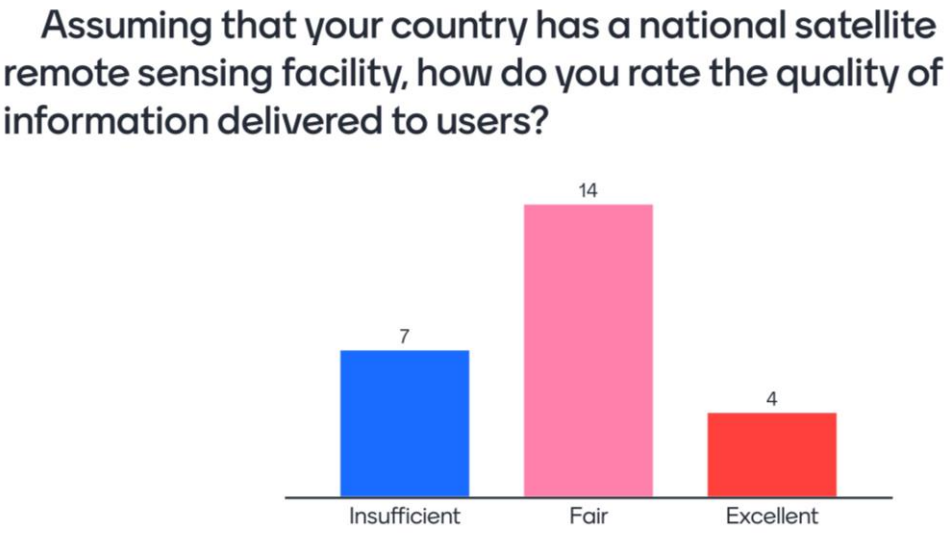
Some polling exercises undertaken with Mentimeter (www.mentimeter.com) sought feedback from the participants on some of the issues that had been raised during the presentation.



From the responses gathered, catch data and logbook topped up the list and followed by fishing effort/number of vessels, catch species and environmental parameters. Size data and fish movement patterns are at par with each recorded 9% of the vote.



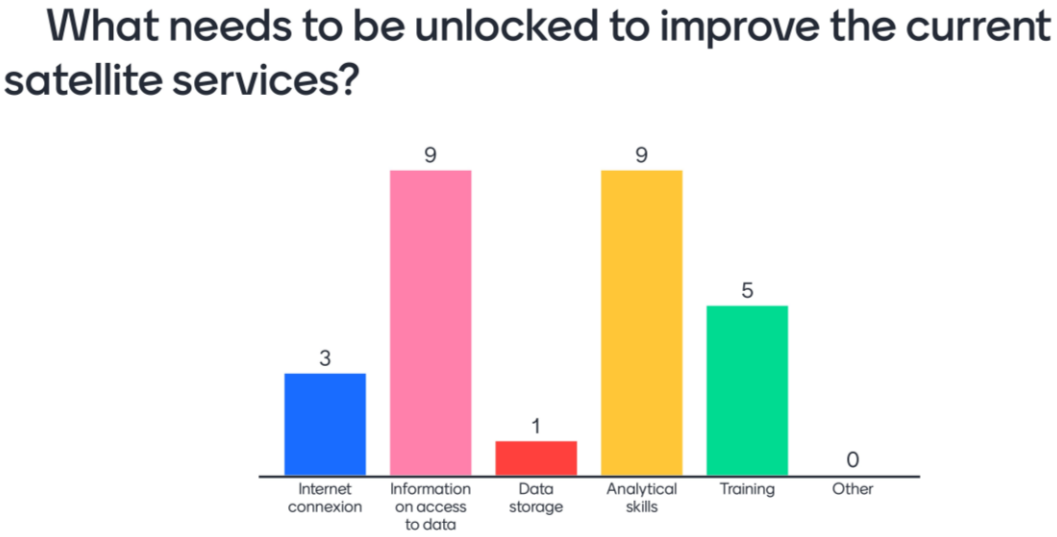
The responses of participants reflected in the figure above are broad and answers include a great extent, shifting of tuna ground, changing tuna distribution and abundance, fish migratory pattern, recruitment, and catchability. National and regional fisheries are also affected.



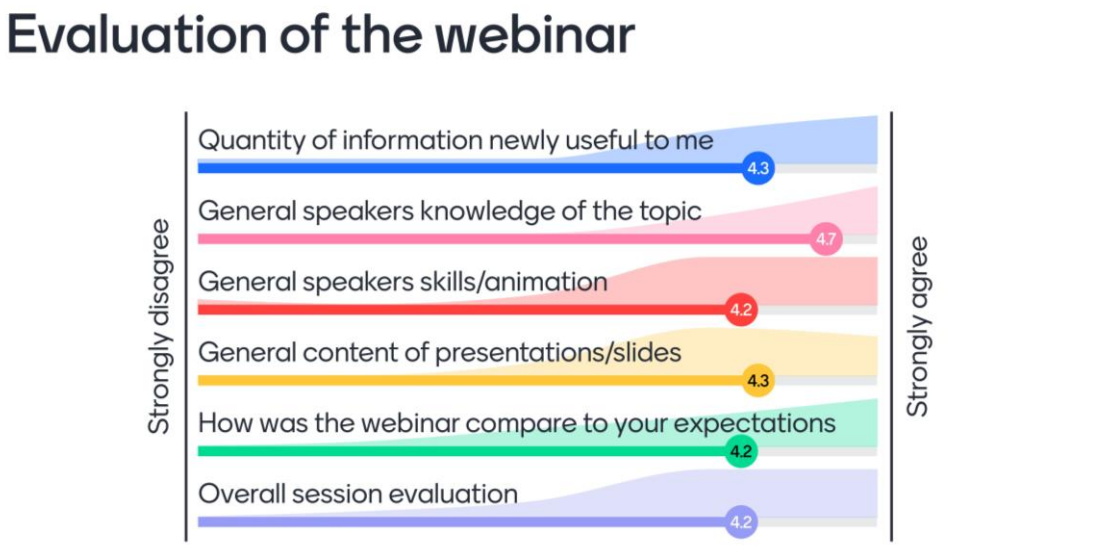
Only 25 from the 56 participants responded to this question.

4 respondents quoted excellent, 14 regarded the quality of information as fair and 7 claimed it as insufficient.

The responses may be limited from participants as most probably they don't have a national remote sensing facility.



27 participants responded. Information on access to data at par with analytical skills came up in order of priority to improve the current satellite services, followed by training, internet connection and data storage.



Participants were asked to score the webinar on quantity of useful information; speakers' knowledge of the topic; speakers' skills/animation; content of slides; expectations of the webinar; and an overall score for the webinar. Generally, all scores confirmed largely positive feedback on the webinar's content: the highest score (4.7) was for the speakers' knowledge of the topic followed by quantity of useful information being at par with content of slides (4.3). The overall score for the webinar was 4.2.

J. CONCLUSION

This was the sixth webinar that was successfully held as part of the AFD Technical Assistance to IORA in fisheries, aquaculture, and environment. The webinar provided the opportunity to inform interested persons in IORA (and elsewhere) on the use of satellite services for fish stock assessment and climate warming.

During this webinar, It was fully recognised that satellite remote sensing will continue to grow as an operational tool for mapping, monitoring and managing the fisheries and the environment. The remote sensing technologies are vital to the social and economic growth of developing countries. They are an ideal tool in marine environmental monitoring. Eventually, they are instrumental for the sustainability of marine resources and the surveillance of fishing fleets and their activities, thereby helping to fight IUU fishing.

It was also emphasized that the appropriate technology is fully available, from satellite products to data loggers and transmitters on board the vessels. Ultimately, ecosystem models, with fine tuning underway, can assist in better fisheries management.

One big challenge is to make this technology accessible in most of the fisheries research centres in the IORA region. Several free software exist to display images and perform analyses but a minimum training is required. Then the scientific information have to be translated into management actions.

Three main recommendations emerged from the webinar:

1) The need to build capacities among the scientific community of the IORA region to better access and process the satellite products for multiple purposes (research, support to economic sectors, environmental monitoring, control and surveillance, etc.). This could be achieved by organising specific training seminars with hands-on sessions;
2) The need to increase collaboration in the IORA region between the countries already equipped with remote sensing facilities and those which are willing to develop such technology ;

3) To analyse the feasibility of setting-up regional early warning systems on extreme events and climate change impacts on productivity and fisheries, incl. HABs, based on (but not restricted to) satellite remote sensing data, as a way forward for the IORA region.

Subsequent to the webinar the Main Resident Expert received requests from participants for the presentations made at the webinar. Links to the presentations were subsequently made available to all the webinar participants, as well as all those other that had registered and who unfortunately did could not attend the webinar.

Annex I: Webinar agenda

TECHNICAL ASSISTANCE TO IORA FOR THE IMPLEMENTATION AND COORDINATION OF IORA ACTION PLAN ON FISHERIES, AQUACULTURE AND MARINE ENVIRONMENT

Webinar on utilization of satellite services for fish stock assessment and a climate warming system

30 November 2021

0700 hrs (GMT)

AGENDA

6:45 to 7:00

- Arrival and connection to the webinar

7:00 to 7:10

- **Dr Gatot H. Gunawan** (Acting Secretary-General/Director of IORA)
  - ⇨ Opening remarks

7:10 to 7:15

- **Mr. Daroomalingum Mauree** (Main Resident Expert for the AFD technical assistance to IORA implemented by COFREPECHE and SOFRECO)
  - ⇨ Presentation of AFD TA to IORA and webinar context

7:15 to 7:45

- **Dr Francis Marsac** (Oceanographer and fisheries biologist, IRD)
  - ⇨ Presentation of agenda and introduction of the topic
  - ⇨ First presentation: A review on the utilization of satellite services to manage fisheries and to monitor the marine environment

Dr Francis Marsac will provide an overview of the multiple uses of remote sensing products in the ocean space, with emphasis on fisheries and marine environmental monitoring. Firstly, it will highlight the remarkable ocean features that can be detected from satellites, and how it links with delineating habitat preferences of marine organisms and informing marine spatial planning. Secondly case studies

in fisheries management in the IORA region will be presented, covering fishery-aid services, conservation purposes and the control and surveillance of the fleets to combat IUU fishing. The third component of the presentation will focus on environmental monitoring, addressing the issues of harmful algal blooms, climate trend detection and the usefulness of satellite services in the development of early warning systems.

7:45 to 8:05

- **Mr. Nicolas Vuillaume** (Representative in the SWIO area, CLS)
  - ⇨ Second presentation: How can Satellite Technology make our fisheries more sustainable?

Monitoring Fisheries activities in very large areas such as EEZ/ocean is a cost/benefit calculation where satellites can offer the most efficient answer. CLS have been designing and operating VMS terminals for over 30 years and is the leading software manufacturer of a FMC turnkey solution, called Themis. Over 15.000 fishing vessels are equipped with CLS VMS/ERS equipment's and 39 countries has chosen Themis to monitor their fishing activities. In just 10 years, Industrial Fisheries Management benefited from various major technological improvements, such as the switch from the paper logbook to the electronic format (ERS, Electronic Reporting System). At the same time, the AIS data (Automatic Identification System) has started to be collected by Satellites, allowing tracking and mapping of Fisheries at a global level. The fishing vessels are getting more and more connected thanks to gears sensors and cameras. The sudden raise of the number of nanosatellites is offering more data to enhance our Fishery and Marine Resources understanding. Even Small-Scale Fisheries can now take advantage of affordable solutions. Combining these several sources of Fishery Data (VMS, ERS, AIS, SAR and Oceanography data), can lead to a new approach of the Fisheries Management with an automatization of the Monitoring Surveillance and Control operations. And these are only the first steps of Big Data applied to the field of Fisheries management, that will also very soon rely on Machine Learning models. This talk aims at describing the latest features of each of these technologies, with some concrete examples of their application in the Indian Ocean Area.

8:05 to 8:25

- **Dr Amos Barkai (**Fisheries Management Consulting divisions, OLSPS)
  - ⇨ Third presentation: Use and Abuse of Data in Fisheries Management- Data technology: The way forward for the efficient and effective management of commercial fish resources

The presentation will showcase the use of modern data technologies as the way forward as it allows for the efficient and effective management of commercial fish resources. It will highlight some of the shortcomings of current recording & management measures, while presenting the software solution developed by OLSPS. This solution was developed with the aim of dramatically improving the entire data management process which is needed for modern and effective management of commercial fisheries

8:25 to 8:45

- **Dr Anna Conchon** (SEAPODYM-LMTL development, CLS).
  - ⇨ Fourth presentation: Using micronekton modelling to sustainably manage fish stocks in the context of climate change

Using micronekton modelling to sustainably manage fish stocks and study top predators originally created at the SPC in the 90's, SEAPODYM – Spatial Ecosystem and population dynamic Model - is developed by the SPC and CLS since 2006. SEAPODYM is a unique spatially explicit population dynamic model. The predator component of this model has been used to simulate both historical and future spatial distribution of tuna (and tuna like) populations in every ocean of the globe. The SEAPODYM prey component, now a model of its own called SEAPODYM-LMTL (for Low and Mid-Trophic Level) models mesozooplankton (drifting organisms from 200µm to 2mm) and micronekton (2 to 20cm animals able to swim). These organisms are typically the prey of top predators (tuna, turtle or marine mammal, etc.) and thus are key stones of marine ecosystems. Yet being central in the oceanic trophic webs, micronekton is less studied than primary producers or top predators. This "dark hole" might be explained by the difficulty to observe these organisms. In such a context, modelling techniques are perfect tools to fill this gap of knowledge. SEAPODYM-LMTL, being spatially explicit, is able to provide unique insights on micronekton spatial patterns and thus feeding grounds of many exploited or endangered species. This presentation will describe SEAPODYM-LMTL modeling framework. The challenges and opportunities arising from the difficulty to observe micronekton organisms will also be discussed. Different applications will then illustrate how such a model can be used to sustainably manage fish stocks. This model is also a tool to study climate change and its impact on ecosystems. An overview of the progress made regarding this aspect will also be presented.

8:45 to 9:15

- **Dr Amos Barkai** (Fisheries Management Consulting divisions, OLSPS)
  - ⇨ Fifth presentation: Olrac Real-time Incentives (RTI): A complete and novel approach that considers biological, ecological, and economic effects in wide-ranging Ecosystem-Based Fisheries Management.

The presentation will cover the development of marine spatial planning management techniques as a means of facilitating the implementation of ecosystem-based fisheries management. However, marine spatial planning as a part of fishing resource management is still a relatively new concept and, due to its comprehensive and all-inclusive nature, can be a complex regime that relies significantly on the cooperation of all involved parties. This is an inherently difficult "status" to achieve. The real-time incentives (RTI) solution is a complete and novel fisheries management approach that aims to avoid unsustainable fishing mortality, minimize ecosystems damage, improve economic efficiency, and empower fishers through technology and data-collection, via a single platform. This solution applies a holistic approach to fisheries management, which is both responsive and evidence-based, addressing issues prevalent in current management strategies, and preparing us for the new challenges of ecosystem-based fisheries management (EBFM). The RTI management approach makes use of spatiotemporally explicit management schemes to incentivize skippers to fish in a way that achieves a range of fisheries and ecosystem objectives. At the core of this approach are credit-point allocations and spatiotemporally varying tariffs that reflect the various impacts of fishing on commercial stocks and ecosystems.

09:15 to 09:30

- Question and answers
- Group exercise on specific aspects of satellite services and fish stock assessment
- Webinar evaluation
- Webinar closure – Concluding remarks and way forward

Information on the presenters

Dr Francis Marsac

Francis Marsac (PhD) is a senior oceanographer and fisheries scientist at the French Institute of Research for sustainable Development (IRD). He has a leading expertise in tuna ecology and assessment of tuna fisheries. From 2006 to 2011, he chaired the Scientific Committee of the Indian Ocean Tuna Commission (IOTC). His research area also includes the impacts of climate variability and change on marine resources in the Indian Ocean. He participated in two Large Marine Ecosystem projects funded by the UNDP and the World Bank in the Southwest Indian Ocean, from 2008 to 2013. In 2015, he became a member of the Steering Committee of the Global Ocean Observing Systems (GOOS) of the IOC-UNESCO and joined the Scientific Steering Committee of the second International Indian Ocean Expedition (IIOE-2) in 2017. He has been working in island countries of the West Indian Ocean and in South Africa (University of Cape Town) where he led an international laboratory on marine and atmospheric sciences (ICEMASA, 2009-2018). He is currently the IRD Representative in the Seychelles. He has published over 60 research articles in international journals, 80 papers in tuna organisations working groups and international conferences and has co-authored several books and book chapters on fisheries development and climate impacts on fisheries in the Indian Ocean.

Dr Anna Conchon

Dr Anna Conchon completed a PhD degree in marine ecology at La Rochelle University (France) and CLS (France) in 2016, supervised by Patrick Lehodey. Her PhD thesis was devoted to zooplankton and micronekton modelling using SEAPODYM-LMTL (Spatial Ecosystem and Population Dynamic Model, Low and Mid Trophic Level). She oversees SEAPODYM-LMTL development at CLS and work on data assimilation into the model. She designs SEAPODYM-LMTL end-user products. She is also involved in H2020 projects related to the impact of climate change on micronekton (MEESO, COMFORT, Mission Atlantic). Besides her theoretical expertise, she also spent several months in the field, acquiring active acoustics data on board the Marion Dufresne or being fisheries observer on a Patagonian toothfish longliner.

Dr. Amos Barkai

Dr Amos Barkai graduated in 1981 with a B. Sc. from Tel Aviv University. He obtained his Ph. D. in Marine Biology at the University of Cape Town (UCT) in 1987, focusing on the population dynamics and predator-prey interactions in benthic populations. His Ph.D. work, which was published in Science Magazine, has been aired by the BBC, and is a regular feature in Marine Ecology textbooks.

During 1988 he participated in the first scientific diving expedition to Marion Island. Dr Barkai received the Oceania group prize for the best scientific publication based on his Ph. D. research on a marine topic. In 1989, Dr Barkai received the “South African Foundation for Research and Development Award” for distinguished postdoctoral scientists.

Mr. Nicolas VUILLAUME

Mr. Nicolas VUILLAUME is Business Engineer in the field of Electronics and Telecommunications. He joined the company Collecte Localisation Satellites (CLS) in 2008 where he conducted product design works in fields like LRIT (Long Range Identification and Tracking System) and ERS (Electronic Reporting System). Based in Réunion Island since 2011, he has been appointed CLS Regional Indian Ocean representative and Operations Manager of the SEAS-OI (Surveillance de l'Environnement Assisté par Satellites en Océan Indien) X-band satellite ground station, antenna which served in IUU detection projects. His work mainly focusses on the Sustainable Management of the Fisheries and Maritime Security solutions.