XII Assessment of Investment & Financial Flows for Adaptation in the Fisheries Sector

12.1 Introduction

Capture fisheries and aquaculture supplied the world with about 110 million tonnes of food fish in 2006, while fish provided more than 2.9 billion people with at least 15 percent of their average per capita animal protein intake, according to the latest assessment included in The State of the World Fisheries and Aquaculture 2008.[140] Aquaculture is the fastest growing food production industry in the world, highly diverse in cultured species in different systems, and has been growing at a rate that is almost 3 times that of terrestrial farmed meat production systems, increasing its relative contribution to world fish supplies and animal protein intake, while reducing pressure on wild fisheries in both developing and industrialized countries.

In addition, fisheries play an important role in food security as approximately 70 percent of marine production is used directly for human food, while part of the world fish production (mainly marine) is reduced to fishmeal and oil used for raising cattle, poultry and fish, and is therefore indirectly used as human food.

The forecasts indicate that global fish production for food is going to increase from now to 2020, but not as rapidly as world demand, while per capita fish consumption and fish prices are expected to rise[141] [142], creating new opportunities for those countries whose regulatory framework, management practices and adaptive strategies are best suited to address the additional challenges posed by current variability and climate change.

The ecosystems on which fisheries are based and fishing-based livelihoods have been subject to a range of climate-related variability effects, including extreme weather events, floods and droughts, changes in aquatic ecosystem structure, increase sea temperature and productivity, as well as changing patterns and abundance of fish stocks. Resource users and managers face continued challenges in responding to this variability.

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[140] FAO (2009). The State of World Fisheries and Aquaculture 2008. Food and Agriculture Organization of the United Nations, Rome, 196pp.

[141] Easterling, W.E., P.K. Aggarwal, P. Batima, K.M. Brander, L. Erda, S.M. Howden, A. Kirilenko, J. Morton, J.-F. Soussana, J. Schmidhuber and F.N. Tubiello (2007). Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 273-313.

[142] Delgado C.L., Wada N., Rosegrant M.W., Meijer S., Ahmed M (2003). Fish to 2020: supply and demand in a changing world. IFPRI; Washington, DC: 2003.

In addition, the Food and Agriculture Organization (FAO) reports that just over half of the wild fish stocks (52 percent) are fully exploited and producing catches that are close to their maximum sustainable yields, while approximately one-quarter are overexploited, depleted or recovering from depletion (16 percent, 7 percent and 1 percent respectively).[143]

Furthermore, according to FAO[144], climate change constitutes a compounding threat to the sustainability of capture fisheries and aquaculture. Adverse effects occur as a result of gradual global warming and associated physical changes, as well as a consequence of the increased frequency of extreme weather events. Climate change is provoking major shifts in ocean system productivity as well as in surface freshwater availability is going to make adaptation in the fisheries sector more difficult and costlier.

In the case of aquaculture, the identified negative impacts of climate change include, among others, temperature increase, eutrophication due to global warming, increased acidification, change in weather patterns and extreme weather events, sea level rise and other physical changes in the sea, water stress, and global decline in ocean productivity.

The general scope of the fisheries sector used in this chapter includes the activities listed below (mainly based on FAO definitions[145,146] and statistical data bases but organized in light of the assessment of I&FF). However, the activities that are relevant to an I&FF assessment in a particular country are entirely country-specific, as discussed below in section 12.2.

Fishery
Activity leading to catching, taking or harvesting of fish. It may involve capture of wild fish or raising of fish through aquaculture.

Capture (inland or marine)
Sum (or range) of all activities to harvest a given fish resource. Defined by:

- location
- target resource
- the technology used
- the social characteristics (e.g. artisanal, industrial),
- the purpose (e.g. commercial, subsistence, or recreational)
- season

[143] FAO (2004). The State of World Fisheries and Aquaculture (SOFIA) 2004, Food and Agriculture Organization of the United Nations, Rome, Italy.
[144] FAO (2009). The State of World Fisheries and Aquaculture 2008. Food and Agriculture Organization of the United Nations, Rome, 196pp.
[145] FAO Fisheries Glossary web link: http://www.fao.org/fi/glossary/default.asp
[146] Crespi, V.; Coche, A. (comps) (2008). Glossary of aquaculture. Rome, FAO. 401pp.

Aquaculture (inland or marine)
The farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants147, crocodiles, alligators, turtles, and amphibians. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated.

It is also possible to distinguish between capture based aquaculture (CBA), the practice of collecting seeds from the wild and subsequent growing-out them in captivity to marketable size, using aquaculture techniques, and hatchery based aquaculture (HBA), which is the practice of producing and using seeds from hatcheries through manipulation of adult maturation and reproduction and larval and juvenile rearing. The difference between capture fisheries and seed fisheries is that the caught aquatic organisms go to market directly in the former case, and to culture operations before entering markets in the latter.

As in all food production sectors, post-harvest activities entail stocking, packaging, transport and post-consumption waste.

- *Freshwater culture*: The cultivation of aquatic organisms where the end product is raised in freshwater, such as reservoirs, rivers, lakes, canals and groundwater, in which the salinity does not normally exceed 0.5%.

- *Mariculture*: Cultivation, management and harvesting of marine organisms in the sea, in specially constructed rearing facilities e.g. cages, pens and long-lines. The cultivation of the end product takes place in seawater, such as fjords, inshore and open waters and inland seas in which the salinity generally exceeds 20%.

- *Brackishwater culture*: The cultivation of aquatic organisms where the end product is raised in brackishwater, such as estuaries, coves, bays, lagoons and fjords, in which the salinity may lie or generally fluctuate between 0.5‰ and full strength seawater.

Post harvesting activities are:

Processing
The receiving and preparation of fish, including, but not limited to, cleaning, cooking, canning, smoking, salting, drying, or freezing. Fish processing can take place aboard fishing and fish processing vessels, and at fish processing plants.

- *Fish handling*: Initial processing of raw fish
- *Fish products manufacturing*: Includes among others production of canned, dried, cured, and precooked fish, as well as fish oil and fish meal.

147 Aquaculture activities related to aquatic plants are not addressed in this chapter.

12.2 Application of I&FF Methodology to Adaptation in the Fisheries Sector

This section describes how the I&FF methodology presented in Chapter II would be applied to adaptation in the fisheries sector. Some of the information provided in Chapter II that is relevant to all sectors is not repeated here, so the reader should read Chapter II before reading this chapter.

Step #1: Establish key parameters of assessment

>>> Define detailed scope of sector

The definition of the fisheries sector and whether all possible subsectors comprised and or related are to be examined, or only a subset within the sector, will need to be addressed here. In this step, the precise subsectors that are to be included in the I&FF assessment must be defined such that the specific processes, activities, entities, and geographic regions that are encompassed by the fisheries sector as defined by the national team for the I&FF assessment are clear. A key distinction in the fish-producing sector is between capture fisheries (usually just called 'fisheries') and farming of fish, or aquaculture. Capture fisheries and aquaculture produce both fish and supply the same processing industries, markets and consumers. It is recommended that nationally the most important subsectors, whether they are wild fish capture or aquaculture, are included. Which subsectors are included, and exactly how broadly or narrowly they are defined, should depend on national circumstances —including current and potential harvest, state of stocks, supply and demand, trade, fishing technology, contribution to the national economy, employment and livelihoods, and potential for sustainable economic growth, as well as their relationship to national and sectoral development plans. This choice should also depend on data availability, the structure of national government entities in which data reside, and the scope of related assessments that have been completed, especially analysis of direct and indirect impacts of climate change identified as part of the national communications, vulnerability assessments and other adaptation studies that may have been completed.

The fishing industry includes recreational, subsistence and commercial fishing, and the harvesting, processing, and marketing sectors.[148]

Fish processing is the processing of fish delivered by commercial fisheries. Aspects of fish processing occur on fishing vessels, fish processing vessels, and at fish processing plants. Further, the commercial activity is aimed at the delivery of fish and other seafood products for human consumption or as input factors in other industrial processes.[149] In many cases the scope will be determined by considering the main target species the country is concentrating its fishing activities and operations. In the case of aquaculture, the subsector is highly diverse at the global level, with more than 440 cultured species in different regions, under different

[148] FAO Fisheries Glossary web link: http://www.fao.org/fi/glossary/default.asp

[149] FAO Fisheries Glossary web link: http://www.fao.org/fi/glossary/default.asp

management systems and conditions, while there are multiple impact pathways in which the indirect impacts will be in many cases large. Manufacturing, marketing and distribution are part of the supply chain by which the food products are made available to consumers and can be included in the detailed scope of the assessment if they are relevant to the country. In addition, in many countries, the shipbuilding industry is strongly related to the fishing industry and its level of activity is correlated to the evolution of the fisheries sector while the food industry receives the inputs provided by the processing of fish products. A country may choose to include all or a subset of these subsectors, and may choose to disaggregate or aggregate subsectors differently. Some subsectors and subsector components are unimportant or irrelevant in some countries (e.g., aquaculture). In addition, it is important that the scope avoids overlap with other sectors (e.g., water, food security).

Some adaptation measures and activities will also result in mitigation benefits in the same sector or another sector. The focus on adaptation does not imply that mitigation opportunities and potential for emission reductions are unimportant or irrelevant in fisheries. The world's marine fishing fleets burn fossil fuels so reducing fuel subsidies granted to fishing fleets could promote energy efficiency as well as assist towards reducing overcapitalization in fisheries and diminishing social costs. Similarly, supporting the use of static-gear – pots, traps, longlines and gillnets, which uses less fuel than active gear such as trawls and seines –and therefore emits less CO_2, in some cases can be integrated into both mitigation and adaptation considerations. In aquaculture, on the other hand, sea level rise, saline water intrusion and acidification could impact on mollusc culture and reduce its contribution to carbon sequestration. Energy efficiency opportunities and measures could be envisaged across the industry from harvesting to processing through transport and marketing.

>>> Specify assessment period and base year

This methodology recommends a 25-year assessment period and 2005 as the base year. If another year must be used for the base year due to data limitations or other national circumstances, it is recommended that the assessment period should still be 25 years in length because of the long lifetimes of capital stock and infrastructure in the sector.

>>> Identify preliminary adaptation measures

Climate change will impact on fisheries through a diversity of direct and indirect pathways whose importance will vary depending on the type of ecosystem and fishery as shown in the pathways identified in Table 12-1.

Table 12-1: Examples of potential impact pathways[150]

Type of changes	Climatic variable	Impacts	Potential outcomes for fisheries
Physical environment	Ocean acidification	Negative effects on calciferous animals, including slowed rates of coral growth	Declines in production
	Warming upper ocean layers	Poleward shifts in plankton and fished species Changes in timing of phytoplankton blooms Changing zooplankton composition	Changes in production and availability of fished species Potential mismatch between prey (plankton) and predator (fished species) and declines in production
	Sea level rise	Loss of coastal habitats Saline intrusion into freshwater habitats	Reduced production of coastal marine and freshwater systems
	Temperature rise	Less oxygen dissolved in water	Reduction in production and availability of species
Fish stocks	Higher water temperatures	Changes in physiology and sex ratios of fished species Altered timing of spawning, migrations, and/or peak abundance Increased invasive species, diseases and algal blooms	Changes in timing and levels of productivity across marine and freshwater systems Reduced production of target species in marine and fresh water systems
	Changes in ocean currents	Effects on fish recruitment	Changes in abundance of juvenile fish and production in marine and fresh water
Ecosystems	Reduced water flows & increased droughts	Changes in lake water levels and in dry water flows in rivers	Reduced lake and river productivity
	Increased frequency of ENSO events	Changes in timing and latitude of upwelling	Changes in pelagic fisheries distribution
	Higher water temperatures	Increased frequency and severity of coral bleaching events Changes in stratification, mixing, and nutrients in lakes and marine upwellings	Reduced coral reef fisheries productivity Changes in productivity

[150] Allison, E. H. et al. (2005,) modified by Adger et al (2009). Effects of climate change on the sustainability of capture and enhancement fisheries important to the poor. Fisheries Management Science Programme, DFID/MRAG. www.fmsp.org.uk

Type of changes	Climatic variable	Impacts	Potential outcomes for fisheries
Coastal infrastructure and fishing operations	Sea level rise Increased frequency of storms	Coastal profile changes, loss of harbours and homes Increased exposure of coastal areas to storm damage Fewer days at sea, increased risk of accidents Aquaculture installations (coastal ponds, sea cages) at greater risk of damage	Fishing activity less profitable, increased costs (insurance and/or rebuilding), increased vulnerability of coastal households. Reduced viability of fishing and fish-farming as livelihood options; reduced profitability of larger-scale enterprises, increased costs of insurance.
Inland fishing operations and livelihoods	Changing levels of precipitation	Where rainfall decreases, reduced opportunities for farming, fishing and aquaculture as part of rural livelihood systems	Reduced diversity of rural livelihoods; increased risks in agriculture; greater reliance on non-farm income Increased vulnerability of riparian and floodplain households and communities
	More droughts or floods	Damage to productive assets (fish ponds, weirs, rice fields, etc.) and homes	
	Less predictable wet/dry seasons	Decreased ability to plan seasonal livelihood activities	

From the point of view of fishery elements, robustness is typically associated with factors such as total fishing capacity being commensurate with the productive capacity of the resource during its lower productivity phases, or the ability and opportunity for alternative livelihoods during lean periods. In the case of aquaculture the range of available adaptive measures is relatively limited, but strongly reliant on management based approaches, including using alternative ingredients, better feed management, and reduction in water use.

Table 12-2: Climate change related impacts and potential adaptation measures in fisheries[151]

Impact of climate change on fisheries and aquaculture	Adaptation measures
Capture fisheries – System elements	
Reduced yield	• Ecosystem based fisheries management • Access higher value markets / shifting of targeted species • Explore the availability of alternative fishery resources • Investments in flexible technologies and flexible processing chains • Reduce costs to increase efficiency • Diversify livelihoods • Educational and training activities (job requalification) • Exit the fishery
Increased variability of yield	• Ecosystem based fisheries management • Insurance schemes • Diversify livelihood portfolio
Change in distribution of fisheries	• Ecosystem based fisheries management • Migration of fishing effort/strategies and processing/distribution facilities
Reduced profitability	• Exit the fishery
Influx of new fishers	• Support for existing local management institutions • Diversify livelihoods through microcredit • Networking civil society
Vulnerability of infrastructure and communities to flooding, sea level and surges	• New or improved physical defenses • Safer harbours and landings • Relocation of facilities • Managed retreat/accommodation • Disaster risk management, including disaster preparedness • Rehabilitation and disaster response • Integrated coastal management • Early warning systems and education • Investment and capacity building on improved forecasting
Increased dangers of fishing	• Weather warning system • Investment in improved vessel stability / in improved safety at sea / communications
Scientific and technological system elements	
Overall impacts	• Assess impacts of climate change adverse effects • Assess risks of future fish stock variation and likelihood of resource collapse • Assess specific cross-sectoral factors which will increase or decrease impacts and adaptation potential.
Financial system elements	
Overall impacts	• Cluster insurance • Emergency funding • Pooling of risks • Other financial instruments
Policy and planning system elements	
Overall impacts	• Spread of sector-related risk through contingency plans

[151] Modified from the Climate Change for Fisheries and Aquaculture Technical Document from the expert consultation held on 7 to 9 April, FAO, Rome. Reference: HLC/08/BAK/6

Impact of climate change on fisheries and aquaculture	Adaptation measures
	• Relocation allowances • Climate-change risk assessments and monitoring • Strategy formulation • Support initiatives to reduce fishing effort in overexploited fisheries • Fiscal incentives • Link with disaster management and risk reduction planning • Resource allocation long term planning
Regulatory system elements	
Overall impacts	• Changes: o in legislation, o enhancement of tenure and ownership, • Regulatory tools, including regulations limiting access to resources (i.e., quotas on captured fish)
Governance and institutional system elements	
Overall impacts	• Changes: o In governance and coordination arrangements o Institutional mechanisms
Aquaculture – system elements	
Warming	
Raise above optimal range of tolerance of farmed species	• Use of better feeds • More care in handling • Selective breeding and genetic improvements (higher temperature tolerance)
Increase in eutrophication and upwelling; mortality of farmed stock	• Improve planning and siting • Establish regular monitoring and • emergency procedures
Increase virulence of dormant pathogens and expansion of new diseases	• Management to reduce stress set up • Biosecurity measures • Monitor to reduce health risks • Improve treatments • Genetic improvements for higher resistance
Limitations on fish meal and fish oil supplies/ price	• Identify fish meal and fish oil replacement • New forms of feed management • Genetic improvement for alternative feeds • Shift to non-carnivorous species; culture bivalves and seaweeds
Sea level rise and other circulation changes	
Intrusion of saltwater	• Shift stenohaline species upstream • Introduce marine or euryhaline species in old facilities
Reduced catches from coastal fisheries, seedstock disruptions, reduced options for aquaculture feeds; income loss to fishers	• Make greater use of hatchery seed • Protect nursery habitats • Develop/use formulated pellet feeds • Develop alternative livelihoods for • Suppliers
Increase of harmful algal Blooms	• Improve monitoring and early warning systems • Change water abstraction points
Acidification	
Impact on calcareous shell formation/deposition	• Adapt production and handling techniques; • Move production zones
Water stress and drought conditions	

Impact of climate change on fisheries and aquaculture	Adaptation measures
Limitations for freshwater abstraction	• Improve efficacy of water usage Encourage non-consumptive water use in aquaculture, e.g. culture based fisheries • Encourage development of mariculture where possible
Change in water-retention period (inland systems reduced, coastal lagoons increased)	• Use different/faster growing fish species • Increase efficacy of water sharing with primary users, e.g. irrigation of rice paddy • Change species in lagoons
Reduced availability and period change of wild seed stocks	• Shift to artificially propagated seed Improve seed quality and production • Efficiency in the use of water
Extreme weather events	
Destruction of facilities; loss of stock; loss of business; mass scale escape with the potential to impact on biodiversity	• Encourage uptake of individual /cluster insurance • Improve siting and design to minimize damage, loss and mass escapes • Encourage use of indigenous species to minimize impacts on biodiversity, Use non reproducing stock in farming systems

Finally, any strategic analysis in the sector should consider the interactions between aquaculture and capture fisheries. A group of relations comprises the market interactions between aquaculture and traditional fisheries, and its impacts on fish prices, rate of technology adoption, share of aquaculture in total fish supply trends, etc. Equally relevant is the consideration of the role played by aquaculture in contributing to rebuild depleted wild fish stocks, a problem which is met with precautionary fisheries management systems, vessel buy-back programs, unemployment insurance projects for fishermen, and fisheries subsidy reduction plans.

>>> Select analytical approach

The analytical approaches that could be used for an I&FF assessment of adaptation in the fisheries sector range from simple spreadsheet models that can be built by members of the project team to models of fishery management that identify or highlight the interactions between economic and ecological dynamic systems. A combination of approaches, e.g. a bio-economic model supplemented with spreadsheet analyses, however, could also be used.

With this regard two sources are especially relevant to decide on the conditions for selecting the analytical approach for the fisheries sector in developing countries:

- The information provided in climate change studies already available at the national level (e.g. National Communications, NAPAs, vulnerability assessments) and
- National fishery plans, whether they are short, medium or long term.

Ideally, the tasks to be completed require first to estimate production levels and make projections of future fisheries production levels driven by medium- and long-term probabilistic climate change predictions. Then it is necessary to forecast impact levels on specific fisheries and/or aquaculture systems relevant to the country. Finally, adaptive tools for decision-making under uncertainty will need to be implemented to guide the assessments.

Table 12-3: Examples of fisheries sector analytical tools and methods

Name	Developer	Methodology	Description and website
BEAM4	**FAO**	Model	The objective of the BioEconomic Analytical Model is to predict yield, value and a series of measures of economic performance as a function of fishery management measures such as fishing effort control, closed season, closed areas and minimum mesh size regulation. Tool for the rational management of exploited living aquatic resources.[152]
CLIMPROD-PLUS	**ORSTOM**	Model	Stock assessment by surplus production models incorporating an environmental variable
FISAT II	**FAO-ICLARM**	Model	Fish stock assessment Tools Management options for fisheries, especially in data-sparse, tropical contexts.[153]
FishStat Plus	**FAO FIES**	Tool	The system provides users with access to Fishery Statistics of various sorts. Any data having time series structure can potentially be stored and processed by FishStat Plus.[154]
SPATIAL	**FAO**	Modeling package	Space time Dynamics in Marine Fisheries: simulation package developed to model the spacetime distribution of fishing intensity using alternative approaches. Includes ALLOC, YAREA and CHART models for fisheries management strategies.[155]
Ecopath with Ecosim (EwE)			A free ecological/ecosystem modelling software suite. Has three main components: Ecopath (a static, mass-balanced snapshot of the system); Ecosim (a time dynamic simulation module for policy exploration); and Ecospace (a spatial and temporal dynamic module primarily designed for exploring impact and placement of protected areas). The model can be used to study the effects of fishing on an ecosystem, evaluate ecosystem recovery after a major disturbance, determine where to locate marine protected areas, and model the effects of changing climate.[156]

However, if countries do not already have extensive experience with a particular model or models, it is recommended that other approaches be used for developing their scenarios. Simpler approaches, like sound extrapolation of trends from historical evolution, may work, though they need to be done based on expert knowledge in order to be reliable.

[152] http://www.fao.org/fishery/topic/16069/en

[153] http://www.fao.org/fi/oldsite/STATIST/FISOFT/FISAT/index.htm

[154] http://www.fao.org/fishery/statistics/software/fishstat/en

[155] http://www.fao.org/fishery/topic/16076/en

[156] http://www.ecopath.org/

Step #2: Compile historical I&FF data and other input data for scenarios

>>> Compile annual historical IF and FF data, disaggregated by investment entity and source

Countries should collect at least three years of historical I&FF data (i.e., for the base year and two years during the previous decade). Ideally, countries would collect ten years of historical data, i.e., for the base year and the previous nine years.

International forms for national accounts places fisheries into the category "agriculture, hunting, forestry, and fishing", which implies that identifying the actual investments in fisheries alone may be difficult. The most relevant grouping of units for supply and use tables in the System of National Accounts is the classification by economic activity. The economic activity classification recommended by 93 SNA[157] is UN's International Standard Industrial Classification (ISIC). ISIC is used to classify kind of activity units and establishments into industries, in which fishing is included.

Historical data on the fisheries sector, including the sector major trends (current and potential harvest, state of stocks, supply and demand, trade, fishing technology), as well as investment in the sector (infrastructure, fleet and gear) and financial flows (associated with training and research), will be available in the country. Such information is generally available through governmental agencies, e.g. Government agencies dealing specifically with fisheries (e.g. Fisheries Departments), or Ministries of Agriculture, Production (in some Latin America Countries), Territorial Planning, Environment, or special governmental agencies dealing with development related statistics.

Of particular interest towards data collection are the national statistical agencies in the participating countries and the national research institutes specialized in fishery resources and fishing. There are also studies including comparative analysis of investment and operational costs for very specific investment decisions such as vessels acquisition or replacement.

To complement the national information available at the pertinent government institutions and agencies and/or in the cases when data is not complete or partially not available to the project team complementary data can be obtained from the following sources:

- **FAO:** The organization maintains a publicly available database FAOSTAT-fisheries that is part of the FAO Statistical Database and provides statistics on fish production - on fisheries and aquaculture - and primary products[158].
- **The Fisheries and Aquaculture Department** of the FAO maintains a publicly available statistic database that provides information on the fishery sector[159] which includes global and regional statistical collections, fishery commodities and trade, global

[157] International standards for compiling National Accounts statistics were laid out in the System of National Accounts 1993.

[158] http://faostat.fao.org/site/629/default.aspx

[159] http://www.fao.org/fishery/statistics/

production, global capture production, consumption of fish and fishery production, among other series.

- The **Fishery and Aquaculture Country Profile** also made available by FAO includes very detailed country profiles and sector information, fishery production and trade statistics, and fishery legislation[160].
- Additional information can be obtained from the **Fishery Resources Monitoring System** (FIRMS) whose primary aim is to provide access to a wide range of high-quality information on the global monitoring and management of fishery marine resources[161].
- The **World Bank** provides a data base with statistical series on country information under the Country Statistical Information Database[162].
- The **International Institute of Fisheries Economics and Trade** (IIFET) provides information on marine resource economics, fisheries management, seafood trade and markets throughout the world, aquaculture economics, and fisheries development[163].
- **Fisheries global information networks:**
    - Aquatic Sciences and Fisheries Abstracts (ASFA), an abstracting and indexing service[164]
    - FishBase a relational database[165]
    - Fisheries Library Networks[166]
    - Ocean Biogeographic Information System (OBIS), web-based provider of global geo-referenced information on marine species[167]
    - United Nations Atlas of the Oceans, internet portal[168]
- **Trade information networks:**
    - FISH INFO Network (FIN), consists of 7 independent intergovernmental organisations and FAO GLOBEFISH[169]

There is a wealth of scientific literature that provides analysis and information that can complement national information.

After the information on I&FF in the fisheries sector has been collected and compiled, the national team has to decide on how to organize the available information and complete Table 2-4, which specifies the amount of I&FF per year, for each kind of investment type, according to the policies and measures, plans, actions, programmes, activities, and projects that are being

[160] http://www.fao.org/fishery/countryprofile/search/en/

[161] http://firms.fao.org/firms/en

[162] http://go.worldbank.org/0EZUI59C70

[163] http://oregonstate.edu/dept/iifet/

[164] http://www.fao.org/fishery/asfa/en

[165] www.fishbase.org

[166] http://www.fao.org/fishery/library/3/en

[167] www.iobis.org

[168] http://www.oceansatlas.org/index.jsp

[169] http://www.infofish.org/

implemented, considering the origin of these investments according to the categories indicated in the methodology chapter of the Guidebook.

To facilitate the task, the following table (Table 12-4) lists the different investment and financial flows types that are being made in the fisheries sector. It is necessary to bear in mind that the purpose of this table is to organize the information that is going to constitute the set of inputs to complete Table 2.4., as presented in the General Methodology chapters 1 &2.

Table 12-4: Examples of investment flows and financial flows in the fisheries sector

Year 2005		
List of investment flows and financial flows	**IF (2005 US$)**	**FF (2005 US$)**
Equipment Wheelhouse Environment Handling	X	
Management Access higher value markets Shifting of targeted species Exit fisheries	X	
Aquaculture		
Technology Harvesting technology Feeding technology Selective breeding Genetic improvement Develop and use formulate pellet feeds Improve seed quality and production	X	X
Management Feed management Hatchery seeding Fish meal and oil replacement Shifting of species alongside sites Relocation of production sites Biosecurity measures Water use efficiency Monitoring of early warning signals/ emergency procedures Develop mariculture options	X	
Training Job diversification Use of new fishing technologies Management of aquaculture		X
Insurance Cluster insurance Pooling of risks Financial instruments		X
Research Forecasting Risk analysis Resource monitoring		X

X Indicates likely type of flow

>>> Compile annual historical O&M data, disaggregated by investment entity and source

The number of years for which historical O&M data are collected should be the same as is done for historical I&FF data (i.e., for three to ten years). Information about the expected lifetimes of the assets in operation during the historical period, and annual fluctuations in O&M costs, also need to be collected. The O&M data that need to be collected may reside in one or more of same locations for I&FF data (e.g., national accounts, ministry records and plans, industry records, statistical agencies, utilities, research institutions). If such data are not available, countries should utilize one of the following approaches to derive estimates:

- Adopt O&M cost data from similar assets in other countries, and adjust the O&M data to in-country production and consumption rates.
- Derive estimates from proportional relationships between O&M costs and total costs, or between O&M costs and capital costs (e.g., 10%, 25%, or 75%). Use either standard assumptions about proportional relationships, or proportional relationships observed in other countries.

When, for example, comparing cost structures of selected fleet of different regions, scales, and types, the operating costs are typically divided into running, vessel and labour costs. The general cost structure of a particular country or region and many other factors is as follows:

Table 12-5: Components of O&M in a fleet and range of variation in cost structure

Cost items	Description	%	%
Running costs	Costs of fuel, lubricants, selling fish via auction, preservation and storage of fish, packing materials, harbour dues, bait, salt, ice and food and supplies for the crew	**31 – 33**	**29 – 30**
Vessel costs	Vessel insurance, vessel and gear repair, and maintenance expenses	**19 - 28**	**18 – 24**
Labour	Wages and other labor charges (insurance and employers' contributions to pension funds)	**25 – 44**	**22 – 42**
Other costs		**6 – 14**	**5 – 13**
Total O&M costs		**100**	**88 – 96**
Capital costs			**4 – 12**

Table 2-5, as indicated in the methodology chapter, should be completed by including historical annual O&M described in Table 12-5 associated to the investment flows types indicated in Table 12-4, with the exclusion of financial flows corresponding to government programmes (essentially FF in that table). If the assessment also includes aquaculture as a subsector the same procedure applies. The major production costs that aquaculture operations require are buying, feeding, and maintaining fish.

>>> Compile other input data for scenarios

What other input data are needed will depend on the analytical approach chosen, the sectoral scope, and whether I&FF for mitigation or for adaptation measures are to be assessed. For example, if a model is to be used, basic socioeconomic and technological data may be needed for model inputs (e.g., population and economic growth projections, demand forecasts for products and services, technology development forecasts). Also, development of appropriate adaptation scenarios will require information about expected future impacts and sector vulnerabilities.

Step #3: Define baseline scenario

The national team should ensure that the analysis of the evolution of the baseline scenario is not a static one by considering the expected trends in the key variables that constitute the main elements that define the baseline scenario. For the baseline scenario a set of assumptions on the likely evolution of those variables should be defined on the understanding that the historical trends will persist without additional measures other than the potential deterioration of the conditions which determine the current situation. Marine fish stocks will continue to be exploited. As an impact of climate change, in many countries the trend is declining capture fisheries and growth of aquaculture. The overall evolution would show that the large-scale climate-related changes in fisheries will likely bring either increased economic hardship or missed opportunities for countries that depend upon them but lack capacity to adapt, or both. If that is the case, the reference scenario should reflect those trends and should reflect adjustment measures for the capture fisheries and stimulus for aquaculture, if any. Accordingly, measures that would be introduced to address some of the current circumstances and conflicts, as sustainable use regulations, improved standards, management decisions on market approaches, codes of conduct and others, if currently being under consideration or implemented, should also be included in the baseline scenario.

A model or a set of indicators (i.e. tons of fish caught/produced per specie, tons of fish consumed per specie, seize and type of fishing fleet, number of fisheries, types of equipment for fish catching, aquaculture technology, etc.) can be used in the analysis, to develop and define the baseline scenario. Otherwise a sector plan, a projection of trends, or the current situation (assuming no change), or some combination, can be used as the basis of the projection. A sector development plan may have been developed by the relevant ministry or government agency, or if sector investments are dominated by private sector entities, investment plans may be available from those entities.

In cases in which countries have been increasingly aware of climate change adverse effects and have already made progress in addressing climate change, these measures should be reflected in the baseline scenario, rather than trying to separate out current action on climate change. This is particularly important given the desired outcome of the analysis, specifically the additional resources needed to address climate change, i.e., above and beyond resources already invested in mitigation and adaptation.

Step #4: Derive I&FF estimates for baseline scenario

>>> Derive annual IF and FF estimates, disaggregated by investment entity and source

In this step, the IF and FF for each of the options and measures identified in the previous step will be estimated. Hence, for the identified indicators listed above (e.g., fish production, size of fleet, technology, etc.) the associated investment and financial flows are estimated.

The source of these data, or method of derivation, will depend on the analytical approach selected, the scope, and the types of investment entities that are relevant for the fisheries sector.

The output of this step will be a stream of annual investment flows and/or financial flows for each investment type in each subsector for the entire assessment period, by investment entity and funding source. These data should be organized as in Table 2-3 in Chapter II.

>>> Derive annual O&M estimates, disaggregated by investment entity and source

Annual estimates of O&M costs for assets purchased during the assessment period, and for assets purchased before the assessment period and that are expected to still be in operation, need to be collected (or derived) for each component (i.e. capture, aquaculture, processing, marketing). As mentioned in step 2 (Table 12-5), the O&M costs in the fisheries sector related to the investment done during or before the assessment period are running costs, vessel costs, labour costs and other operating or maintenance costs.

Step #5: Define adaptation scenario

The adaptation scenario contains the predicted climate change like the baseline scenario, but here the policies and measures are not business-as-usual, but instead to adapt to climate change, with options and measures as defined previously in the National Communication, NAPA, and other national studies and strategies.

In addition, other drivers that are important in shaping fisheries production systems, such as fishing pressure, fuel prices, future changes in trade flows and consumption patterns, are to be taken into account when assessing and deciding on the optimal set of adaptation options. Both adaptation research and adaptation practices are complex and the context of multiple stressors must always be kept in mind.

If climate change is likely to lead to lower output from capture fisheries, continuing the trend of growing aquaculture in detriment of fisheries, the adaptation scenario should have (more) adjustment measures, possibly including shifts or policies encouraging aquaculture.

Operationally, the starting point for the definition of the adaptation scenario is to re-evaluate, confirm or modify the preliminary set of the adaptation options that were identified in the

National Communication, NAPA, national studies etc.; thus the set should be now revised or expanded if needed.

It is recommended that at this stage, countries also undertake a prioritization of the adaptation measures, based on national or regional climate change concerns as well as national development priorities, and preferred sustainability pathways. This initial prioritization will be re-evaluated in the step #8 of the assessment of I&FF.

Step #6: Derive I&FF for adaptation

>>> Derive annual IF and FF estimates, disaggregated by investment entity and source

In this step, as in step 4, the IF and FF for each of the options and measures identified in the adaptation scenario (previous step) will be estimated. That is, annual IF for the adaptation scenario (facilities, equipment and infrastructure investments), and annual FF for the adaptation scenario (technology, training, insurance and research), are estimated for each component. In consequence, for the selected indicators in the baseline and adaptation scenarios (e.g. fish production, size of fleet, technology, etc.) the associated investment and financial flows are estimated.

The output of this step will be a stream of annual investment flows and/or financial flows for each investment type for the entire assessment period, by investment entity and funding source. These data should be organized as in Table 2-3 in Chapter II.

>>> Derive annual O&M estimates, disaggregated by investment entity and source

As in step 4, the O&M are estimated but for the adaptation scenario. The output of this step will be a stream of annual O&M costs for each investment type for the entire assessment period, disaggregated by investment entity and source.

Step #7: Estimate changes in I&FF needed to implement adaptation

The changes in IF, FF, and O&M costs that are needed to implement the adaptation measures in the fisheries sector are calculated according to the general methodology as outlined in Step 7 in Chapter 2 of this Guidelines. The changes in investments and financial flows are obtained by subtracting baseline scenario costs from climate change scenario costs. There are two primary objectives of this step: 1) to determine how cumulative IF, FF, and O&M costs would change; and 2) to determine how annual IF, FF, and O&M costs would change. Five separate sets of calculations should be completed – two for estimating changes in cumulative IF, FF, and O&M, and three for estimating changes in annual IF, FF, and O&M. In addition, if subsidy costs are included explicitly in the assessment, the changes in subsidy costs may be calculated. The accompanying volume on reporting (Reporting Guidelines for the Assessment of Investment and Financial Flows to Address Climate Change) contains worksheets that can be used as models for developing country-specific worksheets for performing these calculations.

Step #8: Evaluate policy implications

Fishery sector policies will be needed to induce the relevant entities identified in the assessment to implement the proposed measures and incur the related I&FF. It will be important to convene a discussion among relevant stakeholder regarding the set of regulations and incentives necessary to influence investment decisions. When addressing policy options, social, economic and environmental benefits should be assessed qualitatively.

The evaluation should allow the formulation and implementation of appropriate policies at the national and also at the regional scale, considering the broader view of exposure and vulnerability patterns in the country, and eventually facilitate comparison across natural resource-dependent industries, potentially providing insight into and allowing for the consideration of processes that cause and exacerbate vulnerability in countries participating of the assessment.

In that regard there is a critical need for design and implementation of sound public policies to minimize impacts of climate change and enhance adaptive capacity in the fisheries sector by, *inter alia*:

a) Building institutional and legal frameworks that acknowledge climate change impacts and consider them in conjunction with other existing pressures in the sector such as overfishing and pollution as well as with other relevant sectors at the country level.
b) Analyzing the long-range perspective of tensions at a national level between fisheries demand and production and domestic supply and international demand for use in fisheries policy development.
c) Identify and quantifying the linkages between the demands generated by human population growth and income level and their effects on a range of natural resources, in particular capture fisheries and aquaculture.
d) Analyzing the specific impacts on livelihoods related to the fisheries sector, the exposure and vulnerability of fishery communities and the direct and indirect of climate change on food access and security.
e) Identifying, formulating and testing a range of policy options which address demand and supply potential imbalances at the national level out to 2030, including a framework of policy incentives, instruments and measures directed at ensuring food security while preserving the environment.
f) Using, as appropriate, the ecosystem approach to fisheries and aquaculture, and monitor environmental impacts of those and related activities in a context of increasing environmental stresses, while considering the principles and standards of the code of conduct for responsible fisheries.
g) Supporting initiatives, such as creation of property rights and other incentive mechanisms, to reduce fishing effort in overexploited fisheries, and linking appropriate financing instruments for change.
h) Eliminating harmful subsidies and perverse incentives, such as subsidizing fishing fleets under stress (through direct funding, cheaper fuel, or tax cuts) that serves to allow

unprofitable fisheries to continue operating and further depresses the state of the fish stocks.

i) Strengthening future fisheries management policies by providing comprehensive, long-term view of the dynamics of production and demand for resources.

j) Enabling fisheries to be properly incorporated into national programs to model future natural resource demand, demographic trends and climate change evolving scenarios.