OPERATIONAL BRIEF

Knowledge, Data, and Information

BLUE ECONOMY FOR RESILIENT AFRICA PROGRAM

WORLD BANK GROUP

PROBLUE

© 2022 The World Bank Group
1818 H Street NW, Washington DC 20433
Telephone: 202-473-1000 | Internet: www.worldbank.org

This work is a product of the staff of The World Bank Group with external contributions. "The World Bank Group" refers to the legally separate organizations of the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA).

The World Bank Group does not guarantee the accuracy, reliability or completeness of the content included in this work, or the conclusions or judgments described herein, and accepts no responsibility or liability for any omissions or errors (including, without limitation, typographical errors and technical errors) in the content whatsoever or for reliance thereon. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of the World Bank Group concerning the legal status of any territory or the endorsement or acceptance of such boundaries. The findings, interpretations, and conclusions expressed in this volume do not necessarily reflect the views of the organizations of the World Bank Group, their respective Boards of Executive Directors, and the governments they represent.

The contents of this work are intended for general informational purposes only and are not intended to constitute legal, securities, or investment advice, an opinion regarding the appropriateness of any investment, or a solicitation of any type. Some of the organizations of the World Bank Group or their affiliates may have an investment in, provide other advice or services to, or otherwise have a financial interest in, certain of the companies and parties named herein. Nothing herein shall constitute or be construed or considered to be a limitation upon or waiver of the privileges and immunities of any of the organizations of The World Bank Group, all of which are specifically reserved.

Rights and Permissions

The material in this work is subject to copyright. Because The World Bank Group encourages dissemination of its knowledge, this work may be reproduced, in whole or in part, for noncommercial purposes as long as full attribution to this work is given and all further permissions that may be required for such use (as noted herein) are acquired. The World Bank Group does not warrant that the content contained in this work will not infringe on the rights of third parties, and accepts no responsibility or liability in this regard. All queries on rights and licenses should be addressed to World Bank Publications, The World Bank Group, 1818 H Street NW, Washington, DC 20433, USA; e-mail: pubrights@worldbank.org.

Cover photo: © Freepik

Acknowledgments

This brief was written by Nagaraja Rao Harshadeep (Lead Environmental Specialist). The series of briefs was prepared by a team led by Lia Carol Sieghart (Practice Manager), Christian Albert Peter (Practice Manager), Sanjay Srivastava (Practice Manager), Maria Sarraf (Practice Manager), Iain Shuker (Practice Manager) and Africa Eshogba Olojoba (Practice Manager). The team includes Peter Kristensen (Lead Environmental Specialist), Marcelo Hector Acerbi (Senior Environmental Specialist), Sajid Anwar (Environmental Specialist), Darshani De Silva (Senior Environmental Specialist), Nagaraja Rao Harshadeep (Lead Environmental Specialist), Kanako Hasegawa (Environmental Specialist), Ede Ijjasz-Vasquez (Lead Consultant), Juliana Castano Isaza (Natural Resources Management Specialist), Federico Scodelaro (Consultant), Madjiguene Seck (Senior Partnership Specialist), Ruth Tiffer-Sotomayor (Senior Environmental Specialist), and Phoebe Girouard Spencer (Environmental Economist).

The publication has greatly benefited from the strategic guidance of Boutheina Guermazi (Director, Africa Regional Integration), Valerie Hickey (Global Director, Environment), Simeon Ehui (Regional Director, West and Central Africa), Paul Noumba Um (Regional Director, Infrastructure and acting Regional Director for Sustainable Development, Middle East and North Africa), Ayat Soliman (Regional Director, East and Southern Africa), Stephen Hammer (Adviser), and Keiko Miwa (Regional Director, Human Development, Middle East and North Africa).

The team benefited from insightful comments and guidance from internal reviewers including Marcelo Acerbi (Senior Environmental Specialist), Sylvia Michele Diez (PROBLUE Program Manager), Ruxandra Floroiu (Lead Environmental Specialist), Ede Ijjasz-Vasquez (Lead Consultant), Christian Peter (Practice Manager), Lia Carol Sieghart (Practice Manager), and Sanjay Srivastava (Practice Manager).

In addition, the team received incisive and helpful advice, comments and input from World Bank colleagues, including Syed Adeel Abbas (Senior Climate Change Specialist), Anjali Acharya (Senior Environmental Engineer), Jacqueline Alder (Consultant), Philippe Ambrosi (Senior Environmental Economist), Tamara Bah (Consultant), Ozgul Calicioglu (Environmental Engineer), Soniya Carvalho (Lead Evaluation Officer), Manon Pascale Cassara (Consultant), Keren Charles (Senior Disaster Risk Management Specialist), Manuela Ravina da Silva (Environmental Specialist), Charlotte De Fontaubert (Senior Fisheries Specialist), Idriss Deffry (Environmental Specialist), Raian Divanbeigi (Senior Economist), Enos Esikuri (Senior Environmental Specialist), Gunilla Greig (Senior Fisheries Specialist), Gabriella Morandi Guimaraes (Consultant), Maged Hamed (Lead Environmental Specialist), Sandrine Jauffret (Senior Natural Resources Management Specialist), Sarah Jung (Consultant), Harrison Charo Karisa (Senior Fisheries Specialist), Jane Kibbassa (Senior Environmental Specialist), Mark Leybourne (Senior Energy Specialist), Maria Lopez (Consultant), João Moura Marques (Natural Resources Management Specialist), Bernhard Metz (Senior Operations Officer), John Morton (Senior Urban Specialist), Dania Mosa (Consultant), Kamakshi Perera Mubarak (Social Development Specialist), Helena Naber (Senior Environmental Specialist), Stefan Ott (Junior Professional Officer), Berengere Prince (Lead Natural Resources Management), Dario Quaranta (Consultant), Hak Joo Song (Junior Professional Officer), and Louise Twining-Ward (Senior Private Sector Specialist).

Support for this report was also provided by PROBLUE, a multi-donor trust fund administered by the World Bank that supports the sustainable and integrated development of marine and coastal resources in healthy oceans.

About the Blue Economy for Resilient Africa Program

The Blue Economy generated nearly US$300 billion for the African continent in 2018, creating 49 million jobs in the process. These and other crucial benefits—most notably food security, livelihoods, biodiversity, and resilience to the effects of climate change—are entirely dependent on the health and productivity of coastal and marine areas.

By safeguarding productive coastal landscapes, countries will be in a better position to take full advantage of future Blue Economy opportunities, which range from sustainable blue energy to aquaculture to blue carbon.

The World Bank's Blue Economy for Resilient Africa Program, announced at COP27, will provide multisectoral analytical, financial, and policy support to Africa's coastal countries and island states to help them leverage the opportunities—and manage the risks—inherent in scaling up their Blue Economies.

About this series of briefs

The Blue Solutions for Africa series of operational briefs captures how a thriving Blue Economy can help African countries better manage the development challenges they face while supporting economic growth, sustainable livelihoods, and the health of these precious ecosystems.

THE BRIEFS COVER THE FOLLOWING THEMATIC AREAS

- Climate change
- Coastal and marine biodiversity and habitats
- Sustainable fisheries
- Marine pollution
- Jobs and livelihoods
- Participatory marine spatial planning
- Data management and knowledge creation
- Innovative financing instruments
- Developing and incentivizing institutions
- New frontiers of innovation

© Shutterstock

© Freepik

Key Messages

African countries and regional entities need greater investment into the production of data for better knowledge and tracking of the state of its marine and coastal resources.

Many new technologies are revolutionizing the way data is collected, processed, and visualized for decision support. A new range of satellite and air-based Earth observation options are complementing traditional and modernized in-situ observations to provide more comprehensive, synoptic, and quasi-real-time data.

Data is increasingly processed using the power of the cloud, moving away from legacy desktop systems to leverage the power of machine learning and artificial intelligence tools.

Beyond data technologies, it will be important to move up in the data value chain to produce accessible knowledge products that support informed decision-making.

Improving the organization of—and strengthening access to—data and knowledge among governments, the private sector, academia, civil society organizations, financiers, and the public will help generate multisectoral, spatial, and sustainable development insights and attract more financing, including from the private sector and other development partners.

© Freepik

Introduction

Africa has significant potential to improve its climate-smart sustainable development by focusing on the Blue Economy. However, efforts to reach this potential are stymied by poor access to relevant data and knowledge due to inadequate historical investments in technology and institutional capacity for modernization.

Today, there are many opportunities to leapfrog traditional development paths by leveraging a new range of technologies. "BlueTech" refers to the innovative use of emerging technologies to scale up the development impact of the Blue Economy, while managing associated trade-offs. These technologies have the potential to accelerate the expansion of the Blue Economy—but only if countries in Africa invest in enabling infrastructure, capacity, and services to strengthen their technological innovation ecosystem. A robust technological backbone will better be able to harness the power of the cloud, e-package data, and technological knowledge to enable new ways to collect, analyze, and share data, making it more accessible and usable. At the same time, it will facilitate the collaborative development of harmonized systems to generate insights into, and support decisions relating to, the Blue Economy.

© Freepik

The Challenge

Africa—with its significant natural resources and increasingly capable workforce—has significant development potential, given its rapid emergence from historical underdevelopment. The Blue Economy could be an excellent way to accelerate this development.

Realizing this great potential requires a better understanding of the continent's role in climate mitigation and adaptation, as well as new approaches to the development of "blue" sectors including fisheries and aquaculture, marine and oceanic pollution, seascape management and marine spatial planning.

Improved data collection and management that draws on rapidly evolving, "disruptive" technologies will be key to building Africa's Blue Economy. Globally, there is a lack of data and knowledge of the marine and coastal environment and related economic activities. In Africa, the situation is worse due to low levels of investments into information, institutional, and infrastructure systems, which plays out in the form of poor monitoring; lack of interoperable data standards; limitations in data access; institutional capacity challenges; and poor and expensive internet connectivity (only 22 percent of the population currently has internet access).

Data and knowledge challenges hinder all aspects of sustainable development and the Blue Economy. Issues such as biodiversity loss or pollution require a good evidence base and analytical insights for action. The management of water catchment areas, coastal zones, and exclusive economic zones—which are sometimes far greater than a country's land area—all require comprehensive, multisectoral insights backed by detailed spatial information. For example, coastal investments such as ports, which can cause unanticipated erosion in neighboring regions, require better coordination and stronger sources of data and analytics to support and inform scoping, planning, and design. This is not possible with the current fragmented systems used for data and analytics.

Africa has great potential to rapidly develop its technological infrastructure, which could lift millions out of poverty and fuel a new age of sustainable growth. There are already good examples in every country of innovations that draw on data-driven approaches to create improved economic, social, and environmental impact. Data-driven approaches will be particularly important for managing Africa's changing climate and demography.

What is Needed

A range of emerging "BlueTech" options could create a new paradigm for sustainable development in Africa while driving the Blue Economy. These technologies are "disrupting" traditional approaches to data and knowledge, evolving and combining at an accelerated pace to change the way decisions are made, things are made, and how stakeholders interact with each other (see next page).

© Curt Carnemark / World Bank / Flikr

A NEW WORLD OF DISRUPTIVE TECHNOLOGY

"DISRUPTED" DATA VALUE CHAINS

- **Data collection:** Monitoring using in-situ, IoT sensors; Earth observation using satellite or drones; crowdsourcing; digitization
- **Data management:** Telemetry; mobile networks; cloud services; open data; blockchain
- **Data analysis:** Big data; machine learning/artificial intelligence; modelling; script repositories; cloud computing; quantum computing
- **Data access:** Open data APIs; data visualization; gamification; mixed, augmented, or virtual reality
- **Outreach:** Platforms and portals; social media; apps; e-books; competitions

"DISRUPTED" PRODUCTION VALUE CHAINS

- 3D printing; additive manufacturing
- "Digital twins"; the Metaverse
- Automation; supervisory control and data acquisition (SCADA)
- Robotics; autonomous transport
- Nanotech; biotech; genomics; energy tech; green tech; agricultural tech

"DISRUPTED" STAKEHOLDER VALUE CHAINS

- Virtual social networks and digital platforms
- Sharing economy
- Crowdsourcing; gamification; competitions (e.g. hackathons)
- Mobile money; fintech; cryptocurrency
- Blockchain-enabled value chains
- Maker movement; DIY; technology incubators
- Virtual learning and reskilling

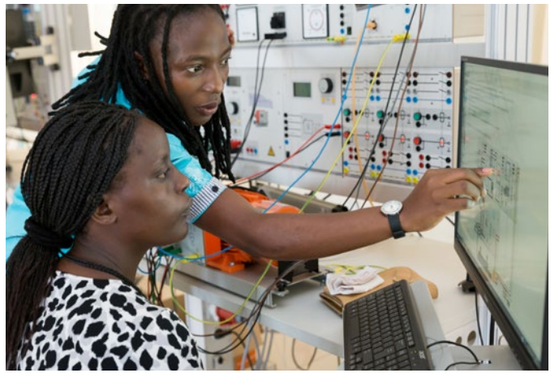
Figure 1: How disruptive technologies are reshaping the world

Many disruptive technologies are ushering in a revolution in the way data is collected, processed, accessed, and visualized. A new range of Earth observation options (from satellites, drones, and other aircraft) are complementing traditional in-situ observations, which have also been modernized through new sensors that are connected to the internet, benefiting from the "internet of things" (IoT) concept. Crowdsourced data collection (such as online surveys) and real-time telemetry advances, even in remote areas, are providing more comprehensive, synoptic, and near-real-time data. Several countries are developing national geospatial data infrastructure to collate data from various entities and make it accessible in the public domain using standardized formats (for example, open geospatial consortium standards and open application programming interfaces, or APIs) to support interoperability. This data is increasingly being processed in the Cloud, supporting online data analytics (for example, online GIS systems or Google Earth) and the use of new machine learning and other artificial intelligence tools. The resulting information can be accessed via digital platforms in various forms, from interactive data dashboards to extended reality, or XR, a concept that includes augmented reality and virtual reality.

Advances in data collection, management, and visualization are also modernizing how knowledge is generated and used. This includes improving the availability of free knowledge resources in the public domain and helping to collate these resources, as it is difficult to find even basic knowledge products in full text across Africa on topics related to the Blue Economy. A new range of new e-packaging options are also available in the form of e-books and story maps, which can be used to disseminate data-rich knowledge using interactive charts, maps or schematics and other multimedia assets. These knowledge products are important tools for spatial planning and the integrated management of marine and coastal zones.

The benefits of technology are not limited to the digitalization of data and knowledge. Governments across Africa face many competing development needs. The improved organization of, and access to, data and knowledge could provide greater insights into the tradeoffs and opportunities inherent in the sustainable development agenda, while supporting the design of Blue Economy investment programs to attract more financing from the private sector and development finance institutions.

Digital innovations could also streamline processes, services, and stakeholder platforms relating to the Blue Economy. However, to seize the opportunities inherent in these innovations, various stakeholder groups across Africa—governments, the private sector, academia, civil society organizations, financiers, and the general public—will need to work together to create an enabling environment.



Source: Kelley Lynch / World Bank

Creating an enabling environment for the rollout of new technologies would help leverage the region's youth dividend. The market for IoT, blockchain, big data analytics and artificial intelligence, among other emerging technologies, is expected to create hundreds of trillions of dollars in value over the next decade. Countries around the world are investing in their youth and enabling infrastructure, services, and capacity-building to benefit from this revolution. There is an urgent need to improve awareness of these new approaches and create a new generation of tech-savvy African professionals to be the engine of modernizing institutions and approaches for sustainable development, including the Blue Economy.

© Arne Hoel / World Bank

How the World Bank Group Contributes to Solutions

With the World Bank Group's support, various African governments are modernizing their institutions and leveraging new technologies to strengthen their base of coastal and marine data and knowledge. This, in turn, supports informed policy-making and the design of Blue Economy investment programs.

Country-level solutions

The World Bank's technology-focused investments are primarily concentrated at national and sub-national levels through support for country-level projects. To date, the World Bank has supported projects in:

- **Guinea:** Funding from PROBLUE was used to produce a web visualization tool that maps coastal land cover changes over time. The tool can be used to, for example, visualize the extent to which rice fields have encroached on mangroves since 2000. The World Bank's support has also allowed the country to start using automatic identification and vessel monitoring systems to analyze marine traffic and fisheries activities in its exclusive economic zone.
- **Tanzania:** Drones were used to take images of beaches in Tanzania and Zanzibar that, when paired with on-the-ground waste characterization and machine learning-based analytics, enabled the country to assess the extent of plastic pollution and related costs to the country. This work was also supported by PROBLUE.
- **Morocco:** The World Bank's Blue Economy Program for Results supported the development of a web-based data-management tool, SIRED, which enables users to access regional information related to the environment and sustainable development for the Rabat-Salé-Kénitra region.
- **Kenya:** A fisheries information and monitoring system was developed with the support of the Kenya Marine Fisheries and Socio-Economic Development Project, a joint initiative between the World Bank and the Government of Kenya. Fisheries data captured in hard copy was transferred to an electronic database using mobile phones. This information will support future spatial planning and fisheries management.
- **Tunisia:** The World Bank is working with the government to identify the best technology to use for stocktaking and assessing the status of various blue sectors. The World Bank estimates that tourism and fisheries alone provide about 450,000 jobs in the country.

Regional solutions

In addition to supporting technological innovation at the country level, the World Bank works through various regional initiatives in Africa. These include the West Africa Coastal Areas Management Program, the South West Indian Ocean Fisheries Governance and Shared Growth Project, and various regional and knowledge projects.

The West Africa Coastal Areas Management Program

The West Africa Coastal Areas Management Program facilitates access to technical expertise and financial resources for participating countries. Among other initiatives, the program has supported the development of a regional *Observatoire regional des littoraux d'Afrique de l'Ouest* (West African Regional Coastal Observatory, or ORLOA) for monitoring the coastline. The observatory is hosted by the *Centre de Suivi Ecologique* (Center for Ecological Monitoring) in Senegal. As part of this effort, the 2020 State of the Coast Report tracks changing conditions in 12 coastal countries and makes recommendations that will inform decision-making and policy formulation.

The World Bank leverages the West Africa Coastal Areas Management Program to crowd in technical expertise and data from international partners to support regional initiatives. For example, it partnered with the European Space Agency's Earth Observation for Sustainable Development Marine and Coastal resources consortium to provide services and capacity building on Earth observation for marine pollution, oil spill, and shoreline monitoring. Similarly, France provided Benin, Togo, and Senegal with historical data—including sea charts, bathymetric surveys, and aerial photos—to help the country better understand the evolution of coastal erosion processes over several decades.

Recently, the program published an e-book to disseminate the results of its call for innovation to tackle the coastal erosion and flooding issues associated with the presence and future development of large commercial ports in West Africa. A similar book on plastic pollution is being developed.

South West Indian Ocean Fisheries Governance and Shared Growth Project

This innovative regional fisheries program is promoting the modernization of sustainable fishing and knowledge exchange in Africa. Regional analytics, such as the support for the Regional Partnership for African Fisheries Policy Reform that produced the Climate Change and Marine Fisheries in Africa report, have been useful to help develop a baseline for action. The World Bank has also supported fish stock assessments along with other surveys of associated water bodies with support for Sub-Regional Fisheries Commission, South-West Indian Ocean Fisheries Commission, the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA), Lake Victoria Basin Commission, Lake Victoria Fisheries Organization, and others. Also see the Brief on Sustainable and Climate-Adapted Fisheries for further information on these aspects.

Other projects

The World Bank has recently competed a report exploring issues of marine plastics, coastal erosion, and air pollution in some countries of the Middle East and North Africa region. The report makes innovative use of available data and analytics to improve insights on these aspects.

The Africa Centre of Excellence in Coastal Resilience was established by the World Bank and the University of Cape Coast, with the support of the Government of Ghana and the Association of African Universities. The Center promotes coastal resilience through the development of technical and scientific expertise of young African professionals. The Center works with the West Africa Coastal Areas Management Program to explore opportunities like the creation of an incubation hub to support talented youth with creative business ideas related to coastal resilience.

NEW TOOLS AND CHANNELS FOR KNOWLEDGE-SHARING

In addition to improving systems for data collection, analytics, access, and visualization, the World Bank is also pioneering ways to e-package information (for example, as interactive e-books and story maps) that are accessible on multiple device platforms, moving away from traditional static hardcopy publications.

INNOVATIONS IN KNOWLEDGE DISSEMINATION

The online Marine Spatial Planning Data Resources Catalog is a collection of tools and knowledge to provide guidance and information, and facilitate discussions between stakeholders, during the marine spatial planning process.

Blue Economy Data and Tools offers a comprehensive breakdown of the types of data that are useful for marine spatial planning, and the tools that can be used to support MSP processes. These tools range from applied modeling tools to decision-support software to online GIS mapping tools and portals.

The BlueTech e-book catalogues global innovations that could help African nations rethink their approaches to driving the Blue Economy. It includes a BlueTech data portal, which showcases several types of global data already available (including maps that depict global seagrass distribution, projected ocean acidification, and global coral beaching monitoring) and a BlueTech Knowledge Resources Catalog.

Other knowledge products and tools available focus on plastics, hydroinformatics (including a two-week forecast for every river segment in Africa and other parts of the world), the World Bank's external Geospatial Platform, and Earth observation for sustainable development (in partnership with the European Space Agency).

A technology-driven focus on modernizing data and knowledge can help improve the foundation for shared vision planning and implementation across sectors to accelerate the realization of the benefits of the Blue Economy while sustaining the health of coastal and ocean ecosystems. The coming decade will be an exciting one for countries in Africa to leverage a range of emerging technologies to help invest in the Blue Economy.

Several groups and networks at the World Bank are working on leveraging new "disruptive" technologies, developing interactive geospatial platforms, and developing innovative interactive knowledge repositories (see "New tools and channels for knowledge-sharing"). The global reach of the World Bank's Open Learning Campus has also demonstrated innovative ways of promoting virtual knowledge exchange as well as in-person sessions that could be leveraged to scale-up learning on such evolving topics. And of course, given the World Bank's deep involvement in Africa's sustainable development, the experience from the financing, convening, and knowledge elements can be particularly useful for the Blue Economy.

What Success will Look Like

Investing in enabling systems, processes, and institutional capacity and collaboration can help unleash a new, accelerated development in Africa that can both learn and contribute to global good practices in sustainable development.

This vision for the future fueled by modern technology will include strong investments in information, institutions, and infrastructure.

Information

A comprehensive multi-sectoral spatial knowledge base leveraging Earth observation, modern sensors, citizen science, cloud analytics, and e-packaging will be accessible in open, interoperable formats to enable customized dashboards and decision-support tools without having to "reinvent the wheel" and break down institutional barriers across sectors and regions. This includes information on climate; hydroinformatics; coastal areas and littoral change; fisheries; biodiversity; the sources, transport, and fate of key water pollutants; plastics and alternatives; blue energy; socio-economic and other aspects of the marine and coastal environment in Africa that will be critical to generate insights and fuel innovative multi-sectoral analytics on the Blue Economy.

Institutions

There will be a set of modern state-of-the-art institutions (including effective governance and a thriving innovation ecosystem in the private sector and academia) across the continent within and across countries that are staffed by well-trained, capable youth that can use and adapt modern technologies with ease to help with the planning, implementation, and monitoring for accelerated development of all aspects of the Blue Economy. Civil society organizations will be empowered with adequate data, capacity, and networking to help be the bridge to local communities and ensure transparency and good governance.

Infrastructure

Adequate financing and knowhow to effectively plan a wide range of Blue Economy investments to address existing and evolving challenges and effectively benefit from the opportunities in the Blue Economy. These infrastructure investments will be well coordinated across internal and country borders to maximize impact and minimize conflict.

Realizing this vision will require not only financing, but a real change in mindsets driven by improved awareness of rapidly evolving global good practices based on accelerating development and combination of technologies. This will require a change to a more "agile" approach based on new opportunities, avoiding "stranded assets" of obsolete technologies, and development of a more collaborative ecosystem of institutional actors. This will require investment in foundational elements of technology, accelerated capacity-building, and building on existing institutions and initiatives.

© Freepik