CLIVAR REPORT

Climate and Ocean: Variability, Predictability, and Change

Workshop Report

Regional Training Workshop on Observing the Coastal and Marginal Seas in the Western Indian Ocean

7-9 July 2022, Maputo, Mozambique & Online

December 2022

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Final Report on the Regional Training Workshop on Observing the Coastal and Marginal Seas in the Western Indian Ocean (WIO)

1. Introduction and objectives

The overall goal of the training workshop was to bring together and encourage the countries in the Western Indian Ocean to engage in ocean (where ocean here refers to ocean, coastal and marginal seas) observing and marine research. Additionally, the training gave insight into the existing tools for ocean observing and accessing data through open platforms.

2. Date, format, and venues

The three-day regional training workshop was successfully organised from 7 to 9 June 2022, in hybrid format (both online and in-person) with physical venues at *Espaço de Inovação* located in the *Centro de Estudos Africano,* university main campus at Universidade Eduardo Mondlane, Maputo, Mozambique and hosted by the Instituto Oceanográfico de Moçambique (InOM). GoToMeeting was used as the virtual meeting platform.

3. Participants

The participants were drawn from an open call for interest/registration on the CLIVAR webpage. The call for registration was open from 1 to 25 March 2022 and distributed to the marine science communities in the Western Indian Ocean (WIO) countries and globally. There was a huge interest in the training workshop with 225 registrants (88 for in-person and 137 virtual participation) from 40 counties, see application report attached as Annex 1.

All the 137 registrations for virtual participation were accepted whereas for in-person only 26 persons were selected, and the others were invited to participate virtually. In the end, there were about 110 attendees online. For in-person participation a selection criterion was set to reflect all the WIO countries with emphasis on technicians, scientists, early career scientists and students mainly from national research institutes and universities. The selected participants from Madagascar and Tanzania could not come in-person due to passport issue and one participant from Comoros was tested positive for covid-19 prior to departure and could not come as well as the second participant from Mauritius could not come. The final list of in-person participants who attended the workshop in Maputo is attached in Annex 2.

Fig 1. Group photo of in-person participants after the opening ceremony and snapshots of the workshop room

4. Opening session

The WIO regional training workshop was opened with a welcome statement by the Director of Mozambican Oceanographic Institute (Instituto Oceanográfico de Moçambique - InOM), Mr. Jorge Mafuca. He highlighted the importance of ocean observation for the changing WIO and Mozambique in particular. He then welcomed all the participants and trainers to Mozambique, and ultimately wished for a good and successful training workshop. In addition, the GOOS co-chair, Dr. Toste Tanhua made opening remarks, followed by POGO CEO, Dr. Sophie Seeyave, and there was a statement by Ms. Jing Li on behalf of Dr. Jose Santos, the Executive Director of the International CLIVAR Project Office.

5. Workshop activities

Following the opening session, Dr Bernardino Malauene from InOM established the ground rules on behalf of the organising committee and introduced the training workshop agenda, summarized in the following main sessions:

- Overview of the WIO Observing Systems
- Observation Instruments and Platforms in the WIO
- Data access, Analysis and Management
- Observation with Societal Needs

Detailed agenda and program are attached in Annex 3 and link to the recordings can be found here: https://www.clivar.org/western-indian-ocean-workshop-agenda The links of resources provided by trainers are summarized in Annex 4.

5.1 Day 1

The 1st session of the workshop provided an overview of the WIO observing systems, where participants from WIO rim countries (Kenya, Tanzania, Mozambique, South Africa, Mauritius) and Kuwait were asked to present updates on existing observation systems in their countries, i.e., updates from various perspectives. Then, the Ocean Decade Africa Roadmap, with emphasis on ocean observation needs and gaps, was presented by Dr. Mika Odido from IOC Africa followed by the Annual Indian Ocean Transect (AIOT) introduced by Jim Costopulos from Global Oceans, a non-profit organisation based in the US.

The session established that there is some kind of ocean observation in each country, with some countries, e.g., South Africa, more advanced than others. Also, the counties share common characteristics and challenges. There was a strong recognition of the need for sustained observations and the desire to further coordinate to implement observations in the WIO.

On the afternoon of Day 1, Session 2 was on the observation instruments and platforms, with a focus on the cost-effective and fit-for-purpose observation instruments for the WIO countries and the best practices on data standard and quality assurance. The first talk was jointly presented by Dr. Tommy Bornman from SAEON, South Africa and Dr. Gregory Cowie from SIBER. They provided an overview of the coastal and marginal sea observation instruments,

by highlighting the necessity, importance and critical criteria for coastal observations. Afterwards, Dr. Gregory Cowie introduced the concept of 'CoLaB: Coastal Lab in a Box', which involves an affordable and easily transported package of sampling gear and instruments as well as methodology for both field and laboratory use for a diverse coastal oceanographic application. The package should be for manual deployments from small boats without need of a research vessel.

Dr. Nadia Pinardi from CoastPredict, a programme endorsed by the UN Ocean Decade, highlighted the game changing for science paradigms for more systemic, holistic and convergent sciences, and the requirements and feedback of the global ocean observing system with the expansion to global coastal oceans. She introduced various examples of routine products from CMCC global model data and reanalyses for climate monitoring, which allow for new scientific understanding and benefit to society. She also emphasised the need for observation systems to receive requirements from prediction models, and the integration with satellite data and new methodologies (e.g., machine learning), which are key for global coastal observations.

Kevin O'Brien from UW/CICOES, NOAA/PMEL and GOOS OCG Vice-chair and Matthew Biddle from US IOOS presented data best practices to support quality assurance, including open science data tools. Mr. O'Brien focused on the data best practices and the recent effort done through the GOOS Observations Coordination Group (OCG) to improve the data flows and interoperability of the global ocean *in situ* observing networks. He highlighted the goals of the OCG data and metadata work, with a strong focus on standards and conventions, metadata and FAIR-compliant data access services. There was also a brief discussion of the data broker and interoperability tool called ERDDAP, which is gaining significant traction in the ocean data community for its ability to provide interoperable and access to data. After this discussion, Mr. Biddled guided the participates through an excellent demonstration to show how to access, make quality assessments and using data with common tools and through open science data platforms. Mr. Biddle was kind enough to create a Jupyter notebook walkthrough, which was distributed to the participates as resource links.

Following a series of questions and discussion, workshop Day 1 was closed at 17:30.

5.2 Day 2

Day 2 was specifically designed for marine robotics, Argo floats and satellite observations. The session began with a presentation on the application of marine robotics for marine science by Prof Mike Roberts from Nelson Mandela University (NMU). Prof Roberts started by setting the scene (showcase) on the WIO climate related challenges and issues and the eminent food security crisis. He continued by demonstrating how marine robotics can be used to provide vital information (data) for management to build resilience and ensure sustainable use of marine resources. Moreover, he suggested marine robotics as an alternative for traditional ocean observation platforms, particularly in a region where research vessels are scarce, such as in the WIO. Mr Elbert Liebenberg and Dr Andrew Young, both from Marine Robotics Unit (MRU) at NMU, joined the talk with an engineering perspective and an actual case including autonomous research vessels, drones, marine gliders, etc under development at MRU.

After the coffee break, Ian Walsh from SeaBird presented the basic principles and introduction to Argo floats, specifically the Bio-Argo floats in the Indian Ocean. The lecture covered what the floats are, how they work and what variables can be measured. He also showed where to find live and archived float data on the web, with a practical case demonstrating finding a float in a particular area (i.e. WIO) and downloading data from the Biogeochemical Argo website. To end he presented a brief overview of data quality control and provided alternative data access portals and links to resources.

The session continued with Dr. Lisan Yu from WHOI who presented the value of satellite observations for science and society. She focused on the ocean surface fluxes (heat, salt, moisture, momentum and gases) at the air-sea interface that drive ocean circulation, variability and change, with emphasis on momentum flux (i.e., wind stress) and its importance on Ekman upwelling. She demonstrated that there are many satellite sensors for monitoring air-sea variables, but most of them only last a few years. She then introduced the OAFlux (Objectively Analyzed air-sea Fluxes) project, which constructed and distributes the surface fluxes from different satellites from 1988 onward (> 35 years) in high resolution. A case study on application of OAFlux in understanding variability and trends in the Indian Ocean and Marginal seas was presented. Dr Nikolay Nezlin from NOAA unfortunately could not present the application of satellite observation for biology, i.e., ocean productivity.

A practical demonstration of deploying and recovering Underwater Temperature Recording (UTR) moorings was performed by Mr Brian Godfrey from NMU. Instrument types, methods for protection and mooring the instruments were demonstrated. He showed the processes required to service the UTR, highlighting the importance of correctly servicing O-rings. Choice of sites and subsequent relocation of moorings was discussed with participants. The appropriate methods for downloading and subsequent data management were also shown, and the relevance of proper data curation and backup was emphasised.

The afternoon was reserved for a site demonstration of oceanographic mapping by an autonomous research vessel (ARV) from the Marine Robotics Unit (MRU) of the Nelson Mandela University at the *Clube Naval Maputo* (Yacht Club Fig 2). The demonstration started by setting up the ARV, launching into the sea, introducing the navigation waypoints in the Maputo Bay, collecting the variable along the track, data downloading and data visualisations. During the process the participants had the chance to interact and were impressed with ARV capability.

Day 2 ended with a social dinner.

Fig 2 Pictures of the autonomous research vessel demonstration and mapping

5.3 Day 3

The last day of the training workshop, Day 3, began with a recap of Day 1 and Day 2 activities by Dr Roxy Koll and Dr Bernardino Malauene. Mr Elbert Liebenberg presented a brief overview of the data collected during the autonomous research vessel demonstration on the previous day. The subsequent talks focused on the actual activities of the day. Day 3 activities then focused on two topics: one is on data access, analysis, and management, and the other is on linking observations with societal needs.

Mr Jethan d'hotman, from SAEON in South Africa, presented the basic principles of data processing, cleaning and validation. He presented the *pros* and *cons* of manual versus automatic data processing and concluded that the choice will depend on one's experience. He emphasised the importance of adding/including all the relevant information about the data, metadata, based on examples in practice in South Africa. Then Dr Bernardino Malauene demonstrated how to achieve a processed and cleaned dataset; hands-on experience on

correcting (uniform) the time format, fill-in the time gaps and removing outliers using case study UTR data from Mozambique.

Dr Udaya Bhaskar, from INCOIS, introduced data management, archiving and sharing with examples from India. He presented the Research Data Life Cycle (RDLC, Fig 3) based on the general principle that data is collected to gather information which leads to knowledge and this in turn leads to wisdom.

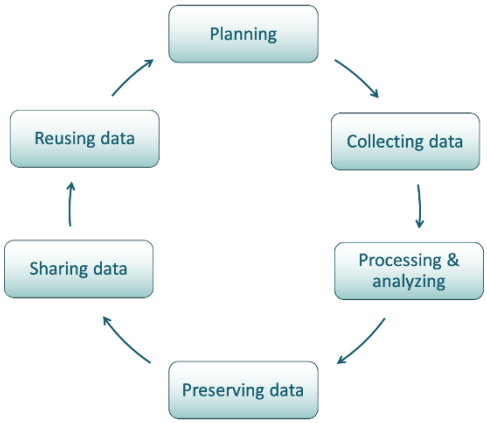


Fig 3: Different stages of Research Data Life Cycle (RDLC).

The subsequent talks focussed on using ocean observation data for ocean sciences, blue economy, assessing the climate impacts and getting the message across to policy makers.

Dr Nicholas Hardman-Mountford, a member of IORP from the Commonwealth Secretariat, presented the Sustainable Blue Economy on the Commonwealth perspective and Commonwealth Blue Charter. He centred on the values of the ocean/blue economy beyond "fish and ship", emphasising the interconnectedness of economic development, local community inclusion and eco-environmental sustainability without prioritising one aspect over the other. He also introduced the principles of Sustainable Blue Economy and the role ocean observing plays in measuring ocean assets (stocks) and flows (services). Dr Tammy Morris from South Africa Weather Services, then presented various observing instruments to perform coastal and marine science research and showed how to link the coast to offshore observation.

In the afternoon, Dr Roxy Koll from IITM and Dr Hindumathi Palanisamy from WCRP Secretariat talked on the impacts of climate change and the rapidly changing Indian Ocean and how to get the message across to policy makers. They reviewed several changes and impacts the Indian Ocean is facing, including the fastest warming surface ocean in the planet as stated in the IPCC Report (AR6). And they suggested the dissemination of evidence-based impacts through the media to reach the community and policy makers.

By the end of the workshop, a panel discussion on how to leverage support from national government and international community for sustained observation in WIO was carried out. It was led by four panellists from partners, across government agencies (Bernardino Nhantumbo from Mozambique Weather Service and Dr Sidney Thurston from NOAA/IRF), and non-profit organisation (Jim Costopulos from Global Oceans) and all the trainers and participants joined to the discussion with voluntary contributions. It was then followed by a discussion on how the

WIO countries can work together with the international community to contribute and benefit from the enhanced ocean observations in the WIO.

6. Wrap-up

Before closing the workshop, participants were invited to say some words about the workshop. Participants shared their feedback and their appreciation to the organisers of the workshop and the trainers. Moreover, participants were encouraged to make more input to the post-workshop survey.

Dr Roxy Koll and Dr Bernardino Malauene thanked all of the trainers and participants, as well as the sponsors and closed the Regional Training Workshop on Observing the Coastal and Marginal Seas in the Western Indian Ocean at 17h05.

7. Conclusions and recommendations

This training workshop was a success and extremely beneficial. It brought together some of the relevant participants from the WIO countries and is believed to be the beginning of a regional working group in ocean observing. The evaluation of the workshop by the participants demonstrates that the topics chosen were well-in-taken by the participants and obviously thought to be relevant; and the selection of trainers met the expectations of participants (for more details see the post-workshop survey analysis in Annex 5)

During these 3-day workshop, participants from WIO rim countries listened to the voices from global experts on ocean observing about observational needs and gaps, in particular in the coastal and marginal seas; understood the best practices on the fit-to-purpose and easy-to-use observation instruments and innovative platforms; found out where to find the data and how to use the data to address the societal needs and discussed how to leverage support from national and international opportunities.

There was general agreement among the participants, to strengthen the national coastal and marginal observations, to perform data management and quality control with regional standards as an important step to improve the WIO ocean observing system.

8. Acknowledgements

We acknowledge the World Climate Research Programme (WCRP) for the travel support to four students from Mauritius, Kenya, Tanzania, Zambeze Province in Mozambique and one trainer from India. We also thank the support from the Partnership for Observation of the Global Ocean (POGO) to cover most of the in-country workshop expenses. The South African Environmental Observation Network (SAEON) and the South African national Indian Ocean Rim Association Academic Group (SA IORAG) covered the costs of attendance for one participant from Zambeze Province in Mozambique, one from Comoros and other from South Africa as well as two trainers from South Africa. ReMoTURB project through Newton Fund covered the travel costs for four trainers from Gqeberha, South Africa, and the autonomous

research vessel demonstration including transport from/to South Africa). Global Oceans sponsored the workshop dinner.

The time of all the lecturers was in kind and their efforts, as well as those of the organising committee was a huge part of the success of the workshop, as well as the enthusiastic involvement of all participants. In addition, the time of Jing Li from ICPO is great fully acknowledged.

Organising Committee

- Bernardino Sérgio Malauene, Instituto Oceanográfico de Moçambique and Nelson Mandela University
- Faiza Yousef Al- Yamani, Kuwait Institute for Scientific Research, Kuwait
- Juliet Hermes, South African Environmental Observation Network, South Africa
- Roxy Mathew Koll, Indian Institute of Tropical Meteorology, India
- Ivan Suege, Instituto Oceanográfico de Moçambique
- Jing Li, International CLIVAR Project Office (ICPO), China

Annex 1: Registration statistics

Regional Training Workshop on Observing the Coastal and Marginal Seas in the Western Indian Ocean

1. Prefix [Single choice]

Options	Total	Percentage
Mr.	93	41.33%
Ms.	43	19.11%
Mrs.	16	7.11%
Dr.	69	30.67%
Prof.	4	1.78%
Total valid responses	225	

2. First Name: _____Last Name：_____ [Gap filling]

3. Email [Gap filling]

4. Gender [Single choice]

Options	Total	Percentage
Female	81	36%
Male	144	64%
Non Binary	0	0%
Prefer not to say	0	0%
Total valid responses	225	

5. Country [Gap filling]

Country	No. of registrants	Country	No. of registrants
Australia	4	Mauritius	2
Bangladesh	9	Morocco	1
Benin	1	Mozambique	23
Brasil	1	Nigeria	7
China	2	Pakistan	2
Comoros	3	Puerto Rico	2
Djibouti	1	Qatar	2
Egypt	5	Senegal	2
Ethiopia	1	Seychelles	1
France	1	South Africa	5
Gambia	1	Spain	1
Ghana	2	Sri Lanka	2
India	44	Sudan	4
Indonesia	11	Sweden	1
Iran	7	Tanzania	12
Iraq	1	Tunisia	2
Kenya	30	UK	3
Kuwait	16	USA	7
Madagascar	1	Yemen	1
Maroc	3	ZAMBIA	1

6. Affiliation [Gap filling]

7. Position [Gap filling]

8. Please kindly indicate your technical expertise related to the workshop and the software tools that you use. [Gap filling]

9. Are you an Early Career Scientist?
(* Early Career Scientist refers to existing PhD students and scientists who have graduated within 8 years upon completion of their PhD or MSc graduates who have a permanent position in a marine agency.) [Single choice]

Options	Total	Percentage
Yes	131	58.22%
No	94	41.78%
Total valid responses	225	

Part II: Attendance

10. What topics of this workshop are you interested in? [Multiple choices]

Options	Total	Percentage
Overview of the WIO Observing Systems	188	83.56%
Observation Instruments and Platforms in the WIO	190	84.44%
Data access, Analysis and Management	202	89.78%
Observation with Societal Needs	159	70.67%
Total valid responses	225	

11. I will attend the training workshop: [Single choice]

Options	Total	Percentage
In-person in Maputo, Mozambique	88	39.11%
Virtually	220	60.89%
Total valid responses	225	

Part III: Financial Support

International funds available for this training workshop are very limited, therefore please make every effort to garner support from your institution or government. However, if you would like to request financial support for your in-person participation in Maputo, Mozambique, please answer the following questions.

12. I would like to request financial support to attend the workshop. [Single choice]

Options	Total	Percentage
N/A	9	10.23%
Full	73	82.95%
Partial	6	6.82%
Total valid responses	88	

13. Which kind of support you are specifically looking for? [Multiple choices]

Options	Total	Percentage
Flight ticket	4	66.67%
Train ticket	0	0%
Per diem	2	33.33%
Total valid responses	6	

14. City of departure [Gap filling]

Please provide the following documents to icpo@clivar.org by **25 March 2022**.
1. Your CV
2. A letter of motivation (not more than one page)

Part IV: Short Survey

15. Please indicate where did you hear about this training workshop [Single choice]

Options	Total	Percentage
Internet	54	24%
Community network/social media	52	23.11%
Work/University	78	34.67%
Friend	27	12%
Others	14	6.22%
Total valid responses	225	

16. Will you participate in a post workshop survey? [Single choice]

Options	Total	Percentage
Yes	205	91.11%
No	20	8.89%
Total valid responses	225	

Annex 2: List of Participants (in-person)

First Name	Last Name	Gender	Country	Affiliation	Email
Krisna	Bucha	Male	Mauritius	Mauritius Meteorological Services	krisnabucha@gmail.com
Josphat	Nguu	Male	Kenya	KMFRI	nguugachoki@gmail.com
Isaac	Brito Morales	Male	United States	Conservation International and UCSB	ibrito@conservation.org
Elbert	Liebenberg	Male	South Africa	MNU	Elbert.Liebenberg@mandela.ac.za
Jethan	d'Hotman	Male	South Africa	SAEON	js.dhotman@saeon.nrf.ac.za
Noca	Da Silva	Male	Mozambique	Universidade Eduardo Mondlane (UEM) – Escola Superior de Ciências Marinhas e Costeiras (ESCMC)	Nocafuraca@yahoo.com.br
Avelino	Langa	Male	Mozambique	UEM – ESCMC	avelinolanga@yahoo.com.br
Nélio	Sitoe	Male	Mozambique	UEM – ESCMC	nelio.d.sitoe@uem.ac.mz
Adelina	Langa	Female	Mozambique	UEM – ESCMC	adelinalanga.al@gmail.com
Jersica	Jequicene	Female	Mozambique	UEM – ESCMC	jersica.jequicene@gmail.com
Carolina Marcela	Mutatisse	Female	Mozambique	Universidade Eduardo Mondlane – Biology Dept	carolinamutatisse@gmail.com
Antonio	Da Silva	Male	Mozambique	INAHINA	manecasdasilva@yahoo.com.br
Ivan	Suege	Male	Mozambique	Oceanographic Institute of Mozambique – InOM	isuege105@gmail.com
Emidio	Andre	Male	Mozambique	InOM	erandre397@gmail.com
Daniel	Fernando	Male	Mozambique	InOM	zulda09@gmail.com
Paulo	Sigaúque	Male	Mozambique	InOM	paulosiga76@yahoo.com.br
Norton	Cossa	Male	Mozambique	Marine Megafauna Foundation	14ernar.cossa@marinemegafauna.org
Natália	Ngome	Female	Mozambique	Universidade Eduardo Mondlane	nataliabeneditongome@gmail.com
Kevin	Nhampule	Male	Mozambique	Universidade Eduardo Mondlane	Knhampule@gmail.com
Jacqueline	Claire Sendela	Female	Mozambique	INAM	14ernardino.sendela@gmail.com
Hipolito	Cardoso	Female	Mozambique	INAM	hicardosomz@gmail.com
Franziska	Steinbruch	Female	Mozambique	Administração Nacional das Áreas de Conservação	fsteinbruch@anac.gov.mz

Student (who could not attend in-person and moved to online)					
Hellen Joseph	Kizenga	Female	Tanzania	Institute of Marine Sciences (University of Dar es Salaam)	hellenkizenga45@gmail.com
Sachooda	Ragoonaden	Male	Mauritius	Association pour le Développement Durable (ADD)	rajouma@yahoo.com
Saifidine	Mohibaca Baco	Male	Comoros	National Agency of Civil Avaiation & Meteorology	saifidine33@yahoo.fr
Nirina Mamy	Rajaonarivelo	Male	Madagascar	National Oceanographic Center of Madagascar	mamy_nirina@hotmail.com
Speaker					
Roxy	Koll	Male	India	IITM	roxy@tropmet.res.in
Greg	Cowie	Male	UK	University of Edinburgh	Dr.Greg.Cowie@ed.ac.uk
Nicholas	Hardman Mountfort	Male	Australia	Commonwealth	n.hardman-mountford @commonwealth.int
Jim	Costopulos	Male	USA	Global Oceans	jcostopulos@global-oceans.org
Tommy	Bornman	Male	South Africa	SAEON	tg.bornman@saeon.nrf.ac.za
Tammy	Morris	Female	South Africa	SAWS	Tamaryn.Morris@weathersa.co.za
Mike	Roberts	Male	South Africa	MNU	Mike.Roberts@mandela.ac.za
Brian	Godfrey	Male	South Africa	MNU	Brian.Godfrey@mandela.ac.za
Andrew	Young	Male	South Africa	MNU	Andrew.Young@mandela.ac.za
Jorge	Mafuca	Male	Mozambique	InOM	jorgemafuca@gmail.com
Bernardino	Nhantumbo	Male	Mozambique	INAM	bernardino.jn01@gmail.com
Bernardino	Malauene	Male	Mozambique	InOM	dinomalawene@yahoo.com.br

Annex 3: Agenda

CLIVAR IORP/POGO Regional training workshop on observing the coastal and marginal seas in the western Indian Ocean

7-9 June 2022, Maputo, Mozambique & Online (Time zone: GMT+2)

Session	Time	Topic	Speaker
Day 1 – June 7, 2022 (9:00 – 17:00, GMT+2)			
	08:30	**Registration**	
Opening Session	09:00	Opening remark from GOOS	Toste Tahuna (GOOS co-chair)
	09:10	Opening remark from POGO	Sophie Seeyave (POGO CEO)
	09:20	Opening remarks from InOM	Jorge Mafuca (InOM Director)
AM - Overview of the WIO Observing Systems (Chair: Tammy)	09:30	Introductions	from Bernadino and Faiza
	09:45	***Coffee break***	
	10:00	Update on existing observation systems in the WIO and marginal seas and, learning from the marginal seas experience. (Flash talks – 5 mins each country & discussions)	WIO countries (Kenya, Tanzania, Mozambique, South Africa, Madagascar, Comoros and Mauritius), Kuwait, UAE, Oman, Yemen)
	11:20	Ocean Decade Africa Roadmap: with emphasis on ocean observation needs and gaps	Mika Odido (IOC Africa)
	11:40	Indian Ocean transect & Global Oceans	Jim Costopulos (Global Oceans)
Lunch	**12:00**		
PM - Observation Instruments and Platforms in the WIO – Part 1	13:00	Coastal and marginal sea observing instrumentation - Discussion: Cost-effective and fit-to-purpose observation instrument for WIO (including how to set up a cost-efficient lab), Chair Greg Cowie	Tommy Bornman (SAEON)
	14:00		Gregory Cowie (SIBER, UK)
	15:00	***Coffee break***	
	15:15	Mid- and long-term observation configuration and design	Nadia Pinardi (Coast Predict)

Session	Time	Topic	Speaker
	16:00	Best practices including Data standard and quality assurance	Kevin o'Brien (NOAA/GOOS OCG)
	17:00	**Close day 1**	
Day 2 – June 8, 2022 (08:30 – evening, , GMT+2)			
AM - Observation Instruments and Platforms in the WIO – Part 2	08:30	Marine Robotics	Mike Roberts (Science)
	09:15		Andrew Young (Engineering)
	10:00	Understanding and accessing available Argo floats data	Ian Walsh (Sea-Bird Scientific)
	11:00	***Coffee break***	
	11:15	Satellite observations and value for ocean science	Lisan Yu (OAFlux, WHOI)
	12:00		Nikolay Nezlin (NOAA)
	12:45	Introduction to deploying a UTR (held in the lab)	Brian Godfrey (UTR practical/field section)
	13:30	***Packed lunch***	***Leave for the field***
	14:00	Marine Robotics demonstrations	Andrew Young
	Social supper	In person opportunity for ECS to network with the speakers	
Day 3 – June 9, 2022 (08:30 – 17:30, GMT+2)			
AM - Data access, Analysis and Management	08:30	Data processing/cleaning/validation	Tammy/Jethan
	09:00		Bernardino Malauene
	09:30	Data management – archiving and sharing	Udaya Bhaskar (INCOIS)
	10:00	***Coffee break***	
	10:15	Blue Economy	Nicholas Hardman Mountford (Commonwealth)

Session	Time	Topic	Speaker
	11:15	Ocean sciences using ocean observing platforms	Tammy Morris (SAWS)
	12:00	Discussion around data management	Chair: Bernardino Malauene
	12:30	***Lunch***	
PM - Link Observation with Societal Needs	13:30	Climate impacts and how to get the message across to policy makers	Roxy Koll (IITM)
			Hindumathi Palanisamy (WCRP Secretariat)
	15:00	**Coffee break**	
	15:15	Panel section: How to leverage support from national government and international community for sustained observation in WIO?	Bernardino Nhantumbo (INAM)
			Arthur Tuda (WIOMSA)
			Sidney Thurston (NOAA/IRF)
			Jim Costopulos (Global Oceans)
	16:30	**Discussion:** How WIO countries can work together with international community to contribute and benefit from the enhanced ocean observations in the WIO.	Chair: Roxy Koll
Close section	17:00	Closing remark from InOM	Jorge Mafuca (InOM Director)

Note: Speakers highlighted in blue will attend the workshop in-person.

Annex 4: Useful links provided by lecturers

- Indian Ocean Observing System (IndOOS): https://www.clivar.org/clivar-panels/indian/IndOOS
- Climate and Ocean: Variability, Predictability and Change (CLIVAR): www.clivar.org
- World Climate Research Programme (WCRP): www.wcrp-climate.org
- Partnership for Observation of the Global Ocean (POGO): https://pogo-ocean.org/

Day 1:

1. The United Nations Decade of Ocean Science for Sustainable Development 2021-2030: **Ocean Decade Africa Roadmap**: https://unesdoc.unesco.org/ark:/48223/pf0000381488

2. **Ocean Observing networks** (provided by Tommy and Greg)
   - Global Ocean Observing System (GOOS): https://www.goosocean.org/
   - International Long-Term Ecological Research Network (ILTER): https://www.ilter.network/
   - WMO-IOC Data Buoy Cooperation Panel (DBCP): https://www.ocean-ops.org/dbcp/
   - Global Sea Level Observing System (GLOSS): https://gloss-sealevel.org/
   - Global Telemetry Network:
     - Atlantic Cooperative Telemetry Network (ACT): https://www.theactnetwork.com/
     - Florida Acoustic Cooperative Telemetry group (FACT): https://secoora.org/fact/
     - Integrated Tracking of Aquatic Animals in the Gulf of Mexico (iTAG): https://itagscience.com/
     - Australian Animal Tracking and Monitoring System (AATAMS): https://imos.org.au/facilities/animaltracking
   - Shallow Marine & Coastal Research Infrastructure (SMCRI): https://smcri.saeon.ac.za/

3. Some **ERDDAP** references (provided by Kevin O'Brien):
   - ERDDAP Introduction: A GOOS Webinar https://youtu.be/kdBTgNEp5TA
   - ERDDAP home page: Home page for documentation and downloads https://coastwatch.pfeg.noaa.gov/erddap
   - Awesome ERDDAP: A curated list of ERDDAP projects and Deployments https://github.com/IrishMarineInstitute/awesome-erddap
   - ERDDAP.com: A Federated ERDDAP search portal http://erddap.com/
   - ERDDAPY: A python module for working with ERDDAP servers https://github.com/ioos/erddapy
   - Rerddap: A general purpose R client for working with ERDDAP servers https://github.com/ropensci/rerddap
   - ERDDAP Docker Image: Use docker containers to install and setup ERDDAP https://github.com/axiom-data-science/docker-erddap

- US IOOS ERDDAP configurations: Example ERDDAP configuration for US IOOS profiles https://ioos.github.io/ioos-metadata/gold-standard-examples.html
- ERDDAP Github: ERDDAP code repository https://github.com/BobSimons/erddap

Day 2:

1. **Argo float data** (provided by Ian Walsh):
- The **Keeling Curve**: a daily record of global atmospheric carbon dioxide concentration maintained by Scripps Institution of Oceanography at UC San Diego: https://keelingcurve.ucsd.edu/
- **BGC-Argo**: https://biogeochemical-argo.org/index.php
- **A BGC-Argo Guide: Planning, Deployment, Data Handling and Usage**: https://doi.org/10.3389/fmars.2019.00502
- **GO-BGC:** Data access and Visualization: https://www.go-bgc.org/data/access-and-visualization

2. **Satellite Observation** (provided by Lisan Yu & Nikolay Nezlin):
- WHOI OAFlux project: http://oaflux.whoi.edu
- Available sources of ocean color data:
  - NOAA: https://coastwatch.noaa.gov/cw/index.html
  - NASA: https://oceancolor.gsfc.nasa.gov/
  - Software for data visualization: https://www.giss.nasa.gov/tools/panoply/

Day 3:

1. **Data processing – Examples/guides** (provided by Jethan d'Hotman):
- Instrument user guides:
  - SeaBird data processing user manual: https://www.seabird.com/asset-get.download.jsa?code=251446
- Program documentation / guides
  - Argo data cookbook: http://www.argodatamgt.org/Documentation
  - Go-Ship Hydro manual: https://www.go-ship.org/HydroMan.html
- Scientific and technical reports
  - Thomson, R.E. and Emery, W.J. (2014). Data Analysis Methods in Physical Oceanography. San Diego, Ca, Usa: Elsevier Science.
- Programs and toolboxes
  - QARTOD: https://ioos.noaa.gov/project/qartod/
  - IMOS: https://github.com/aodn/imos-toolbox
- Ocean Best Practices (OBPS) Repository: Links to more than 1000 data processing documents / guides: https://search.oceanbestpractices.org/

2. **Data management** (provided by TVS Udaya Bhashkar)

(1) Data Archiving:

- Argo Global Data Assembly Centers (GDACs):
  - In Brest, France:
  - In Monterey, California, USA: https://ncei.noaa.gov/data/oceans/argo/gdac/
- Global Argo Data Repository: https://www.ncei.noaa.gov/products/global-argo-data-repository
- Registry of Research Data Repositories: https://www.re3data.org/
- Sea Scientific Open Data Publication (SEANOE): https://www.seanoe.org/

References:

- https://dataoneorg.github.io/Education/bestpractices/create-and-document.html
- https://us.norton.com/internetsecurity-how-to-the-importance-of-data-back-up.html
- https://en.wikipedia.org/wiki/Data_preservation
- Cindy Parr, Heather Henkel, DataONE (Aug 30, 2011) "Best Practice: Create and document a data backup policy". Accessed through the Data Management Skillbuilding Hub at https://dataoneorg.github.io/Education/bestpractices/create-and-document
- https://dataoneorg.github.io/Education/bp_step/preserve/
- https://dataoneorg.github.io/Education/lessons/06_protect/06_protect.pdf
- https://digitalguardian.com/blog/what-data-repository
- https://www.infotoday.com/cilmag/apr16/Uzwyshyn--Research-Data-Repositories.shtml
- https://guides.library.oregonstate.edu/research-data-services/data-management-archive-preserve
- https://www.nature.com/sdata/policies/repositories

(2) Data sharing:

- Doi: https://doi.org
- Tools for writing data paper:
  - GBIF Integrated Publishing Toolkit (IPT): https://www.gbif.org/ipt
  - NephilaPaper: https://ferramentas.sibbr.gov.br/nephila/ (Português)
  - Arpha Writing Tool: https://arpha.pensoft.net/tips/Start-amanuscript

Reference:

- https://www.library.yorku.ca/web/open/overview/data-licensing/
- https://www.cessda.eu/Training/Training-Resources/Library/Data-Management-Expert-Guide/6.-Archive-Publish/Publishing-with-CESSDAarchives/Licensing-your-data
- Creative Commons: https://creativecommons.org/
- European Data Portal Licensing Assistant: https://data.europa.eu/en/training/licensing-assistant
- https://www.doi.org/
- Piwowar HA, Day RS, Fridsma DB (2007) Sharing Detailed Research Data Is Associated with Increased Citation Rate. PLoS ONE 2(3): e308. https://doi.org/10.1371/journal.pone.0000308

3. **Ocean observation and blue economy** (provided by Nick Hardman-Mountford)

- Commonwealth Blue Charter: https://bluecharter.thecommonwealth.org/

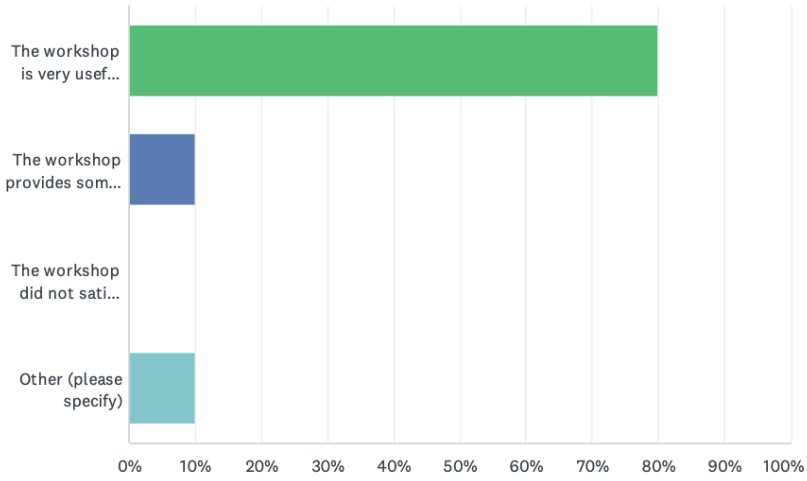
    - Commonwealth Blue Charter Training Database: https://training-bluecharter.thecommonwealth.org/
- The Global Ocean Accounts Partnership: https://www.oceanaccounts.org/
- Skylight: a product of AI2: https://www.skylight.global/
- Blue ventures: https://thecommonwealth.org/case-study
- Global Fishing Watch: Transparency for a Sustainable Ocean: https://globalfishingwatch.org/
- Allen Coral Reef Atlas: http://www.allencoralatlas.org/
- NEKTON: https://nektonmission.org/

Annex 5: Post-workshop survey analysis

Survey for the Regional Training Workshop on Observing the Coastal and Marginal Seas in the Western Indian Ocean

Q1 Your overall opinion to the workshop:

Answered: 20 Skipped: 0



ANSWER CHOICES	RESPONSES	
The workshop is very useful and I learned a lot.	80.00%	16
The workshop provides some relevant information, but not as much as I expected.	10.00%	2
The workshop did not satisfy my expectation, and I was disappointed.	0.00%	0
Other (please specify)	10.00%	2
TOTAL		20

#	OTHER (PLEASE SPECIFY)	DATE
1	The workshop was useful, we should have a collaborative research in this area pooling all the participation from the scientists from countries surrounding the western Indian Ocean, wonderful results will be obtained.	6/24/2022 3:04 PM
2	abs	6/16/2022 11:56 AM

Q2: Please rate the content of the workshop:

	STRONGLY AGREE	AGREE	HARD TO SAY	DISAGREE	STRONGLY DISAGREE	TOTAL
Topic coverage and relevance were satisfactory.	75.00% 15	25.00% 5	0.00% 0	0.00% 0	0.00% 0	20
The presentations were well prepared.	80.00% 16	20.00% 4	0.00% 0	0.00% 0	0.00% 0	20
The presentations were clearly presented.	70.00% 14	30.00% 6	0.00% 0	0.00% 0	0.00% 0	20
The content of the talks was too difficult for me.	5.00% 1	5.00% 1	20.00% 4	20.00% 4	50.00% 10	20

Participants were also asked to rate the onsite (Q5) and online (Q6) logistics of the workshop, comment on the arrangement of talks and discussion sessions (Q3), the most interesting/useful thing they have learnt during the workshop (Q10).

For online participants, 76.92% attended more than half of the workshop. The main factors that prevented the online participants to attend the workshop are: other work commitments and time zone issue (Q7&8).

Over 60 percent respondents would like to have in-person trainings in the future (Q9).

Several topics have been identified for the future trainings (Q11)

#	RESPONSES	DATE
1	How to develop and formalize regional partnerships and projects. Modes and resources for developing funding for resources and projects in the region, including where regional governments have interest in supporting efforts (e.g. regional university partnerships, access to infrastructure, etc.)	7/10/2022 8:05 PM
2	Local engagement i.e science outreach	7/4/2022 7:39 AM
3	Practical sessions on data acquisition and analysis.	7/1/2022 9:12 PM
4	More involvement of potential end-users and discussion of the specific needs and interests of WIO nations, with case studies. It would have been good to map these needs/interests against international objectives for coastal and open-ocean observing systems.	6/30/2022 3:36 PM
5	cyclones, typhoons, dust storms in arid regions	6/30/2022 3:02 PM
6	- How to envolve grassroots communities to the scientific topics? - How to expand and reach all stakeholders in the Marine environment and topics to be more atractive in the society?	6/29/2022 10:32 PM
7	I would like to propose to have some funding to support for doing a collaborative basic research in the western Indian Ocean. All participating countries then work together on a common platform, have intercalibration etc, this will further help in collaboration and scientific interaction in the long run.	6/24/2022 3:12 PM
8	the new method of survey and the new sources of marine data available	6/23/2022 6:43 PM
9	Ocean and marine data management	6/23/2022 3:03 AM
10	A ship cruise that involves some ocean observations and onboard training.	6/22/2022 7:48 PM
11	Infrastructure installation	6/22/2022 7:14 PM
12	Marine Robotic vehicle - Monitory - Processed technician	6/22/2022 6:20 PM
13	Marine data observation for Mozambique channel.	6/22/2022 4:50 PM
14	Prove a concrete example how to analise the data	6/22/2022 3:49 PM
15	Basic modeling, time-series statistics and remote sensing product analyses (freely available)	6/22/2022 3:00 PM
16	Ocean mapping applications on physical oceanography	6/22/2022 2:23 PM

The full post workshop survey results can be found in the link below
https://drive.google.com/drive/folders/1MR4YfuJK69qRGEC6H6yFOCeFm7KqUfmJ