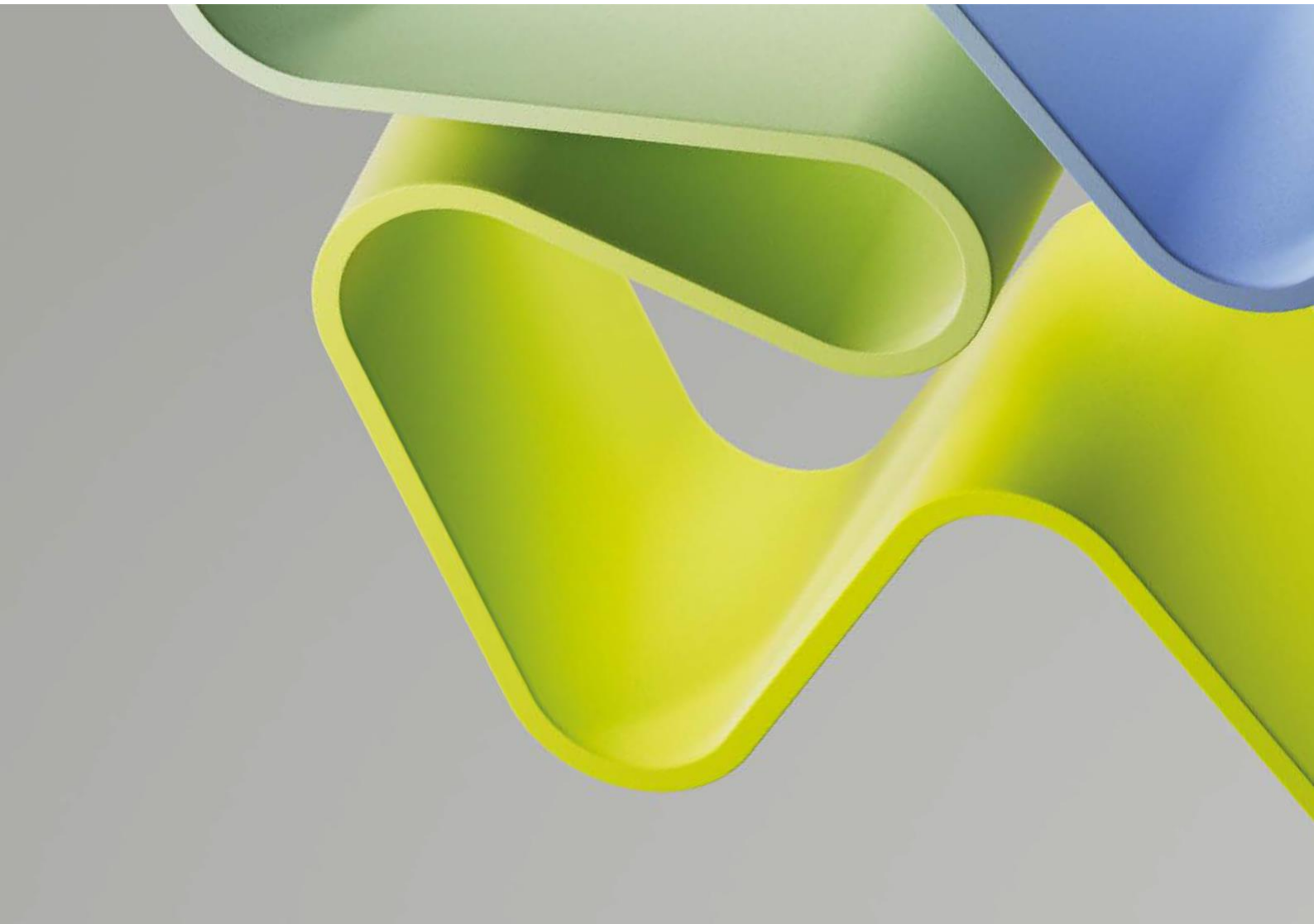
Research results 2018 – 2023

South Africa – Norway co-operation on ocean research, blue economy, climate change, the environment and sustainable energy

SANOCEAN



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Preface

Joint statement by National Research Foundation CEO, Dr Fulufhelo Nelwamondo, and the Research Council of Norway CEO, Dr Mari Sundli Tveit

Two decades of research collaboration between South Africa and Norway is certainly something to celebrate and look back on with pride. Since the start in 2002, four bilateral programmes have been funded jointly by the South African Department of Science and Innovation and the Norwegian Ministry of Foreign Affairs. During this period, 96 projects in a variety of areas relevant to Norwegian and South African priorities have been undertaken by researchers, students, and administrators.

The longstanding collaboration has been unique because it was designed as a fully bilateral and equitable partnership with each project headed by a South African and a Norwegian principal investigator (PI). The programmes have been operated through a partnership of two collaborating funding agencies – the National Research Foundation (NRF) and the Research Council of Norway (RCN). It has been a meaningful and fruitful way to enhance excellence in research and human capacity development in our two countries. The number of co-authored scientific publications over the five last years has doubled from 270 in 2018 to 454 in 2022. The quality of the publications measured as citations is also high and comparable to Norwegian co-publications with Canada and Japan. This close cooperation has also resulted in high participation in joint projects funded by the EU framework programmes. In the Horizon 2020 programme, Norway and South Africa had 48 joint projects. In the first two years of the current seven-year Horizon Europe programme, 10 joint projects with Norwegian and South African partners have already been funded.

In this brochure, you can read all about the achievements of 10 projects funded by the SANOCEAN programme (South Africa – Norway Research Co-operation on Blue Economy, Climate Change, the Environment and Sustainable Energy). The overall aim of enhancing knowledge-based policies in the areas of ocean and ocean space has been achieved, together with impressive human capacity development, especially for female early career researchers and postgraduate students. Research cooperation over the last 21 years has proven to be a flagship in the wider bilateral relations between South Africa and Norway. Hopefully, SANOCEAN's success will lead to further new initiatives between the two countries.

The Research Council of Norway

NRF National Research Foundation

Joint Statement by Ambassador Gjermund Sæther on behalf of Norwegian Ministry of Foreign Affairs and Deputy Director General (International Cooperation and Resources) Mr. Daan du Toit on behalf of South Africa's Department of Science and Innovation on the SANOCEAN programme

As the SANOCEAN programme ends, South Africa and Norway reflect on the research collaborations that have not only strengthened bilateral relations between the two countries. Throughout the last five years, researchers from both countries have done more than produce knowledge to inform policy and facilitate the achievement of the Sustainable Development Goals through the ocean.

While the aims of the projects in the SANOCEAN programme are different, they have contributed to solving issues relating to climate change, the environment and sustainable energy which no country can solve on its own, which makes programmes like SANOCEAN crucial to obtaining shared goals. Through the vision of the UN Ocean Decade, the projects have also provided valuable insights in the global vision that both countries find most crucial.

The two countries will continue to create long-term, high-level cooperative relationships through joint research projects, promoting gender balance in research communities as well as prioritizing growing expertise within historically disadvantaged groups in South Africa. We applaud the outcomes of the programme and look forward to our continued close collaboration in research and education.

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Norwegian Embassy
Pretoria

Key facts South-Africa and Norway Collaboration

Phase 1

- NOK 30 million + ZAR 3 million allocated
- 129 applications in two calls; 40 funded
- 15 NO institutions and 10 SA institutions involved

Phase 2

- NOK 42 million + ZAR 9 million allocated
- 79 applications in one call; 27 funded
- 13 NO institutions, and 13 SA institutions involved

Phase 3

- NOK 40 million + ZAR 10 million allocated
- 52 applications in one call; 19 funded
- 18 NO institutions and 13 SA institutions involved

Phase 4

- NOK 30 million + 15 million allocated
- 22 applications in one call; 10 funded
- 10 NO institutions and 11 SA institutions involved

Managing coastal resources for sustainable livelihoods

«If you understand the movement of the fish, you can better understand how to manage the fisheries.» Dr Taryn Murrat, Instrument Scientist and Project Manager South Africa

Key takeaways: Navigating a complex ecosystem

- Holistic management: Estuaries demand an all-encompassing approach, recognizing human connections alongside ecological intricacies.
- Continuity is key: Long-term research continuity prevents restarting from scratch, fostering sustainable solutions.
- Tailored solutions: Each estuary requires a unique management strategy, emphasizing diligent effort and tailored solutions.
- Cultural sensitivity: Successful cross-border research hinges on adapting to local culture and respecting host countries.

Coastal gem under threat

South Africa's enchanting coastline, with its sandy shores and rugged cliffs, harbors hidden treasures in the form of dynamic estuaries where rivers meet the sea. These estuaries serve as crucial nurseries for both estuary and marine fish, sustaining aquatic life and offering a lifeline to economically challenged communities. Amidst their serene beauty, however, a looming crisis unfolds as overfishing and habitat destruction jeopardize these invaluable resources.

Pioneering research on socio-ecological systems

The project builds on 20 years of research on the movements of important estuary fish species. It incorporates crucial, yet often overlooked, socio-cultural and socio-economic research, setting this project apart from anything previously done in this field of estuarine fisheries in South Africa. This holistic, or socio-ecological, approach ultimately seeks to guide a more sustainable approach to the conservation of estuarine ecosystems and services, promoting more equitable yet sustainable use of estuary resources.

Surgical implantation of an acoustic transmitter into a juvenile dusky kob caught on the Sundays Estuary. Photo: Tor Fredrik Næsje.

Lessons learned
A comprehensive 120-page report summarizes the project's findings. The report emphasizes the interconnectedness of estuaries with the lives of those who rely on them. The research underscores the need for a multifaceted approach, acknowledging fishing, recreation, cultural practices, and livelihoods as important elements in managing estuaries. This interplay highlights a key principle: managing estuaries and their resources means better and more equitably managing the people tied to these important ecosystems.

The project extended its impact beyond scientific findings by nurturing the growth of future researchers in both countries. Embracing diversity, it engaged previously disadvantaged students, providing them with hands-on experience as co-researchers. Their active involvement has fostered empowerment and a sense of ownership.

To complement the final report, the executive summary will be translated into several indigenous languages spoken by the coastal populations of South Africa. This initiative aims to enhance accessibility of the information to both local communities and governmental bodies within the country.

"We could not have completed this project without the students involved. They were vital participants of the field work." Dr Tor Fredrik Næsje, Senior Researcher and Project Manager Norway

Fostering long-term research
The Norway-South Africa collaboration, spanning two decades, has been successful in many ways. Among other things, it has sparked a large research network and opened the door to new possibilities within the field. Furthermore, it has been a testament to the value of continuity and long-term research. Hence, the aim is to further advance ongoing research pursuits.

Operating in turbulent waters: Overcoming challenges of the pandemic
In the face of challenges, the project demonstrates resilience. The COVID-19 pandemic altered plans, prompting adjustments in estuary selection and research questions. However, through these adjustments, work was focused on arguably more important estuaries; each with impoverished communities whose community members heavily rely on the systems for their livelihoods. As such, these systems are heavily exploited, with lower levels of compliance, making them ideal study systems. The resilience demonstrated underscores the project's commitment to its mission.

FACTS

Awarded: NOK 1 500 000, ZAR 4 500 000
Project Manager: Senior Researcher DR Tor Fredrik Næsje and Instrument Scientist Dr Taryn Murray
Research collaborators: Instituttsektor / Miljøinstitutter / Stiftelsen Norsk Institutt for Naturforskning / Nina Trondheim / Akvatisk avdeling / South African Institute for Aquatic Biodiversity (SAIAB) / Institute for Coastal and Marine Reasearch (CMR) at Nelson Mandela University.
Project aim: Study estuarine fish management through a holistic and multidisciplinary research.
Scientific impact: A socio-ecological approach is important for a sustainable approach to the conservation of estuarine ecosystems and services, promoting more equitable yet sustainable use of estuary resources.

Sources

1. Interview with Project Manager South Africa, Instrument Scientist Dr Taryn Murray
2. Interview with Project Manager Norway, Senior Researcher Dr Tor Fredrik Næsje
3. LINK - Project description (Prosjektbanken)

Marine sewage outfalls – Environmental impact evaluation

«Chemicals of emerging concern (CEC) that were present in sewage were detected in seawater, marine sediments and bioaccumulated in marine biota. We traced substances such as antibiotics, caffeine and toxic metals.» Professor Leslie Petrik

Key takeaways

- Chemical Impact: Chemicals of emerging concern found in sewage were detected in seawater, marine sediments, and marine life, including substances like antibiotics, caffeine, and toxic metals.
- Different Impacts: In South Africa, sewage pollution caused long-lasting chemical contamination, bacterial presence, and antibiotic-resistant bacteria, affecting both marine ecosystems and public health. In Norway, findings were similar but less severe due to lower population and climate conditions.
- Medication Concerns: The high levels of medication found in the water attracted attention from pharmacists and doctors, emphasizing the need for more environmentally friendly and biodegradable medicines.
- Global Impact: The study's insights should contribute to shaping global policies about sewage disposal in oceans and its impact on health and ecosystems.
- Educational Value: The ongoing collaboration not only advances research but also provides valuable training for future scientists and experts in the field.

The primary objective of The Marine Outfalls Project was to assess water quality and identify the presence of sewage-derived chemicals. This was achieved through water samples, and aquatic organisms were collected and analyzed for common contaminants found in sewage. The samples, analyses, and case studies have been used as a basis for the evaluation of ocean health in Cape Town and Stavanger. The project aimed to assess the impact on water quality and potential dangers posed by sewage discharges into the ocean.

Groundbreaking Results in The Marine Outfalls Project

The testing took part in eleven different sites around the coastal zone near Cape Town, South Africa, and in Stavanger, Norway. The research work in South Africa proved the environmental impact of sewage by tracing CEC in sewage, and by detecting and quantifying these compounds in marine biota, sediments, and seawater. The scientists in both countries investigated bioaccummmulation in marine organisms such as mussels, starfish, sea snails, and fish to mention some, and the results were groundbreaking. In Cape Town CEC that were present in sewage and were detected in seawater, marine sediments, and bioaccummulated in marine biota includes a wide range of medication, such as antibiotics. The water was also highly contaminated with toxic metals, pesticides, and perfluorinated compounds.

In Norway, comparable findings emerged. However, due to the low population in the region and distinct weather and climate conditions, the prevalence of pollutants is comparatively lower. Unlike South Africa, the Norwegian study did not prioritize the impact on drinking water quality. Instead, it looked at how the outcomes could influence marine ecosystems along the coastline and the implications for fish farming facilities situated near sewage outfalls.

Scientific impact and key findings in South Africa

This study has uncovered some concerning facts: sewage is a consistent source of long-lasting chemicals that can interfere with our hormones and harmful metals. In South Africa, these pollutants are being dumped into the sea every day because the sewage is not treated properly. Fecal microbes such as E.coli can be found in the water near beaches and in the sea. The medicine that gets into the water, like antibiotics, can make bacteria resistant to treatment. When sewage is not treated properly or is just ignored, it can, in the long term, affect our health.

Scientific impact and key findings in Norway
Findings from analyses in Stavanger, Norway, will be of good use when the city is planning new desalination plants and sewage treatment plants. The results have also been used to investigate the behavior of different fish species. The findings reveal traces of substances like antidepressants, which in turn allows them to assess how this affects the animals' behavior. It found that this impacts both reproduction and response patterns, not unlike humans.

Due to the large quantity of medication discovered in the water, this study, in both countries, has caught the interest of both pharmacists and doctors. It is important for medications to be biodegradable and break down more easily in the environment.

What happens next?
The SANOCEAN project will be followed up in the INTPART project that is based on this project. The INTPART project will run through 2023.

Teamwork and Challenges
Working with government authorities took different routes in Norway and South Africa. In Norway, local officials and politicians showed interest and got involved. A local sewage treatment plant called IVAR was cooperative right from the start. In South Africa, things were somewhat different. They faced more resistance in getting their work recognized, and their findings sometimes provoked discomfort among the population. The aim going forward is that the insights from these studies should guide global policies about dumping sewage into the oceans so that health decisions can be made – both for humans and the oceans.

One of the eleven coastal zones near Cape Town, South Africa, where the sampling took place. Photo: Professor Leslie Petrik

FACTS

Awarded: NOK 1 600 000, ZAR 3 550 000
Project Manager: Scientist Magne Olav Sydnes (Norway) and Professor Leslie Petrik (South Africa)
Research collaborators: UoH-sektor / Universiteter / Universitetet I Stavanger / Det Teknisk-Naturvitenskapelige Fakultet / Institutt for matematikk og fysikk / University of the Western Cape (UWC)
Project aim: Investigation of the impact of sewage pollution on the marine environment in Cape Town
Scientific impact: Chemicals of emerging concern (CEC) that were present in sewage and were detected in seawater, marine sediments and bioaccumulated in marine biota included an extensive range of medication, such as antibiotics. The biodata and sediments were also highly contaminated with toxic metals.

Sources

1. Interview with Professor Leslie Petrik (South Africa)
2. Interview with Professor Magne Olav Sydnes (Norway)
3. LINK - Project description (Prosjektbanken)

Unraveling ocean mysteries – Microplastics and their coastal journey

«When a physical item, like plastic, enters the marine environment, its surface becomes a foundation for microorganisms such as bacteria and algae. These organisms colonize the surface, creating what is known as a biofilm. We aimed to study how different plastic types influence biofilm formation and if variations exist due to these plastic differences. » Chief Scientist Andy Booth, Project Manager in Norway

Key Takeaways:

- UV radiation and temperature are critical factors influencing how microplastics break down.
- Chemical additives can affect microbial growth on plastic particles.
- Collaborative efforts amplify the ability to address complex global challenges.
- Microplastic pollution in coastal areas is a significant concern and demands urgent attention and improved understanding.

The FORTRAN project provided essential insights into the problem of microplastics in our oceans. By understanding the factors that influence their formation and movement, we are better equipped to address the issue of microplastic pollution.

Decoding microplastics: Hypotheses and investigative focus

The FORTRAN project aimed to understand the formation of microplastics from ocean-bound plastic waste, by studying coastal conditions, the nature of plastics, and additives. It sought to uncover how these factors influence the creation and movement of microplastics, as well as the environmental consequences of microplastics. The project's scope was guided by hypotheses that UV radiation, temperature, and chemical additives play a role in how microplastics break down.

What impacts microplastic breakdown?

Laboratory experiments replicated coastal scenarios, revealing diverse responses of the most common plastic types to UV radiation and temperature. The project's outcomes underscore the relationship between environmental factors and microplastic degradation. Moreover, it proves that different plastic materials react differently. Experiments in the lab showed that clear polypropylene (PP) plastic breaks down faster in UV radiation than darker PP plastics, possibly due to UV stabilizers in dark plastics. Furthermore, the research team created models to reveal how microplastics behaved and moved within and away from coastal zones.

“The way chemicals inside the plastic are structured and how the plastic is exposed to UV light influence how the plastic behaves physically. This is a chain reaction, with UV exposure being the primary factor. UV light starts a process of chemical changes within the plastic, which then leads to changes in its physical properties. This ultimately causes the plastic to degrade,” says Prof Guven Akdogan, Project manager in South Africa.

Pre-production microplastic pellets, also known as nurdles, collected during the research period. Photo: WildOceans

This information helps us understand how different environmental factors affect microplastic breakdown and can guide future solutions for governments regarding which plastic types have the least possible negative impact.

To amplify the reach of the project findings, the team collaborated with the non-governmental organization WildOceans South Africa to create a platform reaching a wider audience. They introduced "Noah the Nurdle", a character that enlightens viewers about microplastics and their negative impacts. This campaign has already reached thousands of viewers.

Research hurdles
The team faced obstacles due to COVID-19, impacting the ability to have in-person meetings. Furthermore, it hindered the exchange of students participating in the project. Despite the challenges, the team managed to overcome the obstacles, ensuring thorough and reliable research while achieving the original project goals.

Collaborative brilliance and future endeavors
The cross-national collaboration enriched the project's insights by combining various viewpoints, leading to a more comprehensive understanding of the issue. There is currently not a lot of research about plastic degradation in the natural environment. Hence, this research has generated knowledge and analytical tools to the research field. The synergy of expertise from Norway and South Africa enhanced the scientific rigor and depth of the investigation.

“This has been a great experience for both researchers in Norway and South Africa, and it has given us a better understanding of the field. Additionally, understanding both the environmental consequences and the societal structures of it has been meaningful.”
Researcher Lisbet Sørensen, Project manager in Norway

Future endeavors aim to dive deeper into the impact of chemical additives on the growth of microorganisms and validate degradation models using real-world samples. These questions prompt the pursuit of additional research grants to investigate the complexities at play.

FACTS

Awarded: NOK 1 500 000, ZAR 3 700 000
Project Manager: Project Managers in Norway; Chief Scientist Andy Booth and Senior Researcher Lisbet Sørensen, and Project Manager in South Africa Professor Guven Akdogan
Research collaborators: SINTEF OCEAN AS / University of Stellenbosch / University of Western Cape / WildOcean
Project aim: To understand the formation of microplastics with a focus on coastal conditions, plastic types, and additives.
Scientific impact: The study highlits the connection between environmental conditions and how microplatics break down, helping to develop more effective mitigation strategies.

Sources

1. Interview with Project managers in Norway; Chief Scientist Andy Booth and Senior Researcher Lisbet Sørensen, and Project manager in South Africa Prof Guven Akdogan
2. LINK - Project description (Prosjektbanken)

Microplastics in wastewater as a carrier and dispersal route of antibiotic resistance in oceans

Key takeaways

- Collaborative research by Norwegian and South African scientists examined the correlation between microplastics, antibiotic resistance, and ecological impact.
- Microorganisms present on microplastics could potentially facilitate the transmission of antibiotic resistance genes, raising concerns regarding both human health and marine life.
- Specific types of plastics attract bacteria, potentially hastening their growth.
- Research findings challenge current ocean sewage policies and advocate for a reevaluation of strategies concerning wastewater treatment.
- Collaborative endeavors between Norway and South Africa showcase the potential of cross-border teamwork to effectively address global environmental challenges.
- The project's success underscores the crucial role of microplastics in spreading antibiotic resistance, thereby emphasizing the importance of a coordinated global response.

In an international collaboration between Norwegian and South African researchers, the intricate relationship between microplastics, antibiotic resistance genes, and their potential ecological impact has been explored. This project aimed to decipher the composition of microplastics present in wastewater and their role as carriers for antibiotic resistance genes, with a focus on wastewater treatment plants in both countries. The ultimate goal was to provide insights that could change strategies for managing waste.

Tracing the microplastic pathway

This research involved collecting wastewater samples from treatment plants across various seasons and locations in Norway and South Africa. By examining microplastic characteristics and assessing treatment efficacy, researchers delved into the genetic makeup of biofilms using 16S rRNA gene sequencing*. While the movement of microplastic-associated bacteria to beaches remained unexplored, laboratory experiments provided valuable insights into gene transfer dynamics and biofilm formation.

Hypotheses and Insight

The project's hypotheses focused on microplastics dispersed in wastewater as potential carriers and distributors of antibiotic-resistant genes in ocean environments. A crucial element was understanding the formation of biofilms on microplastics and the possibility of horizontal gene transfer within these biofilms. A comparative analysis of wastewater treatment plants in Norway and South Africa aimed to inform policymakers about the threats posed by microplastic release and underscored the importance of wastewater management.

Shaping a new paradigm

The research made a significant discovery: microplastics possess the capability to carry antibiotic-resistance genes. Bacteria from wastewater remained alive on microplastics over time, causing concerns about potential new paths for gene transfer. This revelation prompted a reevaluation of ocean sewage practices and underscored the necessity for rethinking sewage management strategies.

This research's implications stretch across plastic usage, waste management, and public health policies. The study also stresses the urgency of further exploration into the potential migration of microplastic-associated bacteria onto beaches and the ensuing ecological and human health consequences.

The synergy of global collaboration

The Norway-South Africa partnership is a strong example of the potential gains of cross-border teamwork. By sharing methods, resources, and knowledge, this collaboration amplified research efforts, fostering capacity-building and knowledge dissemination to marginalized communities. This collaboration offers a powerful blueprint for addressing global environmental challenges effectively.

Insights for action
This collaborative endeavor, although impacted by the disruptions of the COVID-19 pandemic, succeeded in its objectives. The findings underscore the critical role of microplastics in spreading antibiotic resistance, making it clear the importance of a unified global response. The Norway-South Africa partnership serves as a testament to the potency of cooperative efforts in confronting shared environmental concerns.

Dictionary
* **16S rRNA gene sequencing** is a method for analyzing bacterial diversity by sequencing a specific region of the 16S ribosomal RNA gene, enabling identification and classification of bacterial species based on genetic variations. It's used to study microbial communities and their roles in ecosystems.

FACTS

Awarded: NOK 2 000 000, ZAR 3 000 000
Project Manager: Scientist Odd-Gunnar Wikmark and Professor Carlos Bezuidenhout
Research collaborators: Instituttsektor / Miljøinstitutter / NORCE Norwegian Research Centre AS / NORCE Miljø / Klima NORD / Unit for Environmental Sciences and Management; Microbiology, North-West University South Africa
Project aim: To study microplastics in South African and Norwegian wastewater, focusing on the microorganisms formed on them.
Scientific impact: The project found that bacteria survived on microplastics for 30+ days, suggesting they can carry and transfer bacteria. Potential pathogens and microplastics raise concern for disease transmission to ocean life and humans. The research challenges current ocean sewage policies and has important implications for wastewater treatment strategies.

Sources

1. Interview with Scientist Odd-Gunnar Wikmark
2. Interview with Professor Carlos Bezuidenhout
3. LINK - Project description (Prosjektbanken)

Impact of seawater desalination and discharge of wastewater on the coastal environment

«Harbor Pollution has become a global issue, particularly in developing countries, and its impact has been felt universally. Addressing this issue requires a holistic approach that encompasses not just technological solutions but also the social aspect of it.» Professor Luke Chimuka, South Africa

Key takeaways

- **Environmental Awareness**: The study focused on the impact of brine and wastewater discharges from seawater desalination on the marine environment, emphasizing the need to understand how these discharges affect coastal and marine ecosystems.
- **Balancing Mission:** The mission is dual-fold: providing safe drinking water and ensuring the long-term health and balance of coastal ecosystems. This highlights the importance of a sustainable approach to meet water needs while protecting the environment.
- **Collaborative Research:** The project underscored the significance of collaborative research in addressing environmental challenges, fostering cross-cultural exchange, and transferring knowledge for a holistic and inclusive scientific approach.

Protecting coastal environments and human health
This project aims to safeguard coastal environments and human health by addressing two key concerns: clean water accessibility and sustainable use of ocean resources. It primarily focuses on investigating the effects of discharging wastewater and desalination (the process of creating potable water from seawater) byproducts into coastal areas, particularly in Durban and Cape Town. The study centers on understanding how pollutants from wastewater and desalination brine impact marine ecosystems.

By gaining insights into these environmental impacts, the project seeks to create actionable solutions and regulations to mitigate pollution risks and ensure the responsible utilization of coastal and marine resources. The ultimate goal is to establish regulations that align with global sustainability objectives for water management and ocean preservation.

Environmental effects for sustainable coastal cities
The project has yielded significant scientific insights into the relationship between brine and wastewater discharges from seawater desalination, as well as the impact on marine ecosystems. Through meticulous assessment of pollutant concentrations in water, biota, and sediment, the research has illuminated the necessity of a balanced approach to managing these discharges.

The project's findings underscore the potential ecological consequences of brine and wastewater discharges, shedding light on the need to consider environmental implications alongside the benefits of water production.

Coast-LaB partners for Wits University after project progress meeting in Johannesburg with Jan Haakonsen from Research Council Norway and Teuns Phahlamohlaka from National Research Foundation. January 2023. Photo: Kuria Ndungu

Guiding sustainable progress
The project has paved the way for further research, seeking to optimize estuarine management strategies. It addresses challenges and the need for a more holistic understanding of coastal ecosystems. The project contributes to a more sustainable future for coastal regions and marine environments worldwide. Its findings align with both *UNEP's Global Programme of Action for the Protection of the Marine Environment from Land-based Activities* and *The UN Ocean Decade - Science We Need for the Ocean We Want*.

> *"This research has allowed us to get into even more research projects. We were able to seek funding from another international funding source, the Belmont Forum, and we got that project."* - Senior Researcher Kuria Ndungu

Research and expertise across borders
The collaboration between Norway and South Africa has greatly benefited the project. Firstly, it has empowered young female researchers and those from historically disadvantaged institutions. Secondly, the collaboration helped both parties in securing international research funding, including initiatives like Horizon Europe and JPI. Moreover, recognizing the importance of expertise, and the diverse perspectives from developing countries highlights the synergistic potential of such collaborations.

> *"Different background roles of expertise bring synergy, which is a good thing. Expertise is important and developing countries have to keep up as they have different ways to look at similar issues."* - Professor Luke Chimuka*, South Africa*

Overcoming challenges
One common challenge was delays due to the COVID-19 pandemic. Also, the study did not get the Cape Town Department of Water affairs to be a partner in the project due to excessive bureaucracy involved. This highlights the need for continued efforts to overcome barriers and ensure robust scientific progress.

FACTS

Awarded: NOK 1 900 000, ZAR 3 400 000
Project Manager: Project Researcher Kuria Ndungu (NIVA) and Professor Luke Chimuka (Wits)
Research collaborators: Norsk Institutt for Vannforskning (NIVA) / Norges Teknisk-Naturvitenskapelige Universitet (NTNU) / The University of Witwatersrand (Wits) / Council of Scientific and Industrial Research (CSIR) / Durban University of Technology (DUT)
Project aim: Understanding how the process of turning saltwater into drinkable water affects the marine environment.
Scientific impact: Revealing critical insights into the environmental consequences of brine discharge from seawater desalination and wastewater released of coastal waters.

Dictionary

- **Desalination**: taking saltwater from the ocean and turning it into clean, drinkable water. This process is called desalination.
- **Brine**: Brine refers to the salty water that is a byproduct of the desalination process. It's the leftover concentrated salt solution that remains after the freshwater is extracted from seawater.

Sources

1. Interview with Professor Luke Chimuka
2. Interview with Senior Researcher Kuria Ndungu
3. LINK - Project description (Prosjektbanken)

Exploring sea cucumber varieties for sustainable aquaculture

«This research looks at various sea cucumber species and their potential for aquaculture, with focus on environmental benefits.» Gan Moodley

Key takeaways

- Research centers on understanding various sea cucumber species, their biology, cultivation methods and commercial potential.
- A key concern is the impact of marine pollution on sea cucumber behavior and quality.
- The study delved into sea cucumber occurrences, reproduction, growth in cultivation systems, and their suitability in integrated aquaculture.
- Custom larval tank systems were developed to study the sea cucumber growth during early life stages.
- Studies on reproduction and broodstock holding conditions provided insights into feed intake and the effects of different food compositions.

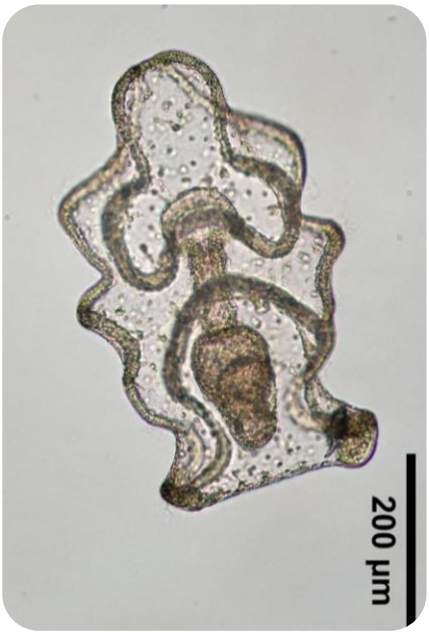
Both South Africa and Norway have significant histories as seafood nations. Over the past decades, expertise in aquaculture - farming of aquatic organisms in water - has grown considerably. Aquaculture offers a sustainable alternative to commercial fishing and could reduce fishing pressures on vulnerable wild populations. There is a growing demand from the Asian market for sea cucumbers, which are echinoderms like sea urchins and sea stars. Sea cucumbers are ecologically important and live on the bottom at different depths in all oceans.

Exploring different sea cucumber species

The project was organized to cover scientific activities, knowledge exchange, networking, and project management. The intention was to generate valuable insights into the biology and cultivation of native sea cucumber species. Sea cucumbers from both Norway and South Africa were examined. The research looked at adult sea cucumbers from natural habitats, how to farm them, their early life care, how they fit in with combined farming systems, and the impact of sea pollution, notably the effects of microplastics.

Reproduction and larval development

A major focus of the project was to understand how the selected sea cucumbers reproduce and develop from egg to juvenile. A custom larval tank system was established for use to study the early growth of the Norwegian sea cucumber. Juvenile production is a challenge in establishing aquaculture of new species, and the different larval stages critical points. Feeding trials provided insights into how well sea cucumber larvae and broodstock can ingest different feed, and the effects of varying food compositions on their behavior. The reproductive cycles of selected sea cucumber species from South Africa have been elucidated.



Parastichopus tremulus larva.
Photo: Jan Sunde.

Charting the way forward

The project's partnership between South Africa and Norway has been a successful international cooperation. Despite challenges, the project promises significant contributions to sustainable marine resource use, aquaculture advancements, biological and environmental understanding, particularly regarding the impact of microplastic pollution.

Dictionary

Aquaculture means cultivating aquatic organisms, such as fish, shellfish, and aquatic plants, in natural or controlled marine or freshwater environments. Seafood farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. to produce food or help in protecting the environment by removing pollution.

FACTS

Awarded: NOK 1 900 000, ZAR 3 100 000
Project Manager: Senior Researcher Gyda Christophersen (Norway) and Gan Moodley (South Africa)
Research collaborators: MØREFORSKNING AS location Ålesund / University of KwaZulu-Natal (IKZN) / National Research Foundation (NRF) / Department of Forestry, Fisheries and the Environment in Cape Town (DFFE)
Project aim: To explore the biology and aquaculture potential of sea cucumber species in Norway and South Africa, with the goal of contributing to sustainable seafood production and conservation efforts.
Scientific impact: The project has advanced the understanding of sea cucumber biology and aquaculture methods, providing valuable insights that can be applied to enhance marine resource management and aquaculture practices.

Sources

1. Interview with Project Manager South Africa, Gan Moodley
2. Interview with Project Manager Norway, Senior Researcher Gyda Christophersen
3. LINK - Project description (Prosjektbanken)

Water & fairness: Perceptions amidst crisis

«Understanding perceptions of fairness in water conservation during times of crisis is crucial. It not only guides policy but also fosters collaborative action.» Professor Alexander Wright Cappelen, Project Manager Norway

Key takeaways

- Misconceptions about resource conservation can influence collective action and need to be addressed.
- Perceptions of fairness vary and play a significant role in collective resource conservation efforts.
- Collaborative international research enriches understanding and provides diverse perspectives on pressing global issues.

After the devastating drought and water scarcity that Cape Town faced in 2018, this project has analyzed beliefs about water consumption and perceptions of fairness across different income groups in the affected area. How do people believe that the burdens during the drought were distributed between the rich and the poor in Cape Town? How should the burden of collective action in conserving resources be distributed during times of crisis?

A deep dive into Cape Town's water conservation dynamics

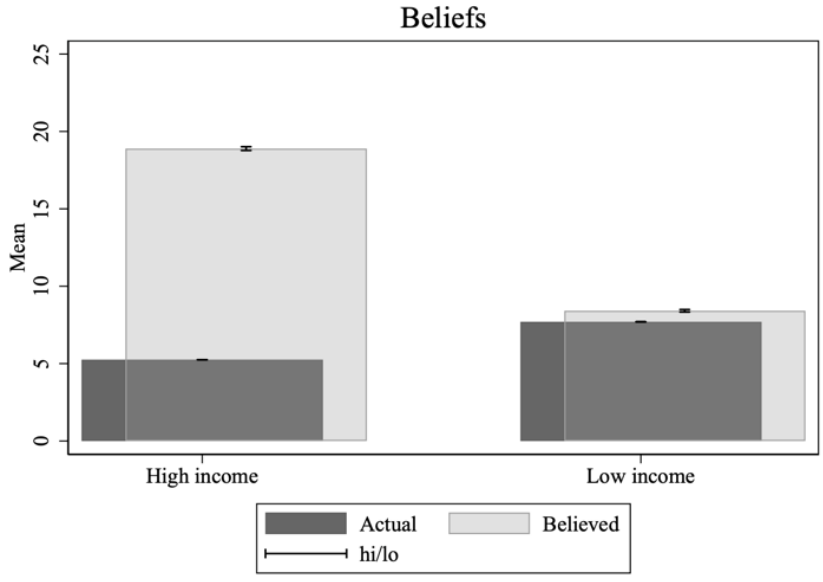
The study addresses three main research questions:

- How did the population in Cape Town perceive that the burdens of water conservation were distributed between the rich and the poor?
- Do various income groups perceive fairness differently when it comes to conserving water and energy?
- What are the population's attitudes to different policies aimed at reducing water consumption in times of drought?

In collaboration with AskAfrica, the project collected data from 3000 respondents in Cape Town during the autumn of 2022 to address these questions.

Decoding perceptions of fairness

The research highlights an important challenge: How to manage situations where resource consumption must be reduced in a society where there historically has been a large inequality in water consumption, where those with high income consumed much more water than those with low income. Important factors to consider are how people perceive this challenge and what they believe is fair. A key discovery was the widespread misconception among both low-income and high-income groups about the extent of water consumption reduction. People with low income especially underestimated the people with high incomes conservation efforts. Such misconceptions can potentially contribute to demotivating the population from conserving water.



The figure shows actual water consumption for high- and low-income groups (darker bars) and the belief on water consuption by high- and low-income groups (lighter bars) for the 2018 drought.

Furthermore, the population was divided on what they considered a "fair" distribution of burden during resource cuts. Surprisingly, a large share of both high-income and low-income residents viewed a proportional reduction in water consumption as fair, even if this resulted in a very unequal distribution of water during the drought.

There was a clear preference among the population for softer measures of water conservation encouragement rather than stringent policies. The South African research team actively communicated with politicians and local authorities, and there is considerable local interest in the study's results.

Overall, the project contributes to a better understanding of human behavior in resource management contexts. The insight gained is crucial for any future water shortages and offers guidance in fostering more inclusive and sustainable practices during crises. Despite the valuable findings, the research is still ongoing. Data collection delays due to the pandemic have pushed back the completion of the full report.

“Our research journey offers insights that are not only applicable to our study of water conservation in Cape Town but also yield broader methodological and conceptual learnings that may find application in diverse fields from behavioral economics to public policy analysis.”

- Professor Martine Visser, Project Manager in South Africa

Solving the complexities of data and demographics
Challenges arose when attempting to link survey answers to individual water consumption data. This goal was only achieved for a small subset, making it non-representative. Additionally, the research posed challenges in formulating questions suitable for respondents with varied educational backgrounds.

The power of international collaboration
The collaboration between Norway and South Africa was a cornerstone of the project. Norwegian researchers gained unique access to South African issues and data, and the academic skills of the South African team added depth and perspective to the study. Young researchers and Ph.D. students from South Africa also found invaluable learning opportunities through this partnership.

FACTS

Awarded: NOK 1 040 000, ZAR 4 617 999
Project Manager: Professor Alexander Wright Cappelen and Professor Martine Visser
Research collaborators: Instituttsektor / Nasjonale samfunnsvitenskapelige institutter / SAMFUNNS- OG NÆRINGSLIVSFORSKNING AS / University of Cape Town / AskAfrica
Project aim: To understand how different income groups perceive fairness in distribution responsibility for conserving water during crises.
Scientific impact: A better understanding of how fairness views and perceptions of burden sharing affect attributes to policies during crises.

Sources

1. Interview with Professor Alexander Wright Cappelen, Project Manager in Norway
2. Interview with Professor Martine Visser, Project Manager in South Africa
3. LINK - Project description (Prosjektbanken)

Probing the electronic properties of nickel oxide (NiO) as electrocatalyst for renewable and sustainable electrolytic hydrogen production

«We hope that our research works towards ensuring clean and renewable energy security for generations to come.» Professor Roelof Kriek

Key Takeaways

- Sustainable Energy Storage: The project aimed to develop a sustainable and cost-effective solution for storing renewable energy from sources like wind and solar power. Adding a small quantity of iron to the nickel-based electrocatalysts realized a 25% reduction in the electricity needed to produce hydrogen from water.
- Importance of Collaboration: Collaboration between institutions, as partnerships allows for the sharing of equipment and expertise needed to tackle complex research topics effectively.
- Research challenges: The COVID-19 pandemic had a negative impact on the project, causing laboratory closures, hindering physical experimentation, and preventing planned travel and conference participation. Funding limitations, particularly regarding student bursaries, have been a major constraint in securing student involvement.

Aiming for Sustainable and Cost-effective Energy Storage

Storing renewable energy from sources like wind and solar has always been a challenge. A promising solution is to convert this energy into hydrogen by splitting water. However, the process, particularly the oxygen production, is slow. Current top-performing materials for speeding up this process, like iridium oxide, are expensive. Nickel-based materials, especially when enhanced with a small amount of iron (Fe), show great promise as more affordable and efficient alternatives. This project delves into understanding the process behind adding iron to nickel oxide (NiO), aiming for a sustainable and cost-effective energy storage solution in line with global goals like the 2015 Paris Agreement.

Effective Water Splitting

The focus of this project was to obtain a clearer understanding of how adding iron can make nickel oxide work better at turning water into oxygen and hydrogen when we apply electricity. This process is called the oxygen evolution reaction (OER), and it is crucial for clean energy. By understanding how iron and nickel oxide team up in this process, we can possibly make cleaner and more efficient energy technologies. Our goal was not just about clean energy; we also wanted to find a way to store renewable energy from sources like wind and solar power in a sustainable manner.

The hypothesis was that nickel oxide (NiO) and iron-doped NiO hold great promise. Depending on how we make them, they can actually work better than expensive iridium-based catalysts. If this holds true, we could create a more efficient and cost-effective catalyst.

Greener Hydrogen for a Greener Future

Adding iron to the mix can make nickel-based electrocatalysts much more effective at splitting water to create hydrogen. This not only speeds up the process of making hydrogen but also makes it cheaper – essentially, it is a way to convert electricity into hydrogen, a high-energy chemical. When linked to solar or wind, as sources of electricity, the production of hydrogen employing this technology is much cleaner and makes for a greener future.

Testing for Success

When doing tests, we were able to get a 25% reduction in the electricity needed to produce hydrogen when compared to the regular nickel oxide electrocatalysts.

Laboratory activity does not, however, directly translate into commercial-scale activity. In that regard, the best-performing samples are to be tested on a pilot Alkaline Water Electrolysis (AWE) facility that employs membraneless technology that is at the forefront of development. Due to challenges, this work did not materialize as part of the project and must be conducted at a later stage.

Collaboration, Challenges, and Complications
To effectively work on a research topic, partnerships are extremely important as a single institution does not always have all the equipment and associated expertise to give effect to the aims and objectives of such a project.

Despite a fruitful collaboration, there were challenges along the way. COVID-19 was an obstacle and impacted the project negatively in many ways. For a long time, laboratories were closed, and no physical experimentation could take place. Planned travel of students and scientists between NTNU and NWU did not take place in this period. In addition, the International Symposium on Electrocatalysis was canceled due to the COVID-19 outbreak. This is one of the most relevant conferences where scientific results related to our work can be conveyed, shared, and discussed.

But the single greatest challenge and inherent constraint that impacted the project negatively, is the fact that there was no security built into the National Research Foundation (NRF) funding system to attract students to take part in this project. We were not allowed to pay student bursaries from the allocated funds. The aims and objectives of this project could only be met with an adequate number of students taking part in this project, with this project requiring a substantial number of students, be it Masters, Doctoral, and Postdoctoral students.

This project requires students with a background and interest in electrochemistry. Students with this interest and background are few and far between. To be able to attract students ahead of time, for enrollment the following year, we would need some form of security, i.e., to have funds available for bursaries. If we were allowed to fund students from this grant, it would have gone a long way in identifying and securing students to take part in this project and give effect to the aims and objectives of this project.

Future Funding
Both the team at North-West University (NWU, South Africa) and the team at the Norwegian University for Science and Technology (NTNU, Norway), have to date not been successful in obtaining research funding through other mechanisms.

FACTS

Awarded: NOK 1 300 000, ZAR 4 191 000
Project Manager: Professor Svein Sunde and Professor Roelof Kriek
Research collaborators: UoH-sektor / Norges Teknisk-Naturvitenskapelige Universitet NTNU / NTNU Fakultet for Naturvitenskap / Institutt for materialteknologi / North-West University / Research Focus Area for Chemical Resource Beneficiation (CRB) / Electrochemistry for Energy & Environment Group
Project aim: To pursue a sustainable supply of clean energy from Hydrogen, and work towards enabling the sustainable storage of renewable energy.
Scientific impact: Adding small quantities of iron to nickel-based electrocatalysts makes it much more effective at splitting water to create hydrogen.

Dictionary
Electrocatalyst: An electrocatalyst is a catalyst that participates in electrochemical reactions.

Sources

1. Interview with Professor Roelof Kriek and notes from Professor Svein Sunde
2. LINK - Project description (Prosjektbanken)

Blue growth opportunities in changing kelp forests

«Kelp forests have captivated human imagination for centuries. Our collaborative project aims to unlock the secrets held by these underwater giants and explore the potential they hold for blue growth. By studying their intricate ecosystems, we aspire to shape a sustainable future where kelp forests thrive alongside human communities.» Researcher Karen Filbee-Dexter

Key Takeaways

- Climate-Resilient Kelp Forests: South Africa and Norway's kelp forests show resilience to climate change, expanding as temperatures rise.
- Economic Value of Kelp: The project quantified the global economic value of kelp ecosystems, highlighting their contribution to coastal economies.
- Socioeconomic Significance: Kelp forests were shown to support coastal identities and provide cultural benefits in these regions.
- Complex Challenges: Data gaps, carbon capture debates, and methodological limitations pose challenges and highlight areas for further marine ecology research.
- Global Collaboration: The project kicked off the Global Ecological Assessment of Kelp (GEAK) which fosters international collaboration and data sharing for kelp ecosystem service research.

In the spirit of international collaboration, the research project "Blue Growth Opportunities in Changing Kelp Forests" has united scientists from Norway, South Africa, and beyond to explore the dynamic and ecologically vital world of kelp forests. With a focus on sustainability, the project aimed to unravel the secrets of kelp ecosystems, their impact on climate change mitigation, biodiversity conservation, and their contributions to the blue economy.

Decoding Kelp Ecosystems
This collaborative research journey involved extensive fieldwork, data collection, and scientific inquiry. Researchers dived into the underwater realm of kelp forests, meticulously studying their productivity, responses to changing ocean conditions, and interactions with human societies. The project was composed of workshops, discussions, and data sharing among experts from various regions. It culminated in a comprehensive understanding of the intricate relationships between kelp forests, coastal communities, and the global environment.

Kelp forest. Photo: blueconnectproject.com

Hypotheses and Discoveries
The project's hypotheses revolved around understanding the drivers of kelp forest expansion in regions like the Norwegian Arctic and South Africa. Researchers investigated how factors such as sea ice loss, increased light availability, and ecological interactions influenced the growth and distribution of kelp forests. Surprisingly, the project uncovered that kelp forests in Arctic regions were expanding in some areas, leading to a possible increased capacity for carbon sequestration and the provision of ecosystem services.

Specifically, the research identified that reduced sea ice dynamics and increased light penetration were key drivers of kelp forest expansion. These findings shed light on why kelp forests are thriving in these areas and offered valuable insights into their resilience to changing environmental conditions.

Ecosystem Services and Beyond
The research not only unraveled the ecological intricacies of kelp forests but also delved into the broader human dimension. By assessing the cultural and recreational significance of kelp ecosystems, the project highlighted their role in shaping identities, fostering local economies, and connecting people with nature. The research group created a global network of experts, fostering cross-cultural collaborations and enriching the project's impact on a global scale.

Implications for Policy and Management
The findings of the project have reverberated in global policy discussions. By shedding light on the importance of kelp ecosystems in climate change mitigation, biodiversity support, and cultural preservation, the project has informed international efforts to protect and manage coastal environments. Project members were key authors on a 2023 United Nations Report on kelp that highlighted Norwegian and South African kelp forests. The research's emphasis on interdisciplinary collaboration, data sharing, and ecosystem-based management approaches offers valuable insights for policymakers and stakeholders alike.

Continued Exploration
The intention of the research was to understand issues around sustainability and utilization of kelp forests in two countries, South Africa and Norway. Various economic implications of seaweed utilization were assessed in collaboration with kelp harvesting companies in South Africa. A global review of the ecological services and benefits people derive from kelp and kelp forests was also conducted, taking note of the impact of climate change on natural resources.

“Blue Growth Opportunities in Changing Kelp Forests" is not merely a research project; it is a testament to the power of collaboration, curiosity, and the shared commitment to preserving our oceans. Through this initiative, kelp forests have emerged as critical players in mitigating climate change, supporting biodiversity, and enriching human lives. Its impact extends worldwide, driving action, shaping policies, and paving the way for a future where the blue economy coexists harmoniously with nature.

FACTS

Awarded: NOK 1 900 000, R 3 213 000
Project Manager: Researcher Karen Filbee-Dexter and Professor Albertus Smit
Research collaborators: Instituttsektor / Primærnæringsinstitutter / Havforskningsinstituttet / University of Western Cape
Project aim: To promote sustainable use of kelp forests in Norway and South Africa, while fostering global networking and knowledge dissemination.
Scientific impact: The project has brought together researchers from diverse regions to understand kelp forest dynamics, ecosystem services, and their contribution to climate change mitigation, supporting biodiversity, and providing reactional benefits. The projects findings have influenced global policy discussions and inspired further research collaborations.

Dictionary
- Blue Economy: The sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem.
- Ecosystem-based Management: A holistic approach to managing natural resources that considers ecological interactions, human activities, and societal needs to ensure long-term sustainability.

Sources
- Interview with Karen Filbee-Dexter
- Written interview with Albertus Smit
- LINK - Project description (Prosjektbanken)

Southern Ocean phytoplankton community characteristics, primary production, CO_2 flux and the effects of climate change

«The Southern Ocean absolutely necessitates international collaboration and cooperation between multiple nations in order to understand its current state and how it may be predicted to change. » Dr. Sandy Thomalla - Project leader, South Africa

Key Takeaways

- Scientific - The project highlighted the Southern Ocean's role in driving global climate and its sensitivity to various environmental factors.
- Collaborative - Pooling resources and expertise between South Africa and Norway not only increased the project's impact but set the stage for future collaborative efforts.
- Humanitarian - The project fostered capacity building, with PhD students deeply involved in various research stages and two notable female PhD graduates from the collaboration.

Climate change poses a formidable challenge to humanity. Addressing its impact requires accurate future climate scenarios. The SOPHY-CO2 project, a collaborative effort between Norway and South Africa, tackled these challenges by venturing into one of the most under-researched regions of the world - the Dronning Maud Land (DML), Antarctica. Aiming to establish a Marine Protected Area in DML, this project collected pivotal data related to phytoplankton production, oceanic CO2 uptake, escalating ocean acidification, and shifts in marine ecosystems.

Key findings highlight the Southern Ocean's sensitivity to climate alterations and its role as a significant CO2 sink. With the successful joint research expedition aboard the RV Kronprins Haakon, SOPHY-CO2 not only brought forth new data from the DML region but also fostered academic exchange, capacity building, and shared resources between the two nations.

Such collaborative endeavors are vital, not just for the direct scientific insights they provide, but for the partnerships they foster, preparing both nations to address the ongoing environmental challenges of our time.

Unraveling Climate Interplay in Undersampled Antarctic Waters

At the outset, this research project aimed to unveil the physical, chemical, and biological oceanography in a remote and undersampled area off the coast of Antarctica, and its effect on climate change. This study never set out with a specific hypothesis in mind. Rather, the driving question was to understand the complex interplay between various elements like phytoplankton blooms, CO2 fluxes, iron availability, and ocean acidification under the lens of the changing climate.

Phytoplankton, the microscopic plants of the ocean, play a fundamental role in the marine food web and global carbon cycling. Just like plants on land, they harness the sun's energy and, through photosynthesis, convert carbon dioxide into organic matter. Phytoplankton blooms are events during which the concentration of phytoplankton in the ocean increases significantly. These blooms can be seen from space as large green patches due to the chlorophyll content of the phytoplankton.

The Ocean's Enhanced Role in CO2 Absorption

The research illuminated numerous significant findings. A notable discovery revealed the Southern Ocean absorbs more CO2 than previously assumed. Additionally, changes in sea ice and the ocean floor layout have a bigger effect on the growth of phytoplankton than we first thought. Despite the previous assumptions that phytoplankton did not have sufficient iron to bloom in the fall, this study proved this to be untrue. The study also observed that large blooms of phytoplankton might be attributed to iron released from hydrothermal vents.

Future Research Horizons

To fully understand the intricate web of the Southern Ocean's ecosystems and their responses to various drivers, require further research. There are still knowledge gaps around the combinations of light, iron, trace metals, and their impact on the phytoplankton bloom's evolution. Also, the recorded record low summer sea-ice extent in 2017 and 2023 requires further investigation. While the current project did not set out with unanswerable hypotheses, the vastness and complexity of the Southern

Ocean demand more comprehensive, multi-parameter studies. Plans are underway for new projects and to seek further funding for these explorations.

Synergies Between two nations
This collaborative endeavor allowed both nations to cover vast expanses of the Southern Ocean across various seasons. Both nations possess complementary expertise and valuable resources, such as research vessels and labs. By combining their resources, expertise, and infrastructure, they enhanced their research's breadth and depth. Cape Town, serving as a gateway to the Southern Ocean and Antarctica, was pivotal in this partnership.

Challenges Along the Way
The project, mainly focused on exchanges between South Africa and Norway, was significantly affected by COVID-19 travel restrictions. Several cruises planned for early 2020 were canceled, leading to many meetings and conferences being held digitally. The pandemic further delayed sample analyses, particularly in dissolved iron, bioactive trace metals, and pollutants. Additionally, COVID-19 restrictions hindered PhD students from accessing office institutes, meeting advisors and participating in conferences.

The collaboration between South Africa and Norway has undeniably set a precedent for international research efforts, showcasing the power of combined resources, expertise, and shared vision.

FACTS

Awarded: NOK 1 900 000 and R 3 182 000
Project Manager: Senior Research Scientist Agneta Fransson (Norwegian Polar Institute) and Dr. Sandy Thomalla (Southern Ocean Carbon-Climate Observatory, CSIR)
Research collaborators: Instituttsektor / Øvrige forskningsinstitutter / Norsk Polarinstitutt / Southern Ovean Carbon-Climate Observatory (SOCCO), CSIR / Stellenbosch University
Project aim: To understand the sensitivity of the Southern Ocean (SO) system to change in order to predict how the SO carbon pump and ecosystem will respond to future climate change scenarios.
Scientific impact: The study highlights the Southern Oceans sensitivity to climate alterations and its role as a significant CO2 sink.

Sources

1. Interview with Senior Research Scientist Agneta Fransson
2. Interview with Dr. Sandy Thomalla
3. LINK - Project description (Prosjektbanken)

The Research Council of Norway

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