Climate change and small-scale fisheries

A case for a comprehensive climate risk management

Published by

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by:
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Global Programme on Risk Assessment and Management for
Adaptation to Climate Change (Loss and Damage)
Friedrich-Ebert-Allee 32
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

E info@giz.de
I www.giz.de/en

Responsible:
Dr. Michael Siebert

Author:
Global Programme on Risk Assessment and Management for
Adaptation to Climate Change (Loss and Damage)

Co-author:
Dr. Mechthild Kronen (Lead author, GIZ)

With support by:
GIZ Sectoral Programme (SP) "Fisheries and Aquaculture", SP "Marine Protection" and global programme "Fisheries and Aquaculture", Alicia White (GIZ), Anja Fischbeck, Bernd Klöckener, Dr. Jörn Schmidt (Kiel Marine Science), Dr. Michael Siebert (GIZ), Eva Quix, Ivo Litzenberg (GIZ), Jan Harrs (GIZ), Johanna Johnson (C_2O Consulting), Jonas Fierke (GIZ), Nicola Hanke (GIZ), Pape Gora Ndiaye (REPAO/ENDA), Dr. Owen Day (Clear Caribbean); Solveig Schindler (GIZ); Jan Henning Steffen (GIZ)

Design and layout:
Eva Hofmann, Katrin Straßburger / W4 Büro für Gestaltung, Frankfurt

Photo credits:
Cover, pp. 4, 10, 15, 26, 39 and 44: © GIZ / Michael Siebert; p. 3: © Michael Gottschalk / photothek.net; p. 3: © by Manuel Barange / CC BY 4.0; pp. 8 / 9, 18, 21, 24, 35, 48 and 54 / 55: © GIZ / Mechthild Kronen; p. 12: © GIZ / Thomas Imo; pp. 13, 19, 27, 29, 31, 33, 41, 43, 46, 47 and 51: © GIZ / Owen Day; p. 14: © GIZ / Waltraud Ederer; p. 35: © GIZ / Christopher Bartlett; p. 38: © GIZ / Uwe Scholz; p. 49: © GIZ / Britta Radike; p. 50: © GIZ / Robert Lee; pp. 52 / 53: © GIZ / Markus Kirchgessner

On behalf of
German Federal Ministry for Economic Cooperation and Development (BMZ)

As at:
Bonn, June 2021

“**Protecting the oceans** is a vital issue for the survival of humankind. Without oceans, we would be gasping for air, because they produce half of the world’s oxygen. Without oceans, climate change would already be much more extreme, because they are sinks that bind one quarter of the world’s CO_2 emissions. Without oceans, billions of people would be deprived of their main source of sustenance.”

Minister Dr Gerd Müller, speech at the Future Ocean Event of the T20 Summit, May 2017

“**The percentage of fish stocks** that are fished at biologically sustainable levels has been decreasing and it’s now 65.8 % by number. This means that 34.2 % of all exploited fish stocks, by number, are unsustainably fished. […] the sustainability index has improved in many of the top producing species, including many of the tunas in recent years. As a result – and on your direct advice to consumers – it’s important to know that 78.7 % of all marine fish landed by volume is from biological sustainable stocks. […] We noticed in recent years, that stocks under effective management are increasingly sustainable and rebuilding and this is now also being recognized in the scientific literature, but fish stocks that are not subject to effective management systems are deteriorating faster […]. The corollary of these messages is that fisheries management works. However, we are not recognizing success where we have it, and therefore we are not transferring the lessons learned, where we are failing.”

PhD Manuel Barange, Director of the FAO Fisheries Division (NFI) at the “Fish(ing) for Future” Event: Sustainable Fish for Food Security and Nutrition in Africa, September 2020

“**Any decrease in fish catches** in [Eastern Boundary Upwelling Systems] EBUS will affect regional food security. For example, coastal fisheries in the Canary Current are an important source of micronutrients to nearby West African countries (Golden et al. 2016) that have particularly high susceptibility to climate change impacts and low adaptive capacity, because of their strong dependence on the fisheries resources, a rapidly growing population and regional conflicts.”

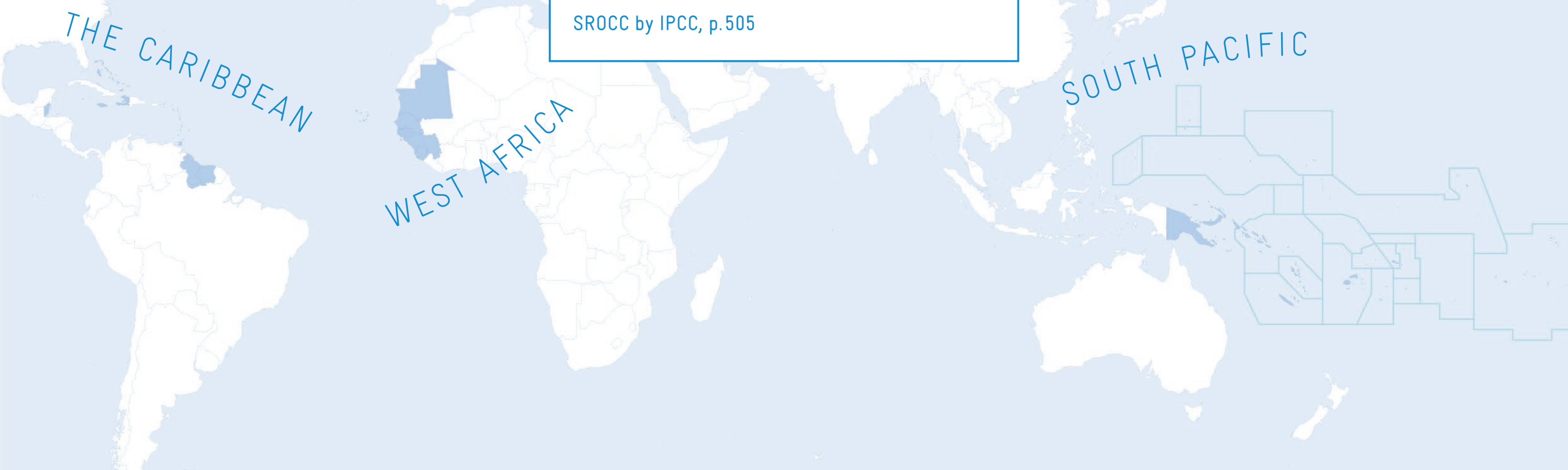
SROCC by IPCC, p. 507

“**Tropical oceans are projected** to experience much larger impacts (three times or more decrease in catch potential) than the global average, particularly the western central Pacific Ocean, eastern central Atlantic Ocean and the western Indian Ocean, by the end of the 21st century under RCP 8.5 (Blanchard et al. 2017). For example, around the exclusive economic zones of the Pacific Islands states, more than 50 % of exploited fishes and invertebrates are projected to become locally extinct in many regions by 2100 relative to the recent past under RCP 8.5 (Asch et al. 2018). These factors cause 74 % of the area to experience a projected loss **in catch potential of more than 50 %.**”

SROCC by IPCC, p. 505

“**The report card highlights the importance of coastal fisheries** for food security and livelihoods in the region, with 89 % of households eating fish or seafood weekly and 30 % of households participating in fishing.”

Coastal Fishery Report Card 2019, Pacific Community



Contents

Figures and tables

Abbreviations and acronyms

CARICOM	Caribbean Community and Common Market
CBD	UN Convention on Biological Diversity
CCA	Climate change adaptation
CCLME	Canary Current Large Marine Ecosystem
CDEMA	Caribbean Disaster Emergency Management Agency
CDM	Comprehensive Disaster Management
COAST	Caribbean Oceans and Aquaculture Sustainability Facility
COP	Conference of the Parties
CRFM	Caribbean Regional Fisheries Mechanism
CRM	Climate Risk Management
DRM	Disaster Risk Management
EbA	Ecosystem-based Adaptation
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
HLP	High Level Panel for a Sustainable Ocean Economy
ICON	Integrated Coral Observing Network
ICT	Information and Communication Technologies
IKI	International Climate Initiative
IOC	Indian Ocean Commission
IPCC	Intergovernmental Panel on Climate Change
JNAPs	Joint National Action Plans
LDCs	Least Developed Countries
LIFDCs	Low-Income Food-Deficient Countries
LPP	Livelihood Protection Policy
MDBs	Multilateral Development Banks
NaDMA	National Disaster Management Agency
NAP	National Adaptation Planning
NAPAs	National Adaptation Programmes of Action
NDCs	Nationally Determined Contributions
NERO	National Emergency Recovery Organization
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
NWP	Nairobi work programme on impacts, vulnerability and adaptation to climate change
OFDA	Office of U.S. Foreign Disaster Assistance
PICTs	Pacific Island Countries and Territories
PIF	Pacific Islands Forum
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SRFC	Sub-Regional Fisheries Commission
SST	Sea Surface Temperature
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
USAID	United States Agency for International Development
WAMER	West African Marine Ecoregion
WIM	Warsaw International Mechanism for Loss and Damage associ ated with climate change impacts
WMO	World Meteorological Organisation

Abstract

The effects of climate change and increasing extreme weather events on the oceans are key challenges for small-scale fisheries. This study highlights some of the economic as well as non-economic losses and damages associated with these effects. It aims to develop a better understanding of the impacts of climate change on small-scale fisheries and to some extent on the mariculture sector, to identify suitable risk-management-solutions, and to show entry points for comprehensive climate risk management (CRM) in order to enhance resilience.

Synthesising the results of three reviews of baseline information (covering the Caribbean, the South Pacific, and West Africa), this study reveals that specific negative impacts of climate change on fisheries are extremely difficult to separate from other threats like overfishing, habitat loss and pollution, as the effects of these threats on socio-economic and bio-physical factors are often interlinked. A comprehensive approach to risk management is therefore necessary.

The study results can be summed up in **4 major recommendations** that are reflected in all **3 regions:**

1. Capacity development at all levels
2. Closing data gaps impeding CRM
3. Developing instruments and tools
4. Promoting scientific cooperation

Key words for citation: climate change, disaster risk reduction, adaptation to climate change, small-scale fisheries, comprehensive climate risk management, GIZ

Executive Summary

The fisheries and aquaculture sector – including mariculture – contributes significantly to income and food security for more than 10 % of the world population *(Allison et al. 2013, HLPE 2014)*, particularly in the Small Island Developing States (SIDS) and coastal Least Developed Countries (LDCs) *(Ye 2015)*. Three billion people, most of whom live in Low-Income Food-Deficient Countries (LIFDCs), rely on fish for essential nutrition *(Béné et al. 2015, FAO 2014b)*.

Since 1950, the number of fishers in the world has grown significantly. Due to the negative impacts associated with climate change, more poor people are projected to turn to fishing in the future *(Williams & Rota 2012)*. Yet already 59.9 % of the reported world fish resources are fished at maximum sustainable levels, while 33.1 % are overexploited *(FAO 2018)*. Combined data on dietary nutrition and declining fish catches show that more than 10 % of the global population is likely to face micronutrient and fatty-acid deficiencies over the coming decades. This is particularly true for the developing nations at the equator *(Golden et al. 2016)*.

IPCC SROCC 2019

Future shifts in fish distribution and decreases in their abundance and fisheries catch potential due to climate change are projected to affect income, livelihoods, and food security of marine resource-dependent communities.

If global warming reaches +2°C by 2050, the annual losses in gross revenue of the global fisheries sector are projected to reach between USD 17 to 41 billion. Developing countries are expected to suffer exceptionally high economic losses. While several technical solutions to strengthen resilience are currently available, adaptation will become increasingly difficult – and in more and more instances impossible – as climate change progresses.

Drawing upon three qualitative baseline reviews covering the Caribbean, the South Pacific and West Africa, the actual impacts that these challenges have on different regions are summarised.

In the wider **Caribbean region**, climate-induced impacts such as mass coral bleaching events and ocean acidification are already causing loss of coral reefs, thus contributing to the loss of ecosystem services and declines in reef fish landings with significant negative economic impacts. More frequent extreme weather events and rougher sea conditions will increase damage to fishing boats and gear, port facilities and infrastructure. Algal blooms and ciguatera fish poisoning are projected to increase with rising water temperatures.

The **South Pacific Islands and Territories**, which are also highly dependent on fisheries, are amongst the most vulnerable regions in the world to the impacts of climate change. Climate change is not only causing the loss of demersal fish, invertebrates and nearshore pelagic fish, but is also exacerbating the influence of regional climate cycles. More frequent extreme weather events will increase risk and damage to infrastructure, fishing boats and equipment. Food security and livelihoods of coastal communities will be compromised.

Fisheries also play a very important role in the national economies of **West Africa**. Given its rapidly growing population, the gap between fish demand and fish supply is likely to increase in the coming decade. However, the lack of data is preventing accurate modelling of the ocean and climate change interactions and the implications for West Africa's small-scale fisheries sector. Threats are projected to increase for certain species and groups of species, but also for entire ecosystems. Changes to the weather and climate will result not only in increased operating costs for fisheries, but also in the migration of some stocks to cooler regions.

Following the presentation of specific impacts that climate change and extreme weather events have on small-scale fisheries and aquaculture in the different regions and the discussion of various policy, institutional and strategic frameworks for the fisheries sector, conclusions and / or recommendations are being developed.

Recommendations

The findings from these three regional reviews were presented and discussed at a workshop by a group of fisheries, climate change and development experts from these regions who then jointly developed a range of recommendations. The most important recommendation is the need for the management of sustainable small-scale fisheries to address the challenges that climate change presents at all levels of the sector. There is a clear consensus that an ecosystem-based approach is the best way forward to restore, maintain and enhance the resilience of small-scale fisheries against external factors, including climate change. A comprehensive climate risk management (CRM) approach that focuses on human needs (i.e. on providing food security and eradicating poverty in affected communities) including transformational approaches and which considers risk along the entire risk continuum (from short-term extreme weather events, such as storms and floods, to long-term gradual changes, such as sea level rise and salt-water intrusion into coastal areas) is also needed.

Fish are not bound by political or administrative territories, and climate change induced shifts in migratory behaviour and patterns will therefore necessitate a regional approach to effective fisheries management. Adaptation and mitigation measures need to be linked to the objectives of the Agenda 2030, in particular to SDG 14 and the implementation of the NDCs. The impacts of climate change also have to be considered in the context of coastal zone management, development planning, and fisheries and ecosystems management. This is particularly important in the context of the most vulnerable SIDS.

Guiding principles for planning adaptation and resilience measures include the identification of 'no-regret' options (options that deliver benefits which exceed their costs), 'low regret' options (generally low-cost actions which deliver potentially large benefits), 'win-win options (contributing to climate adaptation objectives while also delivering on other goals and objectives), and avoiding adaptation-constraining actions (e.g. high-carbon approaches).

Small-scale fisher in Mauritania

This study elaborates on **4 major recommendations** to:

1. address capacity development at all levels,
2. close data gaps impeding CRM,
3. develop innovative market instruments and insurance tools, and
4. promote scientific cooperation

Further recommendations for development corporation are:

- identifying key actors who can pursue relevant and promising approaches;
- promoting partnerships between actors from different sectors, institutions and countries;
- bringing together national governments, using already existing international frameworks to increase pressure on them to take action;
- fostering multi-stakeholder information exchange and communication between governmental agencies, fishery communities, non-governmental organisations (NGOs), the scientific communities and others;
- supporting approaches and measures, including financial mechanisms and funding opportunities which address the development of supplementary livelihoods if not alternatives income sources to small-scale fisheries in specific regions.

In order to be able to make use of existing knowledge, structures and networks, as well as to learn from existing experiences, a three-step approach is suggested:

1. Review which measures worked, which ones did not and why;
2. Make tried-and-tested good practices available to others;
3. Develop and implement new ideas to fill gaps at local, national, regional and global levels.

1

Introduction

Fisheries are important sources of food, nutrition and income for hundreds of millions of people worldwide. The sector has a high potential to contribute significantly to food security and adequate nutrition for a global population expected to reach 9.7 billion by 2050. Fish continues to be one of the most traded food commodities worldwide, with more than 50 % of fish exports (by value) originating from developing countries *(FAO 2018, Bondad-Reantaso, Garrido-Gamarro & McGladdery 2018)*.

More than two thirds of the partner countries supported by Germany's development cooperation are island or coastal nations. In these countries, up to 91 % of the people working in the sector are artisanal fishers and small-scale aquaculture farmers. The sector is of particular importance for Small Island Developing States (SIDS) and coastal Least Developed Countries (LDCs), which are also the most vulnerable to the impacts of climate change.

According to recent reports by the Intergovernmental Panel on Climate Change *(IPCC SROCC 2019, AR5 2014, SR 1.5 2018)* climate change is very likely to influence marine species redistribution and marine biodiversity, while jeopardising the sustained provision of fisheries productivity by the mid-twenty-first century *(IPCC 2014, Barange et al. 2018)*.

Ocean ecosystems are already experiencing some of these large-scale changes, and critical thresholds are expected to be reached at 1.5°C and higher levels of global warming, with some ecosystems (e.g. coral reefs, kelp forests) projected to experience high rates of mortality and loss *(Hoegh-Guldberg et al., 2019)*.

The small-scale fisheries sector is informal by nature and thus not well documented. This characteristic combined with the uncertainty of current and future risks (predictions on climate change and extreme weather events) prevents the possibility to establish cause-effect-relationships for different risks for the small-scale fisheries sector. Thus, the combination of weather and climate factors with socio-economic and institutional conditions produces an overall risk for small-scale fishers. Modelling and assumptions can give an indication on potential economic and non-economic losses and damages in the future.


Fish vendors in Dakar – Senegal

IPCC SROCC 2019

Migration of fisherfolk and migration of non-fishers into fisheries may be due to many drivers, including climatic, socio-economic, ethnical, security and demographic reasons. Free access may escalate migration of small-scale fishers and contribute to rapidly depleted fish stocks and conflicts as documented from West Africa where Senegalese and Ghanaian fishers are active from Mauretania to Sierra Leone and beyond.

For instance, stress from climate-induced changes in ocean conditions may lead to a tipping point, causing the collapse of an already heavily exploited fish stock. These bio-physical changes are inextricably linked with socio-economic and institutional conditions. A comprehensive approach that makes it possible to analyse all risk factors and to identify suitable, context-specific climate risk management (CRM) measures can help strengthen resilience, thus averting, minimising and addressing losses and damages from climate change.

Small-scale traditional fisheries contribute little to the greenhouse gas emissions, yet they are extremely exposed to potential climate-related losses and damages. By threatening the livelihood of people who depend on fish, those consequences may subsequently trigger further marginalisation of socially disadvantaged groups and minorities as well as local, if not global food insecurity and malnutrition. In addition, non-economic consequences pertaining to traditional and cultural values intricately connected to marine resources – the way of life, religious and societal beliefs and cultural identity – have the potential to undermine social and communal cohesion, aggravating instability and migration.

IPCC SROCC 2019

Changes in the ocean have impacted marine ecosystems and ecosystem services with regionally diverse outcomes, challenging their governance. Both positive and negative impacts result for food security through fisheries.

1.1 Objectives

This study aims to strengthen comprehensive CRM – more specifically the consideration of losses and damages in the small-scale fisheries and to a certain extent the mariculture sector. This is particularly important for many partner countries heavily dependent on fisheries, and for more effective international development cooperation. The study hopes to facilitate a better understanding of the effects of climate change on small-scale fisheries by describing climate-change-related losses and damages (economic and non-economic), identifying challenges, and how to react to them. It is directed at all relevant stakeholders – both governmental and non-governmental (e.g. donor organisations, NGOs, scientific institutions) who are engaged in the field of comprehensive climate risk management (CRM) and in the fisheries sector.

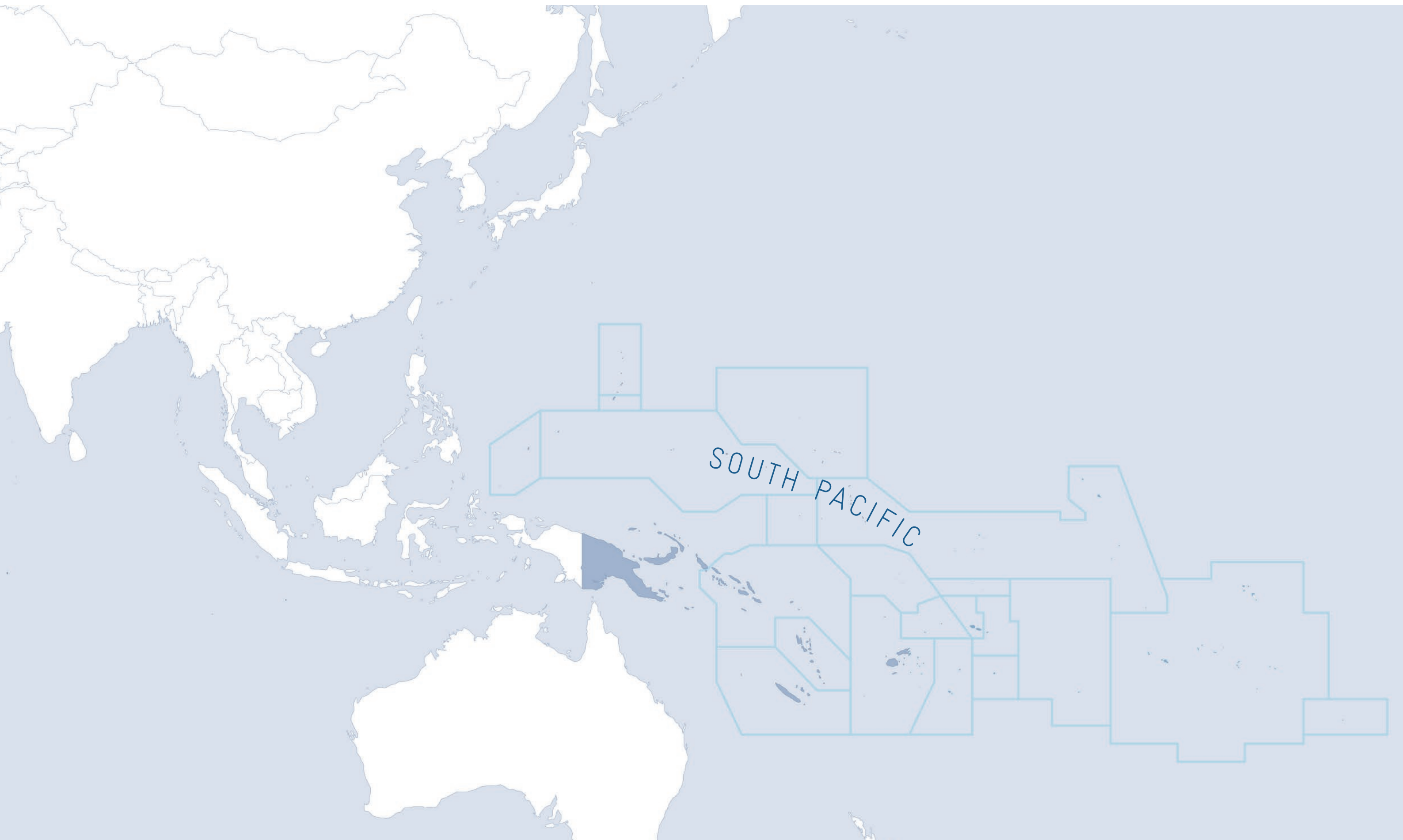
Suitable measures to enhance the resilience of small-scale fisheries are presented, as well as entry points to expand the portfolio of international development cooperation. The needs of partners to develop, adopt and implement CRM are also considered.

1.2 Method

This study synthesises the results of three individual review papers, carried out in the Caribbean, South Pacific and West Africa – three regions that are both highly dependent on small-scale fisheries (socially, economically and culturally) and highly vulnerable to the impacts of climate change and extreme weather events. Pointing out commonalities as well as differences between them, the study identifies synergies for cooperation and potential for the exchange of good practices. The results are limited by discrepancies in data availability and reliability, as well as differences in geography and socio-cultural norms among the three regions. Recommendations, context-specific CRM measures and strategies to prevent or reduce risks both from slow onset changes and from extreme weather events are presented.

The results of all three individual reviews were discussed during a technical workshop in October 2018 by more than 20 senior experts from various organisations and countries. Their suggestions and ideas on priorities for further action have been incorporated into this study.

[**In this study, we focus on small-scale fisheries and mariculture, which is aquaculture that occurs at sea and in coastal areas (e.g. coastal ponds and lagoons) (FAO 2018). Freshwater aquaculture is excluded in this report, however it is important to recognise that freshwater/inland aquaculture currently represents the majority (64 %) of current aquaculture production and may have important expansion potential (FAO 2018).* Where applicable, the study explicitly refers to mariculture additionally to small-scale fisheries. For reasons of accordance, the study refers to aquaculture explicitly when exisiting literature is cited.]



2

The importance of small-scale fisheries and aquaculture

Fisheries contribute significantly to income and food security for more than 10 % of the world population *(FAO 2018)*, particularly in SIDS and coastal LDCs *(Ye 2015)*. There are more than 55 million fishers worldwide, 90 % of whom are employed in small-scale fisheries and aquaculture (freshwater and mariculture) which provides most of the fish that is consumed in the developing world. Half of the people involved in the fishery sector are women, when both the primary (e.g. capture) and secondary (e.g. processing) sub-sectors are taken into regard *(FAO 2018)*.

In most countries, the contribution of the fisheries and aquaculture sector to gross domestic product (GDP) ranges from around 0.5 to 2.5 % but may reach as much as 10 % in island countries such as Nauru *(USAID 2016)*. Fish provides essential nutrition for three billion people, most of whom live in Low-Income Food-Deficient Countries (LIFDCs) *(Béné et al. 2015, FAO 2014b)* and 400 million rely on fish for at least 50 % of their animal protein and essential minerals supply *(FAO 2011b)*.

Combined data on dietary nutrition and fish catches show that more than 10 % of the global population will face micronutrient and fatty-acid deficiencies over the coming decades. This is particularly true for the developing nations at the equator *(Golden et al. 2016)*. Climate change is likely to aggravate this prediction.

In 2015, 60 % of the reported world fish resources were fished at maximum sustainable levels, while 33 % were overexploited *(FAO 2018)*. Fish stocks, including those targeted by the small-scale sector, are declining because of unsustainable management and practices, as well as pollution, sedimentation, and destructive human activities that contribute to deterioration and loss of habitats and ecosystems *(Pauly 1997)*.

Since 1950, the number of fishers worldwide has grown by 400 %, predominantly in the small-scale fisheries sector of developing countries *(World Bank 2005)*. It is likely that more poor people will turn to fishing and other common pool resources (forests, underwater basins, irrigation systems) in the future because of the increasing demand

IPCC SROCC 2019

A decrease in global biomass of marine animal communities, their production, and fisheries catch potential (reduction of maximum catch potential by 20.5 to 24.1 % by the end of the 21st century relative to 1986 – 2005 under RCP 8.5) and a shift in species composition are projected over the 21st century in ocean ecosystems from the surface to the deep seafloor under all emission scenarios. The rate and magnitude of decline are projected to be highest in the tropics.


Fisherman preparing his nets – Jamaica

for food combined with mounting negative impacts associated with climate change *(Williams & Rota 2012)*. This may aggravate over-exploitation and the phenomenon known as 'the tragedy of the commons'.

If managed sustainably however, small-scale fisheries have the potential to supply developing countries, and the world, with the majority of fish for human consumption, while also consuming much less energy than industrialised fisheries.

2.1 The Caribbean

The Caribbean Community and Common Market (CARICOM) is a grouping of twenty countries – fifteen member states and five associate members – with a population of approximately sixteen million, 60 % of whom are under the age of 30. Except for Belize, Guyana and Suriname, all members and associate members are island states. The total Exclusive Economic Zone (EEZ) of 2,046,948 km², governed by the member states of CARICOM, holds enormous fishery potential *(Masters 2014)*. Data reveals that the exploitation levels of commercial fish stocks in the Western Central Atlantic region are the highest in the world. More than half (54 %) of the commercially harvested fish stocks in this region are over-exploited or depleted, while 41 % are fully exploited *(FAO 2014a)*. Illegal, unreported and unregulated fishing further add to the problem.

The reported catch of marine fish of all CARICOM countries averaged 160,000 tonnes annually between 2003 and 2014 *(Masters 2014)* and is dominated by a few countries. The total annual fish export to markets outside the CARICOM amounted to 64,510 tonnes in 2011 and 2012, corresponding to a value of USD 442 million. Most of this export was from two countries, the Bahamas and Guyana. Total annual fish imports into the

Table 1: Fishery dependency in project countries (Source: Monnereau et al. 2015)

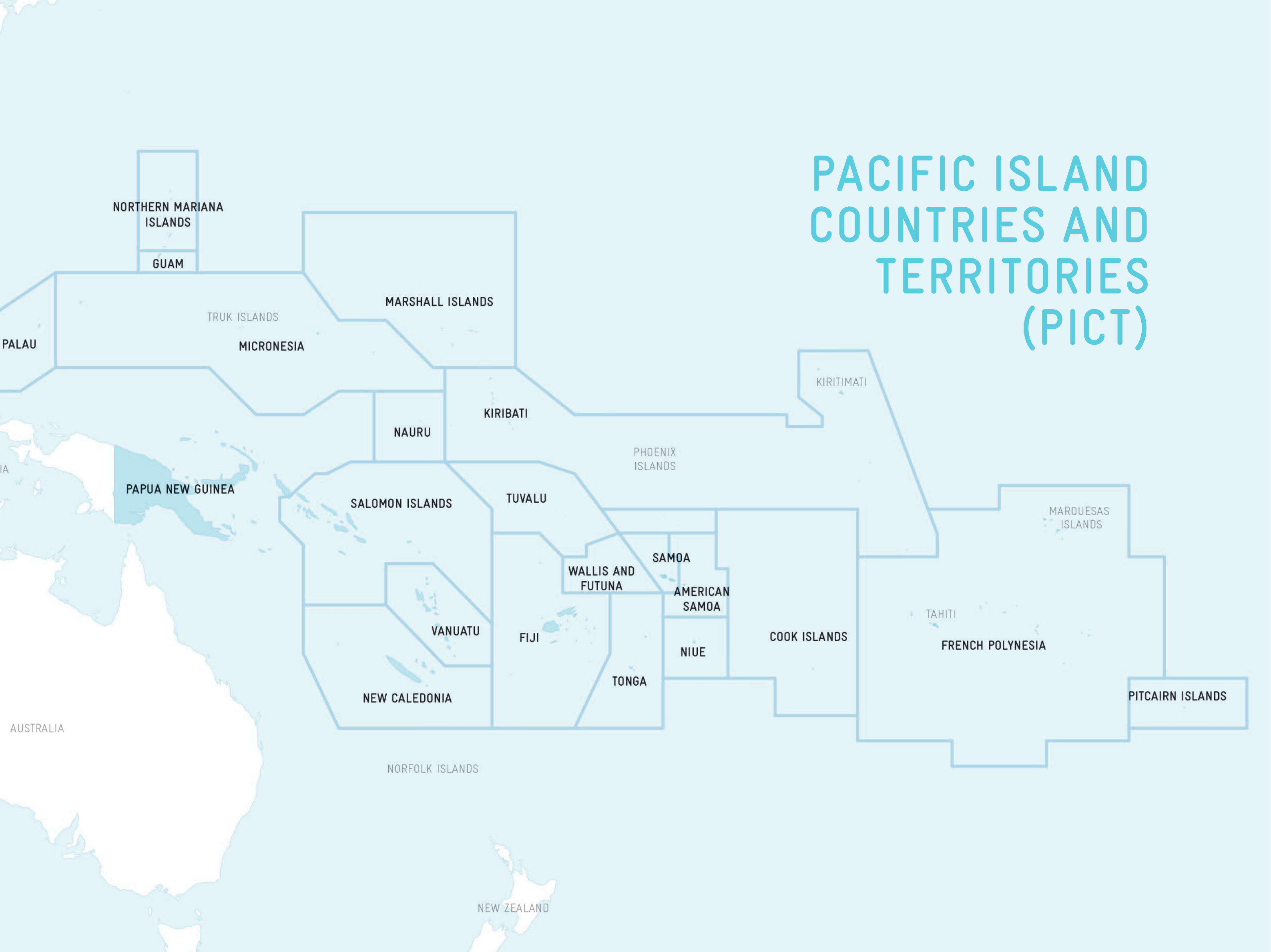
Countries	Fish catch (in mt)	Fish nutrition (fish as % animal protein) (2009)	Fisher-folk as % national labour force	Number of fishers engaged in marine fisheries	Number of process-ing sector workers	Number of fishing vessels	Fisheries sector % of GDP (2010)
Antigua and Barbuda	3,500	23.6	3.80	1,521	50	388	1.2
Dominica	550	16.9	4.00	1,584	50	650	0.7
Grenada	2,974	28.1	6.22	2,805	75	770	1.4
St. Kitts and Nevis	19,304	21.2	4.21	756	50	254	0.4
Saint Lucia	1,844	17.8	2.91	2,556	376	402	0.7
St. Vincent and the Grenadines	813	11.0	5.09	2,500	500	737	0.5
Trinidad and Tobago	12,839	14.7	0.01	3,477	250	1,918	0.5

region generally exceed the export volume. In 2011 and 2012, 70,111 tonnes were imported at a value of USD 538 million, with Jamaica, Haiti and Trinidad and Tobago being the largest fish importers during this period.

For many Caribbean nations, marine fisheries play an important role in the social, economic and cultural fabric of the country **(Table 1)**. The traditional high dependency on marine resources and a growing population has led to mounting fishing pressure that is likely responsible for the collapse of certain reef fish stocks *(Jackson et al. 2014)*. As a result, not only the livelihood and food security of coastal communities are at risk, but also the health of coral reefs *(Hawkins & Roberts 2003)*. The degradation of coral

Coastal fishermen hauling their nets – Grenada

PACIFIC ISLAND COUNTRIES AND TERRITORIES (PICT)



reefs in the Caribbean – partly due to overfishing – but also to pollution and climate change – is projected to cause a loss of ecosystem services estimated to be worth between USD 140 to 420 million annually by 2050.

While the overall contribution of the fisheries sector is generally small in CARICOM countries (0.4 to 1.7 % of GDP) fishing plays an important part in the livelihoods and nutrition of Caribbean people. The annual per capita fish consumption in CARICOM is high, ranging from 10 to 35 kg per year *(Masters 2014, FAO 2014b)* with an average of 20 kg.

2.2 The South Pacific

The Pacific Island region comprises 22 countries and territories, which are diverse in geography, population size, culture and economy. Melanesian island countries are typically large and mountainous with fertile soils, whereas the smaller Polynesian and Micronesian countries are either steep volcanic islands or low-lying coral atolls *(Barnett 2011)*. Population sizes vary from as little as 1,200 in Tokelau, the smallest Pacific Island territory, to 7.4 million in Papua New Guinea, the largest Pacific Island country *(SPC 2013)*. Five Pacific Island Countries and Territories (PICTs) – Kiribati, Samoa, the Solomon Islands, Tuvalu and Vanuatu – are currently classified as LDCs *(Barnett 2011, UNCTD 2013, Charlton et al. 2016)*. According to the World Risk Report, five Pacific countries are among the 20 countries with the highest average annual disaster losses scaled by gross domestic product *(Bündnis Entwicklung hilft 2017)*. The regional review paper focused

Table 2: Estimated subsistence catch volumes (mt) compared to total coastal catch production, and the proportion (%) of subsistence catch in the total coastal catch for all 22 PICTs (Source: Gillett 2016)

PICT	Coastal subsistence catch (mt)	Total coastal catch (mt)	Proportion subsistence (%)
MELANESIA			
Fiji	16,000	27,000	59
New Caledonia	3,500	4,850	72
Papua New Guinea	35,000	41,500	84
Solomon Islands	20,000	26,468	76
Vanuatu	2,800	3,906	72
MICRONESIA			
Federated States of Micronesia	3,555	4,280	83
Guam	42	114	37
Kiribati	11,400	19,000	60
Marshall Islands	3,000	4,500	67
Nauru	210	373	56
Northern Mariana Islands	350	492	71
Palau	1,250	2,115	59
POLYONESIA			
American Samoa	120	162	74
Cook Islands	276	426	65
French Polynesia	2,350	8,016	29
Niue	154	165	93
Pitcairn Island	6	9	67
Samoa	5,000	10,000	50
Tokelau	360	400	90
Tonga	3,000	6,900	43
Tuvalu	1,135	1,435	79
Wallis and Futuna	675	825	82
		AVERAGE:	66.73

on 14 PICT-countries: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu, covering an area of more than 19 million km² of EEZ. Oceanic fisheries are dominated by large-scale, industrialised fleets (national and foreign) primarily targeting tuna, while coastal fisheries, mainly small-scale fishers, tend to be highly diverse.

In general, offshore resources are in relatively good condition, except for bigeye tuna and, to a lesser extent, yellowfin tuna *(ISSF 2018)*. Coastal fishery resources, on the other hand, are heavily depleted, often showing signs of overfishing both from commercial and subsistence fishing pressure. The combined harvest of the four main tuna species from the EEZ of PICTs totalled 1.5 million tonnes in 2014 *(Williams & Terawasi, 2015)*.

Access fees from distant water fishing nations, particularly Japan, USA, China, Taiwan, Korea and Spain, generate the greatest income: in 2013/14, for example, seven PICTs received up to 84 % of their total government revenue from access fees and associated licenses *(Gillett, 2016; Johnson et al., 2017)*. Onshore processing of tuna also contributes significantly to employment and to GDP in many PICTs such as American Samoa, Fiji, Papua New Guinea and Solomon Islands *(Bell et al., 2011)*.

With an average contribution of 41 % of the regional GDP *(Gillett 2016)*, the coastal artisanal fisheries (commercial and subsistence) are even more important. Between half and two thirds of national households engage in subsistence fisheries, estimated to have a value of about USD 200 million *(Seidel & Lal 2010)*. Socio-economic surveys showed that on average 47 % of coastal households across 17 PICTs earn their first or second income from catching or selling fish and invertebrates *(Pinca et al. 2010)*.

PICTs are highly dependent on fisheries – socially, economically and culturally **(Table 2)**. The annual per capita fish consumption in the South Pacific region is 3 to 5 times higher than the global average. In rural areas, fish often supplies 50 to 90 % of dietary animal protein *(Bell et al. 2009)*. According to Seidel & Lal *(2010)*, if the current status 'of overexploitation, pollution, and destruction were to prevail in addition to predicted climate change effects, Pacific Island economies face the prospect of becoming non-viable.'

Destruction at the coast of Futuna after landfall of cyclone Tomas in 2010

MEMBER COUNTRIES OF THE WEST AFRICAN SUB-REGIONAL FISHERIES COMMISSION

2.3 West Africa

The West African Marine Ecoregion (WAMER), administered by the West African Sub-Regional Fisheries Commission (SRFC)[1], includes the seven member states of Cape Verde, the Gambia, Guinea, Guinea Bissau, Mauritania, Senegal and Sierra Leone. They share a maritime area of the South-East Atlantic Ocean, which – due to two major currents, the Canary and the Gulf of Guinea current – is one of the most fish-rich marine regions in the world, covering an EEZ of 1,547,282 km^2.

Demographic and economic pressures will increase as the population in West Africa is estimated to reach 430 million by 2050 *(OECD 2008)*. The fisheries sector is of enormous importance for the national economies in the region and constitutes the main livelihood for a majority of people living along the coasts and in riparian areas *(Béné 2006)*.

1 West African Sub-regional fisheries commission (SRFC), in French CSRP.

In 2016, fisheries resources worth an estimated USD 983 million were exported (CSRP). Low value, small pelagic fish account for more than three quarters (77 %) of all catches (CSRP), the remaining quantity being high value demersal species. However, small pelagic fish play an essential role in the food and nutritional security of West Africa's population. The artisanal sector is the main supplier of fish production in this region, contributing more than 60 % of the total marine catch *(Alder & Sumaila 2004)*.

The sector offers significant employment opportunities – both directly (as artisanal fishermen or workers on board of industrial vessels) and indirectly (in processing, trade, transport or export) *(Sall et al. 2006)* – especially for young people and marginalised groups: women, for instance, dominate the processing, retailing and local trading of fish products *(Akrofi 2002)*. In Mauritania, the sector provided an estimated 55,000 jobs in 2013. In Senegal, the small-scale fisheries sub-sector generates 67 % of total employment in the fisheries sector **(Table 3)**. Overall, the number of fishermen in the region is increasing. Coastal communities mainly use pirogues and traditional fishing techniques.

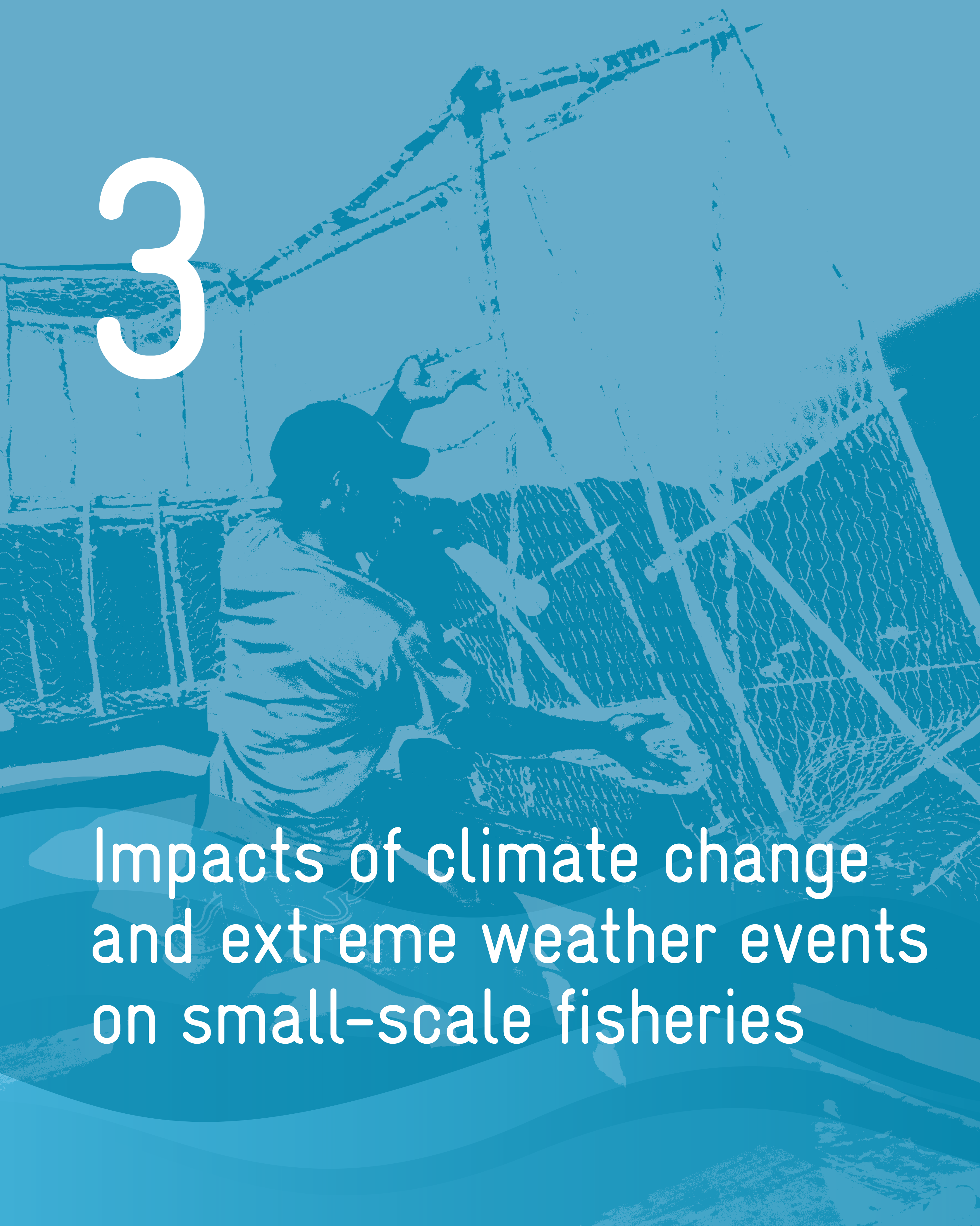
Table 3: Economic importance and artisanal fisheries fleet data for The Gambia, Mauritania and Senegal
(Sources: 1) World Bank 2016; 2) CSRP, figures for 2015)

Country	Contribution of fisheries sector to GDP (%)[1]	Number of pirogues (artisanal fisheries)[2]	Motorisation of pirogues (%)[2]
The Gambia	4.72	1,700	37
Mauritania	6.49	7,000	90
Senegal	2.65	19,009	90

In coastal West African countries, capture fisheries provide an important source of animal protein. In Senegal for example fish accounts for 44 % of the total animal protein intake and this proportion could be similarly large or larger in other developing countries if affordability was assured *(Westlund et al. 2008)*. With the decline of regional fish stocks and the rise in population, the per capita annual fish consumption has decreased from 14.1 kg in 2008 to around 13.5 kg in 2013 *(FAO 2017)*.

Given the current resource status, it is believed that the contribution of fisheries to the nutritional and protein requirements of a rapidly growing population will decline significantly in the coming decades.

Small-scale fish vendors in Dakar – Senegal



3

Impacts of climate change and extreme weather events on small-scale fisheries

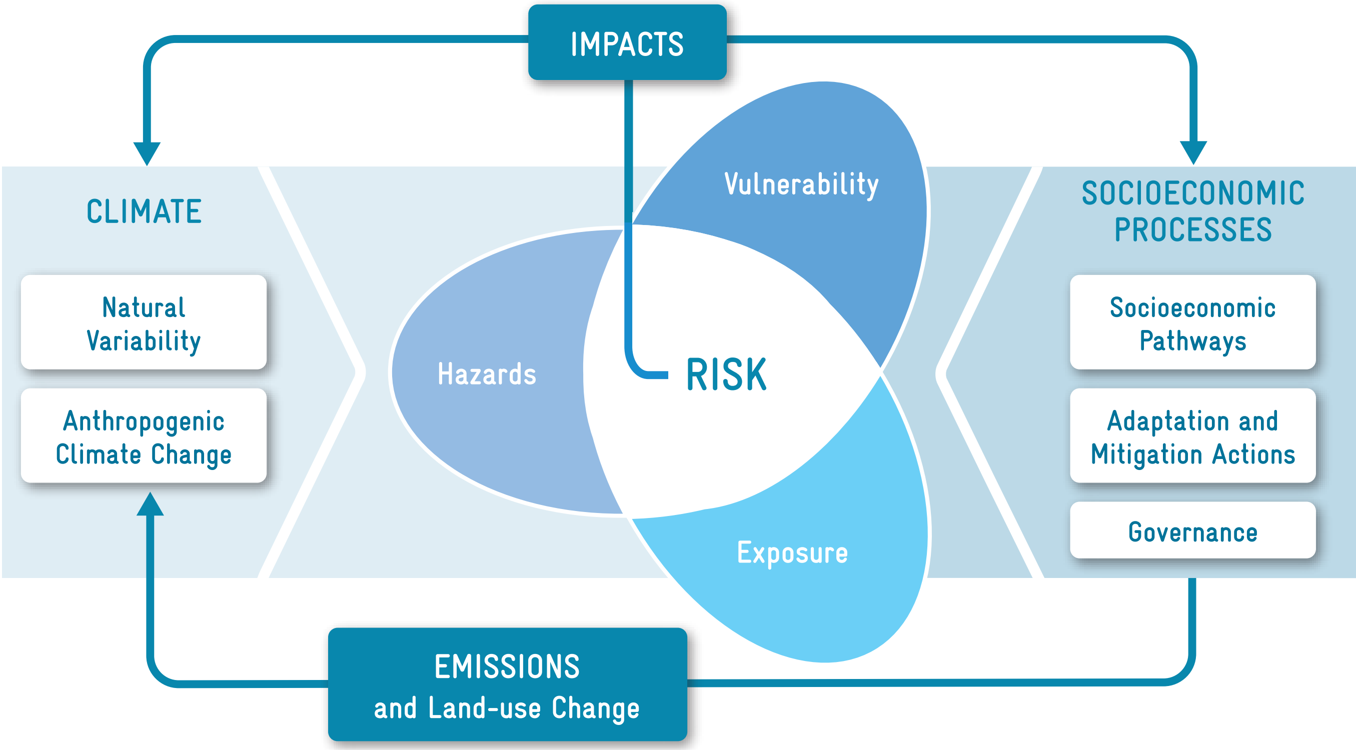


Figure 1: IPCC (2014) Risk Concept

Recent climate projections suggest a significant increase in the frequency and / or magnitude of extreme weather events such as storms and floods as well as slow-onset changes, for instance sea level rise and desertification *(IPCC, 2014, 2019)*. Increased heat in the upper layers of the ocean is already driving more intense storms and greater rates of inundation in some regions, which, together with sea level rise, are driving significant impacts to sensitive coastal and low-lying areas *(Hoegh-Guldberg et al., 2019)*.

These trends threaten the ability of all countries to achieve their sustainable development goals, and will affect livelihoods, ecosystems, economic performance and key assets. These threats are of particular concern for poor and vulnerable people in developing countries, where they jeopardise poverty reduction achievements and may result in substantial economic and non-economic losses and damages.

Comprehensive CRM is an approach that aims to take the entire risk continuum into account, from short-term extreme weather events to long-term gradual changes. As shown in Figure 1, the risk framework of IPCC *(2014)* highlights the interaction of impacts on climate and socio-economic processes, and regards the risk for any system as a function of vulnerability, hazard and exposure.

By embracing the risk concept, the IPCC

- accounts for the fact that a large proportion of interrelated impacts are triggered by hazardous events, which is addressed by the risk concept;
- encourages the climate research community to strengthen its efforts to determine the likelihood of potential consequences as part of the risk assessment; and
- contributes to an integration of the two research areas of climate change adaptation and disaster risk reduction.

The climate-related trends and impacts on the oceans will have many direct and indirect effects on fisheries and aquaculture *(Bindoff et al., 2019; CDKN 2014; Holmyard 2014)* (Figure 2). The main drivers include rising water temperature and the associated decrease in dissolved oxygen that can lead to hypoxia when oxygen levels fall below a critical point for a given species. Ocean warming will therefore cause many fish species to migrate towards the poles into cooler and more oxygen-rich waters. The expansion of oxygen depleted zones will particularly affect upwelling areas of Eastern boundary currents, such as the Humboldt, Canary, and Benguela Currents. Ocean acidification caused by rising levels of dissolved carbon dioxide (CO_2) is also a key driver of ecological change. Acidification reduces the availability of carbonate ions which decreases the productivity of calcifying organisms. The above mentioned drivers will affect the distribution of fish stocks and the productivity of certain areas, with some regions gaining and others losing. The anticipated changes will impact the economies of many islands and developing countries, where small-scale fisheries account for up to 56 % of the catch and 91 % of people working in fisheries.

The impacts of climate change and ocean acidification are often exacerbated by other factors such as overfishing, habitat loss and pollution. Overfishing is one of the most important non-climatic drivers affecting the sustainability of fisheries *(Cheung et al., 2018b; Harvey et al., 2018)*. Eutrophication of coastal areas caused by excessive nutrient inputs, disruptions to the food-web due to overfishing, and rising seawater temperatures can all increase the frequency of harmful algal blooms. Similarly, the rapid decline of coral reef ecosystems caused by warmer seas, may trigger a collapse of some coastal fisheries. Incidences of mass coral bleaching events are already increasing, and this trend is expected to continue. The Central and Western Equatorial Pacific, parts of Micronesia and Melanesia, and Southeast Asia are considered some of the most vulnerable regions to coral bleaching. 10 to 12 % of all fish caught in tropical countries and 20 to 25 % of fish caught by developing island nations depend on healthy coral reefs. In the Pacific alone, production of reef fish – already in a state of unsustainable exploitation – could decrease by up to 20 % by 2050 *(IPCC 2014b)*.

Aquaculture can be affected in many ways, from reduced catches of feed-fish to more frequent harmful algal blooms, and more severe flooding and storm surges. Farmed fish and shellfish are likely to suffer from an increased susceptibility to disease, exacerbated by stress linked to higher temperatures and lower oxygen levels *(Holmyard 2014)*. Modelling and forecasting of aquaculture and climate change include assessments of overall vulnerability. Sensitivity, exposure and adaptability have to be analysed separately for each environment *(Handisyde, Telfer & Ross 2017)* so that both challenges and opportunities for the sustained production of farmed aquatic food and those engaged throughout the value chain can be assessed *(Soto et al. 2018)*. Interactions of aquaculture with other sectors, particularly fisheries and agriculture, may exacerbate existing climate change impacts, or in some cases help develop beneficial synergies *(Beveridge et al. 2018)*.

Settlements damaged by beach erosion

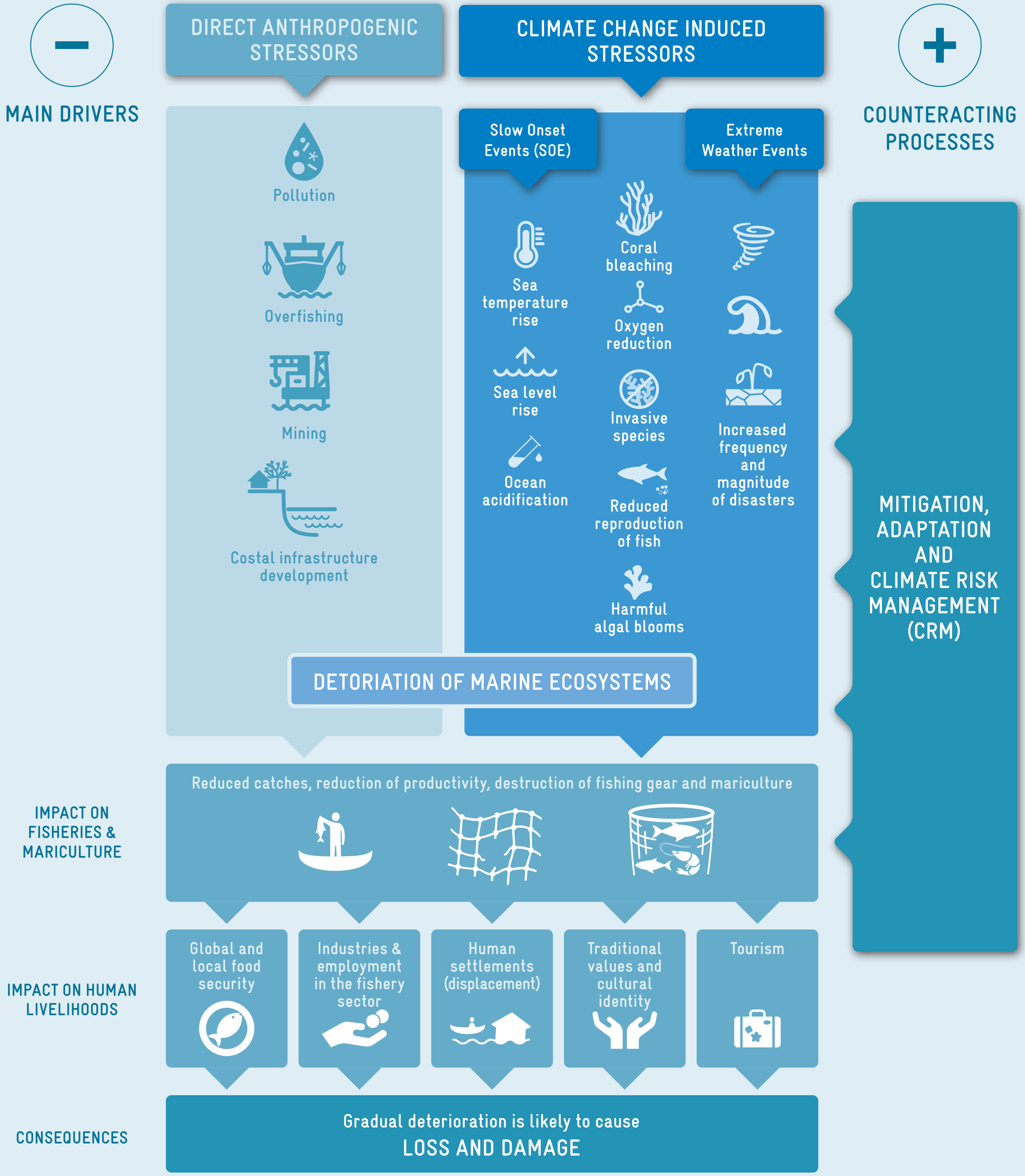


Figure 2: Impacts on fisheries and mariculture sector in the era of climate change
(© GIZ/Global Programme on Risk Assessment and Management for Adaptation to Climate Change [Loss and Damage])

Fishers can adapt to some climate impacts, for instance by changing gear or target species or by shifting to related practices such as aquaculture – respectively mariculture. They can also move to more dynamic management policies, or if alternative livelihoods are available, they can leave the sector temporarily or permanently; the scope for adaptation to factors such as ocean acidification is however limited. Conflicts over fishing grounds are likely to increase, as the distribution of fish stocks shifts towards to the poles.

While it is well established that climate change will have significant direct impacts on small-scale fisheries by affecting both individual target species and ecosystems **(Figure 2)**, the precise and localised impacts are still poorly understood *(FAO 2018, Stern 2007)*. This is due to the inherent uncertainties of downscaled climate models but also because of the complex linkages and interactions between the bio-physical, social and economic characteristics of any given location *(World Fish Centre 2007)*.

Tropical fisheries, which are most important for the small-scale sector in developing countries, have received less scientific attention *(Roessig et al. 2004)*. Focus must be directed to boosting adaptive capacity by improving the health of fish stocks, and the resilience of freshwater, marine and coastal ecosystems on which the communities depend *(Williams & Rota 2012)*.

IPCC SROCC 2019

Marine heatwaves will further increase in frequency, duration, spatial extent and intensity under future global warming pushing some marine organisms, fisheries and ecosystems beyond the limits of their resilience, with cascading impacts on economies and societies.

A number of measures are available to help small-scale fishers and fish-farmers adapt to the effects of climate change, including *(Holmyard 2014)*:

- Targeting new fishing grounds, and / or new species based on projected climatic shifts (i.e. planned rather than ad hoc responses);
- Establishing marine protected areas and implementing specific conservation measures (e.g. coral reef restoration) to increase the resilience and adaptive-capacity of critical ecosystems;

Woman farming seamoss in Savannes Bay – Saint Lucia

- Acceleration of the expansion of sustainable aquaculture to ensure livelihood and food security, but also to compensate for the anticipated decline in wild-caught fish and shellfish;
- Application of technical solutions to react to changes in the acidity of seawater, and / or relocation of hatcheries and shellfish farms.

However, as pointed out by the IPCC AR5 *(2014)*, 'adaptation (to climate change) will become progressively more difficult as climate change progresses, and increasingly there are likely to be situations in which it is impossible.' Against this backdrop, it is clear that individual measures are not enough. A comprehensive approach to manage risks, including those triggered by both slow-onset and sudden-onset events, is needed.

3.1
The need for Comprehensive CRM

Climate risk has become an important consideration in the current thinking around climate change: the International Panel on Climate Change (IPCC) has built key concepts from the disaster risk reduction discourse and introduced the concept of climate risk in its Fifth Assessment Report (WGII AR5). The IPCC AR5 risk concept broadens the perspective on climate related impacts triggered by extreme events and slow-onset changes. Poulain et al. (2018) also base their adaptation approach for fisheries and aquaculture on this risk understanding. There is a growing consensus that even with ambitious adaptation and mitigation actions, it will not be cost-effective, or even technically feasible to eliminate all economic and non-economic damages caused by climate risks. Certain adverse impacts of climate change are already 'locked in'. Moreover, long-term effects are expected to be much more disruptive, including risks of fuelling forced migration and conflicts.

Therefore, a holistic approach to managing risk is needed. Comprehensive CRM implies that all sectors factor risks into plans, including considering how risks may affect action across sectors (Figure 3). At present, existing approaches to include CRM and loss and damage in national policy rely on their strong linkage to, and possible integration into, current processes such as National Adaptation Planning (NAP), development planning, existing disaster risk reduction and management policy, as well as the (re)orientation of national policies towards sustainable development. Institutional integration is crucial for mainstreaming CRM and loss-and-damage-considerations into new and existing development planning and budgeting processes, within all relevant institutions, sectors, and levels.

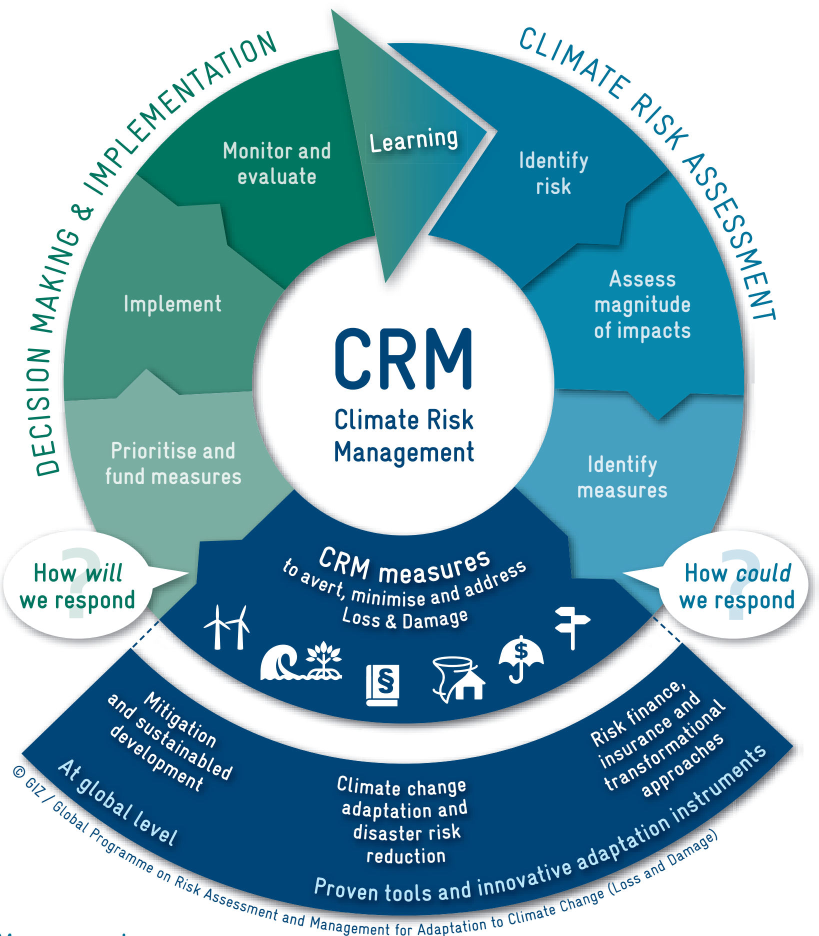


Figure 3: Climate Risk Management

Climate risk assessment lays the foundation for successful CRM. By identifying risks, assessing the magnitude of impacts on people, assets and ecosystems, CRM shows possible options for action and answers the question: How could we respond? The assessment shows how climate change and extreme weather events interact with socio-economic factors. The interaction of these factors determines the overall risk for the affected population. The assessment includes evaluating the magnitude of the expected impacts and identifying the costs and benefits of the most promising risk management options. Opportunity costs show that anticipatory planning pays off. This integrated evaluation demonstrates effective measures for dealing with risks and forms the basis for the integration of climate policy measures into public budgets and national policies.

To identify the smartest mix of instruments, it is crucial to understand the organisational and economic ability of countries, communities and the private sector to adapt and respond to risk. These factors play an important role for identifying the right measures ensuring climate-resilient development pathways. Due to the partly subjective nature of risk assessments, it is not possible to identify appropriate CRM measures solely through cost-benefit analysis. Many important aspects cannot be quantified and / or monetised, but might have a significant impact especially on poor people.

Identifying appropriate measures is context-specific. In order to include affected and marginalised populations, a suitable combination of different measures to foster sustainable development and stakeholder participation has to be considered. Due to the inherent uncertainty of climate change, measures of incremental nature will not always be sufficient. To appropriately manage current and future climate-related risk, measures that have transformational character and involve fundamental changes need to be considered, too. Comprehensive CRM builds on the strong participation of stakeholders from different sectors and scales, proposing a set of instruments that enable stakeholders to take timely action to prepare for climate-related extreme events and to strengthen overall resilience, including slow-onset events.

Based on the identified CRM measures and related costs, decision makers from the public and private sector are able to better prioritise, fund and implement measures to respond. Monitoring and evaluating the implemented measures leads to continuous learning that feeds into the CRM cycle and informs future decisions.

3.2 Regional impacts of climate change on small-scale fisheries

3.2.1 The Caribbean

In the Caribbean, climate change will cause a rise in average temperature, resulting in a warmer, dryer region with more intense hurricanes and possibly more climate variability, affecting the entire marine ecology and thus the small-scale fisheries sector.

Fishing boats in Grenada

Consequences for small-scale fisheries are likely to include:

→ CHANGES IN THE DISTRIBUTION AND PRODUCTION OF FISH

The degradation of coral reef and associated habitats may be further aggravated by climate change impacts. Reef-associated species are expected to become scarcer, while pelagic fishes – both highly migratory oceanic and regional large species – move towards the poles. If they move at the projected rate of between 28 to 36 km per decade (Cheung et al. 2012), they will be beyond the reach of small-scale fishers, and possibly beyond the relatively limited EEZs of most Caribbean states within a matter of years.

→ DAMAGES TO INFRASTRUCTURE AND EQUIPMENT

Fisheries are likely to be impacted by more frequent and more intense storms and hurricanes. In 2008, for instance, hurricane Gustavo caused costs of lost and damaged fishing gear, including boats and engines, of USD 14 million in Jamaica (Planning Institute of Jamaica 2008), in 2010, hurricane Earl caused similar costs to fishers of USD 122,000 in Antigua and Barbuda, and in 2015, hurricane Erika similarly cost Dominica over USD 2 million (COD 2015).

→ INCREASED FREQUENCY OF HARMFUL ALGAL BLOOMS

Harmful algal blooms (HABs) are proliferations of phytoplankton or macroaglae that have negative effects on the marine environment. Recent studies show range expansion of warm-water HAB species, such as Gambierdiscus that causes ciguatera fish poisoning (Sparrow et al., 2017) and regional increases in the occurrence and intensity of toxic phytoplankton blooms in relation to ocean warming (McKibben et al., 2017; Díaz et al., 2019). In recent years, fisheries in the Caribbean region suffered from massive sargassum blooms, which are believed to be the result of elevated sea surface temperature and increased levels of nutrients originating from Sahara dust and the large South-American rivers (Smetacek & Zingone 2013). These blooms have limited the operations of fishing vessels, interfered with fishing gear, and clogged the cooling intake of boat engines.

→ SPREAD OF CIGUATERA FISH POISONING

Generally concentrated in the northern Caribbean, ciguatera fish poisoning may become more common throughout the Caribbean with increasing sea surface temperatures and intensifying storms.

→ BEACH EROSION AND INUNDATION

Almost all port and harbour facilities in the Caribbean can expect to suffer inundation in the future, yet few are prepared for this eventuality (Cashman & Nagdee 2017). Beach erosion is already widespread, as well as forced community relocation in Barbados. Tropical storm damages concern fisheries and small-scale aquaculture facilities.

→ OCEAN ACIDIFICATION

The effects of ocean acidification on coral reefs will have economic impact on Caribbean SIDS (Melendez & Salisbury 2017). They will contribute to the deterioration of reef conditions and reduce their capacity to recover from acute events such as thermal bleaching. Local stressors, such as pollution, sedimentation and over-fishing (McField 2017) exacerbate the damage caused by bleaching events. Climate change and local stressors both trigger ecological regime shifts from coral to algal reefs (Anthony et al. 2011).

→ DECLINE OF MANGROVES

Development and construction activities along the coast have already caused extensive loss of mangroves (Spalding et al. 2010, Van Bochove et al. 2014). Climate change will potentially worsen this decline through increased variations in air and ocean temperatures, ocean chemistry, rainfall, wind strength and direction, sea level rise, wave climate, and weather extremes such as hurricanes, droughts and storms (IPCC AR5, Nurse et al. 2014; Birchenough 2017).

3.2.2 The South Pacific

Although the South Pacific Islands collectively produce far less than 1 % of total global greenhouse gases, they are one of the world's most vulnerable regions to the effects of climate change. Coastal and oceanic ecosystems in the South Pacific are already heavily influenced by regional climate cycles (e.g. the El Niño – Southern Oscillation or the Pacific Decadal Oscillation) and the projected changes will affect them in different ways, depending on their location and geomorphology. Spatial downscaling of climate models to a national-level has been undertaken for 14 PICTs *(BoM & CSIRO 2014)* and provides higher resolution data to inform decision-making for fisheries adaptation and DRM **(Table 4)**.

Destroyed boat as a result of tropical cyclone Pam in 2015 – Vanuatu

Sail canoe fishers, Maskelynes – Vanuatu

Table 4: Summary of downscaled climate projections for 2050 based on projections under a high emissions scenario relative to 20-year period centred on 1995 for the selected 14 independent PICTs (Source: BoM & CSIRO 2014)

Country	Surface temperature (°C annual)	Total rainfall (% annual)	Mean sea level (cm)	Aragonite saturation (Ω)	Coral bleaching risk (recurrence interval)[2]
MELANESIA					
Fiji	+1.3	+1	+25	-0.7	6.4 months to 2 years
Papua New Guinea	+1.4	+8	+25	-0.7	1.5 months to 1.9 years
Solomon Islands	+1.3	+3	+25	-0.7	1.4 months to 2.2 years
Vanuatu	+1.3	0	+26	-0.8	4.9 months to 3.2 years
MICRONESIA					
Federated States of Micronesia	+1.4	+5–6	+26	-0.7	1.1 months to 1.4 years
KIRIBATI					
Gilbert Group	+1.5	+30	+24	-0.6	1 month to 2.3 years
Phoenix Group	+1.5	+23	+24	-0.6	
Line Group	+1.4	+9	+24	-0.6	
MARSHALL ISLANDS					
Northern	+1.5	+8	+26	-0.7	3.4 months to 2.5 years
Southern	+1.4	+4	+26	-0.7	
Nauru	+1.5	+32	+25	-0.6	0.8 months to 2.5 years
Palau	+1.4	+4	+26	-0.7	0.8 months to 1.1 years
POLYNESIA					
COOK ISLANDS					
Northern	+1.3	-1	+24	-0.7	2.1 months to 2.7 years
Southern	+1.2	+1	+24	-0.8	1 to 7 years
Niue	+1.2	+1	+25	-0.7	10.3 months to 6.7 years
Samoa	+1.3	0	+24	-0.7	1.1 months to 2.7 years
Tonga	+1.2	+2	+25	-0.7	7.9 months to 7.7 years
Tuvalu	+1.4	+3	+24	-0.7	0.8 months to 2.3 years

2 Expected changes in severe coral bleaching risk based on projected increase in sea surface temperature by 2050 relative to 1982–1999 mean.

The consequences for fisheries and mariculture in the South Pacific may include:

→ SIGNIFICANT DECLINE IN PRODUCTIVITY AND FORCED CHANGES IN FISHING PRACTICES

Models simulating a high emission scenario suggest losses by 2050 and 2100 of between 5 to 50 % for demersal fish, invertebrates, and nearshore pelagic fish in the Western Pacific (Pratchett et al. 2011). In the Eastern Pacific nearshore, pelagic fish may increase due to the eastwards shift of the pelagic food web. These figures are in line with the RCP 8.5 (representative concentration pathways) emissions scenarios that relate changes to coral reefs and other fish habitats, and suggest likely reductions to fish and invertebrates harvests from small-scale coastal fisheries of up to 20 % by 2050, and up to 50 % by 2100 (Bell et al. 2018) (Table 5). Fishers will also have to adapt their techniques, equipment and safety at sea[3] provisions to allow for the projected increase in extreme weather events.

→ ADVERSE IMPLICATIONS FOR FOOD SECURITY AND LIVELIHOODS

The predicted reduction in fishery productivity will jeopardise food security and livelihoods in coastal communities, especially in Melanesia. These effects will be exacerbated by population growth, particularly in Papua New Guinea and the Solomon Islands. In Micronesia and Polynesia, the predominant commodities of mariculture are pearls, marine ornamentals, seaweed, trochus and clams, which are all highly vulnerable to climate change. Adaptation and the development of alternative aquaculture techniques will therefore be of paramount importance.

→ DAMAGE TO INFRASTRUCTURE, FISHING BOATS AND EQUIPMENT

Extreme weather events such as tropical storms and cyclones develop enormous destructive force. In 2015, the coastal fisheries sector of Vanuatu suffered extensive damage after tropical cyclone Pam destroyed fisheries infrastructure (including market facilities), fishing equipment, canoes and boats with an estimated value of USD 2.4 million (Government of Vanuatu 2015). This event also caused damage to aquaculture facilities. Losses to the fisheries harvest were estimated at USD 1.1 million as daily catches were significantly reduced due to the loss of fishing equipment, including canoes and boats, and reduced access to fishing grounds, caused by debris and sedimentation (Government of Vanuatu 2015).

→ REDUCED ENVIRONMENTAL SERVICES DUE TO MORE FREQUENT AND MORE INTENSE EXTREME WEATHER EVENTS

After tropical cyclone Pam passed over Vanuatu in 2015, a basic benefit-transfer methodology and economic valuation revealed losses of environmental services from damaged coral reefs and mangroves of approximately USD 6.4 million and USD 10.1 million respectively (Government of Vanuatu 2015).

→ PARTIAL DECREASE OF MARICULTURE PRODUCTION

Mariculture production systems may suffer due to ocean acidification, sea level rise, extreme weather events and other climate change induced factors. Nevertheless, inland and fresh water aquaculture, particularly tilapia and carp productivity, also bares potential to increase, as some of the climate change driven effects improve particular production conditions (Bell et al. 2011).

IPCC SROCC 2019

The projected redistribution of resources and abundance increases the risk of conflicts among fisheries, authorities or communities. Challenges to fisheries governance are widespread under RCP 8.5 with regional hotspots such as the tropical Pacific Ocean.

3 Improved safety at sea has for decades been of major concern to various institutions who recognize that a functional legal framework is the prerequisite for concerted actions for improved safety. Alt-hough many nations have adopted legislation concerning safety at sea, there is in fact no international convention in force that deals specifically with the safety of fishing vessels, largely because the great variations in design and operation between fishing vessels and other types of ships have always proved a major obstacle to their inclusion. See www.fao.org/3/x9656e/X9656E01.htm.

Fisherman in Buru

Table 5: Projected changes in production potential of coastal fisheries (three categories) in 2050 and 2100 under a high emissions scenario (Source: Pratchett et al. 2011)

		Coastal fisheries category				Total coastal fisheries[c]	
		Demersal fish	Nearshore pelagic fish		Invertebrates		
Contribution to coastal fisheries production (2010)		56 %	28 %		16 %	100 %	
Change in primary productivity	2050	–20 %	West[a]	East[b]	–5 %	West[a]	East[b]
			–10 %	+20 %		–10 to –20 %	–5 to –10 %
	2100	–20 to –50 %	–15 to –20 %	+10 %	–10 %	–20 to –35 %	–10 to –30 %
Main effects (direct and indirect) of climate change		· Habitat loss; · Reduced recruitment (due to rising sea level temperature & reduced circulation)	· Reduced prey (zooplankton) in food webs; · Shifted tuna distribution		· Habitat loss; · Reduced calcification		

a = 15° N to 20° S and 130° E and 170° E; b = 15° N to 15° S and 170° E and 150° W; c = assumes that the proportions of the three coastal fisheries categories remain constant.

Fish vendor presenting his catch at a local fish market in Dakar – Senegal

3.2.3 West Africa

West Africa is considered to be one of the regions that is most vulnerable to climate change *(Lam et al. 2012)* with significant threats to the livelihoods and well-being of the communities and countries that depend on fisheries for food and income. However, research on the potential impact of climate change on the region's fisheries and its subsequent impact on human well-being is limited *(Baptista et al. 2013)*.

Lam et al. *(2012)* estimate that direct and induced economic impacts of climate change have cost the West African fisheries sector (14 coastal countries) up to USD 155 million in losses due to decreased landings and another USD 156 million due to losses in related economic sectors. A list of direct and indirect effects of climate change on the small-scale fisheries sector in Senegal is presented in Table 6 *(Ndiaye 2014)*.

Table 6: Direct and indirect effects of climate change on fishing activities in Senegal (Source: Ndiaye 2014, GIZ)

Direct Impacts (Fishing)	Indirect Effects (Related Activities)
→ Catch decreases in general and in particular, e.g. catches of small pelagic fish (Sardinella spp.) and molluscs → Average size of fish species caught decreases → Number of species caught decreasing	→ Increasing efforts and number of fishing units → Duration of trips increasing → Lower turnover of value chain operators depending on small pelagics (processors, industrialists, wholesalers, exporters, transporters) → Frequency and risks of conflicts between groups of actors (fishermen, wholesalers, processors) increasing → Closure of processing units for specific fish products → Higher operating costs → Deterioration of local / regional food security → Drop in fish exports and foreign exchange revenues
→ Frequency of accidents at sea increasing	→ Higher risks for fishers and their families

These consequences may include:

→ AN INCREASE IN TIME AND EXPENDITURE, WHILE CATCHES BECOME IRREGULAR

Projections for the West African coast show a decrease of the maximum catch potential by 5 to 16 % for Namibia, by 15 to 31 % for Cameroon and Gabon and up to 50 % for the coast of Liberia and Sierra Leone under a warming scenario of 2°C above pre-industrial levels (Cheung et al. 2010). These predictions do not account for changes in ocean acidity or oxygen availability, which are known to negatively affect populations of marine organisms (Pörtner & Peck 2010).

→ DAMAGES TO INFRASTRUCTURE AND EQUIPMENT

The predicted increased risks of sea level rise, extreme rainfall events, and flooding in the coastal zone, as well as extreme storm events and tidal waves (IPCC 2007), will cause loss of canoes and fishing gear.

→ DECLINE IN PRODUCTIVITY

Post-harvest losses will increase, impacting the artisanal fisheries-value-chains (Kifani et al. 2018), as conditions in processing, handling for trade, and hygiene practices remain unchanged, while temperatures, precipitations, moisture, and inundations are likely to increase.

→ REDUCED FOOD SECURITY

The volume of fish available for consumption in sub-Saharan Africa is expected to drop at an annual rate of 1 % or to 5.6 kg per capita/year by 2030 (World Bank 2017).

→ LAND LOSSES BY FLOODING OR EROSION

A sea level rise of 0.5 meters by 2100 will cause land losses by flooding or erosion. About 30 % of coastal infrastructures, including human settlements throughout Guinea, the Senegalese and Gambian coasts, are likely to be submerged. In addition, 25 to 40 % of species' habitats could disappear by 2085.

→ INCREASED RISK OF POVERTY TRAPS AND 'FORCED' MIGRATION

These effects may occur due to the anticipated exposure of populations and assets to sea level rise in low-lying coastal zones (Alex & Gemene 2016, Kifani et al. 2018), including 'seasonal' and 'circular' fisher folk migrations (Binet, Failler & Aggosah 2015).

IPCC SROCC 2019

Increases in the risks for seafood security associated with decreases in seafood availability are projected to elevate the risk to nutritional health in some communities highly dependent on seafood, such as those in West Africa and Small Island Developing States.

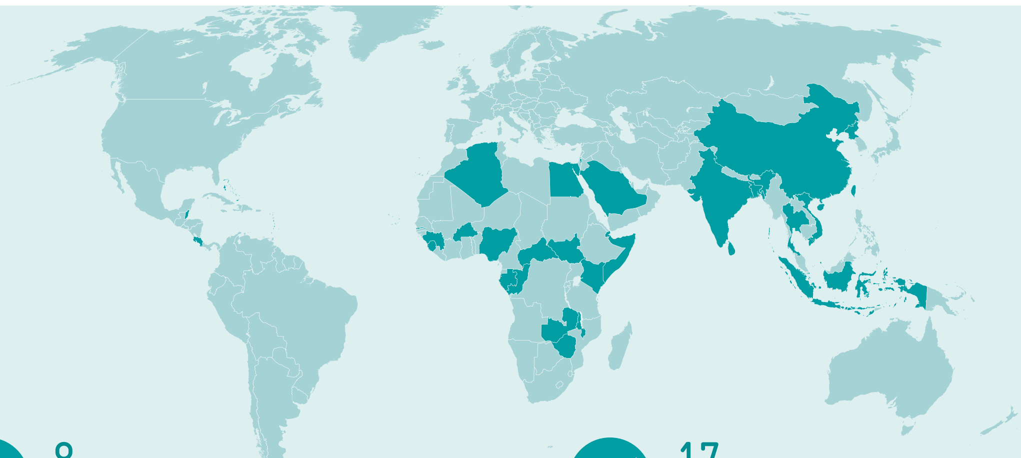
4

Policy, institutional and strategic framework for the fisheries sector

The international community increased its efforts to protect and sustainably manage the world's oceans, their ecosystems and resources. This has led to a number of high-level processes to advance cooperation on oceans and marine diversity governance. International processes and agreements setting the overall policy and strategic frameworks include the UN Agenda 2030 and its Sustainable Development Goals (SDGs), the UN Convention on Biological Diversity (CBD), and the Paris Agreement on Climate Change.

With the implementation of the Paris Agreement, the international community pays greater attention to the importance of ocean-marine conservation and coastal protection. As of 2017, 55 parties have acknowledged coastal zones and their ecosystems as particularly vulnerable in their Nationally Determined Contributions (NDCs). Out of 78 countries who submitted NDCs, 55 reported impacts of climate change on their fisheries and aquaculture sector.

Figure 4 provides an overview of reported measures in NDCs for climate change adaptation in the fisheries and aquaculture sector. In total, 16 NDCs reported particular consequences on fisheries-dependent local communities *(Kalikoski et al. 2018)*.



8 INCLUDE FOOD SECURITY
Seychelles, Zambia, Guinea, Bahamas, Dominica, Belize, Bahrain, Egypt

32 INCLUDE RESILIENCE
Djibouti, Kenya, Mauritius, Seychelles, Zambia, Central African Republic, Sao Tome and Principe, Gambia, Guinea, Nigeria, Sierra Leone, South Sudan, Antigua and Barbuda, Bahamas, Dominica, Grenada, Saint Lucia, Saint Vincent and the Grenadines, Saint Kitts and Nevis, Belize, China, India, Indonesia, Maldives, Singapore, Viet Nam, Cook Islands, Kiribati, Bahrain, Saudi Arabia, Algeria, Egypt

1 INCLUDES GENDER
Dominica

17 INCLUDE PUBLIC PARTICIPATION
Djibouti, Malawi, Mauritius, Seychelles, Somalia, Zambia, Congo, São Tome and Principe, Burkina Faso, South Sudan, Grenada, Costa Rica, Bangladesh, Thailand, Democratic People's Republic of Korea, Bahrain, Egypt

5 INCLUDE SOCIAL PROTECTION
Seychelles, Antigua and Barbuda, Dominica, Maldives, Sri Lanka

7 INCLUDE DECENT RURAL EMPLOYMENT
Central African Republic, Congo, Gabon, Guinea, India, Democratic People's Republic of Korea, Egypt

2 INCLUDE ACCESS TO SERVICES
Maldives, Palestine

Figure 4: Overview on reported measures in NDCs for climate change adaptation in the fisheries and aquaculture sector (Kalikoski et al. 2018, pg. 29)

The Paris Agreement did not only lead to a better recognition of the ocean ecosystems as an important part of the climate negotiations, but also to growing attention to loss and damage under the United Nations Frameworks Convention on Climate Change (UNFCCC). In Article 8 of the Paris Agreement, the Parties of the Convention recognised the 'importance of averting, minimising and addressing loss and damage'. Thus, loss and damage was established as a separate pillar next to mitigation and adaptation. The issue of marine conservation has moved up the international policy agenda. In response to the 2030 Agenda for Sustainable Development – specifically SDG 14 ('Conserve and sustainably use the oceans, seas and marine resources for sustainable development') – Germany manifested its commitment to the conservation and sustainable use of the oceans in the Marine Conservation and Sustainable Fisheries Ten-point Plan of Action. Its implementation has focused on preserving biological diversity and ecosystem services in marine and coastal protected areas, sustainable use of the oceans for food and nutrition security, reducing marine pollution, and supporting climate change adaptation in order to protect people living in coastal regions.

IPCC SROCC 2019

Rising temperatures, and changes in ocean nutrients, acidity, and salinity are altering SDG 14 (Life Below Water). The productivity and distributions of some fish species are changing in ways that alter availability of fish to long-established fisheries, whereas the range of fish populations may move to become available in some new coastal and open ocean areas.

Fishing boats lying in front of Île à Vache – Haiti

Local fish market in Suva – Fiji

The most recent UNFCCC Conference of the Parties (COP) that was held in Madrid in December 2019, regarded the ocean related effects of climate change as one of the major issues. Although the topic is not represented among those items under negotiation, increased attention has been and is currently paid at it. With the Nairobi work programme (NWP), a mechanism under the Convention that works towards facilitating and catalysing development, dissemination and use of knowledge in order to inform and support adaptation policies and practices, has dedicated its 13th Focal Forum and current work period to the topic of ocean, coastal areas and ecosystems. Additionally, the second United Nations Conference on the Sustainable Development Goal SDG 14 – Life below water – is scheduled to take place in 2020 and intends to dedicate at least one of the eight dialogues to the sub-topic of small-scale fisheries.

In preparation for the United Nations Ocean Conference in Lisbon in 2020, the High Level Panel for a Sustainable Ocean Economy (HLP), commissioned 16 Blue Papers and two special reports,Ocean as a Solution for Climate Change: Five Opportunities for Action and Towards a Sustainable Ocean Economy to inform this agenda and provide value to the UN Decade of Ocean Science. The HLP is a global initiative of 14 serving heads of state, representing 30 % of the world's coastlines, that was established in 2018 and is working with multiple stakeholders to develop a transformative action agenda for a sustainable ocean economy. Two of the Blue Papers have recently been launched, The Future of Food from the Sea *(Costello et al., 2019)* and The Expected Impacts of Climate Change on the Ocean Economy *(Gaines at al., 2019)*. Two of their key policy recommendations to promote sustainability are to move towards rights-based fishery management (including frameworks that provide a platform for co-management, cooperatives, local ownership and stewardship) and by removing capacity-enhancing subsidies, particularly in industrial fisheries that lack sound management[4].

4 Updates on the HLP and its blue papers are available at: www.oceanpanel.org/blue-papers [Retrieved on 24th March 2020]

4.1 The Caribbean

Strategic and Action Plans

In the context of the 'Regional Framework for Achieving Development Resilient to Climate Change', the Caribbean Regional Fisheries Mechanism (CRFM) and FAO developed a strategy and action plan to integrate climate change adaptation and disaster risk management, focussing on small-scale fisheries and small-scale aquaculture in the CARICOM and wider Caribbean region.

FAO supports project development activities with the aim to increase the understanding of the Caribbean fisheries' vulnerability to climate change. The Regional Comprehensive Disaster Management (CDM) Strategy and Programming Framework 2014 to 2024, drafted by the Caribbean Disaster and Emergency Management Agency's (CDEMA), is another core document that emphasises the need to focus on community-level adaptation and management.

4.2 The South Pacific

Strategic and Action Plans

Many PICTs have – with international support – developed national level plans, including Joint National Action Plans (JNAPs) and National Adaptation Programmes of Action (NAPAs). However, fisheries and aquaculture are not a specific focus for action. Even the more detailed action plans lack efficient strategies for this sector. Adaptation actions relating to fisheries are about sound management and assessment practices, activities that are viewed as core business for relevant agencies thereby not a true adaptation response to climate change impacts. This reflects the reality of historically poor administration of coastal resource management in the Pacific *(Gillett et al. 2014)*.

Due to the crosscutting nature of national policies and frameworks, many plans and policy documents in PICTs approach climate (and disaster) risk management in a more general multi-sectoral way. Thus, fisheries and aquaculture are generally poorly represented relative to other sectors and therefore not included in national frameworks and policies.

4.3 West Africa

Strategic and Action Plans

In most member states of the African Union, the fishery sector suffers from ineffective governance, combined with poorly conceived and implemented policies, rarely coordinated between neighbouring states and regions. Also, due to little coherence of policy frameworks, regional programmes hardly meet local needs. Although policies that aim to regulate fishing capacity are critical for maintaining production and supply of fish products, policy makers hardly focus on the crucial role of fisheries and aquaculture for national economic development, food and nutrition security.

At the regional level, the Canary Current Large Marine Ecosystem (CCLME) adopted a Strategic Action Programme to reduce vulnerability and promote climate change adaptation and mitigation. It recommends operationalising this action programme to reduce disaster risk and to prevent displacement.

The Sub-Regional Fisheries Commission's Strategic Action Plan, approved in 2017, focuses on strengthening resource management, monitoring, control and surveillance activities to reduce illegal fishing. Ministers and directors in charge of fisheries meet on a regular basis in order to harmonise their efforts in this direction.

5

Conclusions & recommendations

All three regional review papers demonstrate that small-scale fisheries, and to some extent also mariculture, cannot be sustainably managed without considering climate-related risks and the impacts of climate change. This is why CRM has to be mainstreamed into development planning and the management of fisheries, coastal marine areas and ecosystems.

Comprehensive climate risk management needs to be applied as a multi-dimensional and multi-sectoral approach and must focus on human needs. In the context of small-scale fisheries, CRM should therefore be aimed at providing food security and eradicating poverty in fishing and mariculture communities. This includes developing the potential for transformation (e.g. alternative or supplementary income sources) in order to provide fishers with temporary or permanent options to diversify or to leave the sector.

In order for CRM measures to be effective, they must empower local stakeholders – in particular the poor and vulnerable – to participate in safeguarding their human rights. That is why issues of power imbalances and inequity such as gender, labour conditions, tenure rights, access to markets, migration patterns and stakeholder conflicts have to be addressed.

By the same token, CRM measures (e.g. tools for mitigation, adaptation, risk transfer, or transformation approaches) need to be linked with national commitments to implement the Agenda 2030, the SDG 14 and particularly the NDCs, which in turn require the necessary technical and institutional capacity, private investments and international support.

CRM-mainstreaming is crucial for strengthening resilience of small-scale fisheries against climate-related threats, notably in the context of the most vulnerable SIDS. To enhance resilience, sustainable exploitation within an ecosystem-based management approach is the best way forward. In addition, preparedness is essential to translate changes into opportunities and to avoid inefficient adaptation measures.

Due to the increasing importance of farmed fish for global food security, aquaculture – and mariculture as addressed here – demands as much attention as fisheries. Appropriate measures can be improving farm management, choosing species and locations that are suitable to the projected climate-related risks, as well as strengthening environmental monitoring and the coordination of local, national and regional risk prevention and adaptation actions *(Barange & Cochrane 2018)*.

Overall, the development of CRM requires a common framework which considers policies, strategic and legislative requirements as well as all other relevant factors, drivers and components.

Pelican bar built on stilts – Jamaica

5.1 Recommendations

Four major recommendations emerged from the global study:

1 Capacity development at all levels

Implementing a comprehensive CRM approach is only possible if all main actors are aware of the urgency of the issue and know what is at stake. Enabling them using a participatory approach to take appropriate actions requires capacity development, most importantly in order to support:

→ **COOPERATION BETWEEN LOCAL COMMUNITIES AND ORGANISATIONS RESPONSIBLE FOR MANAGING AND MONITORING SMALL-SCALE FISHERIES**
Bringing climate change information to fishing communities not only improves the understanding of possible impacts of climate change on their livelihood, but also facilitates a dialogue with the responsible institutions and authorities. This, in turn, can help develop adaptive capacities and measures for sustainable fishing (such as the introduction of marine protected areas or the restoration and enhancement of habitats, e.g. artificial reefs) and strengthen governance systems by strengthening compliance and enforcement.

→ **INSTITUTIONS / ORGANISATIONS INVOLVED WITH FISHERIES**
With the appropriate information and communication technology, these institutions can focus on climate change, sustainability and mainstreaming good practices in appropriate holistic frameworks such as marine spatial planning and an ecosystem-based approach to managing small-scale fisheries.

→ **RESEARCH INSTITUTIONS**
Research needs to be supported so that it can provide relevant information on future climate change impacts on small-scale fisheries and tools for addressing them at all levels (policy, strategy, monitoring and surveillance, adaptive measures, etc.).

→ **NETWORKS AND PLATFORMS**
Strengthening or building networks and platforms helps to facilitate the exchange of good practices and approaches at the regional, national and sub-regional level.


Shrimp mariculture – St. Kitts & Nevis

2 Closing data gaps impeding CRM

Monitoring, assessing and predicting impacts of climate change on fisheries and marine ecosystems requires a large amount of data. Yet, in many instances, there is insufficient data available, and the capacity to collect new data is limited. It is important to ensure that data gaps are filled to allow effective CRM. Priorities include:

→ **IMPROVING DATA ACQUISITION**
Whether additional data is needed, depends on the objective and/or product required. Important types of data include:

- social and economic data on communities in order to be able to assess their vulnerabilities
- stock assessments and bio-physical data of relevant ecosystems
- fisheries data, such as landings, and catch per unit effort
- systematic gathering of weather and climate related data
- improving downscaled climate change projections at the local/regional/national level and associated scenarios.

→ **CONCENTRATING AND PRIORITISING RESOURCES**
It is important to identify key indicators (e.g. status of stocks or climate-related indicators) that can be monitored with the available resources.

→ **JOINTLY DEFINE DATA NEEDS**
Bringing together all relevant stakeholders ensures comprehensive definition of climate change related data requirements.

→ **DEFINING DATA FORMATS**
Standardisation of data, using simple proxies and innovative, effective monitoring technologies can improve comparability and prevent duplication.

→ **IMPROVING DATA STORAGE AND COMMUNICATION**
Making existing data accessible to fishing communities, research institutions, policy makers and other groups of actors does not only help them to adapt to climate change, but should also facilitate feedback and two-way communication, so that they can also share their data and recommendations.

3 Provide support for tools and instruments

Support should be given to help develop and use instruments, tools and technologies that reduce the vulnerability of the small-scale fisheries sector. These include financial instruments (e.g. insurance), as well as Information and Communication Technologies (ICTs) used in early-warning systems, information exchange, spatial planning and fisheries management. The support may be provided through mutlistakeholder platforms, networks, and/or partnerships.

→ IDENTIFY INNOVATIVE AND IMPORTANT INSTRUMENTS

There is a range of instruments such as insurance schemes, financing mechanisms and transformational policies and approaches available, especially designed for small-scale fisheries. There are also tools to improve market access for small-scale fisheries and aquaculture, and to assess the impacts of large industrial fisheries on the small-scale sector.

→ EARLY-WARNING SYSTEMS AND WEATHER SERVICES

In addition, there are technologies that can improve linkages between disaster risk management (DRM) and climate change adaptation (CCA) for small-scale fisheries, such as the use of early warning systems and weather services.

→ TOOLS TO FACILITATE INFORMATION EXCHANGE

Knowledge management and distribution at local, national and regional level need to be strengthened, calling for tools to support inter-regional knowledge and experience exchange. Find out if they have yet to be developed, or if pertinent tools are already successfully tested and available.

→ TOOLS TO IMPROVE FISHERIES MANAGEMENT

Promote knowledge, skills and tools to mainstream the application of an ecosystem-based-approach to fisheries management and to mitigate competition for marine and coastal resources with Marine Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM).

4 Promoting scientific cooperation

Interdisciplinary research and cooperation is essential for the development of sound policies and the implementation of effective CRM. Examples for important research questions in the context of fisheries and aquaculture that can only be answered with a cross-cutting approach are:

- How do changes in sea surface temperature (SST) affect commercial species, coastal and pelagic ecosystems as well as ocean currents and food webs (e.g. primary production, plankton, algal blooms)?
- What impacts will ocean acidification have on key calcareous species, ecosystems and small-scale fisheries?
- What is the connection between disease outbreaks, food security and income of small-scale fishers and aquaculture farmers?
- How do social and economic systems in the fisheries sector interact, and what are the effects on social resilience?
- What needs to be considered when designing networks of marine protected areas to support small-scale fisheries?
- Are there ways to mitigate coral bleaching and its impact on marine ecosystems?
- How are fisheries management and climate change adaptation connected?

Seamoss farming – St. Lucia

REGIONAL RECOMMENDATIONS

5.1.1 The Caribbean

- → Support adoption and transfer of the Caribbean Community Common Fisheries Policy (CCCFP) into national fisheries management plans aligned to national DRM plans.
- → Promote the employment of new digital technologies to improve cost-effectiveness of data needed to ensure good governance.
- → Develop and make available reliable insurance schemes for the artisanal fisheries sector using the Caribbean Oceans and Aquaculture Sustainability Facility (COAST) and Livelihood Protection Policies (LPP) initiatives as useful.
- → Enhance the use of marine protected areas and MPA networks in transboundary fisheries management.
- → Multi-disciplinary research for diversified, supplementary and alternative livelihood options for fishing communities including new technologies and industries.

5.1.2 The South Pacific

- Foster the development of climate change action plans for coastal communities that take into account sustainable fisheries management, food security and livelihood adaptation (emerging economies, new community opportunities).
- Support availability and access to reliable data to allow development and implementation of detailed action plans that are economically feasible, resourced and prioritized.
- Support transition within the sector for diversification regarding gear, target species, spatial and temporal flexibility, alternative production and post-harvest processing and marketing.
- Establish networks between scientists, fisheries managers and local communities for co-management of coastal and marine resources.

5.1.3 West Africa

- Strengthen considerations of the climate change and small-scale fisheries nexus in regional and national strategies including the risk of climate-induced human migration.
- Support reliable systems for data collection, management and dissemination.
- Develop and establish an appropriate financial mechanism (e.g. insurance) adapted to the needs of artisanal fisheries to reduce their exposure to climate related risks.
- Establish a sub-regional network of relevant researchers, organizations and partners to support sharing and exchange of information on climate change and artisanal fisheries.

5.2 Key entry points for international development cooperation

To facilitate exchanges between relevant actors engaged in climate change and small-scale fisheries, and promote the sharing of experiences, knowledge and expertise, the following actions are recommended:

- **IDENTIFY KEY ACTORS** for relevant and promising approaches and evaluate institutional capacities and experiences;
- **PROMOTE PARTNERSHIPS** between actors from different sectors, institutions and countries;
- **BRING TOGETHER NATIONAL GOVERNMENTS** by using existing international frameworks to increase pressure on them to take action;
- **FOSTER MULTI-STAKEHOLDER INFORMATION EXCHANGE** and communication between governmental agencies, fishery communities, NGOs, the scientific communities and others; and
- **SUPPORT APPROACHES AND MEASURES** – including financial mechanisms and funding opportunities – to address the development of supplementary livelihoods (if not alternative income sources for enhancing transformation and transition) for small-scale fishers in specific regions.

References

Agence Nationale de la Statistique et de la Demographie, Senegal (2013). Republique de Senegal. www.ansd.sn/ index.php?option=com_ansd&view=theme&id=9

Akrofi, J. (2002). "24 Fish utilisation and marketing in Ghana: State of the art and future perspective in the Gulf of Guinea Large Marine Ecosystem." In: Environmental Forcing & Sustainable Development of Marine Resources. Elsevier, pp. 345–354. www.sciencedirect.com/science/article/pii/S1570046102800465

Alder, J. & Sumaila, U.R. (2004). "Western Africa: A fish basket of Europe past and present." In: Environment and Development, 13 (2), 156–178.

Alex, B. & Gemenne, E. (2016). "Impacts du changement climatique sur les flux migratoires à l'horizon 2030". In: Futuribles, Institut de relations internationales et stratégiques (IRIS), Rapport No. 1, Mai 2016, 53 pp. www.iris-france.org/wp-content/uploads/2016/09/2016-mai-Etude-Impact-du-changement-climatique-sur-les-flux-migratoires-à-lhorizon-2030.pdf

Allison, E.H., Delaporte, A., Hellebrandt de Silva, D. (2013). Integrating fisheries management and aquaculture development with food security and livelihoods for the poor. Report submitted to the Rockefeller Foundation. Norwich: School of International Development, University of East Anglia.

Anderson, J.L. (2007). "Britain's right to roam: Redefining the landowner's bundle of sticks." In: Georgetown International Environmental Law Review 19: 375–435.

Anthony, K.R.N., Maynard, J.A., Diaz-Pulido, G., Mumby, P.J., Marshall, P.A., Cao, L. & Hoegh-Guldberg, O. (2011). "Ocean acidification and warming will lower coral reef resilience." In: Global Change Biology, 17 (5), 1798–1808. http://doi.org/10.1111/j.1365-2486.2010.02364.x

Baptista, S., Brottem, L., de Sherbinin, A., Edquist, M., Fischer, A., Levy, M., Schnarr, E., Simon, C., Sundareshwar, P. V., & Trzaska, S. (2013). Background Paper for the ARCC West Africa Regional Climate Change Vulnerability Assessment. USAID. http://community.eldis.org/ARCC

Barange, M. & Cochrane, L. (2018). "Impacts of climate change on fisheries and aquaculture: conclusions." In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F. 2018. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627: 611–628. FAO, Rome.

Barnett, J. (2011). "Dangerous climate change in the Pacific Islands: food production and food security". In: Reg Environ Chang. 2011 (11) Suppl 1: 229–3.

Bell, J.D., Allain, V., Gupta, A.S., Johnson., J.E., Hampton, J., Hobday, A.J., Lehodey, P., Lenton, A., Moore, B. R., Pratchett, M.S., Senina, I., Smith, N. & Williams, P. (2018). "Climate change impacts, vulnerabilities and adaptations: Western and Central Pacific Ocean marine fisheries." In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Bell, J. D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. & Andréfouët, S. Marine Policy, 33, 64–76.

Bell, J.D., Johnson, J.E., Hobday & A.J. (eds.) (2011). Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia.

Béné, C. & Heck, S. (2005). "Fish and Food Security in Africa. NAGA." In: WorldFish Center, 28 (3 & 4), 8–13.

Béné, C. (2006). "Small-scale fisheries: assessing their contribution to rural livelihoods in developing countries." In: FAO Fisheries Circular. No. 1008. Rome, FAO. 46 p.

Béné, C. et al. (2015). "Feeding 9 billion by 2050 – Putting fish back on the menu." In: Food Security. 7 (2): p. 261–274.

Beveridge, M.C.M., Dabbadie, L., Soto, D., Ross, L.G., Bueno, P.B. & Aguilar-Manjarrez, J. (2018): "Climate change and aquaculture: interactions with fisheries and agriculture." In: Barange, M.; Bahri, T.; Beveridge, M.C.M.; Cochrane, K.L.; Fungee-Smith, S.; Poulain, F.: Impacts of climate change on fisheries and aquaculture Synthesis of current knowledge, adaptation and mitigation options. Italy, Rome, FAO Fisheries and Aquaculture Technical Paper 627, pp. 491–500. http://agritrop.cirad.fr/588315/1/ID588315.pdf

Bindoff, N.L., W.W.L. Cheung, J.G. Kairo, J. Arístegui, V.A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M.S. Karim, L. Levin, S. O'Donoghue, S.R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, & P. Williamson (2019): Changing Ocean, Marine Ecosystems, and Dependent Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

Birchenough, S.N.R. (2017). "Impacts of Climate Change on Biodiversity in the Coastal and Marine Environments of Caribbean SIDS." In: Caribbean Marine Climate Change Report Card: Science Review 2017, pp. 40–51.

BOM (Australian Bureau of Meteorology) and CSIRO (2014). "Climate Variability, Extremes and Change in the Western Tropical Pacific." In: New Science and Updated Country Reports. Chapter 16: Vanuatu. Pacific-Australia Climate Change Science and Adaptation Planning Program Technical Report, Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation, Melbourne, Australia.

Bonadad-Reantaso, M.G., Garrido-Gamarro, E. & McGladdery, S.E. (2018). "Climate change-driven hazards on food safety and aquatic animal health." In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627: 517–533. FAO, Rome.

Bündnis Entwicklung Hilft (2017). World Risk Report. http://weltrisikobericht.de/wp-content/uploads/2017/11/WRR_2017_E2.pdf

Burke, L. (2010). Economic Valuation of Coral Reefs in the Caribbean. World Resources Institute. Presentation for ICRI – Monaco. www.icriforum.org/sites/default/files/ICRIGM24_Econ_valuation_Overview.pdf

The Caribbean Community (CARICOM) (2018). Who we are. https://caricom.org/about-caricom/who-we-are

Caribbean 360 (2014). CARICOM to harmonise Caribbean business rules. www.caribbean360.com/business/caricom-to-harmonise-caribbean-business-rules

Cashman, A. & Nagdee, M.R. (2017). "Impacts of Climate Change on Settlements and Infrastructure in the Coastal and Marine Environments of Caribbean Small Island Developing States (SIDS). Caribbean Marine Climate Change Report Card." In: Science Review 2017, pp. 155–173.

Charlton, K.E., Russell, J., Gorman E., Hanich, Q., Delisle A., Campbell B. & Bell, J. (2016). Fish, food security and health in Pacific Island countries and territories: a systematic literature review. BMC Public Health series. https://doi.org/10.1186/s12889-016-2953-9

Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D. & Pauly, D. (2010). "Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change." In: Global Change Biology, 16, 24–35.

Cheung, W.W.L., Sarmiento, J.L., Dunne, J., Frölicher, T.L., Lam, V.W.Y., Palomares, M.L.D., Watson, R. & Pauly, D. (2012). "Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems." In: Nature Climate Change, 3, 254–258.

Cheung, W.W.L., M.C. Jones, G. Reygondeau & T.L. Frölicher (2018b). Opportunities for climate-risk reduction through effective fisheries management. Global Change Biology, 2108, 1–15, doi:doi:10.1111/gcb.14390

Climate and Development Knowledge Network (CDKN) (2014). The IPCC's fifth assessment report; What's in it for Small Island Developing States? https://cdkn.org/wp-content/uploads/2014/08/IPCC-AR5-Whats-in-it-for-SIDS_WEB.pdf

COD (2015). Rapid Damage and Impact Assessment, Tropical Storm Erika – August 27, 2015; September 25, 2015; http://documents.worldbank.org/curated/en/142861467995411564/text/104251-WP-PUBLIC-Rapid-Damage-and-Needs-Assessment-Final-Report-Oct5.txt

Costello, C., L. Cao, S. Gelcich et al. (2019). The Future of Food from the Sea. Washington, D.C.: World Resources Institute. www.oceanpanel.org/blue-papers

CRFM (2013). CRFM Formulation of a Strategy, Action Plan and Programme Proposal on Disaster Risk Management, Climate Change Adaptation in Fisheries and Aquaculture in the CARICOM and Wider Caribbean Region – Regional Workshop Report. www.crfm.net/index.php?option=com_k2&view=item& id=341:formulation-of-a-strategy-action-plan-and-programme- proposal-on-disaster-risk-management-climate-change- adaptation-in-fisheries-and-aquaculture-in-the-caricom&Itemid=429

Dabbadie, L., Aguilar-Manjarezz, J., Beveridge, M.C.M., Bueno, P.B., Riss, L. & Soto, D. (2018). Effects of climate change on aquaculture: drivers, impacts and policies. In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper, 627: 449–463.

Díaz, P.A. et al. (2019). Impacts of harmful algal blooms on the aquaculture industry: Chile as a case study. Perspect. Phycol. DOI: 10.1127/pip/2019/0081

FAO (1992). Code of Conduct for Responsible Fisheries. www.fao.org/3/a-v9878e.htm

FAO (2011b). Summary tables of Fishery Statistics: Food Balance Sheets 2011. www.fao.org/tempref/FI/STAT/summary/summ_11/FBS_bycontinent.pdf

FAO (2014a). The State of World Fisheries and Aquaculture 2014. www.fao.org/3/a-i3720e.pdf

FAO (2014b). The Sustainable Intensification of Caribbean Fisheries and Aquaculture. Factsheet 3. www.fao.org/3/a-i3932e.pdf

FAO (2015). Voluntary Guidelines for Securing Sustainable SmallScale Fisheries in the Context of Food Security and Poverty Eradication. FAO, Fisheries and Aquaculture Department, Rome. www.fao.org/3/a-i4487e.pdf

FAO (2015). Final version of the adopted guidelines. https://igssf.icsf.net/en/page/1053-FAO%20SSF%20 Guidelines%20Adopted.html

FAO (2016). "Summary of the Recommendations of the Regional Technical Commissions." In: FAO Regional Conference for Latin America and the Caribbean. Thirty-fourth Session. Mexico City (Mexico), 29 February – 3 March 2016, FAO, Bridgetown, Barbados. www.fao.org/3/a-mq197e.pdf

FAO (2017). Short-term projection of global fish demand and supply gaps. www.fao.org/3/a-i7623e.pdf

FAO (2018). The State of World Fisheries and Aquaculture 2018, Rome. www.fao.org/3/I9540EN/i9540en.pdf

FFA & SPC (2015a). A regional Roadmap for Sustainable Pacific Fisheries. www.ffa.int/system/files/Roadmap_web_0.pdf

FFA (2015b). The Fisheries we want: FFA ministerial 2015 decides – Yes to new Roadmap for Future of Pacific Fisheries. www.ffa.int/node/1543

Gaines, S., R. Cabral, C. Free, Y. Golbuu, et al. (2019). The Expected Impacts of Climate Change on the Ocean Economy. Washington, D.C.: World Resources Institute. www.oceanpanel.org/blue-papers

Gillett, R. (2016). Fisheries in the economies of Pacific Island Countries and Territories. Published and printed at the Pacific Community. New Caledonia. 688 pp.

Gillett, R. & Cartwright, I. (2010). The future of Pacific Island fisheries. Edited by Secretariat of the Pacific Community. www.spc.int/fame/doc/corporate_docs/Future_of_PI_ fisheries_Report.pdf

Gillett, R., Lewis, A. & Cartwright, I. (2014). Coastal fisheries in Fiji: resources, issues, and enhancing the role of the fisheries department. A review supported by the David and Lucille Packard Foundation. 64p. www.gillettprestonassociates.com/GPA%20%20Review%20of%20Fiji%20Coastal%20Fisheries.pdf

Golden, C., Allison, E.H., Cheung, W.W.L., Dey, M.M., Halpern, B.S., McCauley, D.J., Smith, M., Vaitla, B., Zeller, D. & Myers, S.S. (2016). "Fall in fish catch threatens human health." In: Nature, Vol 534: 317–320.

Government of Vanuatu (2015). Tropical Cyclone Pam: Lessons Learned Workshop Report. Port Vila, Vanuatu, 55 pp. www.spc.int/wp-content/uploads/2016/12/TC-PamLessons-Learned-Report.pdf

Handisdye, N., Telfer, T.C. & Ross, L.G. (2017). "Vulnerability of aquaculture-related livelihoods to changing climate at the global scale." In: Fish and Fisheries, 18 (3): 466–488, doi.org./10.1111/faf.12186

Harvey, B.J., K.L. Nash, J.L. Blanchard & D.P. Edwards (2018). Ecosystem-based management of coral reefs under climate change. Ecology and Evolution, 8 (12), 6354–6368. doi:10.1002/ece3.4146

Hawkins, J.P. & Roberts, C.M. (2003). "Effects of artisanal fishing on Caribbean coral reefs." In: Conservation Biology 18: 215–226.

Heenan, A., Pomeroy, R., Bell, J., Munday, P., Cheung, W., Logan, C., Brainard, R., Amri, A., Alino, P., Armada, N., David, L., Rivera-Guib, R., Green, S., Jompam, J., Leonardo, T., Mamauag, S., Parker, B., Shackeroff, J. & Yasin, Z. (2015). "A climate-informed ecosystem approach to fisheries managmenet." In: Marine Policy 57: 182–192.

High Level Panel of Experts (2014). Sustainable fisheries and aquaculture for food security and nutrition. A report by the high level panel of experts on food security and nutrition of the committee on world food security. Rome: FAO.

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren & G. Zhou (2018). Impacts of 1.5°C Global Warming on Natural and Human Systems. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor & T. Waterfield (eds.)]. In Press.

Holmyard, N. (2014). Climate Change: Implications for Fisheries & Aquaculture. Key findings from the Intergovernmental Panel in Climate Change Fifth Assessment Report. Climate Everyone's Business. University of Cambridge, Sustainable Fisheries Partnership. www.cisl.cam.ac.uk/resources/publication-pdfs/ipcc-ar5-implications-for-fisheries-and-aquacultu.pdf

IPCC (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K & Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland.

IPCC (2014a). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom, New York, N.Y., USA.

IPCC (2014b). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri & L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.

IPCC (2019). IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

ISSF (2018). "Status of the world fisheries for tuna. ISSF Technical Report 2018-02." In: International Seafood Sustainability Foundation, Washington, D.C., USA. https://iss-foundation.org/knowledge-tools/technical-and-meeting-reports/download-info/issf-2018-02-status-of-the-world-fisheries-for-tuna-feb-2018

Jackson, J.B.C., Donovan, M.K., Cramer, K.L. & Lam, V.V. (eds.) (2014). Status and Trends of Caribbean Coral Reefs: 1970–2012. Global Coral Reef Monitoring Network, IUCN, Gland, Switzerland.

Johnson, J.E., Bell, J.D., Allain, V., Hanich, Q., Lehodey, P., Moore, B.R., Nicol, S., Pickering, T. & Senina, I. (2017). "The Pacific Islands: Fisheries, Aquaculture and Climate Change." In: Philips, B. & Perez-Ramirez, M. (eds.) The Implications of Climate Change on Fisheries and Aquaculture: A Global Analysis. Wiley Publications, New York, N.Y., USA.

Kalikoski, D.C., Jentoft, S., Charles, A., Salazar Herrera, D., Cook, K., Béné, C. & Allison, E.H. (2018). Understanding the impacts of climate change for fisheries and aquaculture: applying a poverty lens. In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper, 627: 19–39.

Katikiro, R. & Macusi, E.D. (2012). "Impacts of climate change on West African fisheries and its implications on food production." In: Environmental Science and Management 15(2): 83–95.

Kifani, S., Quansah, E., Masski, H., Hiussa, R. & Hilmi, K. (2018). "Climate change impacts, vulnerabilities and adaptations: Eastern Central Atlantic marine fisheries." In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627: 159–183. FAO, Rome.

Kreienkamp, J. & Vanhala, L. (2017). Climate change loss and damage. Policy Brief. Global Governance Institute. www.ucl.ac.uk/global-governance/ggi-publications/policy-brief-climate-change-loss-and-damage

Lam, V.W.Y., Sumaila, R.U., Dyck, A., Pauly, D. & Watson, R. (2011). "Construction and first applications of a global cost of fishing database." In: ICES Journal of Marine Science 68(9): 1–9.

Mahon, R., Parker, C., Sinckler, T., Willoughby, S. & Johnson, J. (2007). "The Value of Barbados' Fisheries – A preliminary assessment. Fisheries Division, Ministry of Agriculture and Rural Development." Barbados. In: Fisheries Management Plan Public Information Document 2: 24 pp.

Masters, J. (2014). CRFM Statistics and Information Report for 2012. Caribbean Regional Fisheries Mechanism Secretariat. Belize, St. Vincent and the Grenadines. www.crfm.int/~uwohxjxf/images/FInal_CRFM_Statistics__Information_Report_2014_2.pdf

McField, M. (2017). "Impacts of Climate Change on Coral in the Coastal and Marine Environments of Caribbean Small Island Developing States (SIDS)", Caribbean Marine Climate Change Report Card: In: Science Review 2017: 52–59.

McKibben, S.M. et al. (2017). Climatic regulation of the neurotoxin domoic acid. Proceedings of the National Academy of Sciences, 114(2), 239–244.

Melendez, M. & Salisbury, J. (2017). "Impacts of Ocean Acidification in the Coastal and Marine Environments of Caribbean Small Island Developing States (SIDS), Caribbean Marine Climate Change Report Card." In: Science Review 2017: 31–39.

Monnereau, I., Mahon, R., McConney, L., Ruener, R. & Vallés, H. (2015). Vulnerability of the fisheries sector to climate change impacts in Small Island Developing States and the Wider Caribbean. Center for Resource Management and Environmental Studies, The University of the West Indie (CERMES Technical Support, 77).

Ndiaye, P.G. (2014). La cohérence des politiques dans les secteurs halieutiques en Afrique de l'Ouest. Fishing for development. A joint session of COFI, DAC, FAO and WB on policy coherence for development in fisheries and aquaculture.

Nurse, L.A., McLean, R.F., Agard, J., Briguglio, L., Duvat-Magnan, V., Pelesikoti, N. Tompkins, E & Webb, A. (2014). "Small islands." In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. p. 1613–1654.

OECD (2008). Fishing for Coherence in West Africa: Policy coherence in the fisheries sector in seven West African countries. www.oecd.org/tad/fisheries/fishingforcoherenceinwestafricapolicycoherenceinthefisheriessectorinsevenwestafricancountries.htm

Pauly (1997). "Small-Scale Fisheries in the Tropics: Marginality, Marginalization and Some Implication for Fisheries Management." In: Pikitch, E. K.;Huppert, D. D. & Sissenwine, M. P. (eds.). Global trends: Fisheries Management. American Fisheries Society Symposium 20, Bethesda, Maryland: 40–49.

Pinca, S., Kronen, M., Friedman, K., Magron, F., Chapman, L., Tardy, E., Pakoa, K., Awira, R., Boblin, P. & Lasi, F. (2010). Regional Assessment Report: Profiles and Results from Survey Work at 63 Sites Across 17 Pacific Island Countries and Territories. Secretariat of the Pacific Community, Noumea, New Caledonia: 512 pp.

Pörtner, H. O. & Peck, M. A. (2010). "Climate change effects on fishes and fisheries. Towards a cause- and effects understanding." In: Journal of Fish Biology 77 (8).

Poulain, F., Himes-Cornell, A. & Shelton, C. (2018). "Methods and tools for climate change adaptation in fisheries and aquaculture." In: Barange, M., Bahri, T., Beveridge, M. C. M., Cochrane, K. L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627: 535–566. FAO, Rome.

Poulain, F. (2018). Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627: 305–324. FAO, Rome.

Pratchett, M. S., Munday, P. L., Graham, N. A. J., Kronen, M., Pinca, S., Friedman, K. & Cinner, J. E. (2011). "Vulnerability of coastal fisheries in the tropical Pacific to climate change." In: Bell, J. D., Johnson, J. E. & Hobday, A. J. (eds.), Vulnerability of tropical Pacific fisheries and aquaculture to climate change: summary for Pacific Island Countries and Territories (pp. 494–576). Noumea, New Caledonia: Secretariat of the Pacific Community headquarters.

Roessig, J. M., Woodley, C. M. , Chech, J. J. & Hansen, L. J. (2004). "Effects of global climate change on marine and estuarine fishes and fisheries." In: Reviews in fish and fisheries 14 (2): 251–275.

Sall, A. & Dême, M. et Diouf, P. S. (2006). L'évaluation des emplois dans les pêcheries maritimes artisanales sénégalaises, WWF: 44 p. https://wwfwamposite.wordpress.com/2011/12/18/levaluation-des-emplois-dans-les-pecheries-artisanales-maritimes-senegalaises

Seidel, H. & Lal, P. (2010). Economic value of the Pacific Ocean to
the Pacific Island Countries and Territories. www.iucn.org/sites/dev/files/import/downloads/economic_value_of_the_pacific_ocean_to_the_pacific_island_countries_and_territories_p.pdf

Smetacek, V. & Zingone, A. (2013). "Green and golden seaweed tides on the rise." In: Nature 504 (7478): 84–88.

Soto, D., Ross, L. G., Handisyde, N., Bueno, P., Beveridge, M. C. M., Dabbadie, L., Aguilar-Manjarrez, J., Cai, J. & Pongthanapanich, T. (2018). "Climate change and aquaculture: vulnerability and adaptation options." In: Barange, M., Bahri, T., Beveridge, M. C. M., Cochrane, K. L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627: 465–490. FAO, Rome.

Spalding, M., Wood, L., Fitzgerald, C. & Gjerde, K. (2010). "The 10% target: where do we stand." In: Toropova, C. (ed.). Global Ocean Protection: Present Status and Future Possibilities. Brest, France. Agence des aires marine protégées, Gland, Switzerland.

SPC (2007): Report of the 5th meeting of the conference of the Pacific Community; Apia, Samoa, 12–13 November 2007.

SPC (2015): Statistics for Development Division. Population and Demographic Indicators Update. www.spc.int/sdd

SPC (2013): Pocket Statistical Summary 2013. Noumea, New Caledonia.

SPC (2016): Climate change vulnerability assessments for communities in six Pacific Island countries: Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu. Suva, Fiji.

Stern, N. (2007): The Economics of Climate Change. The Stern Review. Cambridge, U. K., 712 pp.

Sumaila, U. R. & Cheung, D. (2010). Cost of adapting fisheries to climate change. Development and climate change discussion paper. No. 5. Washington, D. C.: World Bank. http://documents.worldbank.org/curated/en/985231468336561312/Cost-of-adapting-fisheries-to-climate-change

Sumaila, U. R., Lam, V., Le Manach, F., Swartz, W. & Pauly, D. (2016). "Global fisheries subsidies: An updated estimate." In: Marine Policy 10 (1016).

Swartz, W., Sumaila, R. & Watson, R. (2012). "Global Ex-vessel Fish Price Database Revisited: A New Approach for Estimating 'Missing' Prices." In: Environmental and Resource Economics.

UNFCCC (2017). Milestones reached and planned by COP 13 to COP 25. http://unfccc.int/files/adaptation/groups_committees/loss_and_damage_executive_committee/image/jpeg/milestones_dec-2017.jpg

UNCTD (2013). United Nations list of least developed countries. http://unctad.org/en/Pages/ALDC/Least%20Developed%20Countries/UN-list-of-Least-Developed-Countries.aspx

UNISDR (2015). Ten-year review finds 87% of disasters climate related. Press release 6 March 2015, UNISDR 2015/05. www.unisdr.org/files/42862_2015no05.pdf

Van Bochove, J.-W., Sullivan, E. & Nakamura, T. (2014). The importance of mangroves to people: a call to action. www.unep-wcmc.org/system/dataset_file_fields/files/000/000/275/original/DEPI_Mangrove_ES_report_complete_Low_Res.pdf?1416237427

Westlund, L., Holvoet, K. & Kébé, M. (eds.) (2008). Achieving poverty reduction through responsible fisheries. Lessons from West and Central Africa. www.fao.org/3/a-i0448e.pdf

Williams, L. & Rota, A. (2012). Impact of climate change on fisheries and aquaculture in the developing world and opportunities for adaptation. https://docplayer.net/20853348-Impact-of-climate-change-on-fisheries-and-aquaculture-in-the-developing-world-and-opportunities-for-adaptation.html

Williams, P. & Terawasi, P. (2015). Overview of tuna fisheries in the Western and Central Pacific Ocean, including economic conditions – 2014. www.wcpfc.int/node/21762

World Bank (2005). Turning the Tide. Saving fish and fisheries; Building sustainable and equitable fisheries governance. The World Bank, 20 p. http://documents.worldbank.org/curated/en/461681468181780318/Turning-the-tide-saving-fish-and-fishers-building-sustainable-and-equitable-fisheries-and-governance

World Bank (2017). Climate impacts on African fisheries: The imperative to understand and act. http://blogs.worldbank.org/nasikiliza/climate-impacts-on-african-fisheries-the-imperative-to-understand-and-act

World Fish Center (2007). The threat to fisheries and aquaculture from climate change. Policy Brief. WorldFish Center, Penang, Malaysia, 8 pp. www.worldfishcenter.org/resource_centre/ClimateChange2.pdf

Ye, Yimin (2015). Chapter 14. “Global Fisheries. Current situation and challenges.” In: Smith, H. D., Suarez de Vivero, J. L. and Agardy, T. S. (eds.) Routledge Handbook of Ocean Resources and Management (2015): Earthscan.

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 – 5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de

On behalf of

Federal Ministry
for Economic Cooperation
and Development