

BOOK OF ABSTRACTS

The Science *and* Research Symposium

A SEGMENT OF THE FIRST-EVER GLOBAL
SUSTAINABLE BLUE ECONOMY CONFERENCE

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A SEGMENT OF THE FIRST-EVER GLOBAL
SUSTAINABLE BLUE ECONOMY CONFERENCE

26th to 28th November, 2018

University of Nairobi, Kenya



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DISCLAIMER

This publication puts on permanent record, the abstracts that were submitted for presentation in the 'Science and Research' segment of the first-ever, global Sustainable Blue Economy Conference (SBEC) held in the City of Nairobi (Kenya) in November 2018. A separate synthesis publication of the presentations has also been published under the title, 'Science, Research and Innovation for Harnessing the Blue Economy'. The abstracts are solely the responsibility of the respective authors who submitted them and their publication does not purport to represent the views or the official policy of any government, any institution that participated in SBEC 2018.



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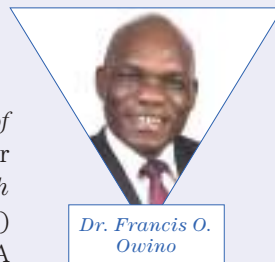
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Foreword

I am pleased to pen this introductory note to the *'Book of Abstracts,'* essentially, an important record of the paper proposals that were submitted for the *Science and Research segment of the Sustainable Blue Economy Conference (SBEC)* held back in November 2018, in our City of Nairobi-Kenya. A full-length book publication of some of the outputs from that segment of SBEC 2018, has already been released under the title, *Science, Research and Innovation for Harnessing the Blue Economy* (GoK and SEI, 2021).




Dr. Francis O.
Owino

As many may recall, that historic and first-ever serious attention to the global ecosystem and resource, currently canvassed as 'the Blue Economy,' was hosted by the Government of Kenya jointly with the Governments of Canada and Japan. Of Course, many other countries, Private Sector institutions and leading global CSOs chipped in as sponsors or co-sponsors of the various dimensions of the conference. Yet, the publication of this *Book of Abstracts* must also be seen as the culmination of our efforts to continue bringing to the fore, the important role of knowledge, including hard-core scientific evidence, to the policy table. It goes without saying, that as a global community, we must continue to invest in the Blue Economy's knowledge, and scientific dimensions as well as in actual investment opportunities, if we are to meaningfully harness its potential. We must, at the same time, remain protectors and custodians of the Blue Economy (Oceans and Inland waters), for the sake of both present and future generations.

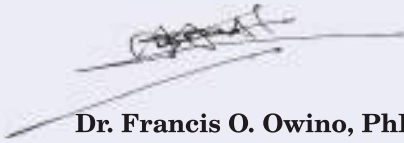
I am especially delighted that the scale and range of abstracts that were submitted and are featured herein, not only reflect the global reach of SBEC 2018, but more importantly, the significant scientific rigour that cannot simply be ignored. I believe that going forward, the book takes forward on its own merit, important scientific topics and themes that are critical to the sustainable harnessing of the Blue Economy.

Altogether, there were close to seventy abstracts submitted to the organising committee that was chaired by my colleague and predecessor in the Ministry, Prof Micheni Ntiba. As readers will see for themselves, each of the abstracts reflects insights, knowledge and critical scientific concerns that are unique. Above all, it is gratifying that Nairobi was able to attract reputable scholars and practitioners from all-over the world to reflect on and cogitate on academic issues touching on Blue Economy. The *Science and Research* segment itself was graced by a number of leading global luminaries and researchers who are active in Ocean studies and the Blue Economy space, generally. The issues featured range from reflections on the actual role of science and knowledge in harnessing the Blue Economy; the demystification of the very concept; infrastructure and marine spatial planning issues, as well as specific case-studies from a whole range of countries and experiences. Others touch on issues of inclusivity;



marine shipping and transportation; the role of the Blue Economy in climate change adaptation, especially in carbon sequestration -among others. It is my hope that those who are active in Blue Economy research in all its many facets and dimensions, will find this a useful addition and referral source.

Last but not least, I wish to thank our partners, the Stockholm Environment Institute-Africa Centre, Nairobi, for walking this journey with us and sponsoring the publication of the main book and this Book of Abstracts. I equally take the opportunity to record my sincere appreciation to the editorial team as well as to the organising committee of SBEC 2018 (Science and Research Symposium segment), for working tirelessly to ensure that this contribution also sees the light of day.

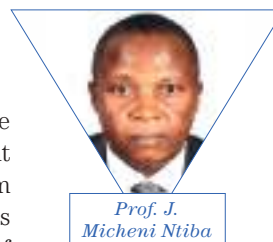


Dr. Francis O. Owino, PhD

Principal Secretary, State Department of Fisheries and Blue Economy
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Preface

The Science and Research Symposium of the Sustainable Blue Economy Conference (SBEC) was designed as a special segment of the main conference. Its core objective was to provide a forum for debating and sharing ideas on the complex scientific issues surrounding the Blue Economy and the potential contribution of academic and research institutions. Participants shared and discussed critical scientific and research topics and in instances, discussed new and cutting edge technological advances, including best practices that can inform the sustainable harnessing of the Blue Economy.




There is no gainsaying that institutions committed to excellence in teaching, learning, research and innovation, are pivotal to society's efforts in seeking to build a sustainable and prosperous future for humankind. Such institutions also play a vital role in training both current and future generations in the fields of natural sciences and technology. These fields provide the foundations for responsible development and the stewardship of marine and inland water resources. Specialized knowledge of how the oceans and inland water bodies work, is fundamentally important in making advances in marine technology, the sustainable economic development of marine and fresh water resources, as well as the protection of coastal and offshore environments.

Although academic and research institutions pursue targeted research which can foster discovery while also promoting the development of enabling technologies and management tools of immediate value, they must remain as centers for pure, curiosity-driven research. They must continue to serve as the reservoirs of scientific knowledge that may, or may not, have immediate application. They must also serve as the frontiers of new discoveries that will be required to sustain innovation and environmental solutions in the future.

As academic institutions and research institutions come up with innovative thinking and cutting edge technological advances and as societies develop, economic use of the ocean and inland waters expands and diversifies. Opportunities come from technological advances that if implemented in a framework of sustainability, can develop the nascent Blue Economy. For example, tides, waves and wind can provide green energy. Moreover, aquaculture, including new applications onshore and in open waters offshore, can potentially provide high-quality food to supplement capture fisheries produced in a sustainably manner. Modern technologies can be used to exploit previously inaccessible resources such as hydrocarbons and minerals in the deep sea and other extreme environments while advances in shipping technology can greatly increase the efficiency and safety of marine transport. The technologies can also help in reducing emissions and pollution, including unwanted transport of invasive species in ballast water.

New opportunities for uses of marine and inland water resources come with challenges, especially if long-term sustainability is not factored into the development and implementation of new technologies. In particular, it is imperative, but difficult, to minimize risks that are at the forefront of such developments today. For instance, the depletion of resources and degradation of ecosystems through overfishing or destruction of habitats. Or, pollution, including eutrophication, industrial wastes, endocrine disrupters and oil spills, as well as,



invasive species that can compromise industrial cooling systems, overtake ecosystems or interfere with aquaculture through toxicity or reduction of yields. At the same time, all these factors require to be considered in the context of other non-anthropogenic impacts such as coastal erosion exacerbated by storm surge, and the hazards of wind, waves, currents and ice in the broad range of extreme environments where marine operations are conducted. Global climate change further complicates risk management and environmental stewardship, because the economic use of marine resources is expanding rapidly while the ocean and its ecosystems are changing due to the natural variability that is increasingly influenced by human activities at the local, regional and global levels.

Academic institutions also have a unique role in establishing engagements and partnerships with the broader society; locally, nationally and internationally. The scope of engagement should also be broad and fostered through strong partnerships with government and non-governmental organizations; industry and other academic institutions, both nationally and internationally. Synergy is the hallmark of these partnerships. For ocean studies, new technologies, knowledge and management strategies are, as a result, leading to an improved framework for prosperous and sustainable relationships of humans with the oceans, seas and inland waters.

Speakers for the Science and Research Symposium submitted abstracts that were focused on the summarized four thematic areas derived from the nine (9) main Sustainable Blue Economy Conference main themes. The four thematic areas selected for the segment were the following:

- (i) *Sustainable Use of Resources*, including minerals, natural gas/oil, and fisheries for poverty eradication, job creation, and sustainable food supplies for humanity;
- (ii) *Climate Action Resilience*, including waste management, conservation of water resources and ecosystems, towards pollution free water bodies;
- (iii) *Global Connectivity and Transportation*, notably through shipping lines and considerations of maritime safety and security, as well as, sustainable regulatory regimes, and;
- (iv) *Blue Economy and Sustainable Cities*, with focus on issues of tourism, infrastructure and culture.

In addition to these selected main conference thematic areas, speakers also submitted abstracts that called attention to a key-related topic of concern identified as, Human Resources and capacities for research, innovations, technology and green shipping for ensuring the development of a sustainable Blue Economy.

As chair of the organising committee of the Science and Research Symposium segment of SBEC 2018, it is my hope that the publication of this book of abstracts will create an enduring record of the wide range of critical science and research issues, including technological innovation possibilities, that were flagged during that historic Conference.



Prof. J. Micheni Ntiba

Chair, Organizing Committee, SBEC 2018, Science and Research Symposium

1. Keynote Address: The Role of Science and Research in Advancing a Sustainable Blue Economy

1.1 New Challenges in Stakeholder Inclusive Development of the Blue Economy: The Case of Port Managing Bodies; Michael Doms, Vrije Universiteit

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The sustainable development of the Blue Economy raises multiple governance challenges, given its cross-cutting nature at the level of societal interests, and many sectors and docket within government involved and impacted simultaneously. Existing actors present in the blue economy's fields of application (ports, marine engineering and construction, maritime shipping,) are confronted with new opportunities for business development. On the other hand, for many of these organizations, expanding the scope of business and becoming active in other industries of the Blue Economy entails engaging with a new set of stakeholders, with different claims on both the specific environment as well as the organization itself.



An interesting case to explore is the case of Port Managing Bodies (also called Port Authorities). Multiple evolutions are simultaneously reshaping activities within port areas, beyond the traditional functions of cargo handling (in the broader framework of maritime logistics) and as a location for mostly heavy industries benefitting from a presence of the water (petrochemical industry, steel industry, etc.). Future drivers of port growth include: energy generation and facilitation of energy projects, food processing related to the Blue Economy, support for mineral extraction projects on the seabed, circular economy projects, among others.

However, Port Managing Bodies across the world have been and are still confronted with severe opposition from inter alia local community stakeholders when it comes to development of their infrastructure projects within the ‘traditional’ sphere of their operations, even if these contribute to sustainability objectives. Involvement in the Blue Economy is likely to further increase the risk and complexity on different levels, exacerbating the challenge of timely development of basic infrastructure. As the role of ports in Blue Economy growth increases, new stakeholder challenges will arise, and might further jeopardize the growth of their clusters. The many sectors involved in the Blue Economy will thus lead to the need to integrate additional stakeholder’s objectives in port cluster strategy formulation, evaluation and implementation. Existing stakeholders, such as marine engineering and construction companies, terminal operators, manufacturing companies but also local communities, will develop new claims towards port managing bodies as their role also changes.

The aim of this paper is to provide insights on the “blue stakeholder complexity” based on a number of concrete Blue Economy development cases, from a Port Managing Body perspective. The description and analysis of the case studies using stakeholder theory frameworks informs practitioners, policy and decision-makers of the need for adapted tools and processes of stakeholder inclusion for sustainable blue economy development. A research and development agenda towards the effective implementation of stakeholder-inclusive blue growth will result from the case study analysis. Finally, results and insights from the IAME 2018 conference held in Mombasa, of which the author was the lead scientific organizer, will also be briefly discussed.

This presentation links to the following themes:

- iii) Global connectivity and transportation via shipping lines, maritime safety and security and sustainable regulatory regime.
- iv) Blue Economy and sustainable cities, tourism, infrastructure and culture.
- v) Human resource capacity for research, innovations, technology and green shipping for sustainable Blue Economy development

2. Demystifying The Sustainable Blue Economy

2.1 | Blue Economy Development in Bangladesh: a Coordinated Effort

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The sustainability concept has been spread worldwide during the Rio Conference in 1992. Twenty years later, during the Rio+20, the Blue Economy one emerged. It originally encapsulated the notion of sustainability as it was derived from the Green Economy Concept developed by UNEP. Its application to the development of maritime activities and sectors in developed countries reduces progressively its capacity to contain this fundamental notion. In other words, BE and blue growth were mainly used to define the concerted development of economic activities in the ocean and coastal spheres. The more recent action towards the adoption of a BE strategy by coastal States and island ones (SIDS) brought back the sustainability in the heart of the BE as the maintaining of marine and coastal ecosystems was central. The adoption of SDG and more particularly the SDG14 on Life below Water (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) provides another justification for the inclusion of sustainability into BE development of countries, regardless their development stage. In that regard, the apposition of the word “sustainable” as a suffix of BE is pleonasm that has however the merit to remind that without healthy ocean and coastal ecosystems BE development cannot be done.



2.2 | **Building Partnerships to Develop the Scientific Research and Innovative Technologies that can Support Countries in the Achievement of Sustainable Ocean**

| Author: |

Vladimir Ryabin

UNESCO

On December 2017, the United Nations General Assembly proclaimed the UN Decade of Ocean Science for Sustainable Development. The Decade will strengthen the international cooperation (mobilizing partnerships and leveraging investment) needed to develop the scientific research and innovative technologies that can connect ocean science with the needs of society. It will provide a common framework to ensure that ocean science can fully support countries in the achievement of the 2030 Agenda for sustainable development, contributing not only to SDG 14 but also to all SDGs.

The Decade will stimulate both interdisciplinary understanding of ocean processes and solution-oriented knowledge research to generate new knowledge and address identified knowledge gaps. More coordinated and consolidated observation and reinforced data systems will contribute to fully comprehending the role of the ocean in the earth system, human interactions with the oceans (cumulative impacts) as well as the value of ecosystem services derived from the ocean. This enhanced understanding, based on effective communication of scientific knowledge, will also trigger and guide substantial technological developments and related transfer of marine technology (including modelling tools or new forecasting capabilities). The Decade will also improve the scientific knowledge base through capacity development to regions and groups that are presently limited in capacity and capability, especially SIDS and LDCs. The Decade will turn the scientific knowledge and understanding into adaptation strategies, science-informed policy responses and actions supporting improved ocean management, stewardship and sustainable development, contributing to UN processes protecting the ocean and its resources.

Through a regionally driven and inclusive process, the Decade will associate a wide range of stakeholders/societal actors (ocean science and technology community, governments and policy makers, businesses and industries as well as civil society and NGOs) to create new partnerships and applications, to support their efforts to develop a sustainable blue economy as well as to reduce pressures on the ocean, preserve and restore ocean ecosystems and safeguard ocean-related prosperity for generations to come.

IOC has been mandated by the UN General Assembly to prepare an Implementation Plan and to coordinate the preparation of the Decade and will conduct extensive consultations (through regional/global consultative and planning meetings) with these societal actors as well as UN partners and Members States to define the scientific priorities of the Decade.

2.3 | **Dead Zones to Clean Zones: Monitoring the Deep Ocean in Real Time, Scott McLean, University of Victoria, Canada**

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Ocean Networks Canada (ONC) is a not-for-profit society based at the University of Victoria that operates and manages innovative ocean observing infrastructure across Canada for science, industry and society supporting ocean discovery and technological innovation. With monitoring sites spanning hundreds of kilometers on the seafloor and down to depths of over 2.6 kilometres wired to the Internet in real time, the presentation will look at exploring extreme environments from a naturally occurring “dead zone” (hypoxic fiords) to pristine “clean zones” (Marine Protected Areas (MPAs)) far offshore from seamounts to hydrothermal vents.

Saanich Inlet on Vancouver Island is a naturally hypoxic fiord with annual renewal of high oxygen waters. The fiord has been monitored using remotely operated vehicle and the real time VENUS cabled observing system since 2006. The progression to hypoxic conditions, development of bacterial mats and the changes in flora and fauna are constantly monitored providing an excellent study site for anthropogenic dead zone sites around the globe.

ONC and Fisheries and Oceans Canada (DFO) are pioneering the development of tools for remotely monitoring MPAs in the northeast Pacific, hundreds of kilometers offshore. A collaborative data-sharing approach is being developed to support MPA planning, decision-making, and management. The Endeavour hydrothermal vent MPA has been monitored by ONC since 2010, will all activities within the MPA mapped in a GIS database. In 2018 ONC, in partnership with DFO, began a program to monitor remote seamount MPAs.

Data and imagery from ROVs, fixed subsea observatory sensors are archived in real time and accessible to the global research community over the Internet using ONC’s Oceans 2.0 software system, enabling the evaluation of decadal scale changes to natural ecosystems.



2.4 | Frugal Innovations as Pathways to Unlocking Sustainable Economic

| Author: |

Dr. Martin Thuo

IOWA State University

Development in low and middle income countries has largely relied on mining (dig, crush and grind economies), importation, technology adaptation, among other imbalanced and unsustainable approaches. Frugal innovation/engineering calls for minimization of complexity and maximization of function and has recently gained interest in addressing challenges with local abundant resources. At the core of this movement is simplification in process and outcome, and integration/translation of the needs of the bottom of the pyramid (BoP) clients to tackle upper market challenges. In this talk, the ability to develop global technical solutions through materials engineering will be discussed. Two case studies will be highlighted; Firstly, synthesis of environmental friendly, sustainable, bio-inspired amphiphobic fibrous materials for semi-permanent structures with concomitant water harvesting capabilities. This technology has potential application in low-cost housing. Biodegradability of the developed material minimizes waste accumulation while water harvesting provides portable water for the residents. Potential use of the produced materials in point-of-care diagnostics, emergency/temporary shelters, water harvesting, mechano-controlled wetting, and self-cleaning surfaces will be discussed. In the second case heat-free and lead-free liquid metal is discussed. The undercooled particles have potential applications in heat-free lead-free solders, additive manufacturing, and printed/flexible electronics. These solders not only improve workplace conditions for the BoP artisans but also address critical challenges in electronic packaging, energy demands and heavy-metal waste generation. Finally, a discussion of how understanding technological needs of the BoP can spur unprecedented innovations through a reverse Rogers diffusion of innovation curve will be highlighted based on the two examples above. Critical to this talk is highlight the role of creative, green, frugal innovations in mitigating waste generation and enabling new solutions in resource-limited settings – an important tool in mitigating overuse or pollution of our waterways.

2.5 | Israeli Experience in Sustainable Blue Economy Development

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Youth unemployment in African countries, both South and North is almost at 50%. Based on forecasts of population growth, this rate will only increase in the coming decade. On the other hand, in Israel, youth unemployment has been estimated at just 5% - 7%, thanks to the government policy of establishing incubators in which young entrepreneurs can commence their initiatives. Israel has agricultural, technological and scientific incubators in addition to the industrial and business incubators.

Agriculture in Israel has already gone high tech, for example the Israeli cow yields about 40-50 litres of milk per day. The production of dates; the average palm tree in Israel yields about 400 pounds of dates per year whereas the average in the rest of the Middle East and Africa reaches 35 pounds per year.

The development of advanced agriculture and high tech in Israel is due to the long-term investment in both education and capacity building. Galilee Institute has been cooperating with many universities and institutes in Africa to apply Israeli methods to increase both employment and agricultural output.

A similar approach was applied in the sector of water management. As Israel is mostly desert, we have developed very efficient conservation methods and reuse of water. Israel actually recycles at least 90% of its water. Most of our agricultural fields are irrigated with reused water. The world renowned, cost-efficient dripping system was also developed in Israel.

We, at Galilee Institute, are willing to develop educational, training programmes for implementation of Israeli methods to the African agricultural and industrial sectors. Already, as part of this policy agreement between Council of Governors and Galilee Institute was signed and 20 senior officials and experts from each county in Kenya are to be trained in Israel at the Galilee Institute. A follow up by the Institute's experts will ensure successful implementation. We can apply advanced agricultural methods which were developed in Israel and will multiply threefold, the agricultural output of African countries.



2.6 | A Study on the “Green” Contribution of “Blue” Economic Strategy, A Case Study on the Strategy of “Shandong Peninsula Blue Economic Zone”

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Evaluation of regional economic policies especially on environmental effects has gradually become a research hotspot. With the principle of green and sustainable development, “Shandong Peninsula Blue Economic Zone” Strategy plays an important role in boosting the regional economic growth of Shandong Province and is capable of promoting environmental protection of Shandong Blue Economic Zone theoretically. This article adopts the difference-in-difference(DID) method which can not only exclude the influence of other factors, but also eliminate the systematic differences in the blue economic zone before experiment, take the panel data of 17 prefecture-level cities in Shandong Province from 2006 to 2015 as the samples, empirically studies the “green” contribution to environmental sustainable development after the implementation of “Shandong Peninsula Blue Economic Zone” Strategy, empirically analyses the “green” contribution to environmental sustainable development after the implementation of “Shandong Peninsula Blue Economic Zone” Strategy and discusses the empirical and analytical methods of post-evaluation of regional economic policies so as to obtain an unbiased estimate of the net effect of the strategy. This paper articulates a negative effect of the “green contribution” of “Shandong Peninsula Blue Economic Zone” Strategy, because the implementation of the “blue” economic strategy ignores the “green” goals of energy conservation and emission reduction, resulting in the improper implementation of the corresponding measures in optimizing the energy consumption structure, intensifying the technological transformation of traditional high-energy consumption industries and comprehensively promoting green design and manufacturing. Furthermore, this article puts forward suggestions for promoting the effect evaluation of regional economic policies and implementing the sustainable development of “Shandong Peninsula Blue Economic Zone” Strategy. The experience of implementing Blue Economy Strategy in Shandong could be a good story for the development of Blue Economy in Kenya.

3. Investing in Blue Economy Research, Innovation and Human Capital

3.1 The Role of Scientific Research, Technology and Innovation for a Sustainable Blue Economy: The Irish Experience

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Ireland's relationship with the ocean is changing and evolving to embrace the blue economy. In 2012, the Irish Government published *Harnessing Our Ocean Wealth (HOOW) - An Integrated Marine Plan for Ireland*. HOOW sets out the Government's vision, high-level goals, and key 'enabling' actions that will allow Ireland's marine potential to be realised. One of the key enabling actions of the HOOW plan recognises the importance of scientific research, technology and innovation (RTI). This paper will focus on three key areas of the Irish marine RTI agenda that are critical elements of a sustainable blue economy. Area 1 - RTI strategy. In 2017 Ireland launched a new National Marine Research and Innovation Strategy (2017 – 2021). The strategy articulates three main goals; (1) raise the research capacity across all marine themes; (2) target funding to match the requirements of state policies and sectoral plans; (3) ensure a coherence in the approach to marine research. Area 2 - Sea bed mapping is crucial for management, conservation and sustainable development of our oceans. The Irish programme provides data products and services that support marine spatial planning, trains Irish graduates in seabed mapping which is applicable worldwide and develops added value products through engagement with small companies and the research community. Area 3 – Socio economic data – Ireland has strengthened the collation of marine socio-economic data to ensure the timely availability of marine socio-economic statistics. This provides an evidence base for policy and decision making, economic forecasting and scenario planning for the blue economy. The ocean is Ireland's new economic frontier. RTI activities will ensure a sustainable frontier through the generation of new knowledge about the ocean, the facilitation of better management and protection of marine ecosystems and the provision of the science that will support policy, governance, and the regulation of the blue economy.



3.2 | The Role of Higher Education in Advancing Science and Research in the Sustainable Blue Economy

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The role of Higher Education in advancing Science and Research in Sustainable Blue Economy

Higher Education institutions have a critical role to play through their mandate of advancing knowledge and furthering societal progress. They are therefore expected to be the moral visionaries and centres of excellence in Blue Economy. This will be possible by enhancing capacities for efficient exploitation and preservation of the health of oceans' ecosystem; preparing learners to deal with globalization challenges; and providing solutions, suggestions and advice on evidence-based policies and interventions, building on meaningful data to support sustainable development as well as enable effective systems of governance.

The success of higher education institutions in the twenty-first century will be judged by their ability to put forward a bold agenda that makes sustainability and the environment a cornerstone of academic practice. Therefore, as institutions of higher learning, the focus should be in contributing to improvement of human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities. Learning must serve to the needs of the diverse populations, economic empowerment, social inclusion, environmental conservation and to furthering international drives for sustainable development.



3.3 **Creating a Blue Economy Investment Facility: A Financial Mechanism in Support of the Sustainable Development of Coasts and Oceans**

Authors:

Felix Dodds and Chris Tomkins


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The Blue Economy – the sustainable use of oceans along with their coastal and estuarine hinterlands which embrace key sectors such as seabed mining, port development, fisheries, energy, and tourism – is a new frontier for sustainable investments. Governments, particularly in emerging economies, working in partnership with the private sector and other relevant stakeholders, and making full use of the substantial foreign investment flows and loans available, can get ahead of the game and guide coast and ocean development in a sustainable and profitable manner.

This Blue Economy approach is key to the development of coastal, oceans (and indeed lakes and lakeside) areas, putting growth, jobs and the natural resource base on a sustainable footing. Done well it has the potential to release the estimated 12 trillion dollars of oceans goods and services in a sustainable way.

To mobilize investment to address the challenges in the Blue Economy this abstract recommends the establishment of a *Blue Economy Investment Facility* which would be created by Member States, intergovernmental bodies the finance sector and other relevant stakeholders. The Facility would develop a pipeline of bankable projects that catalyze sustainable investment requiring close public-private cooperation. This cooperation would utilize the UNECE Guiding Principles on People-First Public-Private Partnerships (PPPs) for the United Nations Sustainable Development Goals (UN SDGs) to guide investment and projects.

In particular, the Facility could work with local and national authorities to produce a list of potential investment projects, screen the projects on do-ability, sustainability and financial criteria and focus on those projects that provide an economic return on investment. The Facility could also work with the regional development banks and large investors to replicate in the regions. Similar to other Facilities it could work with project proponents to further define pipeline projects and assess their feasibility.



3.4 **Success of KCDP and How Science can be used to formulate projects to benefit communities: Opportunities for Counties to Model Wealth Creation Using the KCDP Experience**

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The Kenya Coastal Development Project (KCDP) was one of the most uniquely designed donor-funded projects ever coordinated by the Ministry of Agriculture, Livestock and Fisheries. It was unique due to its many levels of multi-sectoral linkages, which brought together seven government implementing institutions namely Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Wildlife Service (KWS), Coast Development Authority (CDA), Kenya Forestry Research Institute (KEFRI), National Environmental Management Authority (NEMA), State Department of Physical Planning (SDPP), the Kenya Fisheries Services which was formerly State Department of Fisheries (SDF) as well as the six Coastal Counties. The project was funded by the World Bank through the International Development Authority and the Global Environmental Facility.

The KCDP strived to transform the coastal communities through the community driven development grant programme known as *Hazina ya Maendeleo ya Pwani* (HMP) which supported communities to implement small scale projects that could transform their lives. The KCDP support reached over 350,000 beneficiaries in the Coastal Counties. Several interventions in the project were anchored on the use of scientific innovations to support community development. The presentation will highlight the different models used in KCDP and the lessons learned that can be taken up by counties to enhance community development at the grass root level.

3.5 | **Human Capital: the Key to Unlocking the Fisheries Potential of Africa's Blue Economy**

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In the context of Africa's Blue Economy discussion about fisheries tends to focus on illegal fishing of African waters by foreign industrial fleets. This focus almost completely obscures the issue of addressing the collapse of Africa's coastal and lake fisheries. To date the ABE focus on fisheries has been on the tip of the iceberg and not the massive iceberg itself, so it wrongly prioritizes issues and solutions. Mis-directing attention to the need for international and big-government solutions, and missing the main low hanging ABE fisheries fruit. In most African fishing nations of most (75 -95%) potential seafood production comes from coastal and lake communities, dwarfing offshore potential. Besides providing the food security for millions, coastal fisheries also support local tourism and infrastructure, and on international markets their production has 3-5 times the value off-shore of snap-frozen white fish. Generally the offshore fisheries have little relevance to the much more valuable coastal fisheries.

Working with fishing communities and agencies to develop the human capacity needed to stabilize and rebuild coastal and lake fisheries, and then fostering value adding through supply chains, will add orders of magnitudes more value to Africa's Blue Economy, than stopping the industrial theft of deep water white fish.

Until recently, top down and overly technical fisheries science had no solutions to assessing and managing community based fisheries. But recently developed simpler techniques work by empowering local fishing communities and governmental agencies to make local assessment and management possible. Applied broadly through Africa to develop existing human capital through fishing communities and agencies the technique could initiate a grassroots social process capable of spreading organically between communities, progressively stabilizing and rebuilding local fish supplies, to support local and international markets for the benefit of nations.

3.6 Coastal Index of Vulnerability to Climate Change by Economic Zone (CIVEZ), Andrew Stewart, Fisheries and Ocean, Canada

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Both ocean temperature and relative sea-level are projected to increase significantly in Atlantic Canada over the 21st century. The overall goal of this project is to provide information at a scale that is meaningful to fishery managers and coastal policy makers in the region. To that end, we assessed commercial fish vulnerability based on defined economic zones. We combined fish vulnerability scores with a parallel process that assesses adaptive capacity/vulnerability of coastal communities to sea-level-rise and storm surge, to create the Coastal Index of Vulnerability to Climate Change by Economic Zone (CIVEZ). Overfished species on the warmer, southern edge of their range are the most vulnerable to warming. Northern economic zones are expected to benefit from climate-driven warming because thermal habitat for lobster, a valuable fishery in Atlantic Canada, will expand. At the scale of economic zones, decision makers can use CIVEZ to develop informed coastal adaptation plans within their jurisdictions. Officials at higher levels of governance can use CIVEZ to prioritize resources towards vulnerable economic zones.

4. The Role of Science in Infrastructural Economics and Marine Spatial Planning

4.1 The role of marine spatial planning in helping provide the underpinning analysis, decision making and structure for economic investment

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New Zealand regulators have considered (and declined) two applications for deep sea mining in its Exclusive Economic Zone:

1. Trans-Tasman Resources proposed mining up to 50M tonnes of iron-rich sediment per year with 5M tonnes of iron ore concentrate extracted and remaining sediment redeposited.
2. Chatham Rock Phosphate proposed mining >35M tonnes of phosphate at 400-500m water depth; ~60,000 tonnes per day to be extracted and processed, and ~40,000 tonnes per day of fine sediment (<2mm) redeposited on the seafloor.

The paper will examine common challenges and possible solutions for all parties involved: regulators, applicants, affected sectors and stakeholders, indigenous people. Key themes of relevance to sustainable development of the blue economy include:

Impacts on Existing Interests and the need for Marine Spatial Planning

The influence on existing uses and interests (e.g. fisheries, marine mammals, MPAs) is very important. This includes sediment movement, ecotoxicological effects, ecosystem responses, economic tradeoffs and uncertainty in decision making. Regulators should undertake marine spatial planning to identify locations and priorities for all users of the ocean environment.



A Precautionary Approach – balancing uncertainty and adaptive management

Balancing uncertainty with the need to make decisions in a very deep, poorly understood ocean environment is a massive challenge. Limited baseline information leads to a reliance on modeling, with a decrease in certainty about current state, or environmental impacts of future mining. A truly adaptive approach is nearly impossible given the capital investment required to begin the mining process requires certainty for investors.

Newness and understanding impacts

It is vital that we provide for “newness” in emerging technologies and practices in the blue economy such as deep sea mining. The fact that an activity is new might be positive, with economic benefits that outweigh environmental costs. Having adverse effects is acceptable; but understanding, communicating and managing them is key, alongside balancing impacts on other uses.

4.2 | **Governing The Land-Sea Continuum: Role of Spatial Planning in Controlling Pollution for Sustainable Management of Kenya's Coastal and Marine Zone**

| **Authors:** |

Philip Olale, Collins Odote, Robert Kibugi

Kenya's coastal and marine ecosystems constitute a rich and diverse national asset that supports the livelihoods of 2.7 million coastal communities and contributes to the national economic development. Coastal and marine ecosystems in Kenya continue to experience unprecedented contestation between various needs including economic interests, social and environmental concerns. To regulate the impact of the resulting land and sea/ocean use contestations, Kenya has put in place considerable effort in policy and statutory frameworks. However, the governance framework has not been effective in overcoming conflicting or incompatible goals, controlling pollution and eventually realizing sustainable management. This paper takes the position that this challenge is compounded by a sectoral approach to spatial planning, enforcement and management of the coastal marine ecosystem, which is characterized by a raft of institutions with varying and sometimes conflicting mandates. Consequently, physical development has often not mainstreamed environmental concerns, resulting in degradation of environmentally sensitive areas, loss of beach access points, beach encroachment and shoreline erosion. Therefore, the paper argues that integration of land and sea use spatial planning systems is germane for a sustainable blue economy.

Keywords: *Coastal Marine Ecosystem, Land Use, Land Use Planning, Sea Use, Marine Pollution, Land-Based Sources of Marine Pollution, Marine Spatial Planning*





4.3 | Science Infrastructure as Catalyst for Education and Economic Development

| Author: |

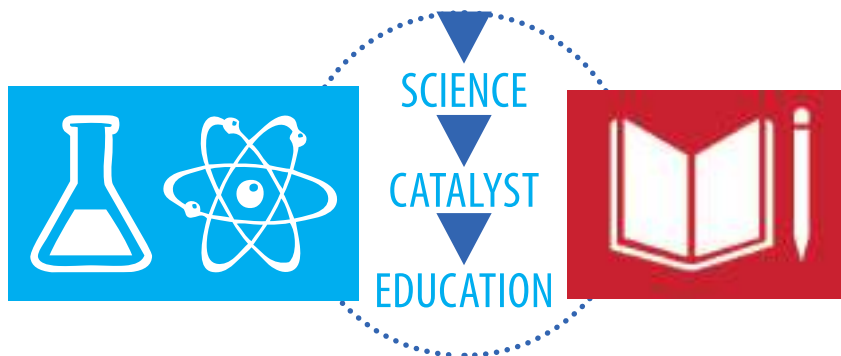
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Modern scientific research depends on increasingly sophisticated infrastructure which can be problematic to establish and maintain, particularly in less developed countries. In the case of environmental research, including ocean- and climate-change-related research, this has led to a serious lack of infrastructure for globally-relevant research in key parts of the world, including in much of the African continent. The establishment and operation of scientific infrastructure has, however, been shown to be capable of supporting economic development via both direct and indirect effects: the siting of national laboratories in remote regions of the continental USA after the 2nd World War is a classic example. The development of science infrastructure in less developed countries has the potential to be win-win, through provision of critical information and knowledge in important regions of the planet and simultaneous creation of an environment that can support technical training, education and innovation.

Getting the connections right is, however, not trivial and involves a great deal of discussion and mutual understanding between scientists and educators from northern and southern countries. I will discuss the historical development of one such international infrastructure for ocean and atmospheric science on the island of Sao Vicente in Cabo Verde. The focus will be on the origins of the idea for shared infrastructure and the challenges and successes encountered during its development.



4.4 | **The Role of Marine Science in Blue Economy: The Experience of Western Indian Ocean (WIO) Region**

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Planning and implementation of the blue economy initiatives require several tools and opportunities including area-based management (ABM) and land and marine spatial planning; ecotourism; green ports; common fisheries policies; and periodic reporting and assessment of the state of the marine environment. For effective utilization of these tools and opportunities, knowledge and innovation using science-based decision support and knowledge management systems and addressing information needs and gaps through focused research, are essential for achieving blue economy.

In the past two decades, the WIO region has seen a significant increase in scientific research on various aspects of the marine and coastal environment, its resources and people at a local, national or regional level, as summarized in the WIO Regional State of the Coast Report (UNEP-Nairobi Convention and WIOMSA, 2015).

The data and information required for blue economy development is being generated by different institutions, for diverse purposes, in many different formats and with varying access policies. This makes the determination of the existence of and the capacity to use large-data sets critical. This paper draws on regional experiences to discuss how results from scientific research have or have not been used for the development of blue economies. The reasons for these scenarios are also be discussed.

Several recommendations are given on how the highlighted challenges are resolved through data management at the project/institutional levels during the implementation of and after completion of research projects.

5. Concurrent Breakaway Sessions

5.1 Education and Building Capacities

5.1.1 The Inclusive Blue Economy: Integrating Humans and Nature into Ocean Science for Management, Governance and Opportunities

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Humans are intimately connected to the Ocean, which is fundamental to life on earth, providing essential goods and services. Ocean ecosystems are dynamic, in a state of continual change and offer promise for future benefits through Blue Growth. However, the Ocean has traditionally been considered as vast and inexhaustible and our actions have led to numerous negative impacts on our oceans, coastal areas, coastal communities and marine-based businesses. How do we plan for Blue Growth while avoiding adding to these negative impacts?

Until recently, the major threat to ocean ecosystems was fisheries over-exploitation and we essentially failed to use science advice to manage ocean use for healthy, productive ecosystems. Now we have the additional threat of climate change and the opportunities of Blue Growth. Clearly there needs to be change in the way we do science writ large, what we consider as science, how we provide science advice, in the way that advice is used, how ocean ecosystems are governed, and in the governance structures themselves. There is a complex set of interactions, at multiple levels, between the natural, social and governing systems. In order to address the challenge of reconciling human use of the oceans and global change, we need to develop understanding of these interactions, their key drivers, impacts and responses. Approaches must necessarily be inter- and transdisciplinary, from local to global and at multiple scales. However, there are still major disconnects between natural and social sciences, science and

policy, and public perception of global change, its causes and the “reality” of change. Our challenge is to address these disconnects and develop approaches to account for and to integrate both humans and nature into ocean science, management, and governance to provide the opportunities offered by Blue Growth. This presentation draws on Canadian and international experience to offer ways forward.

5.1.2 Knowledge Management and the Blue Economy; an Exploratory Research

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The Blue Economy presents an untapped growth frontier for the emerging and developing Economies. Knowledge management aspects such as the knowledge Economy and Knowledge alliances present solid pillars for Africa’s Blue Economy development. Knowledge alliances motivate organizations to enter into strategic alliances with other firms in order to balance knowledge deficiencies, obtain necessary competencies and or create new knowledge. Knowledge economy theory describes the need for professional support in organizations and is concerned with the This paper examines the nexus between knowledge and management and Blue Economy with a view to establishing the linkages. In addition, it focuses on evidence-based research in exploring the knowledge management practices in Kenya’s blue economy with a view to documenting the practices. The paper does a comparison of practices in other developing and developed countries and recommends future strategic knowledge management directions that will catapult the growth of the Blue Economy. Production and distribution of knowledge a commodity for consumption within the organization’s value chain. It is also concerned as with knowledge as a direct product of the value chain to be marketed outside the organization.

5.1.3 Aquaculture for Food Security: Role of Academic and Research Institutions in Promoting Blue Economy

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Aquaculture is the fastest growing food production sector with an average annual growth of 9% over the past three decades (FAO, 2016). Yet sub-Saharan Africa lags behind with a production level that has stagnated at about 1% of the world production in spite its vast freshwater and marine resources. This is mainly because current aquaculture systems in Africa are largely traditional, extensive and operate below capacity. Until recently government policy in most African countries addressing the various problems was incoherent and resulted in rather scattered initiatives. Policy makers and research entities in Africa, as well as donor organizations, are now increasingly aware of this situation, especially in view of the aggravating food security situation in many countries. Kenya has had an unprecedented growth of aquaculture in the last few years as a result of the implementation of its National Aquaculture Development Strategy. Through the Economic Stimulus Program, which costed the government over 80 million US dollars, aquaculture was revamped from a production of 4,000 MT in 2008 to over 22,000 MT in 2014. Although the country has a potential of 14million MT annually and targets to achieve a production of over 100,000 MT in the short and medium terms, the latest statistics show a drop in the production to 15,000 MT by 2016. There is therefore need to invest in research in order to improve production through diversification of farmed fish species, genetic improvement, intensification of present systems, diversification into new more intensive systems, reduction of post-harvest losses and increased value addition and promotion of fish consumption. But even more importantly, development of the relevant expertise at both academic and vocational level is crucial to support the industry. In this paper we shall explore the role of academic and research institutions in enhancing and maintaining aquaculture production in Kenya.

5.1.4 Building Capacity for Climate Change Mitigation and Adaptation through Mainstreaming Climate Change in Curricula of Tertiary Training Institutions in Africa

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Climate variability and change, which intensified since 1970s, is threatening natural resources and livelihoods in Sub-Saharan Africa where people depend on climate sensitive natural resources, such as agriculture and fisheries, but have limited capacity to adapt. Increasing human and institutional capacity for sustainable blue economy requires building capacity to generate and disseminate information and knowledge on threats such as climate change, its impacts, adaptation and mitigation through research, education and



raising awareness. Most tertiary training institutions in Africa have curricula covering basic and applied natural resources conservation but with less emphasis on the blue economy and climate change. This paper presents a training curriculum and manual that was developed to address these gaps. The purpose is to provide in-depth information on how Climate Change can be integrated into the fisheries and aquaculture curricula of tertiary training institutions. The aim is to mainstream climate change in fisheries training. The specific objectives are to facilitate introduction of climate change in fisheries training in Uganda that can be adopted by other countries in Africa and elsewhere; Equip students with scientific and technical capacity to anticipate and evaluate changes in climate and its influence, communicate information to stakeholders, design, and test adaptation strategies and mitigation measures; and Increase human resource capacity to address blue economy and climate change issues. The curriculum consists of seven modules covering that will be delivered through lectures, discussions, case studies and field visits. It is recommended that the curriculum and manual be incorporated into training programs of tertiary training institutions to build the capacity required to address climate change challenges particularly for fisheries in Africa.

5.2 | Aquaculture Resources

5.2.1 Advanced Aqua Farm with Food and Economic Security

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-
- 1- Modern advanced systems for growth fish in RAS (recycling aquaculture system) technologies, enabling high productivity with an emphasis on environmental protection
 - Intensive system
 - Super intensive system
 - 2- “central farm” model that enables improvement of: food security, economic security, and agricultural technological education
-

5.2.2 Aquaculture –Plans for Africa

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Aquaculture has been the fastest growing food production sector in the World over the past decades. Production volumes are at par with or in some cases surpass capture fisheries as a source of fish for human consumption. In recent years, Africa has seen a surge of growth in aquaculture production driven by investment by private sector and a renewed interest by African Governments. However, while other regions predict increased per capita fish consumption, Africa is likely to maintain or lower its fish



consumption levels if constraints to aquaculture development are not tackled. This paper explores historical trends and drivers for aquaculture growth, and indicates that although Egypt and Nigeria are by far the largest aquaculture producers with Egypt being the third largest producer of tilapia in the world, growth in aquaculture is still restricted to a few countries. It discusses the influence of policy and regulatory frameworks, national strategies, role of science and technology application, and capacity building on continent-wide efforts by different actors. It highlights contributions by African Union, African Development Bank (AfDB), International Fund for Agriculture Development (IFAD), WorldFish, World Bank, European Union, Swedish International Development Cooperation (SIDA), FAO and others on growth trends in the subsector. It discusses Africa-wide and regional plans for aquaculture growth and concludes that Africa is at the verge of a Blue Economy revolution that it must seize for further accelerated growth of aquaculture across the continent.

5.2.3 Sustainable Aquaculture in the Blue Economy

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Integrated agriculture-aquaculture systems in China have been practiced for ages. These practices have not only provided protein food for the world-wide consumers, created job opportunities, but also been a “food-saving”, “water-saving” industry. The present paper will show both conventional agriculture-aquaculture systems and the most recent-improved technologies of the Chinese experience on aquaculture as well. The systems are effective for both aquaculture activities but also minimal use of water for maximal fish production through various bio-approaches of the water treatment. The paper will in details analyze the successful examples of flow-through system, Open RAS system with a minimal consumption of water sources. Keywords: integrated agric-aquaculture, water and food-saving, flow-through systems, Open RAS.

5.2.4 State of Cage Culture in Lake Victoria, Kenya

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Capture fisheries and aquaculture have remained important sources of food, nutrition, income and livelihoods to millions globally, with annual per capita consumption of fish in developing countries having increased from 5.2 kg in 1961 to 18.8 kg in 2013. In the contrary, low income food-deficit countries (LIFDCs) annual fish per capita consumption rose from 3.5 to 7.6 kg against 26.8 kg among industrialized countries. Between 2000 and 2011 Kenya recorded a decrease in the per capita fish consumption from 6.0 to 4.5 kg, a factor closely linked to low capture and aquaculture fish output (fisheries and aquaculture contributing paltry 0.8 percent to the country's GDP) against a growing population. Increased demand for animal protein and declining capture fisheries has seen aquaculture grow rapidly than any other food production sector over the past three decades accompanied with considerable social and economic benefits. The contribution of aquaculture to the world total fish production reached 43.1%, up from 42.1% in 2012. The rapid global aquaculture growth is directly related to technological advancement and levels of technological adoption and adaption specifically in the Asian continent. This has seen most developed and developing countries transit from semi-intensive to intensive and super intensive aquaculture production systems. The advancement has further seen an increase in use of race ways, re-circulating systems and use of automated aerators in ponds. In light of the Blue Economy potential, cage culture is fast gaining prominence in aquaculture production contribution. It is based on the investment and production scales, ease of management and underlying economic benefits that the Lake Victoria Kenyan side has since 2009 experienced a rapid growth on cage investment. This began with trials at Dunga and Obenge beaches by the Fisheries Cooperative Societies under the Beach Management Units (BMUs) in Kisumu and Siaya Counties respectively. However there has been limited documented success on these trials. Nonetheless, cage culture



picked up in the lake in 2012, through a participatory research approach by KMFRI who engaged Dunga BMU using locally fabricated mild metal frame cages (8m³) with great success. This later attracted interest resulting in the current 3696 cages across the five riparian counties with an estimated production capacity of 3,180 MT valued at Kshs 955.4 Million (9.6 million USD). Cage Culture in L. Victoria has created over 500 jobs directly and indirectly created income opportunities for over 4,000 people in rural and urban settings. Siaya County accounted for 85% (n=3141) of the 3696 cages documented. Cage construction materials included wooden, PVC, mild and galvanized metals and HDPE pipes with mild and galvanized dominating across the 5 counties. The sub-sector's value chain, its supportive value chains and associated enterprises are rapidly expanding thus creating jobs, enhancing incomes and ensuring food security in rural and urban areas. To commercialize cage culture activities, technological investment and its associated enterprises are gradually experiencing adaption to overcome competition from capture fisheries and imported fish. As cage culture commercialization takes root in Lake Victoria, there is urgent need to address issues such as conflicting interests in shared resource, introduction of exotic culture species, disease and parasite invasion, marine parks, and maximum carrying capacity among other aspects. This will require a trans-boundary and cross-border policy in light of devolution and the neighboring countries to ensure sustainable utilization of the lake as a common resource.

5.2.5 Ocean-Inspired Protein Sources for Human Nutrition

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For more than 75 years, the National Research Council Canada (NRC) has maintained world-recognized biomarine and agricultural research facilities and scientific expertise. These capabilities are currently being deployed to support Canada's Ocean Supercluster initiative based in Eastern Canada, and the Protein Industries Canada

Supercluster initiative based in the Prairies. NRC's R&D experience on both land and sea provide a unique view that spans marine and land-based food production. Many opportunities are now emerging in the space where these environments intersect.

Traditionally, when humans looked to oceans for food, they were essentially harvesting protein in the form of fish. Today we understand that sustainability issues limit the amount of protein we can obtain this way. We now use coastal regions for aquaculture – but the provision of fish feed, and especially its protein component, remains an issue – and offers opportunities for bridging land-based agriculture with aquaculture. We can also cultivate marine species, including algae, on land thus further blurring the land/marine divide.

This presentation will provide a review of some of the complexities of cycling between marine and land environments to supply sustainable sources of protein, and will offer insights into relevant National Research Council Canada initiatives.

5.2.6 Current Experimental Observations Making Kenyan Aquaculture Sector's Contribution to Poverty Reduction Insignificant

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Aquaculture has expanded considerably in Kenya since 1992, with the introduction by the Kenya Government of the Economic Stimulus Programme. The sector relies mainly on Nile tilapia, the Common Carp and the North African Catfish, produced by extensive, semi-intensive and intensive culture methods. More than 70% of aquaculture farms in Kenya and in the study region, rear Nile tilapia by semi-intensive culture. Currently, the sector is facing a decline due to factors that this study aimed to unravel. To obtain the information required for the analysis, the Project relied on literature review, semi-structured questionnaires, interviews, focus group discussions and observations in



Bomet, Kericho and Nakuru Counties, in the Rift Valley Region of Kenya. Eighteen farms, rearing Nile tilapia by semi-intensive culture, and using on-farm formulated feeds were purposively selected for the study. Three of the farms, one in each County and using commercial feeds, were part of the study. The project examined on-farm feed formulation methods; analyzed the composition of the formulated feeds; the manner of ingredient and feed handling and feeding practices, some aspects of production costs, extension and training service provision, and fish marketing, were also examined. The project established that the high cost of commercial feeds, drove farmers to on-farm formulation of fish feeds, most of which did not meet the nutrient requirements of grow-out tilapia. Commercial feeds manufacturers are located in the cities, thus making rural aquaculture enterprises incur high feed transportation costs. Some of the commercial feeds did not meet the Official Kenya nutrient Standards for grow-out tilapia. The project established that farmers are not getting appropriate education to enable them run the enterprises profitably. Moreover, most fish take more than 1 year, and some as long as 2 years to reach table-weight, making them unaffordable. From the results of this study, we recommend that the State Department of Fisheries be elevated to a Ministry, which should make aquaculture a major operational and results area. Also, Counties should place emphasis on aquaculture as a strategy for poverty reduction among its resident farmers, with the keen support of the Ministry. We recommend that credit to farmers or subsidy of fertilizer, seed, feeds, etc. be provided, alongside appropriate extension services, and aggressive marketing of fish to consumers; Scientific feed formulation, and good animal management and business practices should be emphasized, if the sector has to contribute significantly to poverty reduction.

5.3 | Pollution – Free Water Bodies

5.3.1 | Minimizing Heavy Metals in Landfills and Waterways Through Unique Commercially Viable Approaches

| Authors: |

Dr. Christophe Frankiewicz, Dr. Martin M. Thuo

In 2014, 23 million metric tons of metallic wastes were generated in the US. In addition, >4 million metric tons of metal-containing e-wastes with >\$20 billion of precious and rare metals entered the waste stream [1], [2]. Copper, one of the most common materials, is recycled or reinjected in the manufacturing stream at a recovery rate of only »28%[3]. Indeed, the recovery rate for indium, a critical material (i.e., a chemical element at high supply risk) used in electronics applications, is even lower, at <1%, similar to that of other critical materials. Current metal extraction technologies face important limitations, including inefficiency, high energy-cost [4] and environmental concerns, that prevent higher recycling rates. Sep-All LLC provides a novel low-heat technology platform enabling the extraction of metallic elements from waste streams while adding a value to the materials through their conversion into high-value micro- and nano-materials (MNM). The technology combines two inventions: an extractive metallurgy technology and a micro- / nano-materials fabrication process.

This low-heat extractive metallurgy process has been patented at Iowa State University (ISU) by the two co-founders of Sep-All (US application #: 62/493,109[5], option agreement signed between Sep-All and ISU). The technology exploits interfaces to control metastability across a material, leading to either frustrated solidification (stabilized undercooling [6]) or phase-evolution and de-mixed high-energy states, which is the basis of SCRAPS™, Sep-All's technology (SCRAPS = Stress and Chemical Reactivity Assisted Process for Separation) [7]. By exploiting the effect of surface-applied stresses (thermodynamic, mechanical and chemical) on the bulk of a mixed material, we are developing a method to de-mix a material by maintaining it far from equilibrium (dynamic), allowing us to navigate its energy landscape far from the limitation of Gibbsian thermodynamics, and therefore attain de-mixing.

To maximize the effect of interfaces on the SCRAPS™ separation process, experimental studies were carried at the micro- and nano-scale (as the particle diameter d is reduced, the surface area increases, as $1/d^2$). A felicitous choice of chemical solvents enables the control of phase re-organization during separation of the “frustrated” materials, resulting in the formation of controlled unique MNM shapes.

Sep-All innovations have great potential to have a direct impact on the worldwide blue economy and society by decreasing the contamination of landfills with heavy metals. Sep-

All provides a solution minimizing the pollution of water sources by offering a low-carbon-footprint solution with non-toxic reagents, and a higher efficiency compared to smelting and leaching, the two current processes largely responsible for the industrial pollution of rivers, lakes, seas and oceans.

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5.3.2 Adaptive Management to Coral Reef Systems in Kenya: Addressing Pollution

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Cornelius Were Okello

Sustainable development and exploitation of Kenya's marine resources is necessary when focusing on the achievement of the UN summit of Sustainable Development Goals and the country's Vision 2030 plan. Coral reefs play a vital role in sustaining the country's economy in terms of income generation from tourism and fisheries and creating job opportunities for many coastal communities. However, unregulated coastal developments together with expanding human population have been shown to threaten these ecosystems. Nutrients released from the discharged poorly treated and untreated urban and industrial wastewater into the coastal and marine ecosystem have contributed to destruction and degradation in coral reef systems by reducing water quality and enhancing growth of macro algae. Changes in reef conditions will affect their ability to provide ecosystem services (ES) that sustain human livelihoods. Conservation and management are therefore, necessary

to ensure maintenance of the integrity of these systems and improve ES provisions. This study looks at water quality in terms of nutrients quality and quantity and examines the coral reefs health as well as algal coverage along Mtwapa Creek, Mombasa Marine Park and Mombasa Marine Reserve exposed to different nutrient sources in the Kenyan Coast, particularly raw sewage from Shimo La Tewa Prison. Furthermore, the research proposes management intervention to save coral reefs in the region; involve local communities through education and awareness creation on the need for waste management, and the impact of urban waste on reef systems and champion management practice change in priority areas

5.3.3 Decarbonization Pathways for International Maritime Transport: A Model-Based Policy Impact Assessment

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International shipping has finally set a target to reduce its CO₂ emission by at least 50% by 2050. Despite this positive progress at the International Maritime Organization (IMO), this target is still not sufficient to reach Paris Agreement goals since CO₂ emissions from international shipping could reach 17% of global emissions by 2050 if no measures are taken. A key factor that hampers the achievement of Paris goals is the knowledge gap in terms of what level of decarbonization it is possible to achieve using all the available technologies. This paper examines the technical possibility of achieving the 1.5° goal of the Paris Agreement and the required supporting policy measures. We project the transport demand for 6 ship types (dry bulk, container, oil tanker, gas, wet product and chemical, and general cargo) based on the Organization for Economic Co-operation and Development's (OECD's) global trade projection of 25 commodities. Subsequently, we test the impact of mitigation measures on CO₂ emissions until 2035 using an international freight transport and emission model. We present four possible decarbonization pathways which combine all the technologies available today. We found that an 82–95% reduction in CO₂ emissions could be possible by 2035. Finally, we examine the barriers and the relevant policy measures to advance the decarbonization of international maritime transport.

5.3.4 Global Ocean Acidification Observations Support the Sustainable Use of Marine Resources,

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The Sustainable Development Goal 14 aims to “*conserve and sustainably use the oceans, seas, and marine resources*”, and consists of 10 targets. The Global Ocean Acidification Observing Network (GOA-ON) is particularly involved in supporting countries to achieve [Target 14.3](#), which aims to “*minimize and address the impacts of ocean acidification, including through scientific cooperation at all levels*”. GOA-ON currently has almost 500 members from 80 countries and coordinates the development of sustained ocean acidification observing systems from local to global scales. GOA-ON and partners organise international meetings and capacity-building workshops, which include technical training, lectures and providing some sensing equipment (‘GOA-ON in a box’) to scientists. The development of regional collaborative hubs e.g. the Latin American Ocean Acidification Network (LAOCA) and WESTPAC, are significant achievements that are bringing together local expertise to tackle the issue of ocean acidification.

The SDG Target Indicator 14.3.1 calls for “average marine acidity measured at an agreed suite of representative sampling stations” (IOC-UNESCO is the custodian agency). This methodology provides detailed guidance to scientists and countries in terms of variables to measure and how, best practices guidelines established by the ocean acidification community. It also provides recommendations on how to report the collected information in a manner that ensures it is transparent, traceable and can be utilised in a global comparison of pH measurements. Through this process, GOA-ON directly contributes to

the achievement of SDG Target 14.3. The collective expertise of GOA-ON in science and policy ensures the development of a guiding vision for the collection and sharing of ocean chemistry data, which in the future will extend to biological data.

5.3.5 The Economic Implications of Ocean Acidification on Shellfish Fisheries and Aquaculture: UK Case Study;

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Shellfish harvesting accounts for over $\frac{1}{3}$ of total fisheries landings by value in the United Kingdom. Contributing over £400 million each year, shellfish aquaculture and wild-capture shellfish fisheries are important economic drivers in the UK. Ocean acidification could affect some of these species, affecting their survival as some of their shells could be affected by low pH conditions. Applying the net present value (NPV) and partial equilibrium (PE) models, we estimate both direct and economy-wide economic losses of shellfish production by 2100. Estimates using the NPV method show that the direct potential losses due to reduced shellfish production range from 14% to 28% of fishery NPV. This equates to annual economic losses of between £3 and £6 billion of the UK's GDP in 2013, for medium and high emission scenarios. Results using the PE model showed the total loss to the UK economy from shellfish production and consumption ranging from £23 - £88 million. The results from both the direct valuation and predicted estimate for the economic losses on shellfish harvest indicate that there are regional variations due to different patterns of shellfish wild-capture and aquaculture, and the exploitation of species with differing sensitivities to ocean acidification. These results suggest that the potential economic losses vary depending on the chosen valuation method. This analysis is also partial as it did not include a wider group of species in early-life-stages or predator-prey effects. Nevertheless, findings show that the economic losses to the UK and its devolved administrations due to ocean acidification could be substantial. We conclude that addressing ocean acidification with the aim of preserving commercially valuable shellfish resources will require regional, national or international solutions using a combined approach to reduce atmospheric CO₂ emissions and shift in focus to exploit species that are less vulnerable to ocean acidification.

5.3.6 Metagenomic Assessment of Anthropogenic Impact on Marine Microorganism: Applications for Sustainable Marine Resource Management

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The coral reef biodiversity in the Western Indian Ocean (WIO) is the second largest globally, presenting a huge potential wealth for the WIO region due to the significant economic role played by oceans through provision of food, jobs, tourism and fisheries. However, the Blue economy potential of the WIO region remains largely untapped. In Kenya, for instance, the marine resources earn the country only ≈US\$ 2.5 billion annually, accounting for less than 4% of the GDP. Research is critical for a holistic understanding of the marine ecosystems which is requisite in informing sustainable marine resource management in the effort to fully exploit the Blue economy. However, WIO is arguable the least studied, especially in regard to molecular mechanisms of natural processes in the marine environment including molecular interactions in marine organisms. In this effort, the Coral Metagenomics Research Group (CMRG) at Pwani University is working on established approaches in molecular biology with potential applications in sustainable marine resource management including Metagenomics, Meta-transcriptomics and Pollution Source Identification. Metagenomics, the genome-level characterization of organism communities in environmental samples offers the best approach to study marine communities. The current studies at CMRG is focussed on anthropogenic impacts on coral-reef-associated microorganisms on the Kenyan Indian Ocean. The approaches use coral mucus samples, water and sediments in identification of pollution sources employing Microbial DNA isolation for deep whole metagenome sequencing (WMS) by next generation sequence (NGS) techniques. Bioinformatics analyses are then performed to characterize the core and accessory microbiomes for corals to elucidate microbial interactions and symbiotic relationships between the hosts and its microbiomes. The approach also utilizes microorganisms as barometers of coral, reef and marine ecosystems' health by correlating effects of human activities with microbial population structures. This information can also help inform conservation efforts as well as sustainable utilization of marine resources. Secondly, the



CMRG employs Metatranscriptomics; an RNA sequencing strategy to provide profiles of all the genes present in a microbial community at a specific time point. We also seek to know the genes expressed by coral microbiota and how these expressions vary with different types and magnitudes of stresses. We isolate and sequence microbial RNA obtained from coral mucus samples for metatranscriptomics analyses. The RNA found in a cell at a specific point in time, indicates the genes switched on that time. Profiling this over time at the different sites allow identifies genes expressed normally and/or due to external factors or stresses. The role an organism plays within its wider environment can then be inferred from the functions of the gene expressed. Results from bioinformatics analyses of these sequences not only augment the metagenomics data with information on the coral microbiome activities but also holds potential for discovery of bioactive compounds with diverse applications. In the face of diminishing coral cover, most interventions have focused on reducing human impacts on the marine environments. However, the Metatranscriptomic approach can inform the alternative intervention strategy of fortifying the resilience of marine biodiversity by identifying genes associated with resilience thereby helping in cloning super corals. Further, with these approaches, the sources of pollution can be identified to prioritize intervention strategies

Using the molecular approaches for rapid and inexpensive detection and quantification of pollutants as well as the origin, with a huge potential for application in the sustainable development of the Blue Economy.

Keywords: *Coral reefs; Western Indian Ocean; Coral Metagenomics; Meta-transcriptomics; DNA/RNA sequencing; Pollution Source; Blue Economy.*

5.4 | Maritime Security

5.4.1 | Maritime Security and the Blue Economy: A Knowledge and Research Agenda

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The Blue Economy is a new often untapped frontier in the expansion of emerging economies, especially in Africa's Indian Ocean Seaboard. A stable and secure environment is a pre-condition for a sustainable exploitation of the Blue economy. required to Maritime security is essential to supporting the Blue Economy. This has placed a special significance to maritime security to secure the Blue Economy. This paper examines the nexus between maritime security and Blue Economy. More importantly, it focuses on the role of research and knowledge production in promoting the blue economy within the context of maritime security. The paper examines the interface between the twin concepts of Blue Economy and maritime security, exploring the role of maritime security as an enabler of the Blue Economy. Second it focuses on evidence based research and knowledge in securing navigation routes, generating useful oceanographic data to marine industries and protecting rights over valuable marine resources. In itself, the Blue Economy is a source of economic development and growth. This paper argues for a robust research to underpin marine security, which will in turn promote the development of the blue economy.


Keywords: *Blue Economy, Maritime Security, development, knowledge, research.*

5.4.2 | The shadow Blue economy: Recent Developments in International Law Against Illegal, Unreported and Unregulated (IUU) Fishing and Related Crimes at Sea

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Illegal, unreported and unregulated fishing (known as "IUU fishing") has become a global challenge and one of the main obstacles to the sustainable management of fish stocks. IUU fishing has changed and extended in parallel with the globalization and the trade



of natural resources. At the heart of the current sustainable development goal 14.4 “*by 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices...*” laid down by the United Nations, IUU fishing represents a shadow aspect of the blue economy’s promises, and in any case a thorny issue.

The exercise to legally define IUU fishing is quite recent as the consideration of this problem over the last twenty years. This presentation briefly reviews the developments of international fisheries Law since it has finally accepted IUU fishing as a legal issue, which must be addressed. If fisheries Law continues to transform itself to improve its ability to eradicate this problem, it is actually going beyond the concern of fisheries lawyers alone. The blue economy, much broader than just the issue of over-exploited fisheries, shows us that IUU fishing interacts transnationally, everywhere in the world, with other forms of infringements and unauthorized behaviors, called “serious offenses” or “fisheries related crimes”, such as human trafficking, forced labor, corruption, tax frauds, trafficking in other illegal substances and sometimes financing terrorism...

The use of other rights than just fisheries Law such as environmental Law, trade Law, maritime Law, fiscal Law becomes evident to close the net on IUU fishing.

The purpose of this presentation is to show the most significant developments in international and national laws that can have a substantial impact on the IUU fishing practices’ decline. This is a good way to see how national fisheries regulatory frameworks, supported by the work of regional fisheries management organizations, or other agencies, could become stronger in the future and help build a legal “Blue” economy, which is an indispensable condition (certainly not unique) of an economy that tries to be “sustainable”.


5.4.3 Criminalisation of Maritime Piracy: A Challenge to Maritime Security, Safety and Enforcement

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Maritime piracy and maritime offences are on the increase. Most striking is that new advanced means and methods are used to perpetrate the offences. The effects of these crimes are felt directly by seafarers and the shipping industry. Indirectly, this translates into negative effects for national economies and the global economy as well as affecting trade, regional development and the environment. This paper analyses the present treaty law on piracy and maritime offences. This paper argues that the practices obtaining from the criminalisation of the offences are not effective in tackling the new



trends and threats. This is because of intrinsic definitional problems in the treaties that lead to practical challenges in their application. This conclusion is reached after analysing the relevant legal provisions on the crimes, as contained in the international instruments. The findings confirm that there is a definite need to amend the current laws defining piracy and maritime offences. The revisions should reflect the changes in how the crimes are committed and tackled. Amending the law in conjunction with other measures need to be adopted. Accordingly, this paper contributes to the debate on the extant problems in the criminalisation of the offence both at the international and national level. Ultimately, it adds to the call for redrafting of the current international maritime laws, further to advocating other viable solutions to address the problem.

5.4.4 Tenacity of Maritime Security Threats: Case for a More Effective Multilateral Enforcement System

| Authors: |

Njoki Mboce

The evolving nature of maritime security threats is an increasing concern especially among littoral states. This is more conspicuous from the heightened states' and regional calls for intervention. The purpose of this paper is to examine the connection between the posture of the existing enforcement systems and the tenacity of maritime security threats. Using a cross-sectional analysis, this paper analyses nature of the incidents of maritime security incidents in the period between the years 2007 and 2017, and examines these against the pre-2007 ones. The paper draws a link between the various shades of unilateralism in maritime security enforcement and the aggressive and dangerous mutation and increase of maritime security threats. The paper therefore argues that a more collaborative enforcement approach could deliver a safer and more resilient blue economy. Consequently, the paper concludes that greater focus is needed on the enforcement framework to establish a more collaborative, pro-active and adaptable enforcement system of maritime security. This paper therefore provides reflections on the necessary policy adjustments and options to help achieve a more sustainable blue economy enforcement mechanism. It also offers a foundation for further development of policies to support a sustainable blue economy.

5.5 | Mapping Blue Economy Resources

5.5.1 | RV MTAFTI and Oceanographic Research in Relationship to the Blue Economy and Investments

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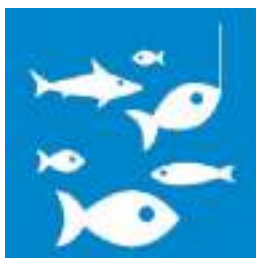
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Kenya is a maritime state with 200 nautical miles (nm) EEZ with and an ocean area of about 142,000 km². The current annual marine fisheries production is slightly above 20,000 mt that is worth about KES 2.6 billion (USD 260 million). The blue economy initiative through RV Mtafiti research aims to provide information that would be used in policy decisions and spurring investments in marine resources to creating jobs and improve economic wellbeing.

In the recent past the government of Kenya has invested heavily on state of art equipment on Board RV Mtafiti to facilitate scientists to gather relevant information on the fisheries resources to inform Blue growth policies. RV Mtafiti acoustic estimates show a total of 240,000 mt of fish valued at KES 60 billion (USD 600 million) are found in Kenya EEZ with varied spatial fish densities and biomass distribution in different regions. The annually exploitable stock is estimated to be worth KES 15 billion assuming a 25% exploitation. There is a steady increase of fish biomass densities from the south to the north in the territorial water. Lamu region registered both the highest densities and biomass. Most fish (90%) were concentrated in the upper layer (0-100 m) of the water column.

From this assessment there is great potential for profitable investment in exploitation of Kenya marine fisheries. Optimum exploitation of the fisheries would create new economic opportunity along the coastal Kenya. Further, value additional on fisheries products would spur other investments along the chain.





5.5.2 Exploring Technological and Policy Solutions for Sustainable and Inclusive Development of the Blue Economy for Developing Countries – focus on Renewable Energy and Mineral Resources

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Prof. Nobert Opiyo

The socio-economic importance of surface waters and their resources cannot be overemphasised: the oceans alone cover almost three quarters of the Earth's surface and are home to more than half of all life forms. This presents both a sustainability challenge and opportunity. The challenge is that this vastness of the Earth's water resources creates a false impression that they are limitless, which has led to their decades' long massive over-exploitation and degradation. The opportunity is the potential to tap into this massive resource for sustainable development of particularly developing countries, and contribute to the 2030 Agenda including the Sustainable Development Goals (SDGs). This paper seeks to assess the potential contribution of these resources to sustainable development of developing countries, from the perspective of marine renewable energy and mineral resources.

It discusses both technological and policy solutions for sustainable and inclusive development of marine renewable energy and mineral resources (non-living resources of the deep ocean), which remain largely unexploited, but with significant implications for sustainable development of developing countries. Resources of interest are offshore wind energy, phosphorites, manganese nodules, offshore sand, gravel, oil and gas. For instance, offshore wind, largely unexploited currently, can make a significant contribution to a country's power/energy supply, limit its generation from fossil fuels such as coal and oil, and consequently reduce carbon-dioxide emissions and contribute to both climate change mitigation and reduction in ocean acidification. Sustainable exploitation of the phosphorites from the deep ocean can provide an additional source of phosphates, and help address the depletion of the land based deposits, which threatens global food production and hence food security. Similarly, offshore sand and gravel could also be sustainably exploited to address the growing global sand crisis.

Potential policy interventions required to sustainably exploit these opportunities may include technology and innovative solutions transfer, north-south collaborations, finance, and research and development, the latter particularly in the area of resource mapping and development.

Keywords: *Blue Economy, sustainability, SDGs, developing countries.*

5.5.3 The Value of Information: Realising the Economic Benefits of Mapping Marine Resources;

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For many SIDS natural resources are one of the few ways to boost economic growth as they are a catalyst for increasing tourism-related activities. This growth has been demonstrated as having implications for conservation. Data are key to evidence based decision making. In the marine environment, the knowledge of resources is limited due to the relatively hostile nature of the environment. Currently less than 10% of our ocean floors and its natural resources have been mapped in detail. Through case studies from across Caribbean SIDS and island states we explore how improved knowledge on the distribution of key habitats can improve the accuracy of economic valuation exercises to provide local decision makers with better management capability.

Methods and key results

The Centre for Environment, Fisheries and Aquaculture Sciences (Cefas), often in partnership with other UK Government bodies, has been involved in a number of seabed mapping programmes to describe the nature and extent of key natural resources in the marine environment, including coral reefs and seagrass beds, in Caribbean Commonwealth States and UK Overseas Territories. One example of where a Cost Benefit Analysis was undertaken will be used to compare costs and benefits of the seabed habitat mapping surveys in the long term.

Conclusion

The marine resource assessments in previously poorly studied areas revealed in some cases up to 800% more seagrass beds than previously known. The increased knowledge of seagrass resource illustrates potential ecosystem service resilience against extreme weather events such as hurricanes. In this case study, the value of sequestration and storage of organic carbon in seagrass meadows has been demonstrated to be between £49,428 and £664,785 in the baseline year, increasing to over £4 million under the most conservative scenario over 50 years. This study illustrates that following relatively modest investment, the projected benefit of seabed mapping and the ability to manage and protect marine resources is substantial and can constitute large economic benefits, especially when related to a country's GDP.

5.5.4 Mapping Living Marine Resources for a Sustainable Blue Economy in Kenya

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The blue economy has been prioritized as one of the key drivers for Kenya's Vision 2030 development agenda, and in line with African Union's Agenda 2063 Aspiration 1, goal six. Kenya's maritime zone is about 230,000 square kilometers and a distance of 200 nautical miles offshore, hence providing great potential for the country's economic development. There is increased recognition of Kenya's rich living marine resources that remain largely unexploited, as focus has been on fisheries which account for only 0.5 percent of the GDP and generate employment for over two million Kenyans. Resource mapping of living marine resources is one of the strategies to ensure sustainable and effective utilization of Kenya's living marine resources for the country's economic development. This will also contribute to achievement of Sustainable Development Goal (SDG) 14 to conserve and sustainably use the oceans, seas and marine resources for sustainable development. This paper discusses the strategies that Kenya plans to undertake to ensure effective mapping of its living marine resources. Other measures will also be proposed for consideration.

Keywords: *Blue economy, Living marine resources, resource mapping, sustainability, economic development*



5.5.5 Opportunities and Limits of Marine Spatial Planning in a Liquid World With Tropical Stakes

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Marine environments are subject to growing pressures as traffic, increasing demand and changing land-use of coastal areas, seabed exploitation, dredging or mining, fishing, tourism, development of renewable energies, etc. Sustainably managed oceans and seas can contribute to economic growth and employment, and will allow the international community to meet its global targets, including the reduction of poverty and hunger as detailed in the global 2030 Sustainable Development Agenda. Thus, marine environments are considered opportunities for future growth around the world.

As a consequence, new frameworks are increasingly needed to regulate and optimize the range of feasible uses of marine areas and resources. Marine Spatial Planning (MSP) aims at reconciling human uses and conservation, and offers an attractive setting to combine different uses of marine resources within a single area.

There is an urgent and critical need for research on the application of MSP in tropical areas. The research should critically address the fact that the policy framework originally designed for the European Union (EU) may not fit the specificities of Southern countries. In tropical areas, MSP faces a critical challenge, the sea grabbing. The political instability in various countries, particularly in Africa, and the economic power of transnational companies affect power relationships. An increasing surface of ocean is affected by activities. The current effort to better organise these activities at sea in western Africa and Brazil illustrates this new framework. In such context it is important to determine whether MSP can intensify the problem of ocean grabbing. Such question is directly related to the role of governments in the implementation and definition of MSP. Adapting MSP to tropical countries can also be a way to question and improve this process that has been developed by and for developed countries. In particular MSP could better account for traditional knowledge and uses, and ecosystem dynamics.

The project PADDLE brings together internationally renowned researchers from countries bordering the tropical Atlantic and from the EU to build theory and methods for relevant MSP in tropical areas. This interdisciplinary team and growing network will be a pillar of knowledge-based MSP by providing critical analyses of the tools and methods used, and by designing innovative approaches to efficient MSP.



5.5.6 Automated Mangrove Plant Identification in the Indian Ocean; Pierre Grard

| Authors: |

Pierre Grard

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The application is a graphical identification system of plant species of Mangroves, the only tool of its kind available on South-Asian and South East Asian Mangroves at present.

The difficulty encountered by non-botanists when identifying species using standard flora is centered around three major constraints, namely, the ability to identify the species without its flowers or before it flowers; the use of dichotomous key, which cannot tolerate any error and imposes the choice as well as the order of questions; and the use of technical terms not understood by the non-specialists. In order to minimize and resolve these constraints, the identification system uses a graphical system which reconstitutes the plants using images.

The system, entirely graphic, enables non-specialists to make determinations with the help of just a small number of characters, chosen according to their availability for the particular plant to be identified. It meets the needs of amateur botanists, agronomists, forest officers and nature lovers with a keen sense of observation. The use of frequently observable vegetative characters has been favored, as well as an extensive illustration of species.

The major part of the work presented in the form of CD-ROM was carried out in the framework of the European Commission funded project entitled “Assessment of mangroves degradation and resilience in the Indian subcontinent: The cases of Godavari Estuary and southwest Sri Lanka” and in Indonesia by the French Agency for Development (AFD).

5.6 | Fisheries

5.6.1 Indigenous Communal Fisheries in Eastern Canada: An Inspiring Model of Collaborative Management, Ocean Sustainability and Social Equity

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Along the extensive Canadian coastline, indigenous groups have relied on marine resources since immemorial times for food, social, ceremonial and economic reasons. Like in other parts of the world, their access to fisheries was restricted following the arrival of newcomers on the continent, leading to multiple social, economic and cultural problems. In the past decades, in a reconciliation effort and through various Supreme Court rulings, the government of Canada has recognized the right to fish to many First Nations. Focusing on the Mi'gmaq and Maliseet people along the Atlantic coast of Quebec, this research presents a sustainable model of collaborative management of fisheries and oceans. Programs have been developed for training, capacity building and access to fisheries. As a result, Mi'gmaq and Maliseet communities now possess commercial fishing licenses, vessels and gear. They have become leading partners in today's fisheries industry. They have trained their own crews and fisheries directors. They have developed a capacity not only in wild catch, but also in aquaculture and transformation, which contributes to provide much needed employment opportunities in their communities. They have created their own fisheries association, playing an important role in fisheries management and ocean conservation. Although some challenges still lay ahead, this presentation provides an inspiring model that could be applied globally to reduce poverty and contribute to the sustainable use of marine resources.

5.6.2 Environmental Data: A Predictive Approach to Fisheries Resilience

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Application of Artificial Neural Networks (ANN) to Fish Catches and

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Many tropical fisheries are thought to be overexploited, many classical models tend to predict complete collapse yet they remain resilient to high fishing pressure. Many schools of thought tend to suggest that the central assumption in classical fisheries models may not necessarily hold for the highly productive tropical fisheries and thus there is need to explore new approaches to model these fisheries. The use of Artificial Intelligence such as Artificial Neural Network (ANN) offers an alternative to modeling such fisheries without making any assumptions. ANN has the ability of determining the underlying relationship between multivariate environmental variables and fish production regardless of the units and magnitude by scaling and partitioning the data for training and testing without using any prior model that is typical of classical techniques. Testing of the ANN with real data provides a robust method of predicting future catches or yield of any target species given a set of environmental conditions and fluctuation. ANN has been used to demonstrate how the impact of climate change can be used to analyze and predict resilience of the fishery based on environmental and catch data for *Rastrineobola argentea* Lake Victoria, Kenya. Using a feed forward propagatin, an ANN architecture of 10-9-1 was obtained based on environmental data and 12-6-1 based on fish catch statistics with 25 hidden layers and 30 hidden layers respectively, when the activation was based on the hyperbolic tangent function. Input importance analysis for environmental variables show that rainfall was the most significant variable (37%) followed by fisheries development classification (33%) and the lake level (17%) for environmental data. For fish catch statistics, the importance of fisheries development classification was 71.1%, accounted for by *Lates* (15.6%), *Haplochromis* (6.6%) and *Bagrus* (4.2%). The actual catches versus output from the network had an average Absolute Error (AE) of 2,072 and 3,843 metric tones and an average Relative Absolute Error (RAE) of 14.2% and 20.7% for catch data and environmental data respectively. The ANN approach could be used to predict the catches of *R. argentea* in Lake Victoria during the different developmental stages of the fishery as well as projection of future production. Model data for both the environmental (r^2

=0.852) and fish catches ($r^2 = 0.910$) fitted well to the raw data. The non-classical methods offer robust alternatives for analysis of fisheries data in light of data availability, nature of multispecies fishery and inadequacies of stock assessment models in tropical freshwater ecosystems. The ANN consistently and adequately produced outputs that are consistent with target values from both environmental and catch data and could be used for predicting future values under varying fishing or environmental regime or climate change as manifested in lake level, evaporation, discharge and rainfall.

5.6.3 Marine Capture Fisheries and Opportunities For Blue Economy Growth

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The Blue Growth Initiative prioritizes promotion of investments and innovations in support of food security, poverty reduction, and the sustainable management of aquatic resources. Fish and fisheries are an important component in achieving Blue economy growth through supporting livelihoods as well as food security and nutrition. Kenya contains diverse coastal and marine ecosystems which host a wide variety of resources that are fished for consumption and trade including fish and invertebrates such as molluscs, shrimps, crabs, lobsters and sea cucumbers. Although the production from marine capture fisheries is low when compared to inland fisheries, the sector has promising potential to contribute to blue economy growth.

The small scale capture fisheries sector which concentrates in nearshore areas of the Kenya coast produces 80 percent of the annual fish production. However, the target resources are either optimally fished or threatened by overfishing due to overcapacity, use of destructive fishing gears, IUU fishing, pollution, high post-harvest losses, inadequate market access. Despite these challenges, there are a number of opportunities to enhance sustainability and economic development through science-based interventions ranging from improving regulatory mechanisms, and investing in tools and strategies to address IUU fishing and destructive fishing practices. Implementing an Ecosystem Based Fisheries Management is fundamental to supporting blue growth as it helps to develop sustainable and equitable fishery management systems using the ecological and human interfaces. Efforts to harness untapped fisheries resources also provides a new direction for securing new investments through private sector involvement in research and innovation. This presentation provides an overview of the existing challenges, and elucidates the opportunities for the development of blue economy in marine capture fisheries using a case study approach.

5.6.4 Capture Fisheries in Freshwater Lakes in Relation to Blue Economy

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Capture fisheries in this case is defined as the science of harnessing fish and other lake resources for providing products and services with economic value such as food, employment, research and innovations, tourism, and fish oil, among others. Kenya's freshwater fisheries produce >80% of the fisheries capture production in Kenya that is mainly from lakes, with the principal fishery being that of Lake Victoria. Some of the major lakes include Turkana (6,405 km²), Victoria-Kenyan side (6% of the whole lake = 4,128 km²), Naivasha (210 km²), Baringo (129 Km²), and Jipe (39 km²). Despite such production, the economic potential of such systems remains unexploited. The current paper focuses on highlighting the status of capture fisheries in freshwater lakes and the potential that remains untapped for possible blue growth. The paper utilizes data and information sourced from Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Fisheries Service (KeFS), existing literature and experts' views. Capture fish-food production from lakes has been averaged to about 140,000 tons with an ex-vessel production trend of Lake Victoria (115,000 tons) > Turkana (7,000 tons) > Naivasha (1,100 tons) > Baringo (200 tons) > Jipe (127 tons) > Kanyaboli (100 tons) > Kenyatta (44 tons) in that order from the highest to the smallest, amounting to about 24 Billion. Whereas, capture fisheries ex-vessel potential could be estimated at 350,000 tonnes, worth KES 52 Billion. However, most lakes' lack diversification potential for tourism, mining, post-harvest losses reduction, water hyacinth and other aquatic plants/weeds' alternative livelihoods, and recreational fishing as conduits of blue economy. This calls for re-valuation and diversification of economic potential from lakes under the blue economy concept for sustainable development.

Keywords: *Freshwater, Lakes, Fisheries, Blue Economy.*

5.6.5 From How Many to How Much? Economic and Financial Valuation of Lake Victoria Fisheries

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Owing to the challenge of under-estimation of catch and value in official fisheries metrics, this study provided a methodological option to compare, contrast and validate official fisheries statistics in Kenya. We applied a standardized Fishing Business Model (FBM) to reconstruct estimates of economic returns from Lake Victoria fisheries; taking into account fish auto-consumption, post-harvest losses and landings from illegal gears which are often missing in the official estimates. Primary data was collected using questionnaires in various fish landing sites in February and March 2018 while secondary data was sourced from latest surveys on fish stocks, catches and fishing effort in the lake. Results indicate that Total annual Fishing Revenue (TFR) per boat was Ksh 7,108,509.01 (USD71,085.10), with beach seine fishers using *Sesse* pointed boats supplying the greatest revenue (Ksh 42,255,130.65 ~ =USD 422,551.30). Fish auto-consumption and spoilage amounted to Ksh 1,274,244.20 (USD12,742.44) annually whereas Total Costs (TC) were Ksh 1,056,326 (USD 10,563.26). *Sesse* flat boats using long lines have the highest operational costs annually (Ksh 3,612,633.70 ~ =USD 36,126.34), while *Sesse* boats using small seines have the highest annual wage for fishermen (Ksh 13,942,098 ~ =USD 139,420.98). The annual Gross Operating Income (GOI) was Ksh 6,152,435 (USD 61,524.35) and the Net Profit Margin was 0.2012. Overall, our reconstructed data shows that average annual landings were 3.9 times more while value to fishermen was 7 times more, than the official estimates. We recommend a review of official fisheries statistics in order to correct under-valuation of Lake Victoria fisheries; adoption of regular Economic and Financial Impact Assessment of the Lake; and use of the information supplied in this survey to adjust management cost recovery and revenue allocation frame-work by national and county governments in regard to the fisheries sub-sector.

Keywords: *Fishing Business Model, Lake Victoria Fisheries, Fishing Revenue.*

5.6.6 Potential of Preparing Highly Gel-Formable Gelatin from Fish Scales Waste

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During fish processing, large amounts of fish scales are disposed as by-products. However, we have the potential use of this fish scales as raw material as a source gelatin. The ratio of fish gelatin product is about 5% of world total outcomes until now. In this study, came up with a 'low-cost preparative method' for obtaining the 'highly gel-formable gelatin (HG gelatin)' from fish scales.

Fish scales were used as the starting material; *Oreochromis niloticus* (Nile tilapia) and *Lates niloticus* (Nile perch). Extraction of gelatin was achieved by pretreatment of fish scales by two step washings in acid-alkaline-solution and heating at 80 °C for 0.5 - 1hr. During extraction, period ultrasonic irradiation (USI) was applied. Solubilized gelatin was separated from residual scales fragments by filtration.

Nile perch gelatin obtained at 0.5hr of extraction period had protein yield of 3%, while the breaking strength (BS) value was 2.33 N/cm² and the m.p. of the gel was 22.8 °C. However, the BS of tilapia was 0.54 N/cm² (m.p. 23.0 °C) at 1hr and 2hrs extraction time, without the ultrasonic irradiation treatment (USI). It was found out that 180sec of ultrasonic irradiation during 80 °C extraction had better quality gelatin with excellent gel-formable ability compared to the ordinary heat extraction method. USI treatment was very effective in tilapia scales which elevated the gel-formability to 3.5 times higher hence a more a superior gel, while USI treatment was not effective in Nile perch.

This finding shows that it is possible to obtain high gel forming gelatin from *waste fish scales*. The method is simple and can be adopted by small scale processors, hence contributing to solving the problem of waste disposal in fish processing industries, and in addition creating a value-added product.

5.7 | Climate Change

5.7.1 Climate Change: Its impacts on Coastal Ecosystems, Ocean Acidification and Coral Reef Biogeochemistry

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Blue carbon ecosystems (hereafter BCEs) including seagrass beds, mangroves, and coral reefs are effective for the mitigation of climate change when they are kept healthy. At the same time, if properly managed, the BCEs could provide mankind with Ecosystem-based Disaster Risk Reduction (Eco-DRR), sustainable food production through fisheries and aquacultures, and sustainable tourism, which could enhance adaptation capacity of the coastal community to climate change. The properly managed coastal ecosystems are thus the basis for the realization of secure, safe, and circular society, which is also the target of Blue Economy.

In my presentation, I will first introduce the definition of BCEs. Then I will introduce some good examples from coastal areas in Japan as well as Pacific countries such as Palau and the Philippines, where sustainable and sometimes adaptive management of the BCEs realizes Blue Economy as sources of livelihood to the locals.

Through the networking and upscaling of these good examples from many parts of the world coastal areas, we should mainstream the management of BCEs into local, national, and international policies to achieve sustainable Blue Economy throughout the world coastal regions.

5.7.2 Mainstreaming Blue Carbon Ecosystems into National Development and Climate Change Agenda

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The paper provides current status of the information about the extent and conditions of vegetated coastal ecosystems in Kenya, challenges facing them, and information for their effective restoration and management. These 'blue carbon ecosystems' are extraordinary ecosystems, providing a wide range of benefits to humans, including exceptional carbon sequestration and protection against climate change impacts. Work in the ensuing years has seen a vast improvement in the depth of information on blue carbon ecosystems in Kenya; thereby providing the basis for considering the reporting of carbon gains and losses associated with national reporting. However, integration of blue carbon into national inventories is still constrained procedurally and by institutional capacity. There is also inadequate information of carbon stocks stored by these ecosystems and emissions levels when degraded. Total economic value of blue carbon ecosystem is also poorly understood, which undermines the development of strategies for minimizing trade-offs between climate, conservation and development goals. We recommend inclusion of blue carbon ecosystem to be included in the nationally determined contributions (NDCs) of Paris Agreement; considering that the next round of NDCs are up for revision.

Key words: *Blue carbon, SDG, Paris Agreement, NDCs, Kenya.*



5.7.3 Small Islands, the Blue Economy and Climate Change

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Island peoples' lives are inextricably linked to the sea. Small Island Developing States (SIDs) such as Trinidad and Tobago and other Caribbean islands, tend to have a vast amount of ocean resources at their disposal relative to their land space. At the same time, they have the most to lose from the degradation of marine resources. The blue economy encourages much needed and improved stewardship of these "blue" resources. Policies, practices, businesses, technologies and "blue innovations" are critical to turn the tide on ocean ecosystem health while reducing poverty and ensuring food security. These opportunities are presently engaging a number of Caribbean islands where issues are now however, compounded by the impacts of global climate change. In this respect SIDs find them with an increased responsibility for advocacy and it is imperative for SIDs to work towards mainstreaming climate change mitigation and adaptation policies across all coastal sectors. For SIDs territories, the holistic nature of the blue economy approach is expected to move the oceans away from the threats and destruction, and on to prosperity.



5.8 | Regulatory Regimes

5.8.1 | The Role of Regional Ocean Governance in Achieving the Blue Economy and SDG14

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Regional ocean governance has been proposed as essential for sustainable use of ocean and coastal ecosystems – the Blue Economy. This study examines the regional arrangements in place for ecosystem-based governance of the ocean. The UN Environment Regional Seas Programme has been promoting regional ocean governance for 17 ocean regions since its inception. Regional Seas conventions, protocols and action plans (43 of 158 arrangements) are an important part of regional ocean governance. However, there are many other regional and subregional multilateral agreements that must be taken into consideration in building comprehensive regional ocean governance (115 of 158 arrangements). Some are associated with UN bodies, but there are many ‘indigenous’ agreements developed solely by the countries of the regions. These ‘indigenous’ agreements may be issue specific or multipurpose economic agreements that include ocean affairs and must be taken into consideration. Dealing with the entire suite of regional agreements is challenging for countries and regional organisations for several reasons; not the least being capacity to engage. There are few well developed regional coordination mechanisms to provide the integration needed for ecosystem based management. Addressing these issues requires understanding the mandates and roles of the full set of organisations and agreements in each region and the options for developing integration mechanisms, which may vary considerably among regions. This study provides a global perspective on the suites of regional agreements in 20 regions of the world, their make-up, complexity, strength, the extent to which countries engage with them and the presence of integration mechanisms. It considers the implications of these factors for the way that strengthening regional ocean governance may be approached from global and regional perspectives.

5.8.2 Intellectual Property and Innovation for Sustainable Development of the Blue Economy in Kenya and Africa

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My overarching argument is that the integration of innovation, technology transfer and intellectual property in Kenya, Africa and globally is crucial for the sustainable development conservation of the blue economy and the conservation of the aquatic ecosystem.

I advance three key arguments. First, that there is need to clearly identify, conceptualize, and problematize resources of, participants in and the role of the blue economy in sustainable development in Kenya and Africa. What are the key natural and environmental resources? What is their role in the (blue) economy? What is the role of local, national, and international agencies? What is the role of women and youth in the blue economy? This conceptualization should be done within the framework of the United Nations Convention on the Law of the Sea, 1982 and should focus on the relevant national, sub national, regional, and international laws on IP, innovation and technology transfer, to secure the conservation, sustainable use and benefit sharing of the blue economy.

Second, Kenya, Africa and the international community should develop or strengthen and integrate intellectual property, innovation, and technology transfer law and policy into the blue economy, through appropriate technical assistance, partnerships and cooperation.

Third, there is need for reforms in Kenya's constitutional, juridical, regulatory, policy, governance and administrative frameworks to implement and enforce IP, innovation and technology transfer for the sustainable development of the blue economy, the aquatic ecosystem and the marine environment. We will tease out recommendations for the findings and conclusions based on the foregoing research objectives, research questions and arguments on the role of intellectual property, innovation and transfer technology in the blue economy of Kenya and Africa.

5.8.3 Towards a More Inclusive Global Blue Ocean Economy Regime: The Case for a Better Global Framework

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There is heightened interest among states and regions in the spaces and resources of the oceans and seas and their potential to meet increasing demands for goods and services for humankind for the present and the future. Consequently the concept of Blue Economy has been catapulted into global limelight and discourse. However, the concept remains rather fluid and imprecise. Further, the rules of engagement among states, regions and other stakeholders remain unclear and rather problematic. This situation extends to crucial aspects including decision making, accountability as well as governance. In this regard, two key deficiencies in the prevailing regime are discussed. First is lack of inclusivity, particularly for developing states and regions and their non-state stakeholders. Second is the apparent inadequacy of global instruments and regimes underpinned by the 1982 United Nations Convention on the Law of the Sea to address emerging challenges of the Blue Economy.

Therefore, this paper reviews the concept of Blue Economy and the existing frameworks that underpin it. The paper argues for a more inclusive and better regime among states and regions. To achieve this, it proposes options for the establishment of a global framework that promotes equity, inclusion and sustainability.

5.8.4 The Exceptionalism of Blue Economy in Africa

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All great nations throughout history are next to the sea, from Roman Empire to modern day China. They rise to greatness because they exploit the sea and the opportunities there in. But it seems African countries by the sea are an exception. This paper will explore this exceptionalism by selecting a number of African countries and comparing them with

a few great countries next to the sea from different parts of the world. It hoped the analysis will inform Kenya's policy makers and investors in making blue economy one of the contributors to Kenya's GDP.

5.8.5 Maximization of the Potential of the Blue Economy in Kenya

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The Blue Economy in Kenya covers aquatic and marine spaces including oceans, seas, coasts, lakes, rivers and underground water. It comprises a range of productive sectors such as fisheries, aquaculture, tourism, transport, ship building, energy (oil and gas), underwater mining and related activities. The concept of the Blue Economy also recognizes that the productivity of healthy freshwater and ocean ecosystems is a pathway for aquatic and maritime based economies. There is, therefore, need for full and sustainable exploitation of the Blue Economy sector to ensure that Kenya fully derives benefits from its marine resources supported by a robust, efficient and comprehensive legal and institutional framework.

This paper argues that for Kenya to secure its waters, it must invest in a competitive and sustainable Blue Economy. Concurrently, securing a competitive Blue Economy is dependent on secure waters. Considering the importance of the Blue Economy, this paper has examined the factors which may contribute to securing, exploiting and sustaining a competitive Blue Economy for Kenya. The paper also examines factors which undermine maximization of the potential and competitive advantage of a Blue Economy in Kenya.

The paper reviews the efficacy of Kenya's legal and institutional frameworks including international and regional conventions ratified by Kenya, declarations, policies and institutions related to the management of Blue Economy sector and regional initiatives which address issues related to resources of the Blue Economy. The initiatives have prioritized the Blue Economy sectors and identified areas of cooperation through capacity building, financing, investments and engaging the private sector. Ultimately the paper seeks to highlight ways in which Kenya may extract and derive the full benefits and resources of the Blue Economy.

5.8.6 Nexus and the Sustainable Blue Economy; Michael Dodds

| Author: |

Michael Dodds

Oceans, seas and marine resources are central to the delivery of the 2030 Agenda for Sustainable Development, including the Sustainable Development Goals (SDGs). Oceans and seas support human well-being and livelihoods and underpin poverty eradication, food security, employment, tourism and protection from natural disasters, and counteract the impacts of climate change as carbon reservoirs. However, human activities continue to threaten oceans and seas and marine resources with detrimental long-term impacts for humanity and the planet.

The Sustainable Development Goals are relatively unique in global agreements as they recognize the interlinkages or Nexus between the different Goals and Targets. Traditionally the 'Nexus' approach has been around the Climate-Water-Energy-Food Goals but increasingly there are other Nexus areas that need to address the interlinkages developing policy responses and developing tools

A sustainable blue economy seeks to promote economic growth, responsible production and consumption, social inclusion, and the preservation or improvement of livelihoods while at the same time ensuring environmental sustainability of the ocean and coastal areas, through the circular economy. At its core, it refers to the decoupling of socioeconomic development through ocean-related sectors and activities from environmental and ecosystems degradation.

The "Nexus" or interlinkages between the relevant goals or targets needs to be thoroughly analysed and understood in order to build coherent sets of Blue Economy integrated policies and action programmes for sustainable development.

There is a growing industrialization of the oceans and coasts that has been increasing over the last few years. By 2030 two out of every three fishes on our plates will have been farmed, offsite wind capacity will have increased by tenfold and seaborne trade is expected to quadruple [2050]¹. The changing nature of our coastlines due to industrialization and the continued pollution of our oceans is not sustainable. For many countries, particularly small island and developing states, coastal activity is a major economic factor in their countries GDP. Addressing the interlinkages across the SDGs and their targets for the blue economy will be critical.

1 Economists intelligence unit

5.9 | Community Mobilization and Involvement

5.9.1 Frugal Innovations in Appropriate use of Resources in Outreach, Education and Community Mobilization

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A key challenge facing science outreach efforts in emerging economies is how to implement costly science education interventions developed in the US to suit both the resource constraints and the cultural context of our countries. For three years I lead a science outreach program in the Bahamas that did just that. We pioneered the idea of social partnership as a way of engaging schools, teachers, parents, government agencies and corporate sponsors to bring a successful science summer camp that was developed at Duke University to the Bahamas. Over the course of 3 years we served students from 7 different islands and 40 different junior high schools in the country. Because of the resources and infrastructure constraints that we faced in our country, we developed novel approaches to structuring the delivery of the curriculum, organizing our team of science mentors to deliver a program that was cost-effective and created value for all of our social partners. The new approaches that we developed were subsequently used to increase the efficiency of our parent program at Duke.

5.9.2 Research Activities at Wangari Maathai Institute on Blue Economy Strategy

| Author: |

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The Presidential Blue Economy Committee established in September 2016, while recognizing the many sectors in blue economy prioritized fisheries and aquaculture; and maritime shipping and logistic services as priority sectors that would deliver fast

socio-economic benefits to the communities in the coastal areas. To strengthen fisheries governance for sustainable utilization and enhanced revenues for the government and employment creation, the government enacted the Fisheries Management and Development Act 2016 in September, 2016. The Act established institutions that would strengthen the governance of the fishing industry and aquaculture, and enable investments along the fishery value chains for socio-economic benefits. The institutions established include the Kenya Fisheries Service, Kenya Fish Marketing Authority and the Fish Levy Trust Fund.

WMI is involved in research on Governance and management of marine fisheries and aquatic resources with a view to enhance marine fisheries and coastal aquaculture governance to control over-fishing, maintain or improve stock productivity and enhance associated ecosystem integrity. The total fish catches may increase due to the various governance and management measures that effectively commensurately implemented to ensure sustainability in terms of limits on fish vessels and restrictions on fishing gears. Studies have contributed to increased information for decision making in the sector.

5.9.3 Environmental Challenges Affecting the Contribution of Wetland Provisioning Services to the Blue Economy in Kenya

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Freshwater and marine wetlands are highly productive ecosystems which contribute immensely to the blue economy. This paper discusses the role of wetland provisioning services to the blue economy and highlights environmental and management constraints. Globally, economic value of wetlands and their associated ecosystem services have been estimated at US\$14 trillion annually. In Africa this varies depending on uses, for instance valuation studies reveal annual value of US\$34-54/ha in the Hadejia-Nguru Wetland in Nigeria, US\$500/ha for Nakivubo Wetland in Uganda, up to US\$203/ha in the Lower Shire Wetlands in the Zambezi Basin and US\$1-14/ha/yr from harvestable resources from the Olifants River catchment in South Africa. Wetland valuation studies in Kenya give a total economic value of between

US\$ 7.5 and 15 million for Lake Nakuru, US\$ 120.4 million for Yala Wetlands and KSh 143.4 billion for Nyando wetlands. Although food production in wetlands appears to be more economical in the short run, sustainable harnessing of natural wetland provisioning services is still superior in the long run. The high productivity of wetlands if sustainably harnessed promises to improve the livelihoods of riparian communities and overall national blue economy potential. Implementation of appropriate wetland conservation and management tools, strategies and procedures are recommended to ensure sustained exploitation of the blue economy arising from wetland provisioning services.

Keywords: *Wetland valuation, Provisioning services, Blue economy, Ecological Integrity, Environmental degradation.*

5.9.4 **Circles in Management; A Need to Re-align Coastal and Marine Fisheries Resource Management for Sustainable Exploitation of the Blue Economy**

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Societal objectives and sustainability needs remain the key considerations in the management of many coastal and marine fisheries resources. Consequently, social considerations have remained the key drivers of fisheries management and decision making. However, decades of fisheries management have shown that these objectives are difficult to define in policy, and thus provide a lot of leeway for skewed management based on “perceived” importance of social outcomes. Moreover, social needs are often relegated to the low, especially in developing countries where the need for revenue and government financing calls for concerted effort towards enhancing full exploitation of the coastal fisheries and However, recently, emphasis is placed on social, economic and ecosystem wellbeing as the key pillars of the Blue Economy. The marine fisheries resources of Kenya have contributed significantly to livelihoods along the coast with exploited stocks ranging from tuna fisheries, shrimps, shallow water lobsters and small and medium pelagics among others. Development of the coastal small-scale fisheries dates to the 9th century with the rise of Indian Ocean trade which triggered the rise of fishing villages. However, documentation of pre-colonial fisheries

management along the coast is very scanty and formal structures only date back to the period after independence, in early 1960s, which was followed by enactment of limited legislation. Evidently, fisheries management is closely linked to traditional systems in the old fishing villages along the coast including Vanga, Shimoni, Msambweni, Takaungu, Shela, Faza and Kiwayuu just to mention a few. Despite the age of the coastal small-scale fisheries, and spirited management efforts, both traditional and modern supported by undeniable progress in scientific research, stock assessment, resource valuation, and understanding of ecosystems, the fisheries have continued to deteriorate in continuous circles of management approaches. This paper gives a broad-brush assessment of the fisheries management along the Kenya coast, from pre-colonial period, through early years of the establishment of fishery management structures including the Departments of Fisheries Departments. Further, various initiatives, from bottom-up approaches to “research”-guided fisheries management; including Monitoring, Control and Surveillance, management of fishing capacity, as well as other drivers of the circles in management approaches, and the social and institutional arrangements are highlighted, forecasting on evolution of the fisheries management paradigms along the Kenya coast and the need to re-orient management in an effort to fully exploit the Blue economy.

Keywords: *Kenya Coast; Small-scale marine fisheries; Resource management; Legislation; Blue Economy*



5.10 | Sustainable use of Non-Biological Resources

5.10.1 Ecosystem Services for Well-Being in Deltas: Integrated Assessment for Policy Analysis in Coastal Bangladesh

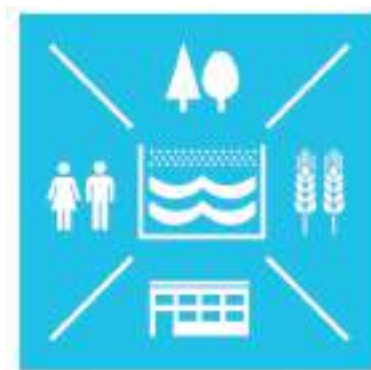
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The authors present the key findings of the ESPA Delta (Ecosystem Services for Poverty Alleviation, Delta - DFID/UKRC/ESPA funded) project and particularly the transferable applications of an Integrated Assessment Model (IAM) to the Bangladesh Delta Plan 2100. Deltas provide diverse ecosystem services and benefits for their large populations globally. At the same time, deltas are also recognised as one of the most vulnerable coastal environments, with a range of drivers operating at multiple scales, from global climate change, unsustainable land practices and sea-level rise to delta-scale subsidence and land cover change. Consequently, significant populations can experience significant poverty and livelihood stress. The focus of this paper is the world's most populated delta, the Ganges–Brahmaputra–Meghna Delta, and more particularly within coastal Bangladesh west of the Lower Meghna River. In particular, concepts of relevance to sustainable management, the Blue Economy in global coastal zones, livelihood resilience and their key policy relevant outcomes and trade-offs are demonstrated.



INTEGRATED WATER
RESOURCE MANAGEMENT

5.10.2 The Potential of Blue Economy Resources in Kenya for the Production of Chemicals, Energy, Industrial Materials, Environmental Cleanup and Strategies for Sustainability

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Whereas the concept of a “blue economy” has received considerable interest globally, its contribution to Kenya economy is currently small. This presentation focuses on the potential and sustainability of harnessing Kenya’s marine ocean resources to increase its contribution to the national economy. The potential of value addition industrial products obtained from our ongoing research activities on utilization of marine fish wastes will be presented. In terms of ecosystem services, it is shown that besides providing vital habitat for marine fish, prawns, oysters, crabs and control of coastal flood protection, Mangrove ecosystems also provide important benefits in terms of carbon sequestration, and environmental pollution control. Research findings on adsorption of dyes and heavy metals such as lead, cadmium, copper and zinc will be presented. The results obtained demonstrate the important role mangroves play and consequently more efforts should be directed towards conservation of mangroves ecosystems. The economic opportunities available for utilization of Kenya’s ocean tidal waves (onshore in coastal locations and offshore), oil and gas resources to generate energy and wealth will also be presented. The feasibility of establishment of industries such as chemicals, biopolymers, Pharmaceuticals, Desalination plants, bio-fuels development and strategies for sustainability will be highlighted. Overall, it is shown that rationale exploitation of Kenya’s enormous Blue economy ocean resources can boost Kenya’s GDP and Big four Agenda.

5.11 | Climate Action Resilience

5.11.1 Regeneration of Ocean Forests: Importance of Seaweeds

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Sea Forester is an initiative that aims to reverse the alarming disappearance of seaweed forests in the world. Its mission is simple: to restore the forgotten forests in our ocean. Seaforester intends to 1) encourage and participate in seaweed reforestation projects on a non-profit basis, 2) create a global network that aggregates funding for projects worldwide, 3) process data and implement common monitoring methodologies, and 4) be a major communicator and educator of the far-reaching benefits of marine vegetation on all continent's blue coastal front yard.

Most of us think about “deforestation” and know the devastation caused by the disappearance of forests on land. But not many of us think about our forgotten forests under the sea. Many of the forests have disappeared, destroyed by agricultural run-off, pollution and other factors. Now, think about restoring these forests as a cheap, quick and decisive step to combat the two biggest challenges we now face – climate change and food security. There are projects under way across the globe but much more needs to be done.

Seaweed grows faster than any plant on land. Its capacity to capture carbon can be up to five times faster than plants on land. At the same time, if we measure the entire world's coastline with depths down to 30 meters where sunlight can penetrate and marine vegetation can grow, we are talking about an area about the same size as all of the world's tropical forests combined, bigger than Europe or the United States. A kelp forest on just 0.03 percent of this area, or 5,000 square kilometers, could support 500,000 tons of fish and capture carbon equivalent to a tropical forest the size of Belgium. Other proven benefits include improved biodiversity, reduced ocean acidification, and seaweed's ability to reduce coastal erosion due to rising sea levels.

5.11.2 Too hot to handle? or simply too complicated to communicate?

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The impacts of climate change on the marine and coastal environment are of critical importance to small island developing states. The remote island locations of the states mean that they are particularly vulnerable to marine climate change, but there are similarities between islands, meaning that overarching information sources would be very valuable for the Caribbean and Pacific regions.

While there is a significant amount of research being carried out on the impacts of climate change in the marine environment, up until now, there has been no synthesis of the science that is accessible to a wide audience of non-specialists. Such information is required in international processes e.g. UN Conference of the Parties agreements, to attain adaptation funding, and to facilitate an understanding of evidence gaps and adaptation priorities.

The Commonwealth Marine Economies Programme, alongside working groups and scientific experts within the regions, recently produced marine climate change report cards for the Caribbean² and the Pacific³ region. These cards are based around a concept developed by the UK's Marine Climate Change Impacts Partnership⁴.

Methods and key results

The report cards cover various topics including fish, shellfish and fisheries, and the habitats that support fish. Peer-reviewed papers on these topics have been produced and the report cards themselves summarise this information, so that fishing communities, marine managers, policy makers and governments can use it to prioritise actions. Recommendations are also made on how to build climate resilience within fisheries and associated habitats, and how climate change interacts with other human pressures, such as pollution and coastal erosion, and how these pressures can be managed.

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/604876/Caribbean_Report_Card.pdf

3 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714511/CEFAS_Pacific_Islands_Report_Card_FINAL_AMENDED_Single-pages_LOW-RES.pdf

4 <http://www.mccip.org.uk/>

Conclusion

The advantage of these report cards over further scientific publications is that they are single, authoritative sources of information on marine (and coastal) climate change to help understand potential risks, and opportunities that countries face. They provide information in a straight-forward format which can then be used by individual countries or regions to understand their social and economic priorities for adapting to climate change, as well as taking advantages of potential benefits.

5.11.3 Blue Carbon Storage in Seagrass Meadows: A Misunderstood Carbon Sink

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Seagrass meadows represent critical habitat for marine animals and have been reported to provide a significant carbon sink. Restoration projects can support resilient marine ecosystems and help to alleviate poverty locally. However, the rate of sequestration of carbon in seagrass meadow sediments is widely overestimated, as a result of a misunderstanding about how marine sediments process and bury carbon. If carbon credits are awarded on the basis of overblown burial estimates, and those credits are used to offset emissions elsewhere, the net effect might be to increase emissions of carbon dioxide to the atmosphere. With appropriate methodology to quantify burial, however, carbon sequestration can increase the value of seagrass meadow restoration projects, further supporting anti-poverty initiatives in these productive marine ecosystems.

5.11.4 Ecosystem Resilience and human impact in the Pacific Ocean scape: current status and future directions

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Human activities produce a range of stressors in the marine environment which have direct and indirect effects on people, planet and prosperity. Marine ecosystems across the Pacific are being increasingly affected by stressors such as pollution, overfishing and increasing frequency of extreme weather and warming events, and are leading to ongoing and pervasive degradation of many Pacific marine ecosystems. Consequently, it is important to understand the vulnerability of the Pacific to future environmental scenarios, and to what extent management actions can build ecosystem resilience and maintain ecosystem service provision.

Methods and key results

Climate change is a global issue and the impacts of a warming world, sea rise and ocean acidification threaten much of the Pacific and impact on the socio-cultural, environmental, economic and human components of Pacific countries and their oceans. However, resilience to climate change can be reduced if systems are overburdened through stressors, such as pollution and overfishing. We will explore many of the pressures through case studies in Vanuatu and Solomon Islands, and explore the impacts of individual and cumulative pressures on the resilience, health and survival of these Pacific ecosystems. Ongoing work is focussing on the impacts of multiple stressors and provides insight into how ecosystem resilience can be built to accommodate future climate change impact scenarios.

Conclusion

The work so far has used targeted field sampling, coupled with satellite imagery and developing hydrodynamic models and socio-economic surveys to extend the data sources to enable a more comprehensive analysis of the individual stressors and impacts on vulnerable Pacific coastal ecosystems. Whilst still preliminary, the initial outcomes show the influence of pollution on coastal habitats is an important consideration for improving resilience. It also identifies the impact of coastal pollution



on human health and that a multiple prong approach to the abatement of pollution will improve resilience, protect coastal ecosystems and contribute to improving human health issues. The project has supported training and studentships in the region to deliver a lasting legacy.

Annex: Pictorial of the Sustainable Blue Economy Conference





