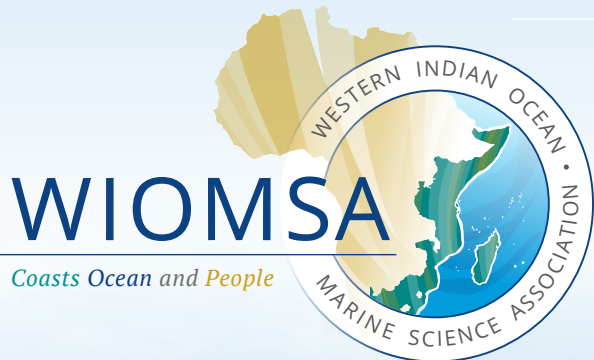


APRIL 2022

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NEWS BRIEF



Surface interval after the first advanced open water dive.

WHAT'S INSIDE?

■ WIOMSA & PARTNERS NEWS

- 2 Mombasa unveils its Climate Change Policy and Adaptation Planning
- 4 SIDA-WIOMSA annual review held in Zanzibar
- 5 WIOMSA's Board of Trustees meets with MASMA's external evaluators
- 5 WIOMSA at the Conference of Sea and the City
- 6 Zanzibar President tours WIOMSA Pavilion at NGO Forum

■ PROGRAMMES: MASMA & CITIES AND COASTS

- 7 Addressing environmental sustainability issues will require a transformation in decision-making
- 8 A real need for plastics education
- 9 Freshwater eels a little-known resource

■ HIGHLIGHTS FROM RECENTLY PUBLISHED PAPERS

- 13 Underwater imagery increases understanding of benthic biodiversity
- 14 Black corals under threat, but studies show hope
- 17 Marine bacteria could prove to be an excellent frontier in the search for new antibiotics to counter antibiotic resistance
- 19 Coastal communities' responses to climate change and variability impacts: a threat to coastal and marine resources?
- 21 Dynamics and fate of blue carbon in a mangrove-seagrass seascape: influence of landscape configuration and land-use change

■ REGIONAL NEWS

- 23 Building Socio-Ecological Resilience through Ocean Protection in the Comoros
- 26 The next generation of coastal and marine custodians in Seychelles
- 28 Seychelles Parks and Gardens Authority Launches New Strategic Plan for 2022-2026
- 29 An assessment of marine protected areas in Tanzania
- 31 Towards Sustainable Port Development in the Western Indian Ocean region
- 32 Protecting Pemba: Improving fisheries management in a marine conservation area in Zanzibar
- 34 Economic benefits of transboundary protection in Tanzania and Kenya

■ NETWORKS: WiMS, WIO-ECSN

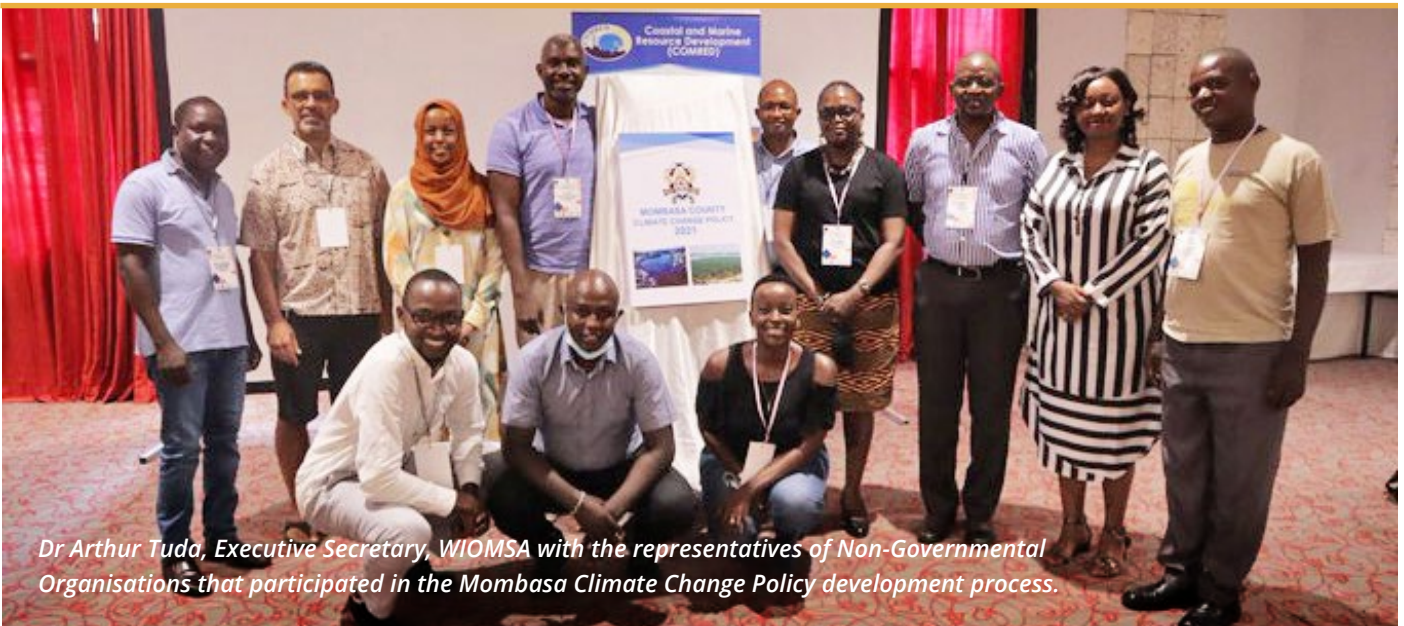
- 36 WiMS: Women marine scientists share their stories to mark International Women's Day
- 39 News from the WIO-Early Career Scientists' Network:
- 39 • INTO THE DEEP: Kenyan and Tanzanian marine scientists experience the NEWF Dive & Story Labs
- 42 • WIO-ECSN at the Marine Litter training

■ NEW PUBLICATIONS

- 44 Reports on the status of marine litter in WIO
- 45 Litter catch up
- 46 Blue Economy publications, WIOJMS

MOMBASA UNVEILS ITS CLIMATE CHANGE POLICY AND ADAPTATION PLANNING | *By Innocent Wanyonyi*

Recognising the work needed to achieve a safe and resilient environment in the face of a changing climate, the Mombasa County Government in Kenya has published the County Government of Mombasa Climate Change and Adaptation Policy 2021, as well as the Climate and Ocean Risk Vulnerability Index (CORVI) report.



Dr Arthur Tuda, Executive Secretary, WIOMSA with the representatives of Non-Governmental Organisations that participated in the Mombasa Climate Change Policy development process.

WIOMSA supported the Miji Bora project to host a workshop on 28 and 29 January that formally launched and disseminated the just-published policy and report.

Mombasa County will contribute to the realization of Kenya's nationally determined contributions (NDC) targets by implementing adaptation and mitigation actions that build climate resilience and reduce emissions.

The County has experienced its share of climatic effects, ranging from floods, storm surges, droughts, increased temperatures and increased incidences of communicable diseases. The related social implications have caused displacement, loss of life and livelihoods and had economic implications such as damage to infrastructure and productive assets.

Increasing environmental concern and awareness, technological development and urbanization have intensified the need and urgency to rethink the structure and management of our cities. The likely impacts of climate change are particularly disconcerting given that many coastal cities have developed without consideration of the risks which climate change will trigger.

These are compelling reasons to position Western Indian Ocean (WIO) cities for sustainable growth and ensure a framework is in place that will facilitate engagement of the different stakeholders in supporting local climate action. **It is everyone's responsibility – urban researchers, city planners, academics, and other stakeholders – to embark on transitioning these cities into environmentally sustainable, economically productive and socially inclusive entities.**

Workshop designed to leverage outcomes of Miji Bora project activities

The WIOMSA-supported workshop in January created awareness about climate change policies, the need and process of their development, and the structure, provisions and links to national and global priorities. The workshop also initiated a process to develop the County Climate Change and Adaptation Plan and involved stakeholders in agreeing to the actions to be taken.

The workshop was designed to leverage outcomes of prior Miji Bora project activities, including:

A situational assessment of relevant drivers, including Greenhouse Gas (GHG) in the transport sector; plastic sector dialogue; the “Climathon Hackathon” and the Mombasa Future Scenarios workshops; peer-to-peer exchange; the stakeholders’ engagement process; institutional frameworks (such as the Mombasa Smart City Forum); and the CORVI assessment 2021 for Mombasa, among others.

Action plans including mainstreaming climate change as a cross-cutting activity in County Integrated Development Planning process, establishing a disaster fund, and allocating more funds in the annual budget to access sector needs. The meeting also proposed that the County develops a climate-proof and resilient infrastructure and addresses the impact of climate on health.



What is the County Government of Mombasa Climate Change and Adaptation Policy 2021?



The policy is a framework for local climate action by different stakeholders who identify climate actions in the County. It will require participation from the national government sector ministries and state departments, County

Government, the youth, women, vulnerable groups, persons with disabilities, non-governmental organizations, civil society and the private sector. It will also require the participation of community members who are fishers or those involved in activities such as mangrove farming.

The policy provides a guide for more sustainable and resilient institutions and communities in the face of climate change, as well as the reduction of carbon emissions through the adoption of appropriate technologies founded on sound research.

It endeavours to map out priority actions at sectoral levels that will transform Mombasa into a low-carbon economy by developing a long-term County Low Carbon Development Strategy. The policy outlines responses the County government will put in place over the next five years to address the challenges identified across sectors, including the implementation framework and monitoring and evaluation plan.

The aim is to integrate climate change into County development and sectoral planning, and decision-making processes so that climate change adaptation and poverty reduction are implemented together.

SIDA-WIOMSA ANNUAL REVIEW HELD IN ZANZIBAR



The Government of Sweden, represented by the Swedish International Development Agency (SIDA) and WIOMSA met from 16 to 17 March to assess progress with the implementation of the Marine and Coastal Science for Management (MASMA) programme and the Cities and Coasts project.

Also discussed were the audit and financial performance of the Association in 2021, the work plan for 2022, as well as the process for the preparation of a new agreement between WIOMSA and SIDA.

The meeting was attended by Claes Kjellström, Senior Policy Specialist of Research (SIDA) and members of the WIOMSA Secretariat led by

Arthur Tuda, Executive Secretary. Also present for part of the discussions was an audit team from PriceWaterhouseCoopers.

A virtual audience of external evaluators currently conducting an evaluation of the MASMA Phase V programme also joined the meeting. Their findings and recommendations will serve as an input to both SIDA and WIOMSA when discussing possible continued support to MASMA.

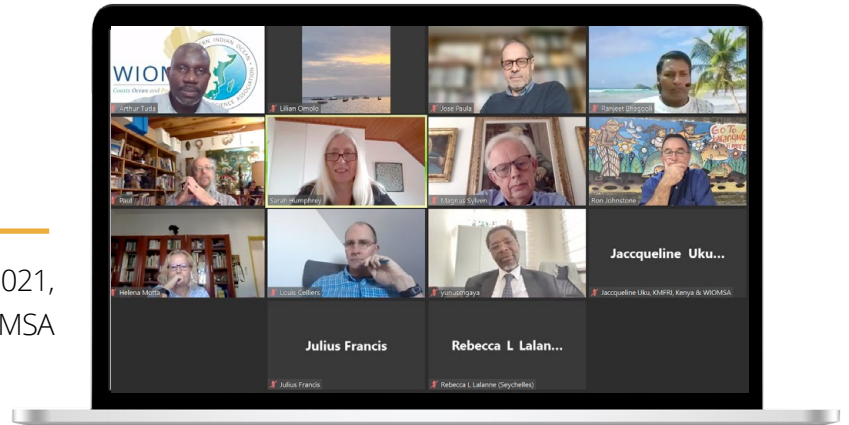
WIOMSA'S BOARD OF TRUSTEES MEETS WITH MASMA'S EXTERNAL EVALUATORS

The first session of the 43rd WIOMSA Meeting of the Board of Trustees took place virtually on March 10, 2021. The MASMA external evaluation was one of the main agenda items.

The external evaluation began in December 2021, and evaluators have met with various WIOMSA stakeholders, partners, and members.

The evaluation considers:

- **Sida's 30 years of assistance** for marine science in the Western Indian Ocean region, as well as the WIOMSA MASMA programme
- **The performance of the MASMA Programme** and the Cities and Coasts project under the current funding phase



The evaluators met with the Board at the 43rd Board meeting to report on the evaluation's progress and to solicit comments and feedback from the Board. The draft report is expected to be completed in April 2022 for the Board to consider further before the final report is produced.

WIOMSA AT THE CONFERENCE OF SEA AND THE CITY

On March 25, 2022, WIOMSA participated in a conference with the theme "Sea and the City: Pathways for Coastal Resilience" in Monaco.

The conference brought together experts to discuss what is at risk in the coastal zone, propose tools for measuring vulnerabilities, and advocate solutions, with a special emphasis on nature-based solutions as a no-regrets option. The conference was convened under the presidency of HSH Prince Albert II of Monaco and organized by the Prince Albert II of Monaco Foundation in collaboration with the Stimson Center and the Ocean & Climate Platform.

WIOMSA, in collaboration with the Stimson Center, published a report on "**Measuring Multidimensional Climate Risks in East Africa's Coastal Cities**" in November 2021, including case studies in Dar es Salaam, Tanzania, and Mombasa, Kenya. The report was also launched at COP 26 in Glasgow Scotland on the 3rd of November 2021. The report provides a detailed assessment of how climate change is



impacting East Africa's coastal cities, with studies in Dar es Salaam and Mombasa. During the Sea and the City conference, WIOMSA highlighted the report's results as well as the Association's involvement in promoting research on coastal vulnerabilities in the Western Indian Ocean region.

The recommendations from the conference are useful for governments, industry, and civil society to inform improved decision making and take collective action to protect and enhance the resilience of coastal and marine ecosystems to climate change to benefit societies and economies around the world.

ZANZIBAR PRESIDENT VISITS WIOMSA PAVILION AT NGO FORUM



The President of Zanzibar, His Excellency Dr Hussein Mwinyi, has lauded the efforts of WIOMSA in supporting the government’s initiatives in the Blue Economy sector.

Dr Mwinyi was visiting the WIOMSA pavilion at the first-ever Zanzibar Annual Non-Governmental Organizations Forum (ZANGOF) in Zanzibar from 12 to 14 March. He praised the efforts of WIOMSA, particularly for offering technical and financial support in the production of a scoping study on Blue Economy opportunities in Zanzibar. The study findings will be released in a report in April 2022. At the WIOMSA pavilion, the president learned

about the different programmes that WIOMSA is implementing in mainland Tanzania and Zanzibar and the WIO region at large.

He also presided over the opening of the three-day forum, commending civil society organizations (CSOs) and non-governmental organizations (NGOs) in the country for their enormous support in the execution of various programmes, urging them to be more creative in soliciting for funds.

“ I appreciate your support in education, health, democracy, human rights, and promoting peace. I call on development partners to continue supporting the CSOs and NGOs,” Dr Mwinyi said in his speech.

ADDRESSING ENVIRONMENTAL SUSTAINABILITY ISSUES WILL REQUIRE A TRANSFORMATION IN DECISION-MAKING | *By Danai Tembo*



The Anthropocene has magnified an array of environmental sustainability issues, ranging from climate change to biodiversity loss. Addressing these issues will require a transformation in how society makes decisions.

Dialogue between policy makers and scientists at a past Nairobi Convention Conference of Parties.
© Nairobi Convention

Through the Science to Policy project, led by Associate Professor Peter Davies and Dr Maina Mbui from Macquarie University in Sydney, Australia, and funded by WIOMSA, the first virtual Science to Policy workshop was held from 22 to 24 February. Twenty-seven participants (15 women and 12 men) from eight countries across the Western Indian Ocean (WIO) attended, ranging from experienced to early career researchers, those working in and for government agencies, and from non-governmental organisations.

The science-policy interface is the critical link connecting researchers to decision-makers. Bridging the science-to-policy nexus is complex and requires new communication skills, an understanding of the policy process, and

consideration of who may be influenced by research across multiple places and timeframes.

To navigate the science-to-policy interface, scientists must orientate their research towards the challenges of the Anthropocene and in doing so, keep policy transition as their goal.

Participants at the workshop were provided with an opportunity to explore and discuss the theoretical and practical aspects of the science-to-policy interface and how this can reshape their research. The outcomes are intended to increase the skills and capacities of participants and in particular, influence the way in which research can improve WIOMSA's impact on coastal and marine resource governance in the WIO region.

In response to an overwhelming 107 expressions of interest in the workshop, a second workshop will be held later in the year. Dates are yet to be set, so watch this space.

A REAL NEED FOR PLASTICS EDUCATION

| By Tony Ribbink and Samantha Sykes



The African Marine Waste Network (AMWN) and WIOMSA hosted a short online course in January this year on plastic waste management and the broader issues related to plastics, to promote a fuller understanding of plastic throughout its value chain.

The course covered plastics manufacture, marketing, packaging and distribution, waste management and recycling, and the economics of plastics. The course included the requirements for data baselines and trends upon which to build management strategies.

Very few people in Africa, including those in the western Indian Ocean (WIO) region, are trained to understand the full spectrum of plastics from the beginning to the end of its life. Instead, they merely have a fair idea of what they need to know specifically to achieve their day-to-day goals.

To address the urgent need to effectively manage plastics, the AMWN and WIOMSA ran a short online course to educate people on various aspects relating to plastics

A quick survey by the AMWN, a Sustainable Seas Trust (SST) programme, confirmed that plastic waste management and its broader issues are taught in very few universities and are not part of the school curricula of most countries.

Interviews with people in almost all WIO countries revealed a need to promote a fuller understanding of plastics throughout its value chain.

Course was well attended

The course was advertised on the WIOMSA and SST websites, but not marketed, and the organizers were pleasantly surprised when 370 people from 26 countries (17 from Africa) registered. Although the course was aimed at WIOMSA countries, it was not restricted to this region. Unfortunately, the timing of the course clashed with some work schedules so that only 222 people could attend via Zoom.

Responses from the attendees about the course and their interactions with course managers, were positive. Participants who attended have online access to all the slides for the presentations, the coursework and the interactive sessions. Those who were able to attend most of the course sessions were issued certificates, provided they also managed to complete the interactive assessments.

This preliminary course also tested future interest and evaluated the need for this training. It was agreed that there is considerable interest and a

real need, and that the course should be expanded in future to include both general courses and more focused courses.

The general courses will cover the entire value chain for those who need a full overview of plastics. The more focused courses will be aimed at those who wish to have greater insight into specific aspects of plastics, from the upstream and midstream components of the value chain, to the management and recycling of plastic waste in the downstream sections.

In-person training is clearly the best way forward, as people are better able to focus on the course and the benefits of linking theory with practical work and their hands-on learning.

If online courses are held, it is recommended that they should be shorter; weekly for three hours a day instead of six hours a day, as this will allow people to accommodate the course within their busy work schedules. These recommendations are being followed as we plan the next courses.



Recycling: key rings made from injection molded marine plastic. © Watamu Marine Trust

FRESHWATER EELS: A LITTLE KNOWN RESOURCE

| By Charles Kihia

Straddling upriver catchments to mid-ocean plateaus at interludes of their life cycle, the freshwater eel's fate is interlinked with human existence. Globally, eels are vulnerable to habitat modification, overexploitation and climate change, among other things, precipitating widespread collapse of populations.



Multi-sectorial interventions involving marine spawning area protection through regional and international instruments; riverine habitat restoration and management; regulation of river resource harvesting; management of exotic species and reduction and treatment of terrestrial effluents is required to protect this little known resource.

WIO region harbours four eel species

Despite subsistence consumption being commonplace among river communities worldwide, commercial eel exploitation and export is dominated by Southeast Asia. The western Indian Ocean (WIO) region harbours four eel species, one of which is endemic, while three are near threatened.

WIO eels begin life as leaf-like leptocephali hatchlings, probably in the Mascarene archipelago. The natal Mascarene plateau extends over 115 000 km² of shallow water from the Seychelles to Mauritius, Reunion and Rodrigues, in addition to several small volcanic islands over 1 500 km east of Madagascar.

The non-feeding, *pelagic leptocephali* are borne by westward flowing WIO currents, landing on WIO continental landmass over several months. Consequently, climate change induced ocean circulation might affect river recruitment.

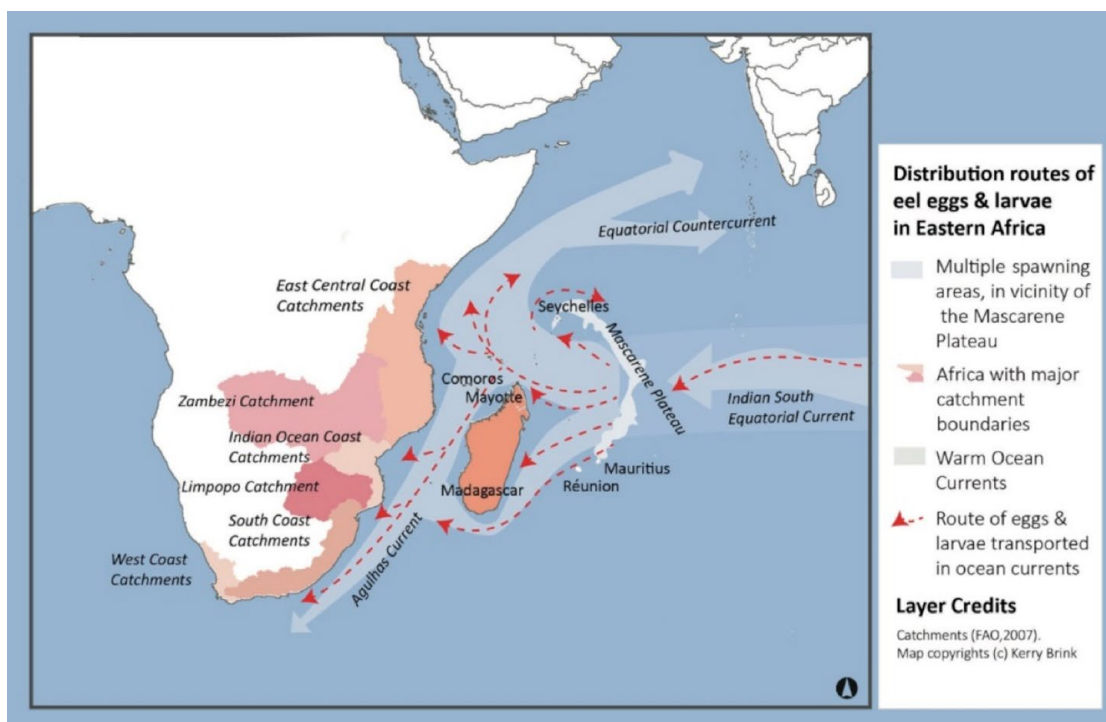


Figure 1: The WIO region and the distribution route of eggs and larvae (from Hanzen et al., 2020)

Once on land, the *leptocephali* transform into slender transparent glass eels, which will inhabit river mouths over the next couple of months.

Glass eels then change into pigmented elvers and penetrate the river mouths to begin their riverine phase. Remarkably, both glass eels and elvers have been observed several hundred kilometres upstream, having surmounted considerable barriers such as massive dams (for example, Kariba Dam) and rapids (for example, Howick Falls).

Upstream, elvers transform into voraciously feeding yellow sub-adults. These long-lived territorial yellow eels are apex river predators, with a diet of fish, shrimp and insects, among others, competing with indigenous and introduced catfish.

On maturation, they convert into non-feeding silver eels, only distinguished from yellow eels by enlarged eyes and a silvery belly, reaching over 3 kg and with vast lipid stores. The silver eels begin their oceanic migration back to their natal spawning ground, during which sexual maturity is completed, with females larger than males. Mating is yet to be observed but is thought to occur in the ocean.



Figure 2: Eel life stages

a) Glass eel, b) elver, c) yellow eel and c) Silver eel

Eels are often a community delicacy and have socio-cultural significance

The WIO eel fishery commonly involves hook, nets and traditional traps, frequently without a vessel or other sophisticated gears. WIO eels are often a community delicacy, and any surplus supports the local economy.

River communities also attach socio-cultural significance to eels. In some areas the eels signify doom, undoubtedly due to their snakelike appearance, slippery nature and ability to crawl overland, and may not be consumed by certain genders.

Some people believe the eels are omens of rain and enhance potency. In Kenya, eel knowledge among fisher communities is substantial, with adult mottled (gwara) and non-mottled (nyono), being very familiar. However, knowledge about the complete life cycle remains sparse, especially among river resource managers. In many WIO states, exploitation data is inadequate, with weak governing legislation.

River modification and effluent

The WIO eel fishery commonly involves hook, nets and traditional traps, frequently without a vessel or other sophisticated gears. WIO eels are often a community delicacy, and any surplus supports the local economy.

WIO river modification through damming, water abstraction, sand harvesting and riparian vegetation encroachment is commonplace. Raw domestic, agricultural and industrial effluent flow into the rivers, making them rich in toxic chemicals and heavy metals. Eels are tainted through direct toxin absorption and contaminated prey.



Figure 3: River fisheries a) hook fishers at Kiaone Athi River, b) net fishers at Sabaki, c) malema fish trap and d) fish displayed for sale

In contrast to other fish with repeated egg shedding reproductive events, the eel's single reproductive effort after a long maturation, coupled with distance migration, enhance exposure to stored contaminated reserves.

The eel project [Slippery resource in peril: Ecology of Western Indian Ocean Anguillid eels and their contribution to sustainable fisheries and livelihood along the East Coast of Africa](#) is funded by WIOMSA through the MASMA project.



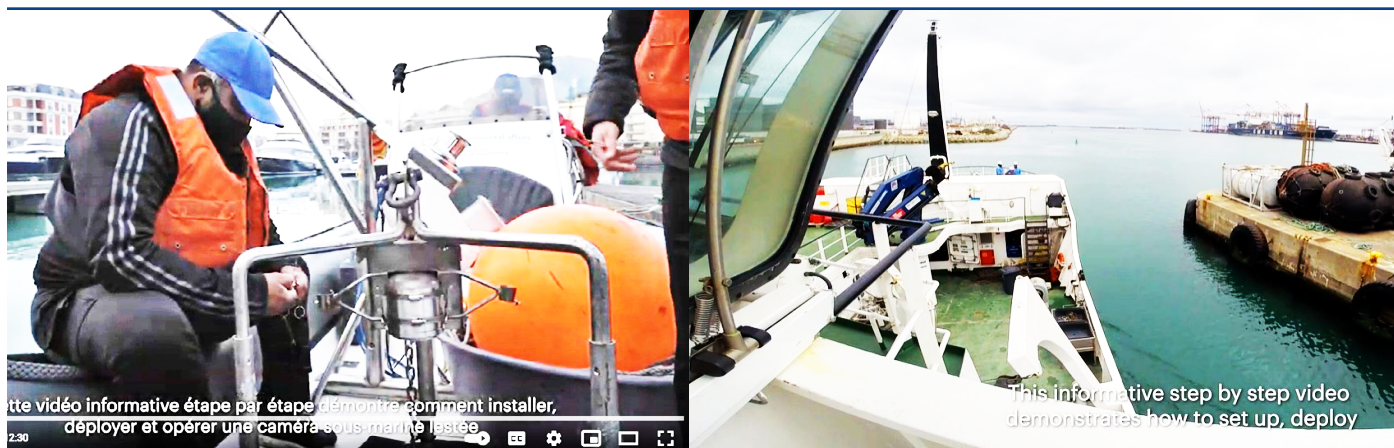
Figure 4: Habitat modification a) barrier bridge at Kiaone, b) Baricho bridge under construction, c) barrier and d) bridge construction at stony Athi, Athi River, Kenya



Figure 5: Resource abstraction a) water pumps at Kiaone, b) Baricho waterworks, c) car-washing at Kiaone, d) Horticulture and sand harvesting boat at Kiaone, Athi River, Kenya

UNDERWATER IMAGERY INCREASES UNDERSTANDING OF BENTHIC BIODIVERSITY | *By Tanya Haupt*

Outcomes from the WIO Regional Benthic Imagery Workshop



Step-by step training videos of various camera systems were produced for the benthic imagery workshop

Originating from the Second International Indian Ocean Expedition (IIOE-2), the Western Indian Ocean (WIO) Regional Benthic Imagery workshop, held from 30 August to 3 September 2021, provided training on how to use underwater imagery to better understand benthic invertebrate communities and associated fish assemblages.

Underwater camera systems such as drop or towed cameras, baited remote underwater videos (BRUVs) and remotely operated vehicles (ROVs), have increased our understanding of benthic biodiversity by enabling the collection of data from shallow and deep habitats.

Imagery evaluations are an important research tool used by scientists and industry, and the non-destructive nature of these techniques allows for use in protected areas.

The workshop was funded by WIOMSA's Marine and Coastal Science for Management (MASMA) programme and hosted by the South African Department of Forestry, Fisheries and the Environment (DFFE). Initially planned as a physical workshop, the week-long event was eventually held via Zoom because of the global COVID-19 pandemic. This allowed for international attendance with a far

greater audience than anticipated prior to COVID-19 (266 participants versus 20).

Sessions covered all the steps required to conduct underwater imagery; from survey design, data collection, annotation techniques, imagery analyses and BRUVs, to good data management practices.

A discussion session covered best practice for regional-scale habitat classification, data challenges to overcome these barriers, and developing collaboration and infrastructure. Recordings of all the workshop sessions, as well as step-by step training videos of various camera systems can be found [here](#)

It is important to build on the momentum established through this workshop, while continuing to form and strengthen partnerships. The lack of resources and infrastructure required to use underwater imagery is an opportunity to promote collaboration and innovation within the region.

For more information, visit [“The WIO Regional Benthic Imagery Workshop: Lessons from past IIOE-2 expeditions”](#) Research Ideas and Outcomes. [doi: 10.3897/rio.8.e81563](https://doi.org/10.3897/rio.8.e81563)

BLACK CORALS UNDER THREAT, BUT STUDIES SHOW HOPE | *By Gildas Todinanahary and Gilles Lepoint*

A black coral bed near the Great Reef of Toliara, Madagascar

The results of two research studies on black corals in the western Indian Ocean (WIO) region are encouraging and can be used to broaden knowledge on the biology of black corals. This would allow for alternatives to the wild exploitation of these protected animals and would also provide valuable information for decision-makers to determine and implement adapted management strategies for black corals and their habitats.

***Antipatharians*, also known as black corals, are colonial organisms found worldwide, from tropical to polar latitudes and from shallow waters to abyssal depths. There are 247 described species.**

For a very long time, especially in the tropical regions, black corals have been used as money, for medicinal purposes and for making jewellery. Except in Hawaii where these fisheries are well known, black coral harvests are usually made without clear management strategies, and this is especially true in the western Indian Ocean region.

To date, the east coast of Africa and islands of the Indian Ocean are amongst the least controlled regions involving black coral trade. In Madagascar, illegal harvests have increased since 2011, despite a ministerial decree since 2014 which prohibits

any form of exploitation. The fisheries department continues to arrest divers collecting black corals from Madagascar's deep south. **The last arrest was in October 2021, with 38 kg of black coral skeletons and dozens of diving rigs seized.**

Recent research undertaken by the Fishery and Marine Science Institute of Toliara and its Belgian partners, have highlighted the consequences of this illegal trade. Some black coral species are already on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, but because of a lack of knowledge for the WIO region, it is impossible to establish an evidence-based conservation policy and therefore, no *Antipatharia* is presently on the Red List of the International Union for Conservation of Nature.

Conservation and Biology of Black Corals project

The two research papers reported on in this article are the results of the Conservation and Biology of Black Corals (COBICO) project (2018 to 2022), funded by the National Fund of Scientific Research (Belgium) and the Fishery and Marine Science Institute of Toliara. The first is on the mechanical properties of four black coral species found along a shallow area of Toliara Great Reef and a first in situ cultivation study of *Cirripathes anguina*.

Dugauquier et al. (2021) measured the modulus of elasticity in tension or compression and the flexural stiffness of both branched and whip-shaped antipatharians living under similar environmental conditions. The study was performed on 12 colonies of four black coral species (whip corals *Cirripathes anguina* and *Stichopathes cf. maldivensis*,

and the branched corals *Cupressopathes abies* and *Cupressopathes cf. pumila*) collected at two sites on the Great Reef of Toliara.

The four species did not present significantly different Young's modulus, but the elasticity was higher in the distal segment of colonies, compared with the basal and median segments. By contrast, the flexural stiffness was significantly higher in whip species compared with branched ones. In the whip species, flexural stiffness was also higher in the basal segment compared with the other two segments.

These results, especially the flexural stiffness, suggest that the different morphologies of the species correspond to their contrasted feeding strategies in a similar strong current environment.

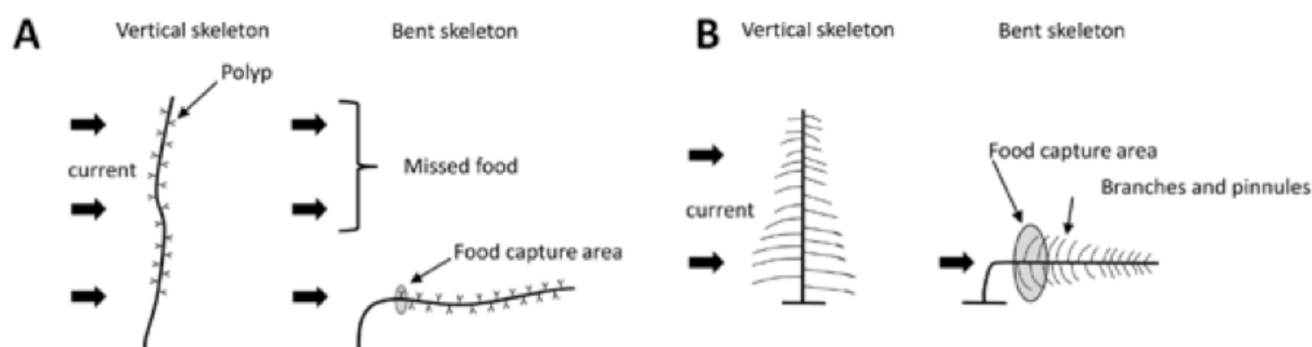


Figure 1. Diagrams of food capture by colonies of antipatharians with different morphologies. A. In whip corals, food capture is reduced when the skeleton bends under the current. In a vertical position, the skeleton maintains all the polyps in an optimized feeding position. B. In branched corals, there is less reduction of food capture when the skeleton bends under the current. The food capture area remains functional because of the polyps on the branches and pinnules. Source: modified from Dugauquier et al., 2021.

The feasibility of transplanting whip black corals

In May 2019, Godefroid et al., performed experimental research on working underwater with black coral nubbins of the *Cirripathes anguina* species from the Great Reef of Toliara. **The aim of the experiment was to test the feasibility of transplanting the whip black corals at two sites with distinct environmental conditions:** North Pass (NP, 23 m depth) and Grande Vasque

(GV, 13 m depth). Apart from depth (and light, accordingly), current regimes also differ. The NP is well exposed to the waves and current generated by the dominant south wind, while the GV is a basin of approximately 1.5 km in length and 300 m width situated in the flat of the reef and well protected from the swell.

A total of 56 fragments from four colonies collected at 23 m depth (from NP) were transplanted at the two sites:

28 fragments each at NP and GV. Each fragment was attached to one iron barred table per site, with special care taken to keep the nubbins in their original direction, i.e. with the apical part directed upwards. Every month, photographs of every fragment were taken, and the length of the growing part (skeleton covered by tissues) was measured in millimetres using the software, ImageJ.

Results show a successful transplantation in both sites with zero mortality (except in the form of missing fragments) and a certain growth over 200 days. Maximum growth rates were 3.4 cm per month and 2.0 cm per month in the North Pass and in the Grande Vasque, respectively.

In addition, mean time to total healing was delayed in the Grande Vasque by ten days compared to the transplants in the North Pass. Differences between sites are likely to be related to differences in environmental parameters.

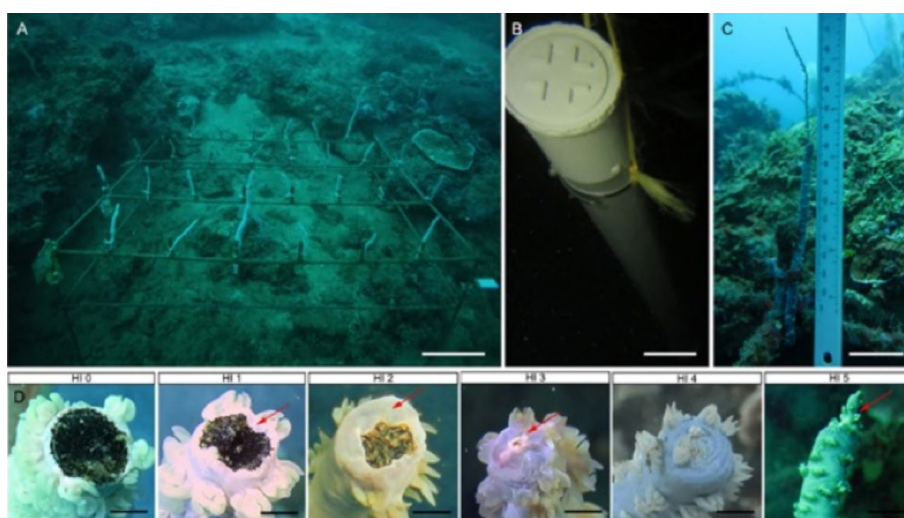


Figure 2. A, the table used with fragments of colonies attached (Scale: 15 cm); B, the PVC pipes used to transport entire colonies (Scale: 5 cm); C, a growing fragment attached with a plastic tie to the table (Scale: 3 cm); and D, the Healing Index used, represented by photographs of the apical portions of the nubbins (Scale: 500 μ m). HI 0 corresponds to a clear section with the skeleton fully exposed; HI 1 is for nubbins with a peripheral bulge of healed tissues (red arrow); HI 2 is for nubbins which have tissues growing over the skeleton (red arrow); HI 3 represents an almost fully overgrown section with the possible development of an apical polyp (red arrow); HI 4 represents nubbins totally recovered but with no sign of growth; and HI 5 represents nubbins having a vertically growing apical part (red arrow). Source: Modified from Godefroid et al., 2021.

The promising results obtained with the easy protocol used in this study encourage the use of black coral transplants in further experiments and restoration projects.



READ THE FULL PAPER:

Dugauquier, J.M., Godefroid, M., M'Zoudi, S., Terrana, L., Todinanahary, G., Eeckhaut, I. & Dubois, P. 2021. Ecomechanics of black corals (Cnidaria: Anthozoa: Hexacorallia: Antipatharia): A comparative approach. *Invertebrate Biology*, e12347.

[Available Here](#)

Godefroid, M., Todinanahary, G.G.B., Dubois, P., Eeckhaut, I., Lepoint, G., Terrana, L. 2021. Perspectives on working underwater with black coral nubbins (Cnidaria: Antipatharia): the case of *Cirrihipathes anguina* (Dana, 1846). *Journal of Experimental Marine Biology and Ecology*, 545: 151645.

[Available Here](#)

MARINE BACTERIA COULD PROVE TO BE AN EXCELLENT FRONTIER IN THE SEARCH FOR NEW ANTIBIOTICS TO COUNTER ANTIBIOTIC RESISTANCE

| By Thomas Dzeha



The study highlights the fact that marine cyanobacterium *Moorea producens* are an overlooked source of antimicrobial compounds that are proving to be an excellent frontier in the search for new antibiotics with which to counter antibiotic resistance.

As the ocean of the WIO region is endowed with a rich biological diversity, it is highly probable that it shall in future produce new drug chemical entities for both human and animal use. The study “Micrococcin P1 and P2 from Epibiotic Bacteria Associated with Isolates of *Moorea producens* from Kenya”, explored the marine cyanobacterium *Moorea producens* from Kenya as a source of bacteria with which to produce cyclodepsipeptides, and for the discovery of new antibiotics with which to fight infectious diseases.

Currently, the major source of bacteria for isolation of antibiotics is soils. During the study, bacteria were isolated from both the sheath and filaments of the cyanobacteria. Interestingly, most bacteria isolated from *Moorea producens*’ filaments were found to be human pathogens.



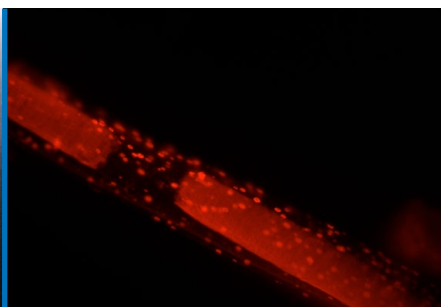
Laboratory preparation of a *Bacillus marisflavi* culture broth in media 5294 for antibiotics isolation

The science behind the discovery

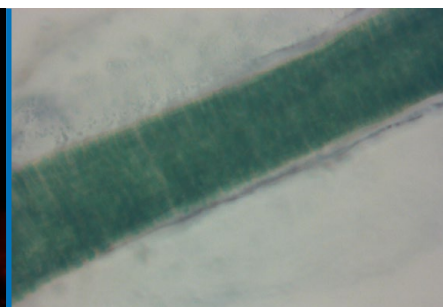
Organic extracts of the epibiotic bacteria *Pseudoalteromonas carageenovora* and *Ochrobactrum anthropi* isolated from the filaments did not produce cyclodepsipeptides. The filaments were stacked with stalked diatoms, suggesting a possible terrestrial origin of some epibionts. This is the most comprehensive work that looks at marine bacteria-cyanobacteria associations and going ahead to find antibiotics in Firmicutes of the association. *Moorea producens* has since been renamed Moorena.



A plate showing colonies of a strain of *Bacillus marisflavi* from which the thiopeptide antibiotics micrococcin P1 and P2 were isolated



Bacteria on the surface of a live *Moorea producens* filament stained with acridine orange.



Undyed natural filament as observed under a microscope.

The first task in the study was to authenticate the identity of the cyanobacteria with genomic DNA tools and the natural products that it produces.

Previously, the cyanobacterium was identified by morphological appearance. Besides morphological appearance, the study detected the natural products homodolastatin 16 (m/z $[M + Na]^+ C_{48}H_{72}O_{10}N_6Na$ [calcd. 915.5202]), dolastatin 16 ($[M + Na]^+ C_{47}H_{70}O_{10}N_6Na$ [calcd. 901.5046]), and antanapeptin A ($C_{41}H_{60}O_8N_4$ [calcd. 759.4314]) known to be associated with the Kenyan *M. producens*.

The dolastatins are a group of *antineoplastic pseudopeptides* initially isolated from the sea hare *Dolabela auricularia* but which originate from the marine cyanobacterium *Moorea producens* distributed pan-tropically worldwide.

As *M. producens* is non-axenic the study also reports a novel method for the gDNA isolation of non-axenic filamentous marine cyanobacteria. It is based on the treatment of cyanobacterial biomass with $CuSO_4 \cdot 5H_2O$ prior to exhaustive differential isolation of bacterial gDNA from the cyanobacterial biomass to provide a residual substrate for isolation of the cyanobacteria gDNA. $CuSO_4 \cdot 5H_2O$ provides the Cu^{2+} ions needed for the contact killing of bacteria on the cyanobacteria biomass during treatment.

This novel method that was used to confirm the identity of *L. majuscula* CCAP 1446/4 from the Culture Collection in Oban, Scotland, unambiguously delineated the Kenyan *M. producens* from other species elsewhere. Bacteria associated with *M. producens*, including those associated with the filaments of *M. producens*, are described. **The study also highlights the first isolation of the antibiotics micrococcin P1 (1) and micrococcin P2 (2) from organic extracts of *B. marisflavi* and establishes an IC_{50} value of micrococcin P1 (1) against *Staphylococcus aureus*.**

The study and publication of the paper were funded by Marie Skłodowska Curie IIF, the Organisation for the prohibition of chemical weapons and WIOMSA .



READ THE FULL PAPER:

Dzaha, T.; Hall, M.J.; Burgess, J.G. Micrococcin P1 and P2 from Epibiotic Bacteria Associated with Isolates of *Moorea producens* from Kenya. *Marine Drugs* 2022, 20, 128. <https://doi.org/10.3390/md20020128>

[Available Here](#)

COASTAL COMMUNITIES' RESPONSES TO CLIMATE CHANGE AND VARIABILITY IMPACTS: A THREAT TO COASTAL AND MARINE RESOURCES?

| By Alex Peter Rubekie, Noah Pauline and Lulu Kaaya



Climate change is real and has had a significant impact on the livelihood activities of the coastal communities of Tanzania.

Crop failure, livestock mortality and declining fish catches are just some of the effects. Coastal communities have resorted to various responses to try to address these effects.

However, little attention has been paid to the effects of autonomous, anticipatory or reactive adaptation strategies in practice on coastal and marine resources, which is a gap this paper addresses.

A total of 150 respondents were randomly selected from village households for the survey. Purposive sampling procedures were used to identify key informants, individuals for focus group discussions and selection of the study area.

Coping and adaptation strategies

Findings of the study revealed various coping and adaptation strategies used by the community as a response to climate change and variability impacts. These strategies were found to vary from one household to another, and depended on the livelihood activities of the household; similarly reported by Yangaza and Nyomora (2017) and Kikwale (2018).

Livelihood diversification and dynamics were two dissimilar adaptation strategies



Sea level rise caused salt intrusion in water wells

identified, where the former meant engagement of individuals in various livelihood activities to spread risks, and the latter going beyond this to where individuals stop engaging former livelihood activities and completely shift to another type of livelihood activity.

For example, response strategies used by farmers in Kondo village included growing drought-resistant and early maturing crops, making charcoal and soliciting aid from neighbours; as was similarly reported by Liwenga *et al.* (2013) and Mbwambo *et al.* (2012).

Lengthening of fishing gears to reach deeper waters, increasing fishing frequency, embarking on seaweed farming and using outboard engines instead of canoes and dhows were the coping and adaptation strategies mostly used by the fishers; similarly presented in the study of Kikwale (2018). The installation of artificial structures resembling coral reefs was a unique, emerging and unreported coping strategy used by fishers in response to declining fish catch attributed to a changing climate.

Land-based and coastal and marine-based livelihoods

Respondents divided their livelihoods into two categories, land-based and coastal and marine-based livelihoods, which concur to USAID (2009), Islam *et al* (2014, 2020) and Ahmed *et al.* (2019).

However, findings indicated significant increased dependence and use ($p<0.033$) of coastal and marine resources by 60 percent (Mlingotini) and

76 percent (Kondo) caused by climate driven livelihood dynamics and coastal-ward migration of people.

It also revealed a significant decrease in the number of farmers ($p<0.0001$), and livestock keepers ($p<0.0214$) in the respective villages.

Conversely, the number of fishers ($p=0.023$), charcoal makers ($p<0.0001$) and other off-farm activities ($p=0.0365$) was increasing significantly; implying that climate change affected land-based livelihood more severely than coastal and marine-based livelihood activities.

Diversification and shift in livelihoods were influenced by climate change ($p=0.0001$); similarly reported by Islam *et al.* (2014, 2020) and Turner *et al.* (2010). Some climate change response strategies had negative consequences on the sustainability of coastal and marine resources ($p=0.041$) which included clearing of mangroves, increased illegal fishing practices and overfishing. The use of scrap metals in water to attract fishes was reported to affect the habitat for benthic organisms.

It is clear that care should be taken when choosing responses to climate change impacts in coastal areas to avoid maladaptation practices.



Figure 3: Local water harvesting as a coping strategies to water scarcity



READ THE FULL PAPER:

Alex P. Rubekie; Noah M. Pauline; and Lulu T. Kaaya (2022). Coastal communities' responses to climate change and variability impacts: a threat to coastal and marine resources? *Climate and Development*, DOI: 10.1080/17565529.2021.2018984

[Available Here](#)

*Alex Peter is a member of the [Western Indian Ocean Early Career Scientist network \(WIO-ECSN\)](#)

DYNAMICS AND FATE OF BLUE CARBON IN A MANGROVE-SEAGRASS SEASCAPE: INFLUENCE OF LANDSCAPE CONFIGURATION AND LAND-USE CHANGE | *By Rashid Ismail*



Rashid Ismail in the field in Madagascar

Seagrass meadows function as efficient natural carbon sinks by isolating atmospheric CO₂ and trapping allochthonous organic material, in this way preserving organic carbon in their sediments – so called “blue carbon”.

The impact of landscape configuration and modification mediated by land use change, such as mangrove destruction, on carbon sequestration dynamics in coastal seascapes across the land–sea interface is less well known.

The aim of this study was to explore the influence of landscape configuration and the degradation of adjacent mangroves on the dynamics and fate of organic carbon in seagrass habitats.

A predictive modelling and multiscale landscape ecology approach was used to determine the content, stocks, and source composition of sedimentary organic carbon in multiple seascapes (km-wide buffer zones) in **northwest Madagascar (western Indian Ocean), characterized by diverse seagrass communities/habitats.**

Characteristics of seagrass communities considered include seagrass species, degree of meadow continuity (continuous versus patchy), seagrass structural complexity, seagrass sediment characteristics and location of the community in terms of distance to intact and deforested mangroves.

Study discovered a strong land-to-sea gradient

Results showed that sedimentary organic carbon content was influenced by a combination of landscape metrics and inherent habitat plant and sediment properties. This study discovered a strong land-to-sea gradient, likely driven by hydrodynamic forces generating distinct patterns in sedimentary organic carbon levels in seagrass seascapes.

There was higher organic carbon content and a mangrove signal in seagrass surface sediments closer to the deforested mangrove area, possibly due to an escalated export of organic carbon from deforested mangrove soils. This finding emphasizes the importance of habitats' connectivity in organic carbon storage and demonstrates that mangrove destruction results in a loss of organic carbon.

Results of this study emphasize the benefit of considering the influence of seascape configuration and connectivity to accurately assess organic carbon content in coastal habitats. Understanding spatial patterns of variability and what is driving the observed patterns is useful for identifying carbon sink hotspots and developing management prioritizations.

 **READ THE FULL PAPER:**

Asplund, M.E.; Dahl, M.; Ismail, R.O. et al. Dynamics and fate of blue carbon in a mangrove-seagrass seascape: influence of landscape configuration and land-use change. *Landscape Ecology* 36, 1489–1509 (2021).

[Available Here](#)

* Rashid Ismail's paper was published as his academic dissertation for the degree of Doctor of Philosophy in Plant Physiology at Stockholm University; December 2021. He is a member of [WIO-ECSN](#).

Seascapes comprising large continuous seagrass meadows had higher sedimentary organic carbon levels in comparison to more diverse and patchy seascapes.

Fig. 1 Maps showing the location of the study area in Tsimipaika Bay (a, b previously referred to Ambanja Bay) in northwest Madagascar. The encircled area in the satellite image (c) visualizes the study



BUILDING SOCIO-ECOLOGICAL RESILIENCE THROUGH OCEAN PROTECTION IN THE COMOROS

| By Zolile Duma



Participants at the Launch in Moroni, Comoros. © Ali Ahamada

The official launch of the “Strengthening Ocean Protection in Comoros” project was held on 27 January 2022 in Moroni on the island of Grande Comore.

This project builds on the three-year marine biodiversity research project funded by the Critical Ecosystems Partnership Fund (CEPF) that ended in June 2021 and which aimed to generate knowledge of marine benthic and fish biodiversity on the mesophotic reefs and build capacity and support for conservation action in Comoros.

The Strengthening Ocean Protection in Comoros project was initiated in 2021 by WILDOCEANS, a programme of the WILDTRUST, in partnership with CORDIO East Africa and regional and Comorian partners: the National Parks Agency and University of

Comoros, the non-governmental organizations in Comoros, AIDE, UMAMA, and OPAS and the Institut de Recherche pour le Développement (National Research Institute for Sustainable Development) in Reunion, France.

“Comoros has an incredibly rich and unique biodiversity on its deeper reefs – the mesophotic reefs from around 40 metres to 150 metres deep,” said Melita Samoily, Co-Director at CORDIO East Africa, at the launch.

“ This was the first time these deeper reefs have been explored with scientific remote camera equipment in our western Indian Ocean region. Comoros is unique with its isolated oceanic location and volcanic islands, and it is an honour for me to be working here again.” Melita Samoily, Co-Director at CORDIO East Africa

A larger initiative to improve ocean protection and resilience in Comoros

Funded by Oceans 5, the new project aims to improve the protection and recovery of marine biodiversity and fisheries of the Union of Comoros, ensuring sustainable use of ocean assets and enhancing the resilience of coastal communities that depend on them.

The project is part of a larger initiative to improve ocean protection and resilience in Comoros that, together with the Planning Commission and the Ministry of Agriculture, Fisheries, Environment, Territory Planning and Urban, has identified key areas for attention and is seeking partnerships and support to achieve them.

These key initiatives include: marine spatial planning; marine protected area (MPA) expansion in line with the National Network of Protected Areas guidelines and national MPA extension and zoning

policies; effective MPA management; sustainable ocean protection financing plans; capacity for offshore monitoring, surveillance and enforcement and awareness of the value of ocean protection and MPAs; and an assessment of opportunities and constraints to positioning MPAs as a key tool in the Blue Economy.

“ We are extremely grateful for Oceans 5 recognising the need for strategic interventions to unlock additional ocean protection and make it effective, especially in Africa,” said project leader, Dr Jean Harris of WILDOCEANS. **“Support for MPAs is critical, not only for biodiversity protection, but for climate resilience and fisheries sustainability and recovery.”**



Ministerial Delegates and Project Partners at the Strengthening Ocean Protection in Comoros Project Launch in Moroni, Comoros. © Ali Ahamada

Project activities

Project activities over the next few years are focused primarily on the four MPAs across the three islands of Grande Comore, Moheli and Anjuoan.

The main objectives of the project are to promote and improve the effective implementation of three recently established coastal MPAs and to improve the management of the existing MPA, Moheli Marine Park. This will double the marine area under effective protection to a total area of 986 km². The project also aims to have 20 percent of the total area of each MPA classified as a no-take (sanctuary) protection zone, and to extend one of the MPAs to the deeper mesophotic zone.

The project aims to generate awareness of the value of MPAs in the national Blue Economy and promote the provision of direct local benefits to coastal communities living near MPAs.

A partnership with many stakeholders

Samoilys expressed the underlying value of the project saying that:

“Our working ethos is partnerships. Both WILDOCEANS and CORDIO have a strong commitment to working in partnerships with government, NGOs, local civil society and the people who depend on the ocean for their livelihoods. This project is a partnership with many.”

The participation at the launch by high-level government figures and senior members of organizations, demonstrated the strong support for the project and the regional partnerships the initiative is promoting to achieve success for Comoros.

The General Planning Commissioner, Fouad Goulame, confirmed Comoros' commitment to the project and the integral role the project will play in the vision of the Emerging Comoros Plan (ECP) that hopes to achieve an operational and sustainable Blue Economy by 2030.

Significantly for a small island state, Comoros has made big strides in protecting its natural assets, curbing climate change and ensuring resilience for its people. It is notable that the Moheli National Park has gained formal recognition as a UNESCO Biosphere Reserve. Comoros has also pledged its commitment to advancing protection of the planet, by joining the High Ambition Coalition (HAC), which is an intergovernmental group formed ahead of the upcoming COP27 from 7 to 18 November 2022. The HAC is advocating ambitious targets in the post-2020 Biodiversity Framework, including at least 30 percent spatial protection by 2030. www.wildtrust.co.za




United Nations
Educational, Scientific and
Cultural Organization



A programme of the  WILDTRUST

THE NEXT GENERATION OF COASTAL AND MARINE CUSTODIANS IN SEYCHELLES | *By Liz Mwambui*

A primary school in the Port Glaud District of Mahé, Seychelles, is the home of a **new and exciting children's environmental club known as LEAP Junior**. Her Excellency Annett Günther, Ambassador of the Federal Republic of Germany to Seychelles, launched the club at the school on 19 February 2022.



Learning about mangroves.

Started as part of Nature Seychelles' Locally Empowered Area Protection (LEAP) project, the club will educate students from the district about the ocean, related seascapes and biodiversity.

It targets both primary and secondary schools in the district. Twenty-one students from the primary school have joined.

The focus of the club's activities is the Baie Ternay and Port Launay marine national parks found in the district and where the LEAP project is situated. The LEAP project is bringing the local community



in the district together to take part in the management of the two protected areas through a co-management process with the designated authority, the Seychelles Parks and Gardens Authority. During several interactive meetings held in the district, local people have shown a passion and willingness to contribute to the conservation and management of the marine parks.

Speaking at the launch, the Ambassador said that the club was another significant step in the way forward for the LEAP project.

LEAP project brings together all stakeholders



“The project is unique because it brings together all stakeholders, including government, local administration, community, youth, scientists and others who can in their own way contribute to the objective of the project, which is to co-manage marine protected areas and protect them.” Her Excellency Annett Günther, Ambassador of the Federal Republic of Germany to Seychelles.

LEAP project’s conservation officers and two teachers from the school jointly run the club.

They supervise after-school classes and a field trip each month. The children have taken part in beach clean-ups in Baier Ternay and a mangroves education trip in conjunction with the Constance Ephelia Resort, one of the tourism stakeholders in the district.

Nature Seychelles is implementing the regional LEAP project in Seychelles

called, “Enhancing coastal and marine socio-ecological resilience and biodiversity conservation in the Western Indian Ocean”, and funded by the International Climate Initiative of the Federal Republic of Germany, with the technical support of International Union for Conservation of Nature and Natural Resources.

“I feel that this is the generation that will change Seychelles, not only for a better environment but for a better Seychelles. The LEAP project is not only about the environment, but it also helps people think about governance and shared responsibility for these resources,” Nirmal Shah, Nature Seychelles’ Chief Executive.



Her Excellency Mrs. Annett Günther plants a custard apple tree to inaugurate the LEAP club

SEYCHELLES PARKS AND GARDENS AUTHORITY LAUNCHES NEW STRATEGIC PLAN | *By Geraldine Joubert*

As a newly formed corporate body, ignited by the merger of the Seychelles National Parks Authority and the National Botanical Garden Foundation, the Seychelles Parks and Gardens Authority (SPGA) has shared its strategic plan with partners and stakeholders.



Based on in-depth consultation between stakeholders and the SPGA management, the **strategic plan will spearhead conservation and protection activities, education and awareness programmes and overall sustainable management plans and practices** adopted.

These strategies will help in achieving the goal to ensure that 70 percent of all protected parks and gardens in Seychelles will be secure from a conservation perspective, and financially sustainable by 2026.

SPGA is the largest Protected Area Management Organisation in the Seychelles. It is entrusted with managing:

- 6** Marine National Parks
- 2** Terrestrial National Parks
- 1** Special Reserve
- 3** Protected Gardens

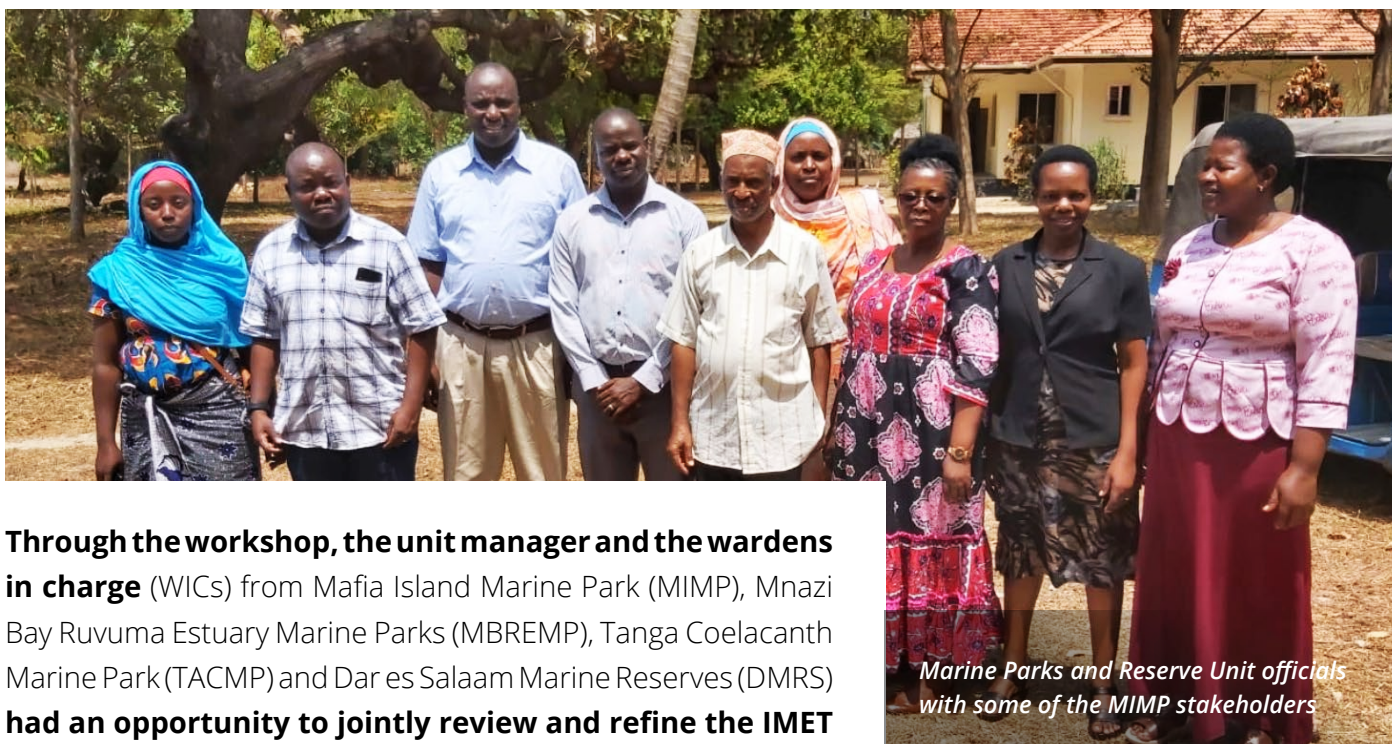
FOUR MAIN PRIORITY STRATEGIES have been identified to guide SPGA towards achieving its five-year benchmarks for all protected areas:

1. targeted and strategic conservation
2. resourcefulness
3. financial autonomy
4. financial soundness

AN ASSESSMENT OF MARINE PROTECTED AREAS IN TANZANIA | *By John Komakoma*



Tanzania's Marine Parks and Reserve Unit (MPRU), with the support of WIOMSA, organised a **three-day workshop to review and complete an assessment of Tanzania mainland's marine protected areas (MPAs) using the Integrated Management Effectiveness Tool (IMET) application.**



Marine Parks and Reserve Unit officials with some of the MIMP stakeholders

Through the workshop, the unit manager and the wardens in charge (WICs) from Mafia Island Marine Park (MIMP), Mnazi Bay Ruvuma Estuary Marine Parks (MBREMP), Tanga Coelacanth Marine Park (TACMP) and Dar es Salaam Marine Reserves (DMRS) had an opportunity to jointly review and refine the IMET assessment reports for MIMP, TACMP, MBREMP and DMRS, using the recommendations observed for each MPA. Workshop participants also had an opportunity to meet with stakeholder representatives from MIMP and obtain their inputs on the IMET assessment of the Park.

IMET training

The three-day MPA assessment workshop was a follow-up of the IMET assessment workshop for Tanzania MPA practitioners which was held in Tanga from 6 to 11 April 2021. In that workshop, each MPA was able to conduct the IMET assessment after the completion of the first training which was conducted in Bagamoyo in December 2020, facilitated by WWF and WIOMSA. This training involved staff from MPRU, WWF, Blue Ventures and other stakeholders, including fisheries officers from Mafia and Kilwa districts. MIMP was used as a case study during the training.

The objectives of the three-day MPA assessment workshop were to:

- **review the IMET assessment for** Tanzania mainland MPAs;
- **obtain stakeholder contributions** on the IMET assessment process;
- use the IMET assessment to develop **issues that need to be resolved** by the management;
- **prioritize the issues** that need to be resolved in Tanzanian MPAs; and
- develop a Tanzania **plan of action.**



Discussion with MIMP stakeholders

Julius Pagu, a Senior Marine Conservation Warden from DMRS, facilitated the process of reviewing IMET assessment reports for the MIMP. This was used as a benchmark for the review of the IMET assessment reports for DMRS, TACMP and MBREMP.

The workshop was also used to hear and collect inputs and views of various MIMP stakeholders, including representatives of tourism, village liaison committees, local governance leaders and the general public.

Among the issues discussed by stakeholders were participation in planning processes for MPAs, with stakeholders emphasizing the need for education programmes to help them understand their responsibilities, and the need to get feedback on various activities and decisions. Other issues raised by the stakeholders included the shared benefits of MPAs, environmental education for the community and eco-tourism.

During the discussion with the stakeholders, the Warden in Charge of MBREMP, Jeniffer Simbua, had an opportunity to share the experience

of conservation and stakeholder engagement from MBREMP. She explained how community engagement is conducted, how the community participates in alternative livelihood activities and the tourism attractions found at MBREMP.

Priority management issues

The team also managed to identify and prioritize a number of issues. Management issues which scored very low across the MPAs and hence need to be prioritized include: management plan; infrastructure, equipment and facilities; environmental education and public awareness; conditions and trends of the key conservation elements of the protected area; management/ protection of the values; staff matters; threats; monitoring and research; monitoring systems for natural and cultural resources; demarcation of the protected area; ecosystem services; and budget.

The IMET Assessment Report for Tanzania Mainland MPAs will form the basis for a review of the MPRU strategic management plan for the next five years, starting in 2022/2023.

TOWARDS SUSTAINABLE PORT DEVELOPMENT IN THE WESTERN INDIAN OCEAN REGION

| By Angela Patnode



DESPITE THE ESSENTIAL ROLE THAT PORTS PLAY IN THE GLOBAL ECONOMY, THEY CAN ALSO HAVE A DRAMATIC EFFECT ON THE ENVIRONMENT.

Port of Port Elizabeth (Gqeberha) at sunset. © Aadila Omarjee

Cargo-handling equipment, ships, power plants and more emit greenhouse gases, contributing to climate change. Ships release wastewater and sewage into waterways, degrading ecosystems and harming marine life. Deepening channels for ships disturbs sediment, damaging or destroying habitats and species. Such environmental impacts – of which these are just a few – have led to efforts worldwide to create “greener” or more “sustainable” ports.

Nowhere are such efforts more critical than in the western Indian Ocean (WIO) region, where significant expansion of port capacity is underway – and where people are deeply dependent on marine and coastal resources. Over 60 million people live within 100 km of the WIO coastline, and rely on the ocean for food, employment, health, recreation and more.

The Nairobi Convention’s Global Environment Facility-funded WIOSAP project, in collaboration with South Africa’s Council on Scientific and Industrial Research, the Maritime Technology Cooperation Center and Macquarie University, is supporting an initiative to explore how sustainable port development can be facilitated in the region.

The Nairobi Convention’s Global Environment Facility-funded WIOSAP project, aims to:

- 1. ASSESS the environmental impacts** of operational, planned and proposed ports in the WIO region. It will show where current and future ports overlap with critically important marine and coastal resources across the region, indicating where action is most urgent.
- 2. IDENTIFY and predict different scenario outcomes**, in other words, what could happen if port development and management ignore environmental considerations, or what could happen if governments and businesses adopted certain sustainable, environmental practices in the operation and building of ports. For instance, examples of sustainable port practices include using the materials from dredging to nourish beaches or create topsoil, instead of dumping it. Ports could also build electric outlets and provide electricity for ships to recharge when docked, which would reduce the amount of fossil fuel discharged and improve local air quality.
- 3. CREATE a policy brief** that identifies key policy and management recommendations for sustainable port development.
- 4. DEVELOP a toolkit** for green port development in the WIO region, encompassing best practices to limit environmental degradation from the siting of ports, construction and operations. Port management authorities in the region will be critical stakeholders in this process to ensure industry concerns are well considered.

The project is expected to be completed by July 2022. For more information, visit www.nairobiconvention.org

PROTECTING PEMBA

IMPROVING FISHERIES MANAGEMENT IN A MARINE CONSERVATION AREA IN ZANZIBAR

| By Angela Patnode, The Nairobi Convention



From Zanzibar to Kilwa Masoko to Mafia Island, Tanzania is famous for its beautiful beaches and rich biodiversity that support a variety of livelihoods and provide life support systems. Yet, as elsewhere, these coastal systems are under threat from the effects of climate change, illegal fishing and other dangers.



Recording the weight of octopus caught on Fundo Island Community Fisheries Management Area during opening day. © Frances Wild, Mwambao

In an effort to protect these paradises, Tanzania has declared 18 marine conservation or protection areas (MCAs or MPAs) on the mainland and an additional nine on Zanzibar. A well-managed MCA can bring significant economic, social and environmental benefits to a country by preventing overexploitation of fish stocks, safeguarding or creating jobs in the tourism and fisheries sectors and halting biodiversity loss.

Rich marine biodiversity

One such MCA is the Pemba Channel Conservation Area (PECCA), declared in 2005 and home to among the most diverse coral reefs in East Africa, important turtle nesting grounds, seabird habitats, mangroves and rich marine biodiversity. The PECCA MCA is jointly managed by Zanzibar's Department of Fisheries Development (DoFD) and the community.

Nevertheless, the MCA faces some key challenges, including persistent illegal and destructive fishing and a lack of alternative livelihoods to reduce pressure on fish stocks, a lack of coordination between the public sector, businesses and communities living near the MCA and inadequate community participation in conservation and planning initiatives.

Helping communities lead in the sustainable management of small-scale fisheries

A community that is empowered to take on these management challenges could help ensure a better functioning MCA. A new [demonstration project](#), spearheaded by Zanzibar's Department of Environment with support from DoFD, aims to help communities lead in the sustainable management of small-scale fisheries in the PECCA MCA by using an ecosystem-based management (EBM) approach.

The project will address many of the issues that have culminated in threats to the PECCA MCA. Project champions will develop an integrated fisheries management plan to conserve, manage and monitor marine biodiversity.

New guidelines for community fishery closure zones will be created. Meanwhile, community-led fishery patrols, which monitor whether any illegal and destructive fishing practices are occurring, as well as enforcement measures will be strengthened.

Alternative livelihood opportunities will be introduced

Alternative livelihood opportunities will also be introduced, which will help to reduce the number of fishers combing the MCA and therefore reduce pressure on fish stocks. One option would be to enhance and expand seaweed farming, the fastest growing [aquaculture](#) sector.

Seaweed farming not only has the potential to be lucrative, but can also have ecological benefits, such as [storing](#) carbon and eliminating harmful nutrients from the water. The project will train the community on seaweed farming and help them acquire the relevant, sustainable gear and access equitable markets.

Another alternative livelihood option is eco-tourism. The project will support both the training and purchasing of equipment for eco-tourism activities in the fishery closure zones, with the aim of getting at least 200 households engaged in eco-tourism.

Creating an MCA that is sustainable and profitable

Such a holistic approach to fisheries management, which is improving implementation of fishery closure zones while also creating alternative employment opportunities for fishers, can help create a PECCA MCA that is sustainable and profitable for local communities in the long term.

The project will also help Tanzania achieve its targets under Sustainable Development Goal (SDG) 14 (Life below water), in which it committed to protecting marine and coastal ecosystems, and help it achieve SDG Goal 2 (Zero hunger) and Goal 8 (Decent work and economic growth).

The initiative is co-funded by the [Global Environment Facility](#) through the WIO Large Marine Ecosystems Strategic Action Programme Policy Harmonization and Institutional Reforms ([SAPPHIRE](#)) project, executed by the [Nairobi Convention](#).

The project promotes policy and institutional reform to help improve the management of the western Indian Ocean. The demonstration project is further supported by the [Partnership Project](#) for Marine and Coastal Governance and Fisheries Management for Sustainable Blue Growth in the WIO, led jointly by the Food and Agriculture Organization and the Nairobi Convention.

For more information and updates on the project, click [here](#) ([SAPPHIRE Reports and Publications](#) | [Nairobi Convention Secretariat](#)).

ECONOMIC BENEFITS OF TRANSBOUNDARY PROTECTION IN TANZANIA AND KENYA

| By Angela Patnode, *The Nairobi Convention*



Marine Parks & Reserves Unity Engaging Community members in Tanga on the proposed TBCA © MPRU

Healthy oceans are critical to human survival. Oceans feed us, regulate our climate, generate most of the oxygen we breathe, and serve as the engine for much of the world's economy.

Yet the world is depleting these ocean resources faster than ever. Soon, the western Indian Ocean (WIO) region may no longer be able to count on the many jobs, food, health and economic benefits – **valued** at USD 20.8 billion – that the ocean provides.

According to the United Nations Environment Programme, marine protected areas (MPAs) are one of the world's best options to maintain ocean health and avoid further degradation. Effective MPAs can bring both ecological and sustainable economic benefits.

Typically, individual countries declare MPAs and are responsible for their management.

According to the Nairobi Convention and WIOMSA's recent [MPA Outlook, Tanzania](#), for example, has proclaimed 18 MPAs on its mainland (3 marine parks and 15 reserves) as well as nine more on the island of Zanzibar, while [Kenya](#) has proclaimed six MPAs. However, physical borders

between countries are less applicable in the ocean, where ecosystems, species, weather patterns, and pollution cross human-defined boundaries.

Valuation will provide information for collaborative management

Transboundary MPAs can be effective tools to manage areas across international boundaries. The transboundary ocean area between Kenya and Tanzania has rich and diverse shared resources, including fisheries, coral reefs, mangroves and seagrass beds, among others. The two countries have been engaging to determine a potential collaborative approach to manage these shared resources.

The Nairobi Convention, through the Global Environment Facility (GEF)-funded WIOSAP and SAPHIRE projects, as well as the SIDA-funded [Partnership Project](#) for Marine and Coastal Governance and Fisheries Management for Sustainable Blue Growth in the WIO region is partnering with the governments of Kenya and Tanzania, as well as with Prime Africa and Lloyd Capital, to undertake an economic valuation of a Transboundary Conservation Area (TBCA) between Kenya and Tanzania. The valuation will provide policy oriented information in support of this collaborative approach to management.

The TBCA will stretch from the northern boundary of the Diani-Chale Marine National Reserve in Kenya to the southern boundary of Mkinga District in Tanzania. These areas share a common ecosystem, weather patterns and oceanographic conditions. The biodiversity found in the proposed TBCA supports local coastal communities in both countries, specifically in the tourism and fisheries sectors.

Tanzania and Kenya to mitigate joint threats

Deforestation, coastal flooding, saltwater intrusion, pollution and several other threats have put this key ecosystem in danger, but managing the proposed TBCA together would allow Tanzania and Kenya to mitigate these threats and continue enjoying the ecological services and economic benefits this area provides.

Although the potential environmental benefits of the TBCA have been well studied, including by WIOMSA, the economic benefits have yet to be fully assessed.

The economic valuation of a TBCA between Kenya and Tanzania will assess the value of the proposed TBCA's marine and coastal resources. It will identify ways in which the TBCA can be best managed to ensure that the area serves the needs of both nature and coastal communities. Finally, it will outline investment opportunities which will ensure that the TBCA's benefits are fully realized.



For updates on progress,
please visit
www.nairobiconvention.org

Community members making a presentation at the Tanga meeting

WiMS: Women marine scientists share their stories

| By Obakeng Molelu

In celebration of International Women's Day on 8 March, the network of Women in Marine Science (WiMS) shares stories here about women doing remarkable work in their research and community empowerment initiatives in the western Indian Ocean (WIO) region. Over the past ten years, WIOMSA has seen an increase in the number of female participants in the marine sciences, especially early career ocean professionals.

The women's stories are from different disciplines, including conservation and marine monitoring, mangrove conservation, smart port cities, oceanography and physical chemistry. We salute these women and many others in the WIO as they #BreakTheBias and advocate for gender equality today for a sustainable tomorrow.

Island conservation and marine monitoring team | By Nasreen Khan, Seychelles

I have a small team of three; two other women, Vanessa Dufrene and Jaymee Clarisse, and one male Said Harryba. We belong to the Island Conservation Society and we manage the conservation on the third largest island in Seychelles, called Silhouette Island.

I am employed as the Conservation Officer and am very proud of my female team members and their "go-getter" work ethic. This was the first year the two female rangers conducted marine monitoring. Despite them having to upskill very quickly, I can proudly say that we were successful in completing our marine monitoring for this season.

On each dive, the team collected data to determine the abundance, diversity and condition of reef-building scleractinian hard corals, level of coral recruitment, as well as selected reef-associated macro-invertebrate groups, including fish point counts and incidental sightings of large predatory fish species.

The information gathered will add to our long-term data and provide insight into changes occurring in the ecosystems; identify key environmental threats related to climate change and other anthropogenic pressures; and assist in determining management actions needed.



Nasreen Khan with Vanessa Dufrene, Jaymee Clarisse and Said Harryba



Risper planting mangroves with local community members

Peri-urban communities in mangrove restoration | Risper Oteke, Kenya

Coastal communities value mangroves as key ecosystems that provide significant support to their livelihoods. This has made mangroves part of their cultural heritage. In Kenya, I work with peri-urban communities to restore the degraded Tudor Creek in Mombasa, using a participatory approach to ensure better governance.

Between 2019 and 2020, I assisted the community in restoring 8 hectares of mangroves. My passion for community resources management has provided me with an avenue to pursue more research about

the sustainability of peri-urban communities with mangrove dependent livelihoods within the creek from a gender perspective.

I consider the restoration of degraded sites as a process and not a one-time activity. You should have the community at heart, listen to their story and share your insights so that you can involve every actor in the restoration. Working with young people and women has really enlightened my scope of community engagement in conservation.

OceanWomxn and SuperScientists breaking the bias

University of Cape Town, South Africa



OceanWomxn fellows, from left, Wanjiru Thoithi, Kolisa Sinyanya, Philile Mvula, Thando Mazomba, Faith February, Sizwekazi Yapi and Lerato Mpheshea.

The fellows of the Advancing Womxn programme (OceanWomxn) in the Department of Oceanography at the University of Cape Town, all experienced primary, secondary and tertiary education without having role models that looked like them. Yet, they followed their dreams and overcame several barriers, including financial challenges, being first generational researchers, racial and gender discrimination, and “imposter syndrome”, to do research in various fields of oceanography (read more at <https://oceanwomxn.co.za/news/>).

The fellows are now #BreakingTheBias and becoming the role models they lacked. Young children and the youth can now be inspired by the OceanWomxn and other scientists through the SuperScientist Programme (read more at <https://www.superscientists.org/>)



SuperScientists was developed to inspire young people and help them see themselves in the faces and life stories of scientists working today.

Through outreach campaigns and science communications in various forms, OceanWomxn are promoting gender equality.

NEWS FROM THE WIO-EARLY CAREER SCIENTISTS NETWORK

INTO THE DEEP

Kenyan and Tanzanian marine scientists experience the NEWF Dive & Story Labs

By Joshua Oginda, Susana Kihia, Nancy Iraba, Jerry Mang'ena and Kaitira Benard



Nature Environment Wildlife Filmmakers (NEWF), an organisation based in South Africa and established in 2017, has been working to develop the ocean conservation filmmaking field within Africa by hosting various labs aimed at capacity building for scientists, filmmakers and conservationists. In 2021, NEWF held its first-ever Kenyan and Tanzanian Dive and Story Labs for four marine scientists who are part of the Western Indian Ocean Early Career Scientists Network (WIO-ECSN).

In partnership with the East African Ocean Explorers, interns from the Kenya Marine and Fisheries Research Institute (KMFRI), Joshua Oginda and Susana W. Kihia, were part of the first cohort from 3 to 13 December 2021. The lab provided the two early career marine scientists with a chance to discover first-hand what lies underwater and the unique opportunity to interact with the ocean under the scope of conservation through storytelling.

Diving and storytelling

One of the lab's main objectives is to build skills in scuba diving and enhance marine researchers' ability to adeptly immerse themselves in the ocean and understand the safety aspects and precautions involved.

The Kenyan participants received exceptional training from the team at Aqua Ventures, a scuba diving training centre in Watamu that offers PADI certification. Oginda and Kihia participated in sequential theory lessons in class, practical sessions in a pool, and at dive sites in the open sea within the Watamu Marine Protected Area.

A core objective of the lab was to introduce the Kenyan participants to the world of underwater filmmaking and storytelling. Jahawi and Elke Bertolli, filmmakers and founders of the East African Ocean Explorers, led Oginda and Kihia through sessions where they watched, analysed, and drew lessons from a wide array of marine conservation films from Kenya and around the world.

Storytelling for conservation

“One of the frequent phrases we heard during the dive lab is that ‘Africans are natural-born storytellers’,” commented Oginda and Kihia. “This statement guided our introduction to elements of storytelling; having an audience and objectives in mind, how powerful narratives can be in determining the perceptions people have of the ocean and its species, and the wealth of knowledge present in indigenous communities.

“This dynamic combination of dive training, together with learning the storytelling aspects of filmmaking, encouraged us to view the science that we interact with as stories that are waiting to be shared to drive ocean conservation.”

Oginda and Kihia say the Dive and Story Lab was a rewarding and immersive experience in which they could engage with the ocean as storytellers.

“We were able to learn how intersecting conservation science with underwater cinematography and powerful storytelling can be a gamechanger in advancing conservation within the WIO region.

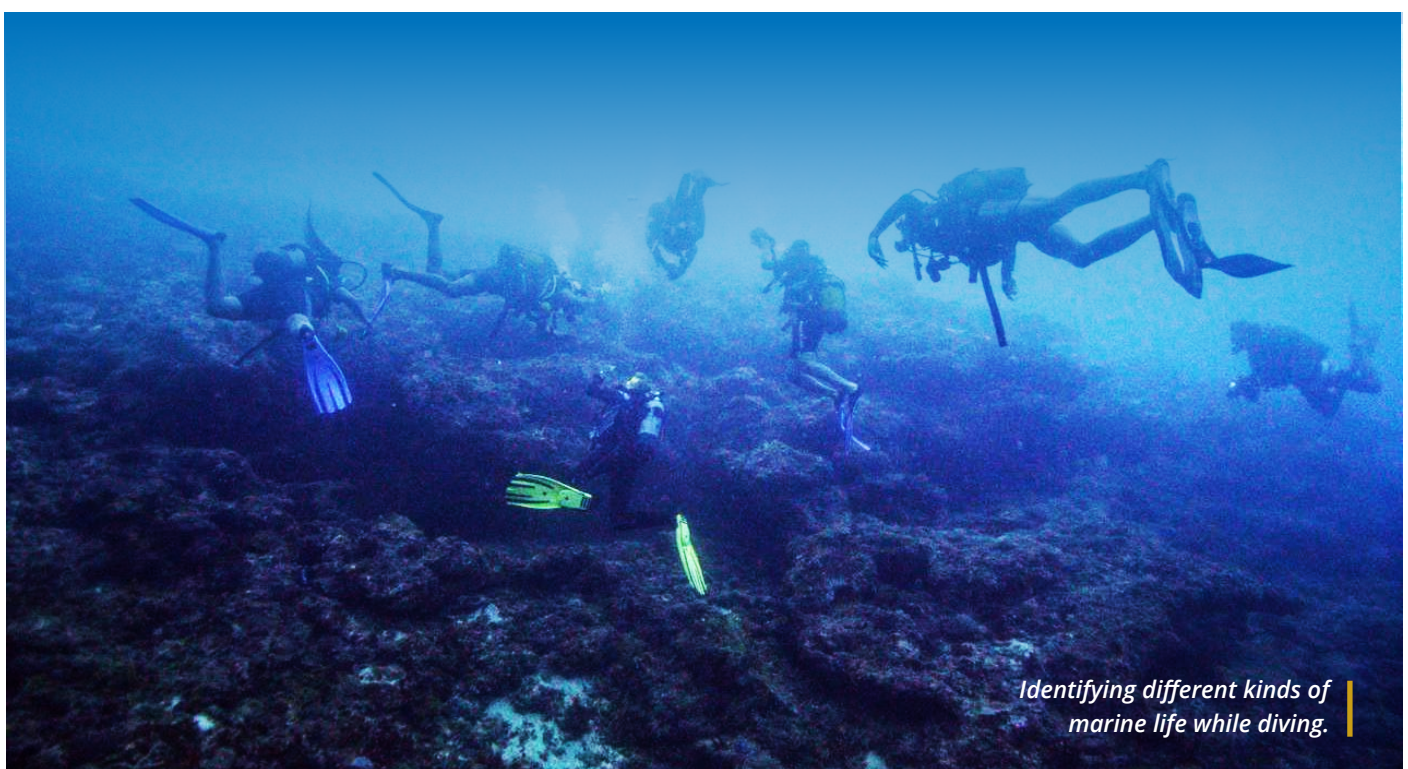
“We are confident that having this remarkable opportunity to be among the NEWF community as fellows will further enable us to contribute towards this noble cause as we develop in our science and storytelling.

“We hope that gainful strides towards showcasing stories from our ocean will be made through the momentum generated by this Dive and Story Lab and that others in the region will be inspired to explore this field.”

Opening up a world of opportunities

“Gaining access to the underwater realm isn’t just beautiful and mind-blowing, it can also open up a world of opportunities for a marine scientist”, commented Jerry Mang’ena and Kaitira Benard, who took part in the Tanzanian Dive and Story Lab on 15-18 November 2021 in Tanzania.

An ambitious youth-led organization from Tanzania, Aqua Farms Organization, and the School of Aquatic Sciences and Fisheries Technology of the University of Dar es Salaam, in partnership with NEWF, enabled Jerry Mang’ena and Kaitira Benard to train and become PADI certified open water divers.



Identifying different kinds of marine life while diving.

As marine scientists, Mang'ena and Kaitira are now able to dive and explore the ocean floor and use their skills to further underwater research and marine conservation. They are both using their underwater skills to craft a “snorkelling for conservation” marine programme.

Prior to this, NEWF also conducted a three-month first-ever Decade Divemaster Storytelling Lab in Sodwana Bay on the East coast of South Africa from 7th April to 6th July 2021. The lab helped to build the capacity of ten women from Tanzania, South Africa and Kenya, to access life below water by training them as RAID Divemasters. A RAID Divemaster is one of the most highly respected ratings in the diving community and the first professional level within the RAID system. As a RAID Divemaster one can plan, organise and lead dives for certified divers.

Nancy Iraba, a marine scientist from Tanzania and co-founder of the Aqua-Farms Organization, was part of the lab. Using the skills gained during the lab, she now works on coral reef restoration at Mnemba Island and conducts regular underwater coral reef monitoring surveys.

She also uses this newfound knowledge to train her team at Aqua-Farms to conduct underwater coral reef surveys that are relevant to their IOC-UNESCO-endorsed Ocean Decade Science project, titled, “Low-cost real-time monitoring of pollutants and water quality along the coral reefs in Tanzania.”

Jerry and Benard are Open water 20 certified

Dividing for research is a necessary skill

“As people working with marine life, it is necessary for us to be able to explore our oceans without limitation. The possibilities are endless when you can reach your full capability and are fully equipped with the skills needed to explore the ocean,” commented members of the Tanzanian group of marine scientists.

“Diving is not something that should be classified as an activity for just a certain group of people. Diving for research is a necessary skill for every qualified marine scientist and those in training.

“There is still more effort needed to qualify more African divers, and through partnerships such as NEWF and WIOMSA we can achieve the goal and create a generation of marine scientists who are truly empowered to explore life below water.

“As early career scientists, we are calling upon more organizations and funding agencies to support African divers from the WIO region in underwater skills exploration for the Ocean Science Decade (2021–2030).”



WIO-ECSN AT THE MARINE LITTER MONITORING TRAINING

| By Ailars David



Workshop participants during marine litter assessments in mangrove forests



The Kenya Marine and Fisheries Research Institute (KMFR I) and WIOMSA hosted a regional marine litter monitoring training course in Mombasa, Kenya, from 22 to 29 November 2021 that I attended.

As a marine scientist in Tanzania, it helped me to create a network of marine practitioners in the WIO region, and to reconnect with various stakeholders from different institutions and build a shared methodology in dealing with marine litter.

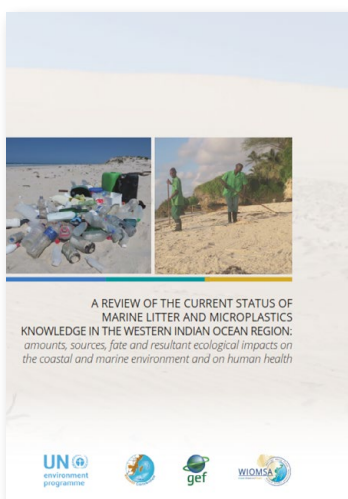
After the training I was able to share and exchange the knowledge I had gained with other marine scientists, ocean leaders and stakeholders

involved with marine litter monitoring, and discuss methodologies to monitor litter.

During February this year, together with **ocean leaders Paul Matonya and Paschal Temba**, we conducted a baseline marine litter monitoring project in the Ununio mangrove forest in Dar es salaam. We aim to save the area's wetlands from various stressors, including marine litter.

REPORTS ON THE STATUS OF MARINE LITTER IN THE WIO

In 2020, the Nairobi Convention and WIOMSA through the Group of Experts on Marine Litter and Microplastics commissioned three inter-related regional assessments on the status of marine litter and microplastics in the western Indian Ocean (WIO) region; the resultant ecological, human health and economic impacts; and measures undertaken by different institutions to address the challenges and highlight opportunities which can be harnessed for greater impacts. These assessments were a follow up to a first report, **“Marine litter in the eastern Africa region: An overview assessment”** that was published in 2008 as a joint publication between the Nairobi Convention and WIOMSA.



on the coastal and marine environment and on human health”.

It reviews and assesses the status of marine litter and microplastics knowledge in the WIO region. For this report, a comprehensive review of the existing literature on the amounts, sources and fate of marine litter and microplastics in the WIO region, and their resultant ecological and human health impacts, was conducted. Furthermore, scientists, non-governmental organization coordinators, citizens and park rangers with experience in marine litter monitoring and management, were interviewed to supplement the information presented in the literature and to further improve our knowledge of marine litter in the region.

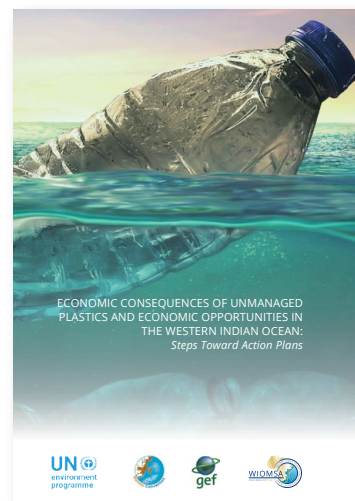
The first of the newly published reports is titled **“A review of the current status of marine litter and microplastics knowledge in the Western Indian Ocean region: Amounts, sources, fate and resultant ecological impacts**

The second report, **“Economic consequences of unmanaged plastics and economic opportunities in the Western Indian Ocean: Steps toward action plans”**, reviewed and evaluated:

- the **economic consequences** of unmanaged plastics;
- the **economic incentives** for each country to reduce the leakage of plastics into the environment through increased reuse and recycling (to establish a local recycling economy);
- the **cost of plastic pollution**;
- the **cost of inaction**; and
- the **economic opportunities that can benefit communities** and the identification of economic incentives that will not only address poverty but will encourage a local secondary resources economy.

The report also makes recommendations on actions to:

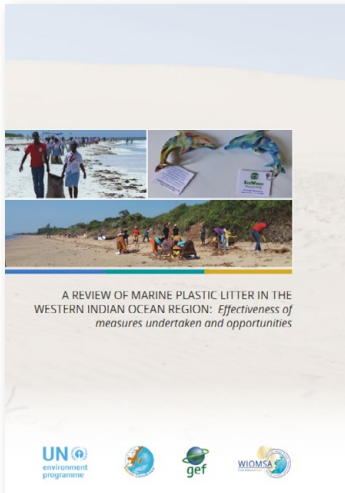
- be taken at national and regional levels to reduce the consumption of single-use plastics, to **improve product design for recycling**, to grow local recycling economies and to identify evidence gaps;
- **promote collaboration** and networking; and
- **build capacity and promote understanding** within the region.



NEW PUBLICATIONS

Reports on the status of marine litter in the WIO

...continued



The third report, **“A review of the current status of marine litter and microplastics knowledge in the Western Indian Ocean region: Effectiveness of measures undertaken and opportunities”**,

assessed, in relation to the marine plastic litter issue, the effectiveness and the diversity of the regional governance landscape, the national policy and institutional frameworks and the effectiveness of the measures conducted by all types of stakeholders. It identifies initiatives at local, national or regional levels, involving cooperation and partnerships, as well as potential synergies between stakeholders regarding marine plastic litter. This identification of initiatives highlights both strong action areas as

well as gaps in policies and actions. Based on these conclusions, recommendations are developed to address the gaps.

The fourth report, **“Marine plastic litter in the WIO region: Status, implications on the environment,**



h u m a n populations and effectiveness of measures and opportunities.

A synthesis report' presents a synthesis and highlights the main results and evidence gaps from the previous reports. It makes

recommendations on management and policy actions to be taken at national and regional levels.

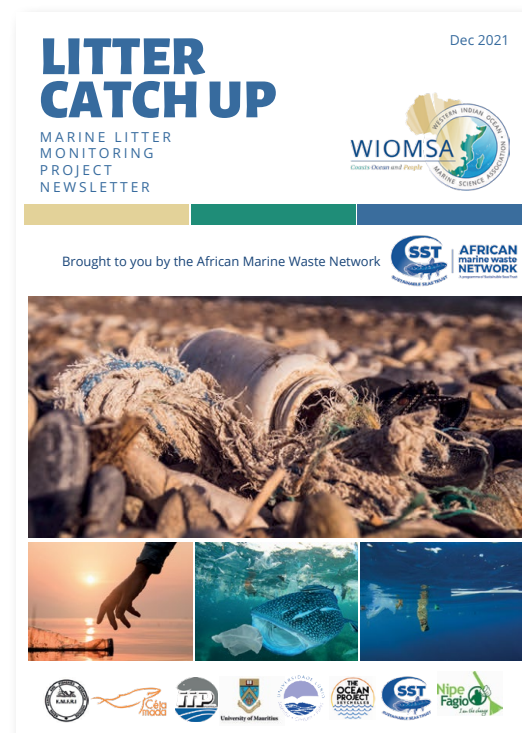
[Download the reports here.](#)

LITTER CATCH UP

WIOMSA and the Africa Marine Waste Network have released the latest issue of the WIOMSA Litter Catch Up newsletter.

The monitoring programme for marine debris is the first of its kind in Africa and could well be the first in the world. Teams in seven countries (Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania) are working together over a large area, collecting data in a harmonious way and sharing information, educational material and reports. This report covers the period from August 2021 to the end of November 2021.

[Read it here.](#)

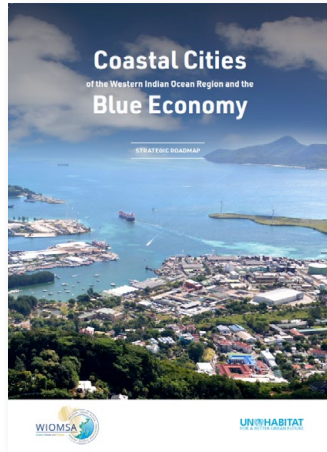
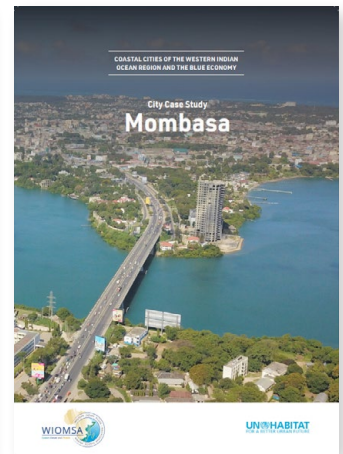
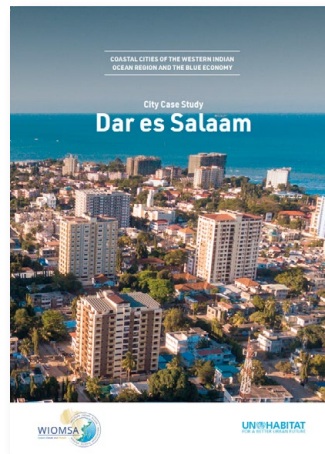
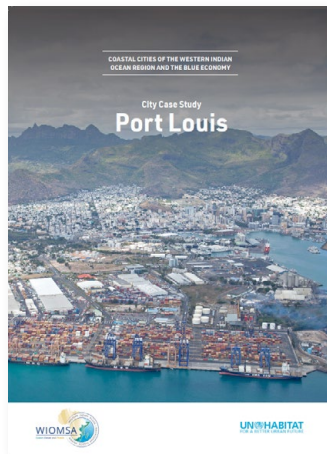
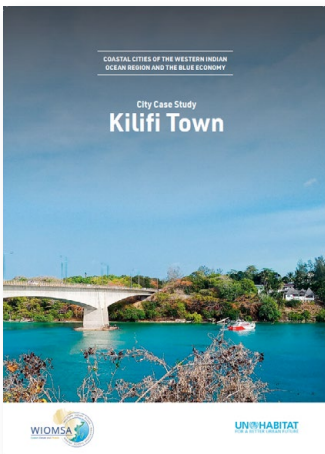


WIOMSA AND UN HABITAT LAUNCH BLUE ECONOMY REPORTS

WIOMSA and UN Habitat commissioned Arup to prepare a portfolio of six reports that were launched during an event held in December 2021. The launch was presided over by Oumar Sillah and Isabelle Wetzel from UN Habitat and Jared Bosire from the Nairobi Convention, with Arthur Tuda and Julius Francis representing WIOMSA.

The reports include:

- four blue city economy case studies on **Kilifi, Port Louis, Dar es Salaam and Mombasa cities**;



- a **“status report”** which outlines more broadly the current situation concerning the Blue Economy in coastal cities across the region; and
- a **“Roadmap for the Development of the Blue Economy in Coastal Cities”**, which provides recommendations for cities in current and future Blue Economy planning, activities and investment.

The reports offer knowledge resources for city and national government stakeholders, WIOMSA, UN Habitat, private sector and civil society.

Each case study provides specific Blue Economy recommendations for each city, focusing on strategic and operational opportunities for the city and its Blue Economy stakeholders, informed by primary and secondary research.

Key points and recommendations from each case study have also been extracted and integrated into the main body of the status report, which has in turn, informed the roadmap. The roadmap provides strategic and operational Blue Economy recommendations across case study cities, which stakeholders are encouraged to read and consider with respect to their city or region.

[Download the Blue Economy Reports here.](#)

WIOJMS VOLUME 20 ISSUE 2

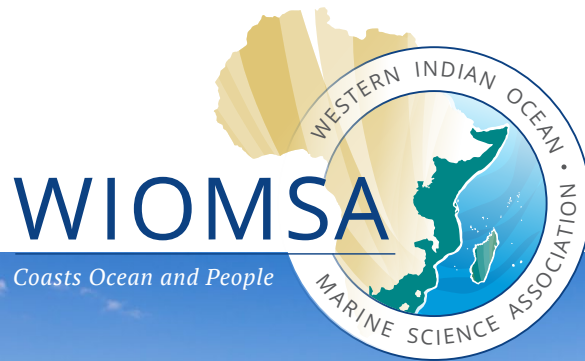
The editorial board of the **Western Indian Ocean Journal of Marine Science (WIOJMS)** has published **WIOJMS Volume 20, Issue 2 (2021)**. The issue contains the following articles:



WIOJMS is a research publication of the Western Indian Ocean Marine Science Association. It publishes original research papers or other relevant information on all aspects of marine science and coastal management as articles, reviews and short communications. [Submit your papers online here.](#)

[Download Volume 20 Issue 2 here](#)

- **Assessment of reef fish** and benthic cover of the North and South Dar es Salaam Marine Reserves system before the 2016 El Niño. Pagu Julius, Magnus Ngoile, Benaiah Benno, Milali Machumu and Nsajigwa Mbije
- **Carbon dynamics and sequestration by urban mangrove forests** of Dar es Salaam, Tanzania. Grace J. Masetta, Simon Mwansasu and Marco A. Njana
- **Composition and structure of the mangrove fish and crustacean communities** of Vanga Bay, Kenya. Caroline Wanjiru, Sonja Rueckert and Mark Huxham
- **Modelling spill over effects of a marine protected area** in the Western Indian Ocean. Riad M. A. Sultan
- **Distribution of organochlorine pesticides and polychlorinated biphenyls** present in surface sediments of the Sabaki and Tana estuaries, Kenya. Veronica, W. Wayayi, Eric O. Okuku and Boaz O. Ohowa
- **Seagrass restoration trials in tropical seagrass meadows** of Kenya. Jacqueline Uku, Lillian Daudi, Charles Muthama, Victor Alati, Alex Kimathi and Samuel Ndirangu
- **Improvement of live coral shipping conditions using an illuminated box.** Gildas G.B. Todinanahary, Antoine Batigny, Thierry Lavitra and Philippe Grosjean
- **Morphometric study of humpback whale mother-calf pairs in the Sainte Marie channel, Madagascar, using a simple drone-based photogrammetric method.** Maevatiana N. Ratsimbazafindranahaka, Emilienne Razafimahatratra, Robin Mathevet, Olivier Adam, Chloé Huetz, Isabelle Charrier and Anjara Saloma
- **Integrated approach to analyse benthic images from an autonomous underwater vehicle** deployed at Pemba Island, Tanzania. Kennedy E. Osuka and Swaleh A. Aboud



© SPGA has several rocky granitic islands



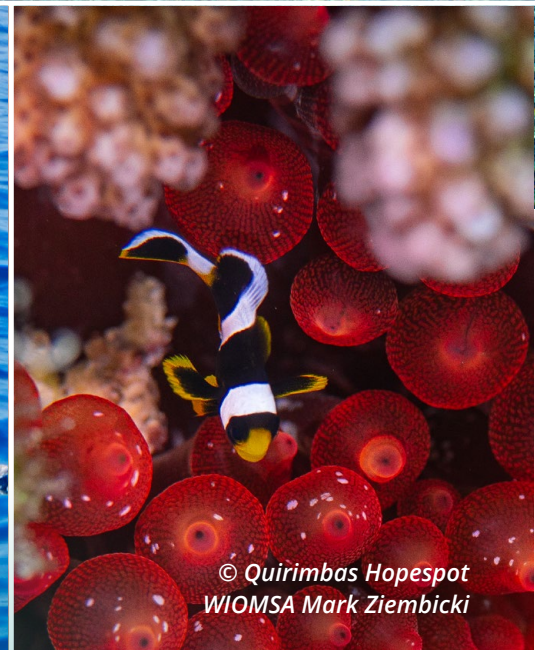
Best wishes for 2022



© Coconut crab at mpunguti island



© Bottlenose Dolphins



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