On behalf of

Federal Ministry for Economic Cooperation and Development

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

MEERWISSEN
African-German Partners for Ocean Knowledge

WHY MACROALGAE (SEAWEED)?

Senegal, ISRA: Dr. Waly N. NDIAYE
Senegal, IRD: Dr. Patrice BREHMER
GEOMAR, Germany: Dr. Florian Weinberger
Dr. Birgit Quack
Associated: Dr. Anna Fricke, IGZ, Germany

ISRA

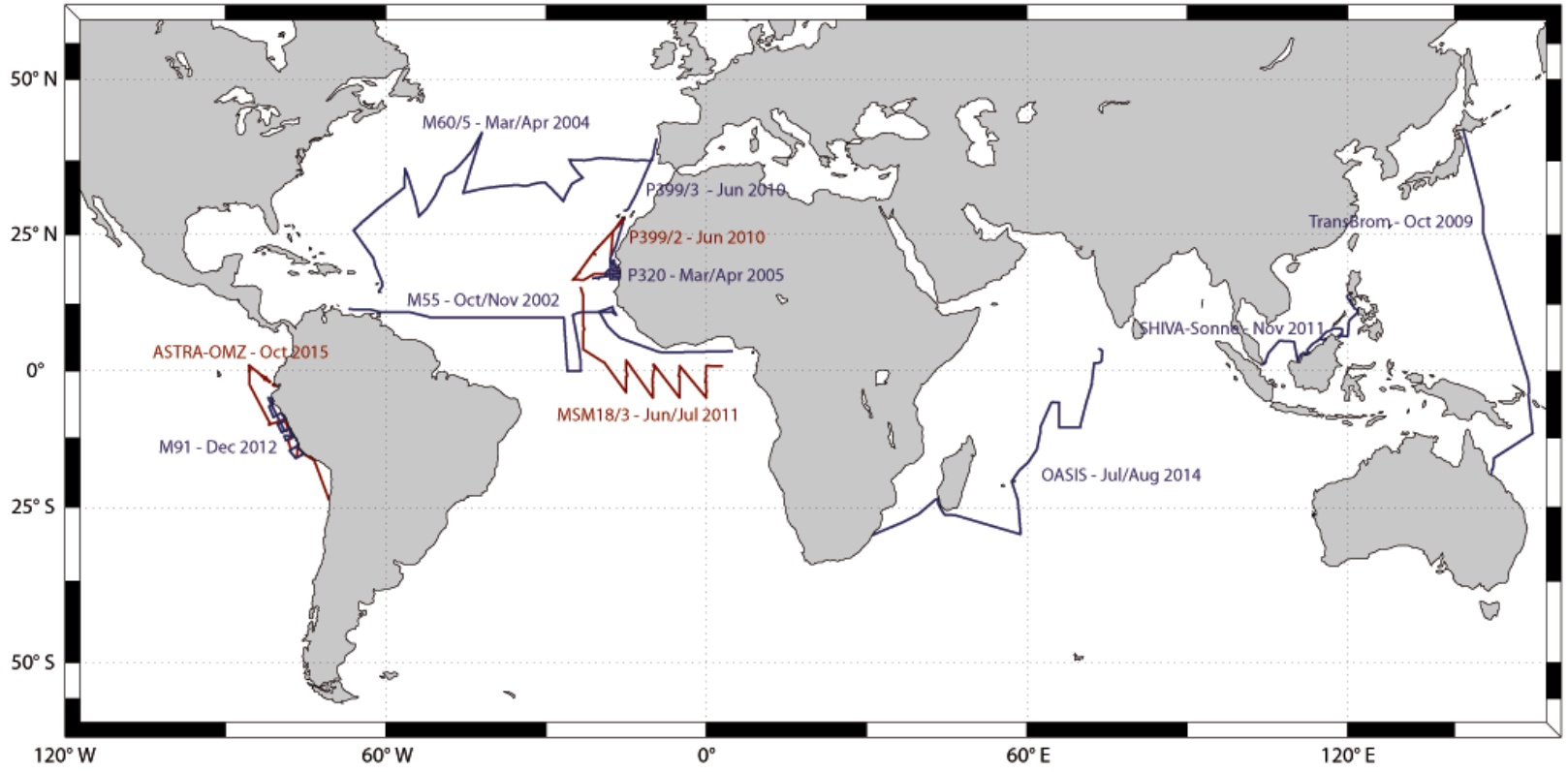
C.R.O.D.T

GEOMAR

IRD Institut de Recherche pour le Développement FRANCE

MEERWISSEN
African-German Partners for Ocean Knowledge

I usually investigate natural and anthropogenic gases from the ocean under climate change on research vessels in the global ocean. (some cruises below)



Why do I now coordinate CLIMALG-SN?

MEERWISSEN
African-German Partners for Ocean Knowledge

Natural and anthropogenic halocarbons under climate change

Macroalgae are great and overlooked

Stratosphere

Ozone (O_3) depletion
involving anthropogenic chlorine

Tropical Tropopause Layer (TTL)

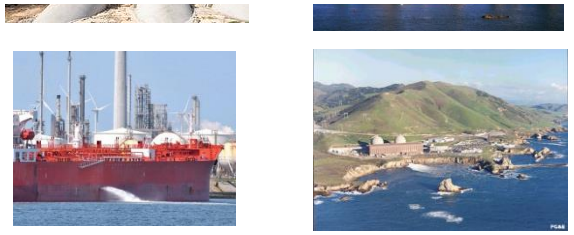
Br , I

atmospheric circulation,
tropical deep convection,

photochemistry (hn), OH

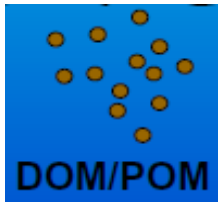
Rising warm air lofts chemical compounds from the ocean

HOx/NOx-cycles
Hg, S, aerosols



Seaweed farming

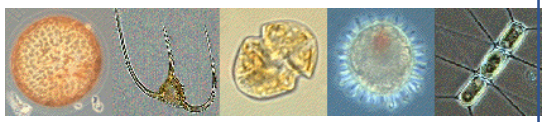
Macro algae



Brominated, chlorinated and iodinated

$CHBr_3$, CH_2Br_2, $CHBr_2Cl$,

$CHCl_3$, CH_2ClI, CH_3I, CH_2I_2



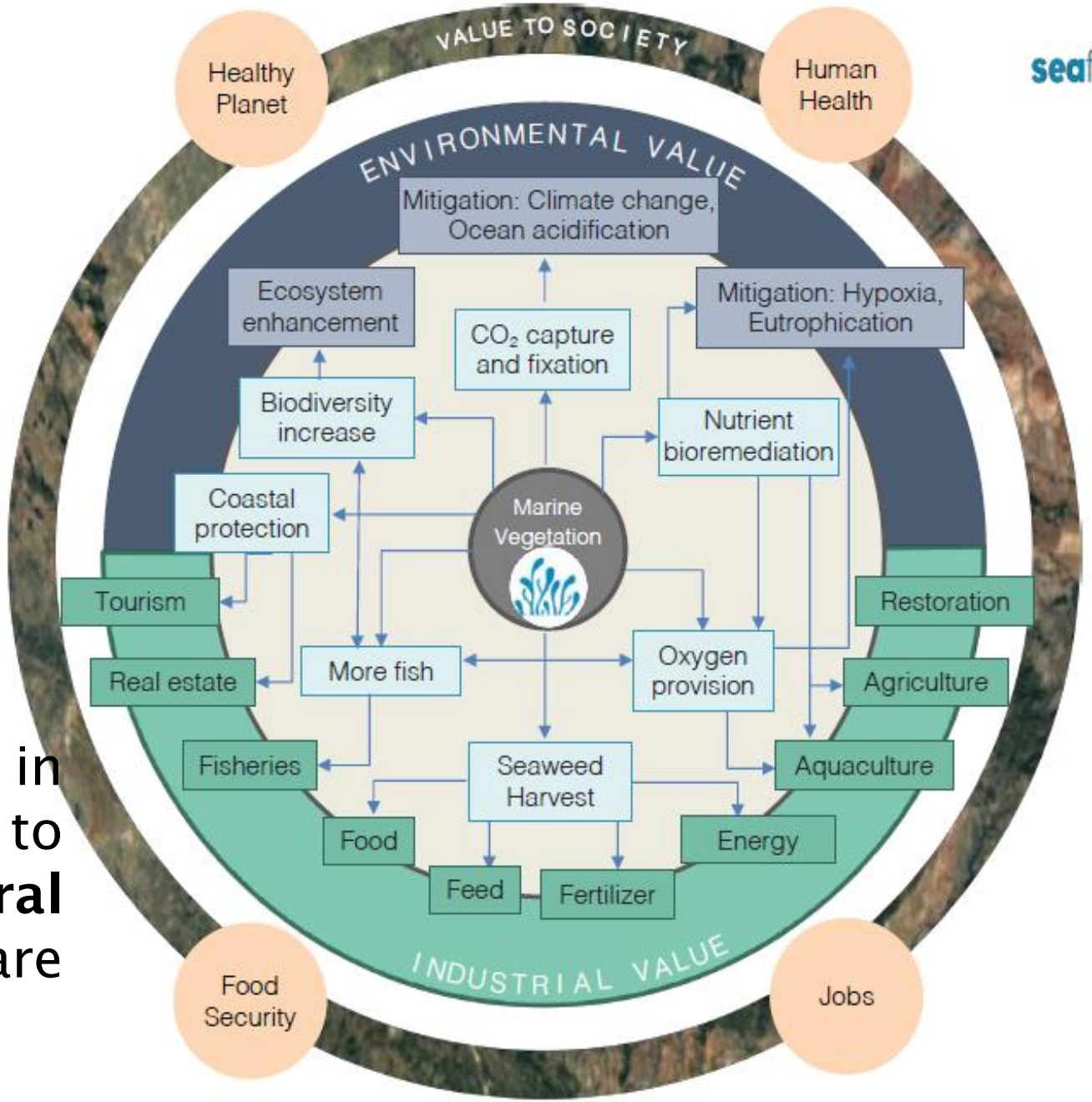
Phytoplankton

MEERWISSEN
African-German Partners for Ocean Knowledge

seaforester

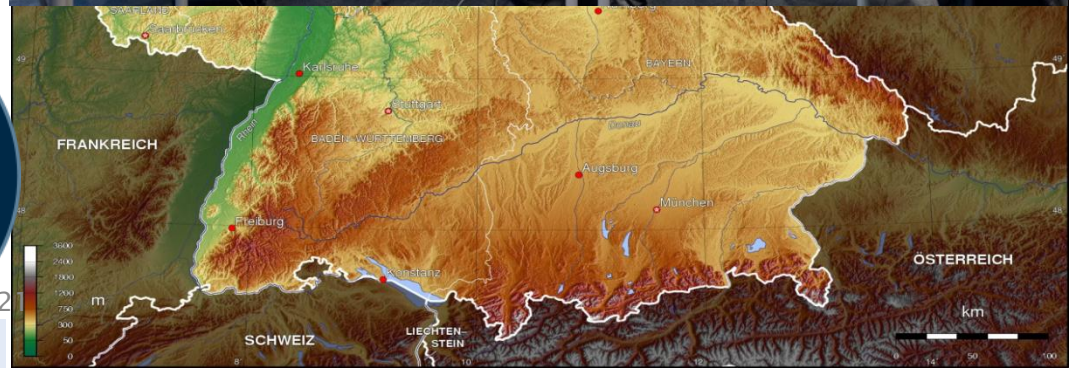
Macroalgae (Seaweed) are great and overlooked

Seaforester is a company in Portugal, with the goal to restore **the forgotten natural forests** in our oceans, which are declining.



www.seaforester.org

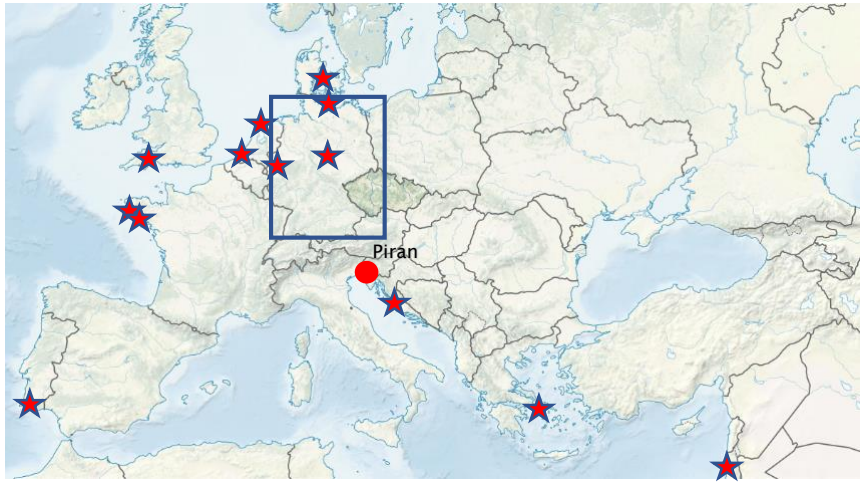
MEERWISSEN
African-German Partners for Ocean Knowledge



EUROMARINE-Workshop on 12.-13. December 2019:

Seaweed aquaculture: A promising tool for the restoration and sustainable development of coastal environments or an expensive end-of-pipe technology?

at GEOMAR in Kiel, Gemany



Senegal

GEOMAR
Helmholtz-Zentrum für Ozeanforschung Kiel

EUROMARINE

MEERWISSEN
African-German Partners for Ocean Knowledge

Seaweed aquaculture

A promising tool for the restoration and sustainable development of coastal environments or an expensive end-of-pipe technology?

We discussed the potential, benefits and obstacles for seaweed aquaculture in Europe and Africa, primarily for coastal remediation and restoration for three different regions.

MEERWISSEN
African-German Partners for Ocean Knowledge

Southern Baltic: Eutrophication

Pros/cons/obstacles

of algae farming

for nutrient remediation.

Madeira: Biodiversity loss in oligotrophic region

Restoration of biodiversity via macro algae farming.

Bight of Dakar: Heavily polluted bay

Pros/cons/obstacles of algae farming for water cleaning.

www.esa.com, Manfred Kaufmann, Patrice Brehmer

MEERWISSEN
African-German Partners for Ocean Knowledge

Benefits of natural seaweeds and seaweed farming can overlapp (Local Knowledge is Key)

Benefits of seaweed farming for coastal remediation:

Seaweed aquaculture can be a sustainable tool to achieve a better environmental status of our coasts.

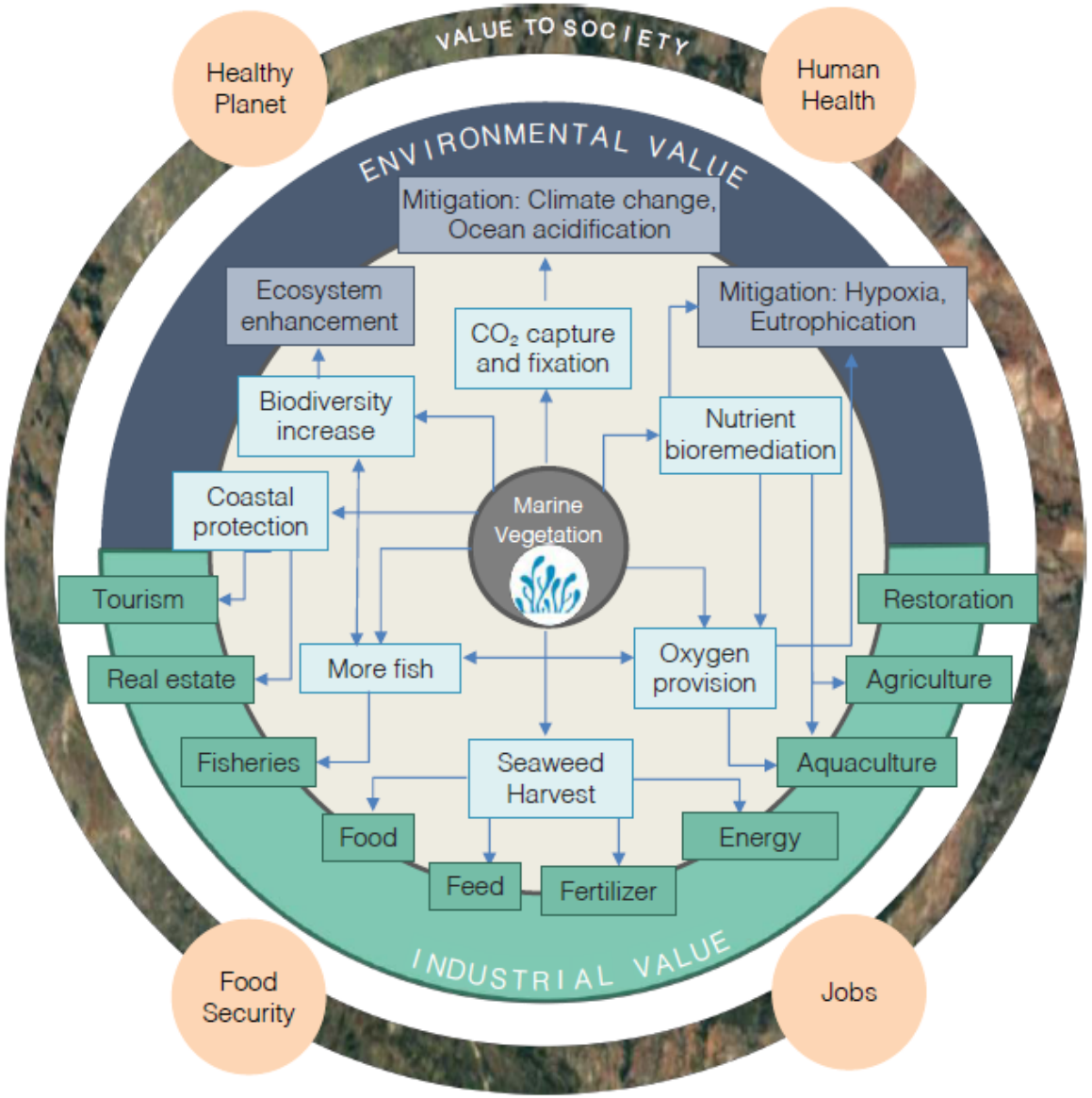
Seaweed aquaculture can support fisheries in many ways (protection and support of natural stock, integration with other aquaculture).

Seaweed aquaculture can attract tourism and therewith generate income.

Protection of natural seaweeds.

Concerns about seaweed farming for coastal remediation:

Costs, spatial competition, attractiveness of coasts and beaches, polluted plants, and the fear of pests and blooms might be potential concerns for politicians, fishers, tourism and the general public. Protection of natural seaweeds.



www.seaforester.org

Seaweeds (>>10.000 species)

CLIMALG-SN is building a database on Senegalese seaweed. There were around 400 species identified in Senegales waters. Some were harvested, and some were cultivated..
…and what is the situation now?

MEERWISSEN
African-German Partners for Ocean Knowledge

Database on Senegalese seaweed of CLIMALG-SN (in production)

Food (Human, Animals, Nutrition, Additives...), Feed (Animal nutrition), Agriculture (Fertilizer, Stimulants…), Energy (Fuel, Hydrogen, Methane...), Health (Pharmacology, Toxicology, Medicine...), Cosmetics (Lotions, Peelings, Skincare, Additives, Serums...)
Material (Plastic/Biopolyethylene, clothing …)
Water treatment (Bio-remediation…)
Algal compounds of interest: Proteins and Amino acids, Carbohydrates, Fatty acids and Lipids, Trace Elements (Calcium, Iron, Magnesium, Phosphor...,) Vitamins, Secondary metabolites (Flavonoids, Alkaloids...), Pigments (Chlorophylls, Carotenoids)
Activity (Caused by or against several microorganisms: Fungi, Bacteria, Cancer Cells...)
Cultivation (Mode of cultivation, IMTA unit), Growth conditions/rates
Contamination/Toxicity (e.g. Heavy Metals, Epiphytic loads)

MEERWISSEN
African-German Partners for Ocean Knowledge

Natural seaweeds, but also the potential of seaweed-aquaculture for remediation, restoration and exploitation are targets of CLIMALG-SN

- 30 Mio tons are globally produced every year (> 6.000.000.000 US$)
- CLIMALG-SN wants to support Senegal to increase knowledge about this natural resource, its value and about its sustainable use.

CLIMALG-SN

Seaweed for climate change resilient blue economies, biodiversity and ecosystem services in Senegal and West Africa (2020-2022)

ISRA, IRD, GEOMAR and partners

MEERWISSEN
African-German Partners for Ocean Knowledge

Few knowledge on seaweed (macroalgae) in Senegal

- **Exploitation of seaweed? Cultivation, harvesting, failure, success, artisanal, industrial…; What next?**

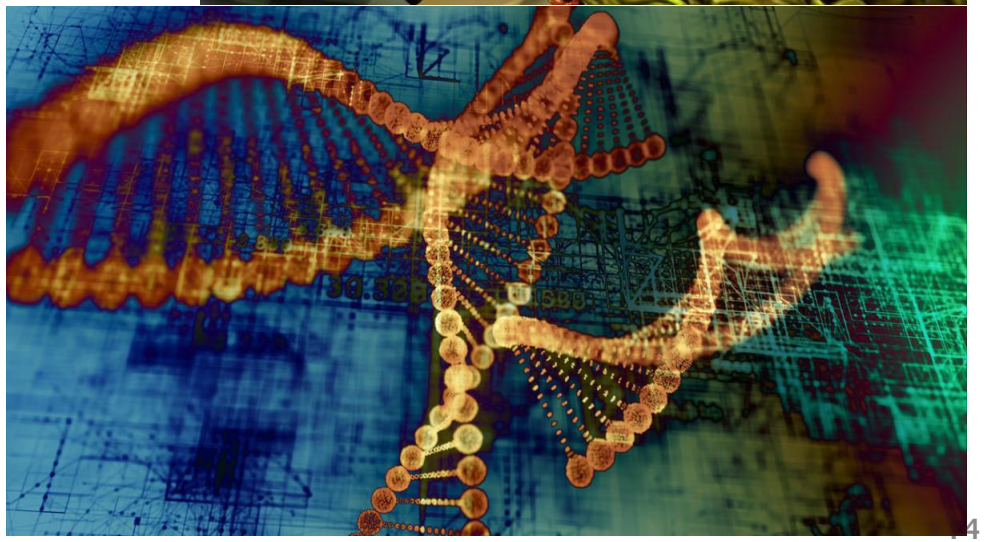
- **What is the biodiversity associated to seaweed ecosystems? From fish to microbiota.**

CLIMALG-SN

Few knowledge on seaweed (macroalgae)

- Reguated area (Park, ZPP, etc.), Marine Protected Area (MPA) and seaweed? What is known in West Africa?

- Genetical approach for idenfiying seaweed and associated biodiversity



CLIMAL-SN project objectives

- The CLIMALG-SN project will make a substantial contribution to the transition of Senegal's coasts towards **sustainable development**;

- **Habitats of seaweed** and their potential to promote blue growth;

- **Capacity building**: Master, PhD, Technician, Researcher, Institution

- A **roadmap for policy makers** to encourage both the cultivation of seaweed and the preservation of natural habitats.

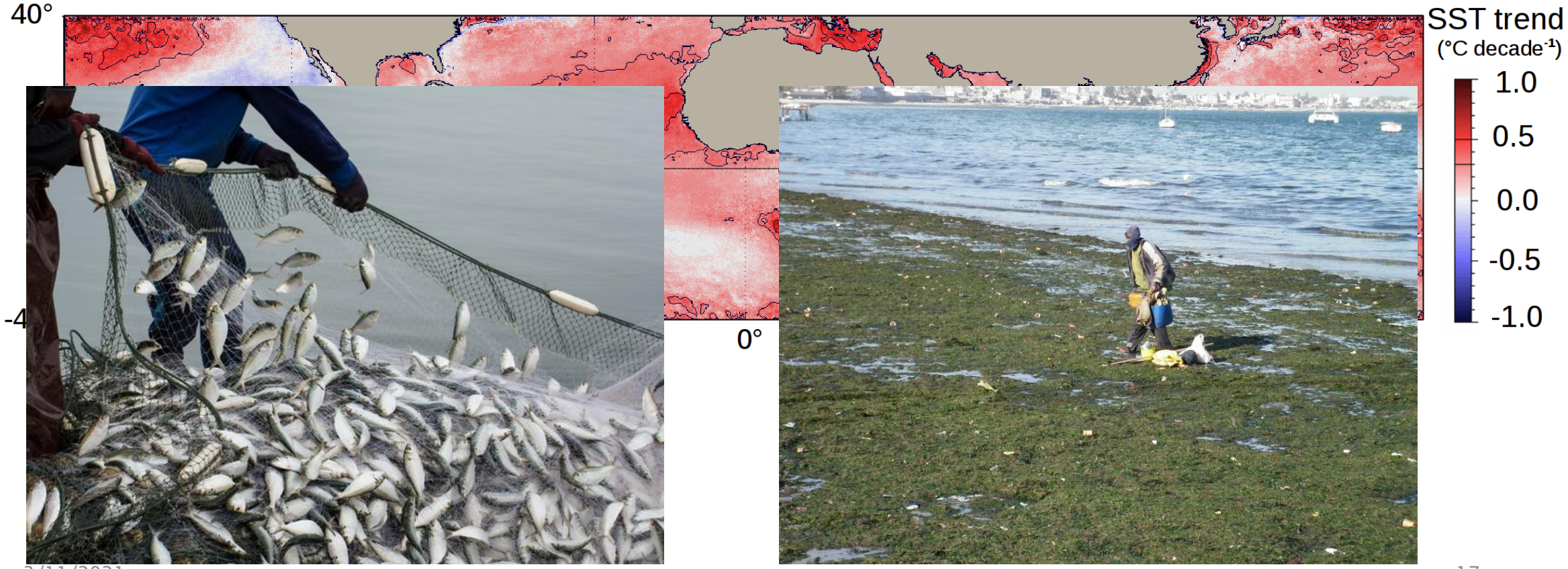
CLIMALG-SN project contributions?

8 priority in the national Senegalese plan name “PSE”

- **Increase knowledge on seaweed and their potential exploitation;**
- **Fisheries and seaweed;**
- **Biodiversity associated to seaweed and function related activities.**

CLIMALG-SN project contributions

Effect of multiple stressors on sea weed; fishing and marine pollution



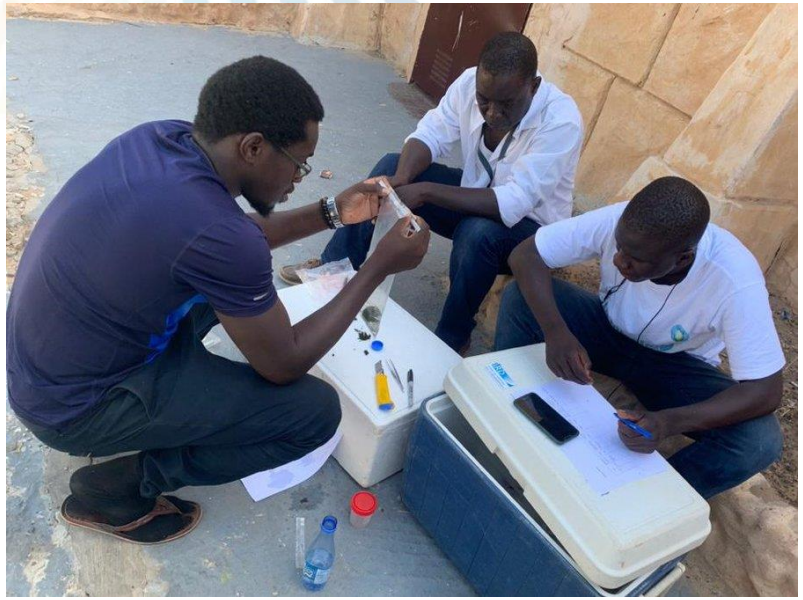
MEERWISSEN
African-German Partners for Ocean Knowledge

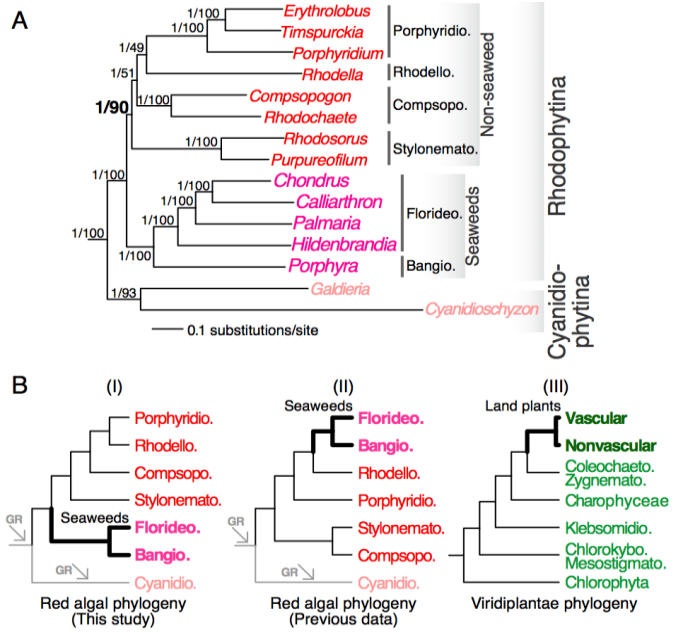
CLIMALG-SN will focus on macroalgae

1) Inventory of Seaweed and Genetics

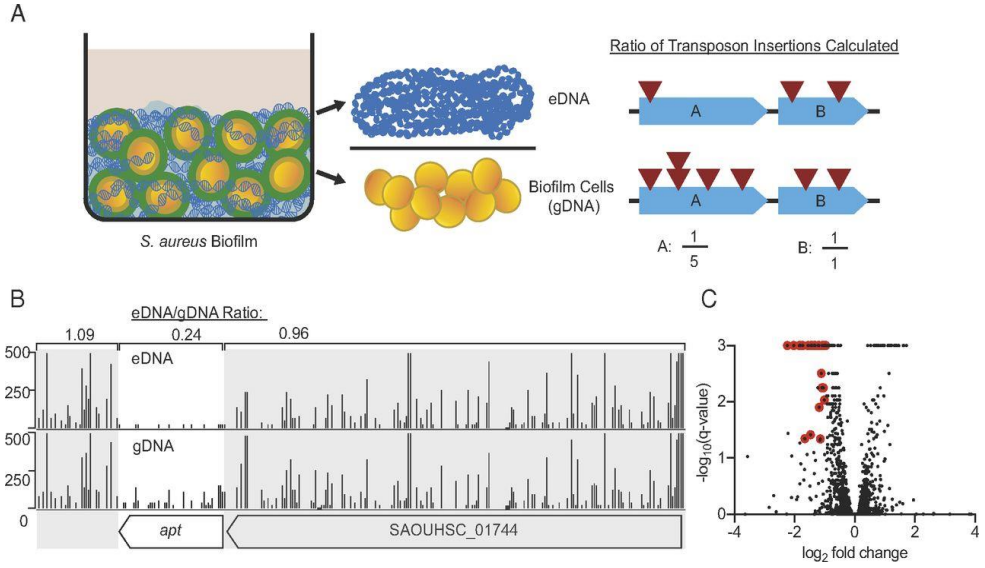
2) Macroalgae and fisheries / local knowledge

3) Interest of the exploitation of macroalgae / conflicts and synergies

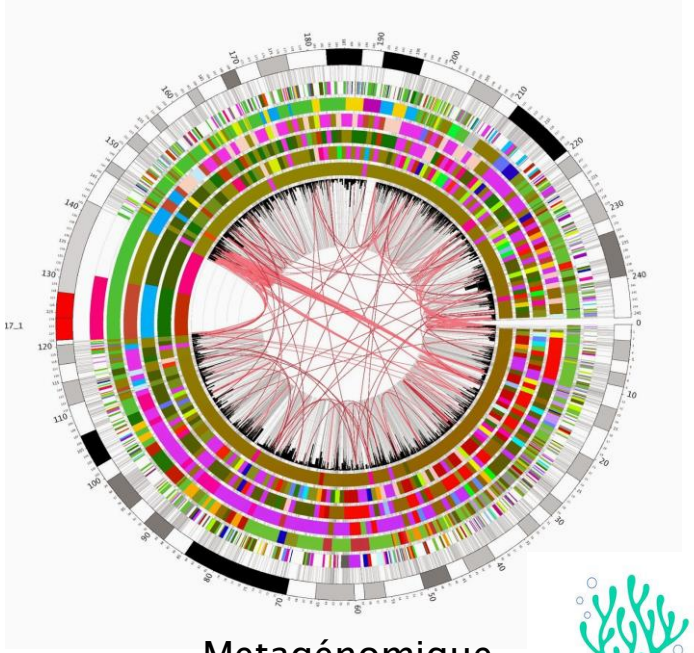




Taxonomie



Génomique



Metagénomique

CLIMALG-SN

MEERWISSEN
African-German Partners for Ocean Knowledge

CLIMALG-SN

CLIMALG-SN will focus on macroalgae

1) Inventory of Seaweed and Genetics

2) Macroalgae and fisheries / local knowledge

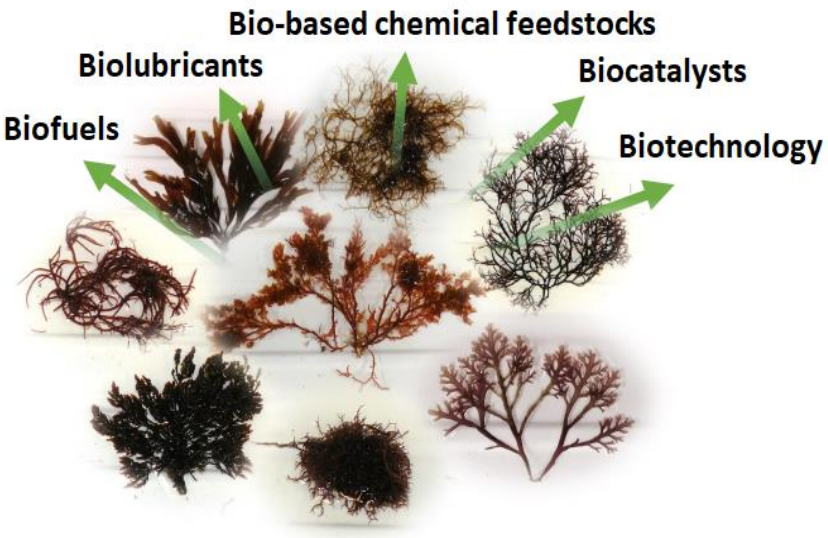
3) Interest of the exploitation of macroalgae / conflicts and synergies

CLIMALG-SN will focus on macroalgae

1) Inventory of Seaweed and Genetics

2) Macroalgae and fisheries / local knowledge

3) Interest of the exploitation of macroalgae / conflicts and synergies



Compost

Methane

Fish feed ingredient

Dams to limit costal erosion

Carotenoids

Stress….

CLIMALG-SN working progress

Name GEOMAR Bottle DB ID	Algaebase ID
26	6
27	636
27	
27	
28	
29	26928
30	
31	
32	923
33	14144
34	
34	
34	
35	13319
36	26946
37	213
37	
37	
38	33
38	
38	
39	
40	174
41	708
42	11252
43	3321
44	693
44	
44	
44	
45	25008
46	11254
46	
47	
48	1127
49	2468
50	1129

JAGO

CENTRE | RESEARCH | CAREER & CAMPUS | DISCOVER | SERVI

Processing of seaweeds at the Senegalese coast. Photo: Patrice Brehmer, IRD©2019.

GEOMAR > Research > Marine Biogeochemistry > Chemical Oceanography > Ocean-Atmosphere Interaction > Team - Halocarbon > CLIMALG-SN Home > Resources of CLIMALG-SN

Presentations, Publications, Fact sheets

Topics of CLIMALG-SN

Management documents (Cloud - for members only, password needed)

RD2

Chemical

Overview

Ocean-At

Water Co

Trace Ga

Study

Staff

Contact

Coordinat

Dr. Birgit C

GEOMAR Research
Düsternbr
D-24105 K
Germany
Tel: +49-4
Fax: +49-
e-mail: bquack(a)geomar.de

More of CLIMALG-SN

CLIMALG-SN

Pictures

Database

Resources

CLIMALG-SN on Twitter.

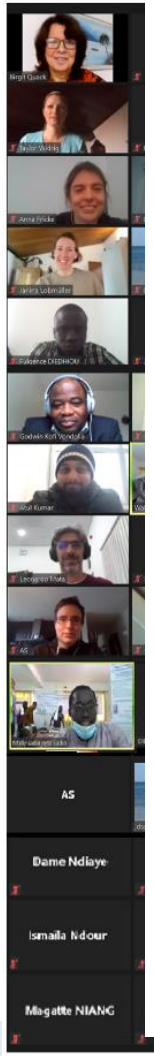
CLIMALG-SN at MeerWissen.

CLIMALG-SN on Facebook.

CLIMALG-SN on Instagram.

MEERWISSEN

Kick off
Seaweed for blu
Janu
Centre de Reche



UCAD/Plant biology departement

PhD student on taxonomy and Genetics

Institut de Recherche pour le Développement FRANCE

GEOMAR

C.R.O.D.T

rd	Region	Lo
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
t	Dakar	
rd	Thiés	
rd	Thiés	15'
rd	Louga	
rd	Saint-louis	
ôte	Dakar	
ôte	Thiés	
ôte	Thiés	
ôte	Thiés	
ôte	Thiés	
d	Kaolack	
d	Thiés	
d	Ziguinchor	
d	Ziguinchor	

UCAD/ESP

PhD student on seaweed valorisation

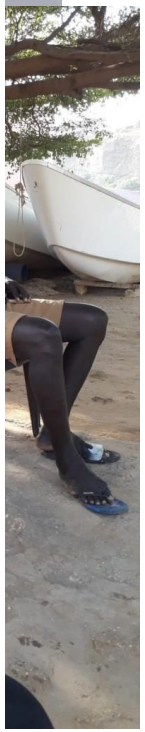
IGZ

GEOMAR

GEOMAR Centre for Marine Biotechnology

Institut de Recherche pour le Développement FRANCE

C.R.O.D.T



Partnerships & Co-design

CO-DESIGN WHAT?

CLIMALG-SN wants to :

1) Co-design the project with local stakeholders - from the beginning and throughout the project

2) Identify synergies with local institutions, projects and people

3) Create partnerships and collaborate with other projects

Development of Ocean Technical Capacity with African Nations

Comité local des pêches
CLPA - CLP

MEERWISSEN
African-German Partners for Ocean Knowledge

CLIMALG-SN

Merci
Thank you
Dieureudief
Dankeschön

Follow us on

DNA-fingerprinting senegalese marine biodiversity

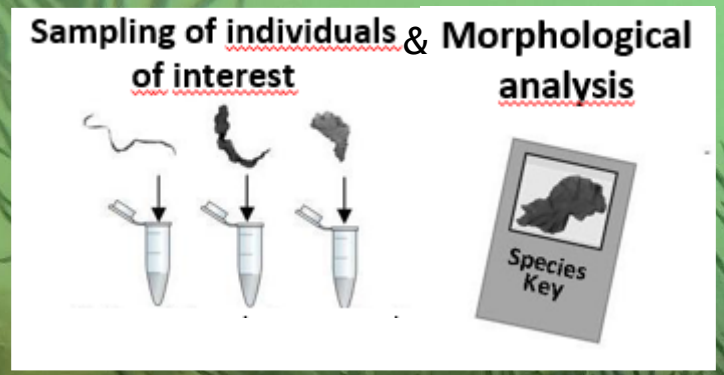
Dr. Florian Weinberger, GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel

MEERWISSEN
African-German Partners for Ocean Knowledge

The ultimate goal: Managing biodiversity in Senegalese coastal waters

How well can we identify what we find?

DNA barcoding for more accurate identification

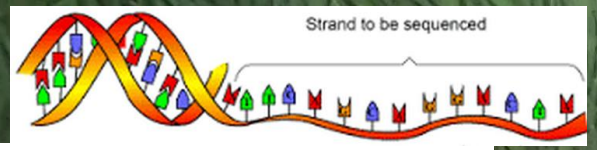


Verification of identification

Improve DNA data bank for Senegal

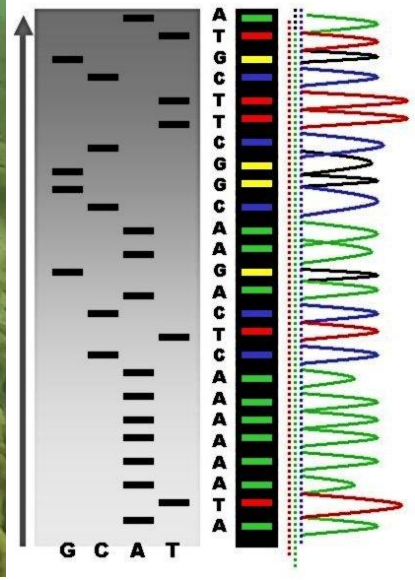
Comparison with DNA data bank

DNA **extraction**



Amplification of a selected marker gene:
tufA for **green macroalgae**
rbcL for **red macroalgae**
COI for **brown macroalgae and animals**
ITS for **fungi**
18SrDNA for **all organisms** except bacteria
(typically 800 – 1400 bases long)

DNA sequencing

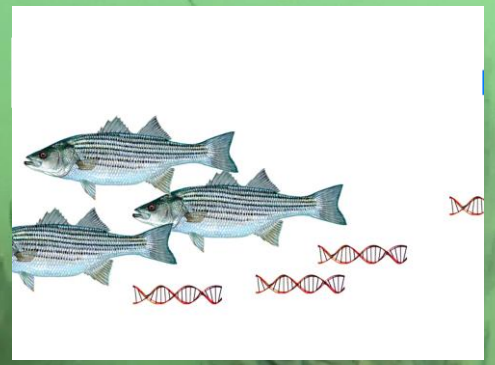


MEERWISSEN
African-German Partners for Ocean Knowledge

How can we solve the resolution problem?

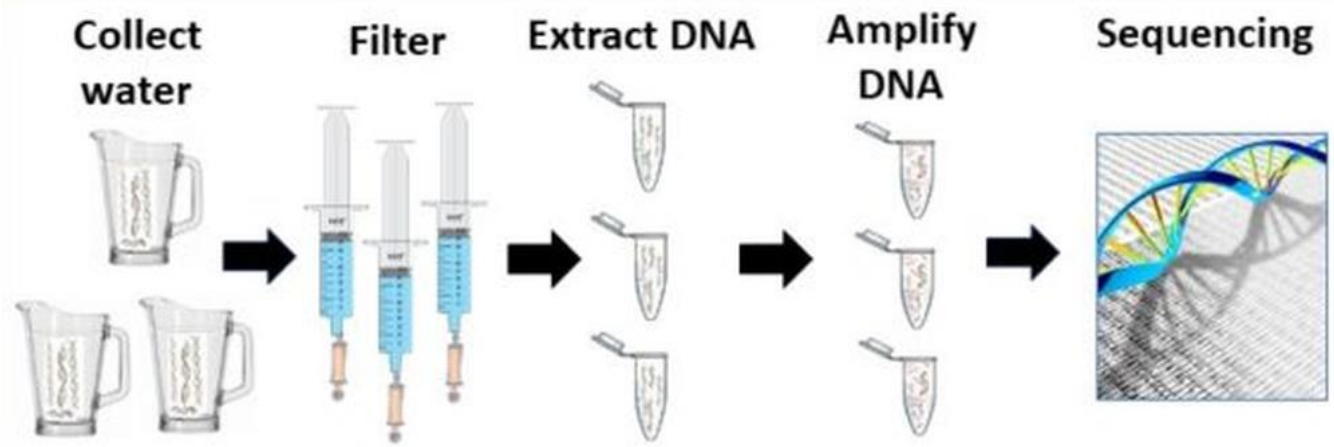
MEERWISSEN
African-German Partners for Ocean Knowledge

Metabarcoding of environmental DNA for better resolution



MEERWISSEN
African-German Partners for Ocean Knowledge

Metabarcoding of environmental DNA for better resolution



tttgagtatacaact
ttcgagcatacgact
aacgtccaaaggagt
ttggagcatacgact
aaggtccaaagagt
ttcgagcatacgact
atcgtccaatggagt
aaggtccaaacgagt
aacgtccaaaggagt
tttgagtatacaact

Comparison with DNA data bank

Species list

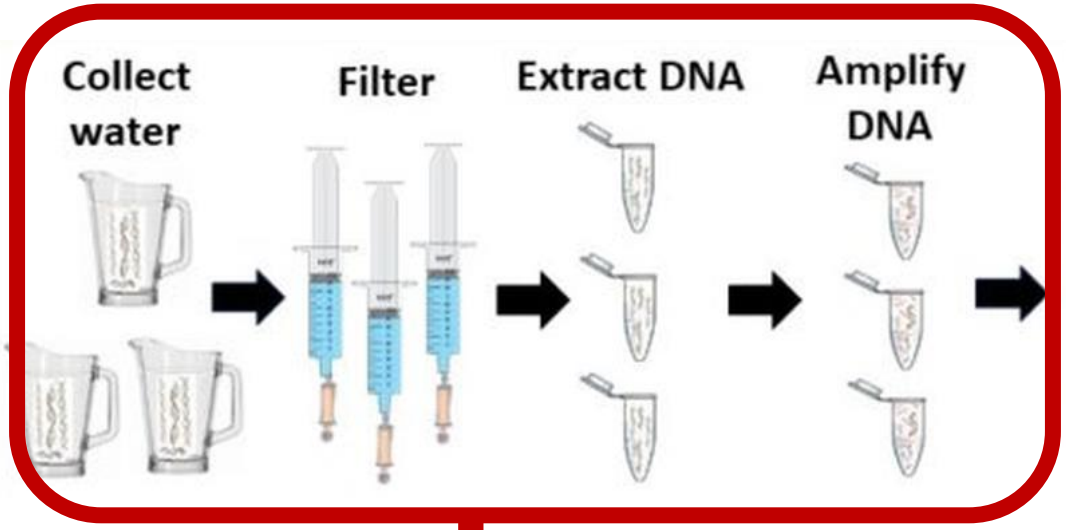
More abundant organisms

More DNA traces

More sequences detected

Semi-quantitative method

Metabarcoding of environmental DNA for better resolution



Sequencing

tttgagtatacaact
ttcgagcatacgact
aacgtccaaaggagt
ttggagcatacgact
aaggtccaaagagt
ttcgagcatacgact
atcgtccaatggagt
aaggtccaaacgagt
aacgtccaaaggagt
tttgagtatacaact

Comparison with DNA data bank

Species list

Very sensitive method

Negative controls & replication are very important

MEERWISSEN
African-German Partners for Ocean Knowledge

Metabarcoding of environmental DNA for better resolution

Good data base => Good result
Poor data base => Poor result

Good data base for commercially relevant fish in W Africa exists

We will improve the data base for seaweed in W Africa

CLIMALG-SN

AQUAGENE

Sequences producing significant alignments Download New Select columns Show 100

select all *100 sequences selected* GenBank Graphics Distance tree of results New MSA Viewer

Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
Meristotheca cylindrica isolate McPB_H70 ribulose-1,5-bisphosphate carboxylase/oxygenase small subunit (rbcS)...	Meristotheca cyli...	342	342	100%	4e-90	100.00%	185	KY979263.1
Solieriaceae sp. MLN-2017a isolate IA3-11 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) ...	Tepoztequiella rhi...	331	331	100%	8e-87	98.92%	319	MF043571.1
Meristotheca cylindrica isolate McIA_E10 ribulose-1,5-bisphosphate carboxylase/oxygenase small subunit (rbcS) ...	Meristotheca cyli...	331	331	100%	8e-87	98.92%	185	KY979260.1
Meristotheca cylindrica isolate 92-15 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) gene, ...	Meristotheca cyli...	309	309	100%	4e-80	96.76%	319	MF043569.1
Meristotheca cylindrica isolate McIA_E20 ribulose-1,5-bisphosphate carboxylase/oxygenase small subunit (rbcS) ...	Meristotheca cyli...	309	309	100%	4e-80	96.76%	185	KY979261.1
Eucheuma sp. E66 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) gene, partial cds; rbcL-r...	Eucheuma sp. E66	303	303	100%	2e-78	96.22%	318	AY687401.1
Meristotheca cylindrica isolate McBT_92-12 ribulose-1,5-bisphosphate carboxylase/oxygenase small subunit (rbc...	Meristotheca cyli...	298	298	100%	8e-77	95.68%	185	KY979262.1
Kappaphycus sp. E108 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) gene, partial cds; r...	Kappaphycus sp....	270	270	100%	2e-68	92.97%	302	AY687409.1
Kappaphycus cottonii ribulose 1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) and ribulose 1,5-bisp...	Kappaphycus cot...	265	265	100%	8e-67	92.43%	354	AF489869.1

MEERWISSEN
African-German Partners for Ocean Knowledge

Metabarcoding of environmental DNA for better resolution

	Wave energy [kW m^{-1}]	Detection limit [m]
Germany, Summer	1	100
Germany, Winter	4	1000
Senegal	15	> 1000

What can DNA fingerprinting provide to environmental management?

1. Identify coastal sections with high and low biodiversity

2. Identify habitats that harbour important species

3. Monitor seasonal changes

4. Monitor effects of interventions

On behalf of

Federal Ministry for Economic Cooperation and Development

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

MEERWISSEN
African-German Partners for Ocean Knowledge

Thank you for listening!

ISRA

C.R.O.D.T

GEOMAR

IRD Institut de Recherche pour le Développement FRANCE