EX-ACT Case Study

Food and Agriculture Organization of the United Nations

Fisheries Development Project — DRAFT

June 2016, GHG appraisal, Africa Region, IFAD Project

Photo credit Ventanasvoyages

Photo credit Mangrove Science Database

Summarized Results

- ⇒ The "Fishery Development Project" would result in a GHG emission of about 6,500 tCO_2-e per year over the 20 years analysis
- ⇒ The project does not result in a negative climate mitigation potential, i.e. increased Carbon sequestration and/or decreased GHG emissions, as a consequence of the fishery development component
- ⇒ Developing the fishery sector and increasing the fish production result in higher fuel consumption.
- ⇒ The development of the fishery sector, which is a priority in term of food security, will have socio-economic impact that could be analyze through the value chain analysis, such as EX-ACT VC
- ⇒ The restoration and plantation of mangrove will result in carbon sequestration of 3,600 tCO_2-e per year

Case Study on Fishery management and mangrove restoration project in the Africa Region

Keywords: Eritrea, Blue Carbon, Mangrove rehabilitation, Coastal fishery, Tier 2 data

Authors: Laure-Sophie Schiettecatte, Louis Bockel & Martial Bernoux

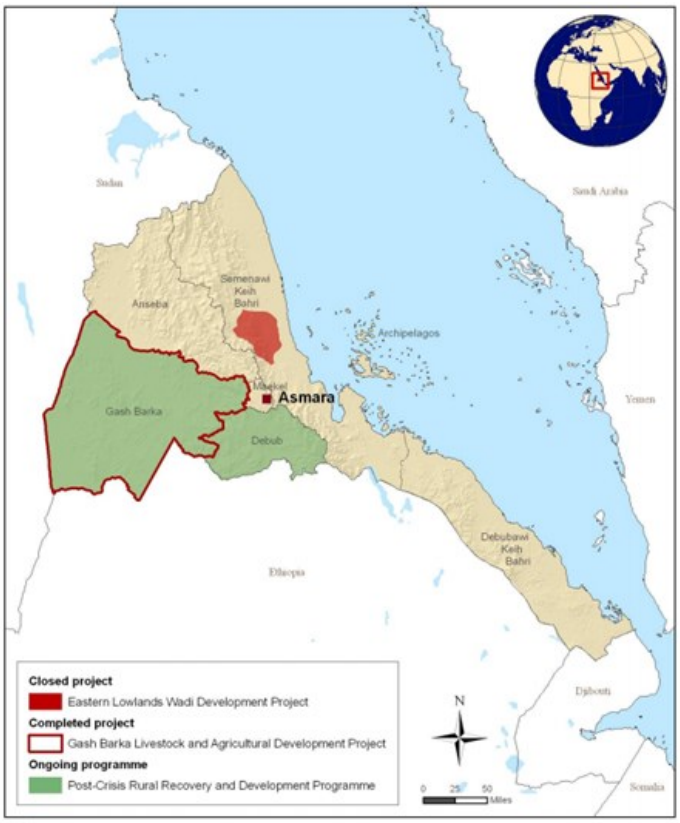
IFAD
Investing in rural people

Project Context

Eritrea is a food insecure country with the agricultural sector (cropland and livestock) producing only 60% of the food requirements even in good rainfall years. The country does however possess abundant but under-exploited fish stocks. Indeed, although the maximum sustainable yield is estimated to be between 40,000 to 85,000 tonnes, recent fish landings data demonstrate that the stock is not fully exploited, table 1. Marine resources under-exploitation is due to (1) the disruption of the fishery sector by the border conflict with Ethiopia, (2) the limited capacity and capital base of local fishers and (3) the limited institutional capacity of the Ministry of Marine Resources (MMR). As a result, the fisheries sector accounts for less than 3% of GDP.

As since the 1998-2000 conflict no major assistance targeting the artisanal fishers has been provided to rebuild the fisheries sector, support to fishing where feasible would have the potential to considerably contribute and diversify national food security and reduce the incidence of poverty, particularly among coastal communities.

In this context the proposed project will assist government to sustainably exploit the fisheries resources of the red sea.



The **goal of the Fisheries Development Project** (FDP) is to positively contribute to household and national food security, alleviate rural poverty, and increase the contribution of the fishery sector to national economy. The **central objective** is to raise production and productivity of the fisheries sector while conserving fish stocks and the marine ecosystem.

The project has three main components:

- Component #1 (US$ 3.74 million): Strengthening the institutional capacity of the ministry of Marine Resources
- Component #2 (US$ 12.44 million): Reorganization and strengthening of fishers cooperatives and support to other artisanal fishers
- Component #3 (US$ 1.96 million): project implementation support services.

Briefly, the FDP will support the establishment of a functional cooperative system to improve access of fishers to credit and inputs and empower them to play a greater role in decision making processes. Artisanal fishing communities on the Red Sea coast will be trained in modern fishing techniques with boats and fishing gear and will built their capacity to market their catch domestically and in external market. The project will be take place in the hot, dry coastal Zobas of Eritrea, and

Table 1: Estimations of the Maximum Sustainable Yield in Eritrean Marine Waters (in tonne), from Project Design Report. Per capita fish consumption 0.5-1 kg per year.

Fishery resource	Lowest MSY	Highest MSY	Recent fish Landing [1]		
			2005	2006	2007
Demersal					
Soft-bottom demersal	8,500	18,000	2,447	4,044	27
Reef based demersal	3,000	5,000	804	1,851	350
Crustaceans					
Shrimps	500	500	235	547	112
Spiny Lobsters	500	1,000	<0.5	<0.5	2
Pelagic					
large pelagic[2]	5,000	5,000	475	1,674	1,301
Small pelagic[3]	25,000	50,000	<0.5	293	--
Sharks	2,000	5,000	25	232	117
Total	40,000	84,500	3,775.5	8,641.5	1,909

[1] *FAO Fishstat*
[2] *Include Spanish Mackerel, barracuda, tuna, jackfish*
[3] *Sardines and Anchovies*

will combine effort to increase fisheries production with numerous conservation and control measures including strengthening integrated coastal area management and supporting mangrove afforestation to protect and improve the coastal, marine and island ecosystems.

The project will span over 6 years and has an estimated **cost of US$ 18.14 million**. It will **benefit directly to 6,000 household**s and **indirectly to other 26,000 household**s from employment created by the project (e.g. in fish processing, marketing, support services for boat repairs and maintenance).

Project Interventions

1. Fishery sector:

Artisanal fishing can be categorized into three types (i) foot fishers which involves fishing (snail nail and shellfish) for daily subsistence (ii) canoe operators using small dug-out wooden structure, gillnets, hooks and line for fishing. Fishing is carried out for only a few hours and does not exceed 20-30 kg per day; (iii) traditional wooden boats (houri and sambuk) which are about 793. With these boats, the majority of artisanal fishing operations take place in waters less than 30 m depth using gillnets to target pelagic species and hook and line for demersal. Traditional fishermen make on average 2-3 trips per month for seven months a year. Offshore fishing trips usually last for about 10-12 days with a catch ranging from 715 to 850 kg per trip (PDR) up to 1500 kg (FAO Fishery Eritrea Profile). Most of the boats are nevertheless currently not functional either due to age, lack of maintenance as a result of shortage spare parts, inadequate gear, infrequent supply and high cost of fuel.

Among intervention from component#2, the project will provide for 200 boats full equipment with fish finder, compass …

2. Mangrove development:

The project will support at mangrove afforestation and restoration activities in order to protect and improve the coastal, marine and island ecosystems. These activities will have synergetic effects between the agriculture and fishery sectors, e.g. mangrove are nursery, shelter and feeding grounds for numerous fish and crustaceans species, supply fodder for the livestock and contribute to climate change mitigation (blue carbon ecosystems). The project will thus develop an afforestation programme on 60 ha and restoration of 300 ha degraded mangrove.

Information, gaps and assumptions

Several assumptions are made for the estimations of GHG emissions from the fishery sector based upon the project design report and FAO Eritrea fishery profile. The project aims at increasing the fish production from 8,813 tonnes to 26,000 tonnes, considering updating and training fishermen to modern fishing equipment and providing them with fully equipped boats to trainees. Building the capacity of fishers and equipping them would suppose that the catch per unit effort will increase with reduced time spent at sea and reduced fuel consumption. We assessed these assumptions in the following scenario.

Scenario#1 is the current situation of the Eritrean fishery sector, as described in the FAO Eritrean Fishery profile, i.e. the number of days spent at sea is in average 9 and can be up to 10-12, depending on the preservation of the catch with ice brought on board. The minimum catch per trip per boat is on average 800 kg (715-850 kg per trip), and an estimated number of trips per month of 2 to 3 during the main fishing season (8 month duration). Thus the total catch per year is about 16.8 tonnes, which if we consider that all the 793 boats are operational give an annual fish landing of 15,226 tonnes within the MSY and some reported past fish landing, i.e. during the 1950-1960's.

Scenario#2 is the same than #1 but considering that a higher average catch of 1,500 kg (data reported in the FAO Eritrean fishery profile). Reported to the total fleet, the annual landing would be of 28,548 tonnes, closed to the expected production with the project.

Scenario#3 is the one described in the working paper #2 from the business and financial analysis of the FDP, i.e. with 200 boats fully equipped with fish finder, compass, improved supplies of fishing gear. It does consider here two fishing seasons, shorter days at sea per trip and a total annual trips of 32. Here the average catch is about 4,500 kg per trip and per boat during the main season, and about 2,000 kg per trip and per boat during the off-season. Annual catch is then of 176 tonnes per boat. If we assume that the annual fish landing should remain below the maximum MSY, i.e. 85,000 tonnes per year, the maximum number of artisanal boat is then of 482, which would result in a significant decrease of the present fleet.

Scenario#4 is an alternative between on field information from FAO and the business and financial analysis from the FDP. Here boats are fully equipped which allow less days at sea, an increase numbers of trips and the catch limited to 1,500 kg during the main season and to 800 kg during the off season. If all the boats are fully operational, the annual fish landing would be of 48,200 tonne, within the MSY range.

We estimated also the **fuel use intensity** (FUI) from information given in the Artisanal Business Unit Model in the FDP. The fuel consumption is based on the number of hours spent at sea while travelling back and forth the landing site and during the fishing phase. Given the relative smoothness of the Red Sea, fuel consumption while fishing is estimated at half during travel to fishing sites. Consumption is estimated of 10 liters per hour during travel and 5 liters per hour while fishing. Travel to fishing points is estimated to be 3 hours and return

after fishing also 3 hours. From these information and the annual catch we estimated the FUI for each scenario, table 2.

Table 2: Scenario for the fishery sector in Eritrea. Estimation are from FAO Eritrea Fishery profile and from the Artisanal Business Unit Model of the Fisheries Development project.

projected catch level and turnover	#1 FAO MIN	#2 FAO MAX	#3 FDP	#4 FDP/A
Assumptions stay at sea day	9	9	5	5
Mean season catch level per trip (kg)	800	1500	4500	1500
Estimated number of trips per month	3	3	4	4
Total trip for the main season	24	24	32	32
Total catch main season (kg)	**16800**	**31500**	**144000**	**48000**
Off season catch level per trip (kg)			2000	800
Estimated number of trips per month			4	4
Total trip for the off season			16	16
Total catch off season (kg)			**32000**	**12800**
Annual total catch (tonne)	**19**	**36**	**176**	**61**
Fuel Use Intensity (l/tonne)	**1425**	**760**	**180**	**521**

The previous estimate and assumptions are taken into account to build the following without project and with project scenarios:

Without project: (1) L**anded production** is about 8,813 tonnes (p.57 POD), scenario#1. (2) On **ice production facilities** are producing ice at half capacity. (3) Increase pressure from grazing on the mangrove already degraded.

With the project: (1) The project will allow an increase of the fish landings to 26,000 tonnes. 200 boats will be fully equipped, i.e. scenario#4, and are substituting older boats. The others artisanal fishers will benefit from reorganization and strengthening of fishers cooperatives and support to them. Trips at sea will last less and will result in decrease of the full consumption, scenario#3. (2) The landing sites and associated infrastructures will be rehabilitated and will provide ice production for the whole catch. (3) The project will support the mangrove restoration on 300 ha (fencing to limit camels grazing) and afforestation on others 60ha.

The appraisal is done using tropical dry climate and HAC soils. The GHG analysis is conducted over 20 years, for a mangrove area of about 360 ha, and a marine resources production of 26,000 tonnes per year with the project.

Fishery Sector: Fish landing will increase from 8,813 tonnes per year to 26,000 tonnes, screenshot 1, with a decrease of the fuel use intensity from 1425 l/tonne at the start of the project and the without-project scenario, to 521 l/tonne for the 200 boats fully equipped with investment from the FDP and to 760 l/tonne for the remaining fleet , screenshot 2.

Fishing operations (based on Fuel Use intensity - FUI - values)

Category	Gear	% with refrigerant syst. Start	Without	With	Management (will impact FUI) Without	With	Total catch per year (tonnes per year) Start	Without	*	With	*
Not Specified	Not specified	0%	0%	0%	100%	100%	170	170	D	12160	D
Not Specified	Not specified	0%	0%	0%	100%	100%	8643	8643	D	13840	D
Not Specified	Not specified	0%	0%	0%	100%	100%	0	0	D	0	D
Not Specified	Not specified	0%	0%	0%	100%	100%	0	0	D	0	D
Not Specified	Not specified	0%	0%	0%	100%	100%	0	0	D	0	D

100% = Nominal FUI (see Tier2)

On-board leakage from refrigeration systems

	Start	Without	With
Total catch with refrigerant systems (fishes, etc.)	0	0	0

Emissions from production of ice produced ashore

	% of total catch concerned by ice production Start	Without	With	Start	Without	With
Total artisanal and coastal catch	50%	50%	100%	4406.5	4406.5	26000

EX-ACT Screenshot (1) and (2): Fishery module (top) and its Tier 2 approach (right side)

Fishing operations (based on Fuel Use intensity - FUI - values)

Category	Gear	Unit	Fuel Use Intensity - FUI (l/t catch) Default		Tier 2 Start	Without	With
Not Specified	Not specified	l/tonne	1606	Gear specific	1425	1425	521
Not Specified	Not specified	l/tonne	1606	Gear specific	1425	1425	760
Not Specified	Not specified	l/tonne	1606	Gear specific	0.0	0.0	
Not Specified	Not specified	l/tonne	1606	Gear specific	0.0	0.0	
Not Specified	Not specified	l/tonne	1606	Gear specific			

On-board leakage from refrigeration systems

	Quantity lost (kg refrigerant) Default	Tier 2
Refrigerant lost per tonne of landed catch	0.023	

Emissions from production of ice produced ashore

	Quantity (tonnes) Default	Tier 2
Quantity of ice (tonnes) per tonne of catch	2.8	1.0
Electricity used per tonne of Ice	60	

Please select the country of origin
(please select the country of origin)

Mangrove ecosystems: *Mangrove restoration* on 300 ha will progressively improve from a large degradation (60%) level to a low degradation level (20%), owing to its fencing to decrease pressure from grazing by camels. Without project, the mangrove degradation process trend will carry on, down to a 80% degradation level.

Additional mangrove will be planted on 60 ha. This will compensate the loss of mangrove from overgrazing by camels, oil spill pollution, and mangrove clearing for coastal development We consider a successful biomass development over 80% of the surface area.

EX-ACT Appraisal results

The following tables summarize the GHGs sequestration and the share of the balance per GHG from the project implementation. Results are given in tonne CO_2 equivalent (tCO_2-e). Positive numbers represent sources of CO_2-e emission while negative numbers represent sinks. The left table section summarizes estimated CO_2-e emissions and sinks from the scenario without-project (left column), from the scenario with-project (middle column) and the total balance (right column). The middle table details the Carbon Balance under project implementation, showing the CO_2 fluxes from biomass and soil carbon fluxes and GHG associated to fisheries management . The right table details annual CO_2-e fluxes for the different activities without and with-project implementation.

Based on the EX-ACT appraisal over the full analysis duration of 20 years, the baseline scenario is assumed to lead to a combined effect from GHG emissions from the fishery sector and from mangrove degradation of 676,637 tCO_2-e. The project scenario provides benefits via mangrove development activities, -57,125 tCO_2-e, whereas the fishery sector remains a GHG source, 864,059 tCO_2-e.

In order to overall evaluate the impact of The "Fisheries Development Project" of GHG emission or mitigation, it is necessary to consider the difference between the gross fluxes of the with - and without-project scenario, which is given by the Carbon Balance (light green column): The implementation of the project leads to an overall **Carbon Balance** of around **129,225 tCO_2-e** over the full analysis duration of 20 years. This is equivalent to about **6,500 tCO_2-e per year**.

When translating the qualitative uncertainty assessments by the IPCC into a quantitative estimation as done by EX-ACT, the here indicated Carbon Balance is associated to an uncertainty level of 26.6 %.

Project Name	Fisheries development proje	Climate	Tropical (Dry)	Duration of the Project (Years)	20
Continent	Africa	Dominant Regional Soil Type	HAC Soils	Total area (ha)	360

Components of the project	Gross fluxes Without (All GHG in tCO2eq, Positive = source / negative = sink)	With	Balance	Share per GHG of the Balance All GHG in tCO2eq CO_2 Biomass	Soil	Other	N_2O	CH_4	Result per year Without	With	Balance
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	0	0	0	0	0		0	0	0	0	0
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management	16,340	-40,851	-57,192	-49,992	-7,200		0	0	817	-2,043	-2,860
Coastal wetlands	0	-16,274	-16,274	-11,427	-4,847		0	0	0	-814	-814
Inputs & Investments	0	0	0			0	0	0	0	0	0
Fishery & Aquaculture	661,369	864,059	202,690			202,690	0	0	33,068	43,203	10,135
Total	677,709	806,934	**129,225**	-61,419	-12,047	202,690	0	0	33,885	40,347	6,461

Discussion & Recommendations

Capture fisheries make a minor but still significant contribution to global GHG emissions. Overfished stocks result in lower catch rates, or aging fleet, lack of maintenance as a result of shortage spare parts, inadequate gear, lead to increasing the fishing effort with higher fuel consumption during the catch phase. Both the fuel efficiency of vessels and the management of resources tend to be weaker in low-income countries. With improvements in fishing technologies, techniques and fisheries management (from vessel construction, changes of gears, upgrading of port and landings site), the global fishing fleet fuel consumption, and consecutive CO_2 emissions, can be significantly reduced. In the present study, the Eritrean marine resources is under-exploited because of aging fleet and inadequate gears. Fishermen are obliged to spend much more time at sea to allow a sustainable catch, increasing the fuel consumption and associated GHG emissions.

The "Fisheries Development Project" is aimed at enhancing marine production by strengthening the institutional capacity of the ministry of Marine Resources, and reorganizing and strengthening fisher cooperatives and giving support to other artisanal fishers. Adapted equipment for the fleet, such as gears, compass, fish finder, allow to decrease time spent at sea during the fish capture phase, lowering the fuel use consumption, e.g. scenario#4, so constraining GHG emissions whereas the production is increasing here by about 3 times.

Mangrove development activities brings numerous benefits such as supply of ecosystems services (nutrients, enhanced productivity of the marine ecosystems, provision of shelters and nursery/spawning grounds), introduction and wide adoption of mangrove based animal feed, protection against coastal erosion. Restoration and conservation of mangrove forests are also a key element for climate change adaptation and mitigation. Some parts of Eritrea are much more prone to sea level rise (SLR), e.g. Massawa and other coastal settlements are less than 1 m above sea level, if mangrove are keep intact, they might be able to keep in pace with SLR and protect coastal habitats and population. Mangroves together with seagrass and tidal marsh are named blue carbon ecosystems, owing to their high primary production rate and their ability to store and sequester carbon within the biomass and the soil. In the present analysis, mangrove restoration and afforestation mitigated about 73,000 tCO_2-e over the 20 years project duration, which is also equivalent to about a third of the net emissions from the fishery sector. Management activities within the catchment that affect long-term trends in mangrove sediment elevation, better management of other stressors on mangroves such as overgrazing, development of protected areas with interlinked ecosystems are options that can increase the resilience to climate change, increase and add ecosystems services to the agricultural and fishery sectors and local population.

Therefore restoration/rehabilitation and conservation of coastal wetlands, adoption of less energy consuming management practices in the fisheries should have benefits on ecosystems services, social and economic aspects and climate change mitigation.

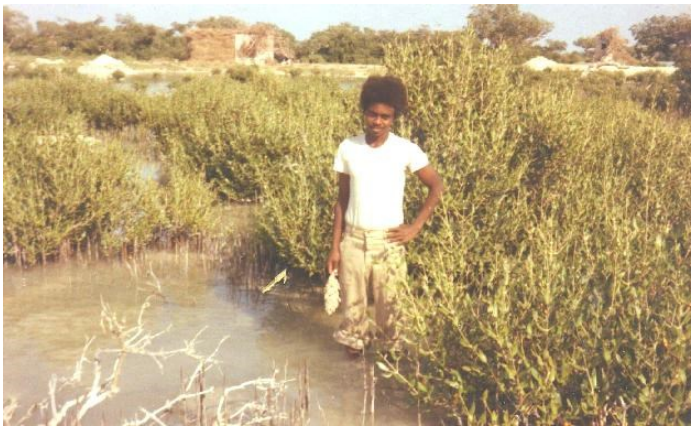
About EX-ACT

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The carbon-balance is defined as the net balance from all greenhouse gases (GHGs) expressed in CO_2 equivalent that were emitted or sequestered due to project implementation as compared to a business-as-usual scenario.

EX-ACT is a land-based accounting system, estimating C stock changes (i.e. emissions or sinks of CO_2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The amount of GHG mitigation may also be used as part of economic analyses as well as for the application for additional project funds.

EX-ACT can be applied on a wide range of development projects from all AFOLU sub-sectors, including besides others projects on climate change mitigation, sustainable land management, watershed development, production intensification, food security, livestock, forest management or land use change. Further, it is cost effective, requires a compared small amount of data, and has resources (tables, maps) which can help finding the required information. While EX-ACT is mostly used at project level it may easily be up-scaled to the programme/sector level and can also be used for policy analysis.

http://www.fao.org/tc/exact/ex-act-home/en/



This GHG is based on information from the Project document "Project Design report" No. 2294-ER and information from the FAO fishstat. The GHG appraisal is at a draft phase and results are inherently associated to assumptions detailed in the present document.

Blue carbon

The Blue carbon has been defined as "The carbon stored, sequestered or released from coastal ecosystems of tidal marshes, mangroves and seagrass meadows". Residing mostly in sediments this "blue carbon" can be released to the atmosphere when these ecosystems are disturbed, i.e. converted or degraded. Globally coastal ecosystems provide a wide variety of services, such as fishery resources, nursery ground for coastal fish and crustaceans, water quality, retention of shoreline, functions to adjacent coastal ecosystems, and revenues for local communities from tourism activities, with over two billion people relying directly on these services. Despite this, they are also highly vulnerable and have already been altered by anthropogenic activities, with a current conversion rate from 0.7 to 3% per year. Globally, mangrove lost already 35% of their coverage, and seagrass 29%. Drivers of their loss include conversion to aquaculture and fisheries activities, industrial and urban pollution, urban, coastal and tourism development, overharvesting for fuelwood and timber extraction, land clearing for agriculture, and climate change. Habitat destruction will thus carry the loss of these services and will contribute to GHG emissions, with subsequent economic consequences. Indeed if these emissions were accounted for, it is estimated that global deforestation would increase by up to 19%, and result in an economic damages of US$ 6 to 42 billion annually.

http://www.fao.org/tc/exact/user-guidelines/blue-carbon-fisheries-and-aquaculture/