FISHERIES

ESTIMATES GLOBAL CLIMATE IMPACT

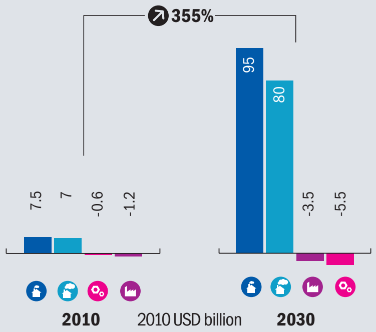
2010 EFFECT TODAY

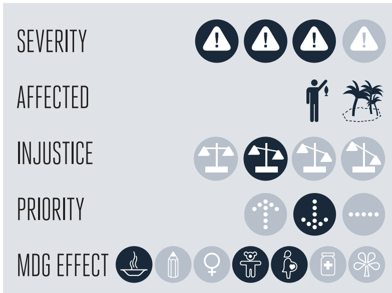
USD **LOSS** PER YEAR **15 BILLION**

2030 EFFECT TOMORROW

USD **LOSS** PER YEAR **150 BILLION**

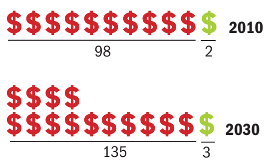
ECONOMIC IMPACT





- Climate change is not just occurring over land, but also underwater
- Water temperature also rises as the planet heats up
- Over 1,000 commercially exploited fish species live in specific aquatic zones already affected: the location of their preferred waters shift as the tropics reach temperatures with no analogue to existing fish habitats and as cooler seas disappear
- Falling fish stocks will affect food security and human development in low-income fishing communities
- Increasing the sustainability of fishing operations and enhancing marine conservation zones may alleviate these strains

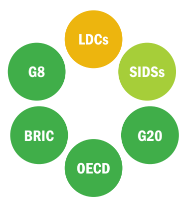
RELATIVE IMPACT



HOTSPOTS

2010		2030
1,500	VIETNAM	25,000
1,500	CHINA	15,000
1,250	PERU	15,000
700	THAILAND	8,500
650	INDONESIA	7,750

GEOPOLITICAL VULNERABILITY



Economic Cost (2010 PPP non-discounted)
Developing Country Low Emitters
Developing Country High Emitters
Developed
Other Industrialized

= Losses per 10,000 USD of GDP

Change in relation to overall global population and/or GDP

= Millions of USD (2010 PPP non-discounted)

As climate change warms the world's oceans, seas, lakes. and rivers, it is fundamentally changing the marine habitat, forcing fish to migrate or perish (Perry et al., 2005; Ficke et al., 2007; Rijnsdorp et al., 2009; Last et al., 2010; Cheung et al., 2011; Engelhard, 2011). Some far northern or southern zones may experience improved stocks as sea ice recedes and fish from the hottest waters seek relative cool (Hiddink and Hofstede, 2008). Declines brought about by climate change will only increase over time as temperature rise accelerates (Cheung et al., 2009). The world's fish stocks are in large-scale, long-term decline, with the ocean fish catch now half what it was 50 years ago due to an increase in commercial catch boats and unsustainable fishing (FAO, 2007; Watson et al., 2012). Climate change is the most significant driver of global marine ecosystem decline (Halpern et al., 2008). Responding effectively is challenging, since the international cooperation and regulations required are notoriously difficult to conclude, monitor, and enforce (Barkin in Dinar (ed.), 2011). In developing countries hard hit by declining fish stocks, food security and livelihoods are at risk (Srinivasan et al., 2010).

CLIMATE MECHANISM

Water temperature is a defining element of fish habitat (Hoegh-Guldberg and Bruno, 2010). Fish have low tolerance for thermal extremes (Pörtner and Rainer Knust, 2007). Part of the sea-level rise from climate change is caused by the thermal expansion of the seas as they warm (Domingues et al., 2008). As equatorial waters undergo unprecedented temperature increases beyond familiar heat thresholds for fish, the total available range of habitats is disappearing (Cheung et al., 2009). Nutrients are also declining in the warmest waters and reefs suffer as well (Brander, 2007; Munday et al., 2008). Considering the range of interconnected factors involved, from biological processes to changes in ocean current, the types of shocks that could occur in oceans which cover more than 70% of the planet's surface may be underestimated (Harley et al., 2006).
The increase in temperature in polar waters shrinks the range of cold-water fish habitats towards the finite limit of the poles. Only the Arctic and southern oceans are compensating species loss by providing new ranges for an invasion of fish from other regions. Nearer the equator, decline will be permanent (Cheung et al., 2009). Inland, similar processes are underway, although with little or no scope for fish migration, depletion could be faster and more permanent (Ficke et al., 2007).

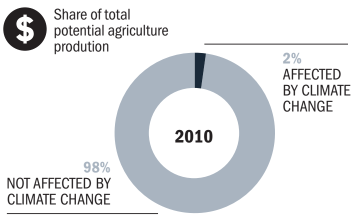
IMPACTS

The current cost of climate change on the fisheries sector is estimated to be about 10 billion dollars a year. By 2030, the impact is expected to more than triple its share as a cost of global GDP, when estimated losses will be over 160 billion dollars per year.
The Pacific, South and Southeast Asia, and Africa, especially West Africa, are the regions worst hit by fishery sector losses due to climate change. Vietnam and China are estimated to suffer the greatest losses, with current impacts estimated to be in excess of 1 billion dollars per year. Vietnam could experience losses in excess of 20 billion dollars per year by 2030. Bangladesh, Indonesia, Myanmar, Morocco, Peru, and Thailand are also experiencing large-scale losses.
The countries with the most severe impacts relative to GDP include small island countries in the Pacific, such as Vanuatu, Tuvalu, or Micronesia; in the Indian Ocean, the Seychelles; and parts of West Africa, such as Sierra Leone and Gambia. By 2030, losses for these countries all exceed 4% of GDP. As traditional livelihoods are eroded, developing countries are worst affected, including a number of least developed countries and small island developing states, raising serious concerns for food security and poverty reduction efforts. Only a handful of countries are expected to gain from the large-scale ecosystem shift, with the largest share attributed to Norway, Russia, and Iceland, and with total gains not exceeding 15 billion dollars in 2030.

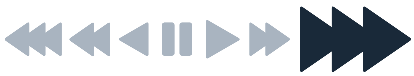
THE BROADER CONTEXT

Global fish catch is on a trend toward predictable long-term expansion owing to increases in aquaculture production (Brander, 2007). Global fish stocks, on the other hand, are experiencing a predictable long-term decline, as the number of commercial fishing craft has increased ten-fold since the 1950s, and 25-fold in Asia (Watson et al., 2012). Experts have estimated that marine fisheries declined by 40% between 1970 and 2007 (Hutchings et al., 2010). With or without climate change, global fisheries are endangered (Halpern et al., 2008). Unsustainable fishing

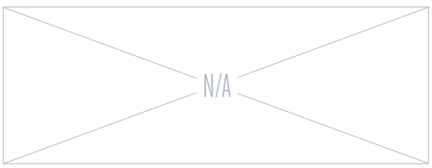
BIGGER PICTURE



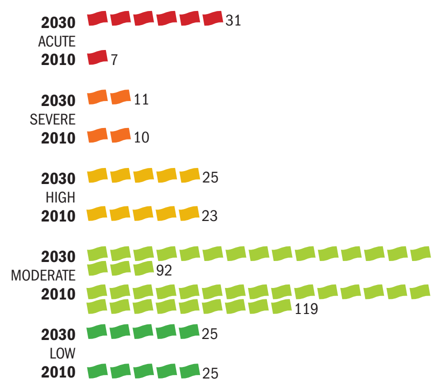
SURGE



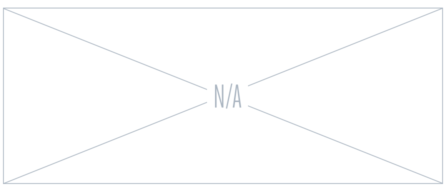
OCCURRENCE



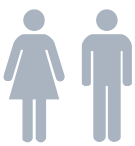
VULNERABILITY SHIFT



PEAK IMPACT



GENDER BIAS



INDICATOR INFORMATION

MODEL: Cheung et al., 2010; O´Reilly et al., 2003

EMISSION SCENARIO: SRES A1B (IPCC, 2000)

BASE DATA: FAOSTAT (2012)

= 5 countries (rounded)

Acute Severe High Moderate Low

and environmentally unsound fishing practices, such as poison dumping, use of narrow-gauge nets that capture immature fish, bottom-dragging, and illegal fishing are important factors in the decline (Gray, 1997; Agnew et al., 2009; FAO, 2012). Bringing these practices under control will be key to responding to climate change-related fishery impacts.

VULNERABILITIES AND WIDER OUTCOMES

Countries with the highest levels of vulnerability are heavily dominated by lower-income nations which depend to a larger extent on fisheries as a share of GDP and are located in highly exposed latitudes or in particular geographical configurations, such as those near to closed water bodies (Allison et al., 2009). Effects will be most severe for subsistence or near-subsistence fisherfolk and fish-reliant communities, both coastal and inland (Srinivasan et al., 2010). The impacts of climate change on the fishing sector will therefore have significant effects on food security and human development progress and will likely feed migration trends (IOM, 2008; Le Manach et al., 2012).

RESPONSES

Responses concern three main types of fish zones where managed (aquaculture) and unmanaged (commercial) fishing are practised, including oceanic marine fish stocks, inland lake or river fish, and brackish or semi-salt waters.

In marine and inland environments, sustainable fisheries management will be key. This can include the strict setting and implementing of fishing quotas, net size restrictions, poison bans, and control of waters from exploitation, including by foreign fishing interests (Grieve and Short, 2007; FAO, 2007). When catch size reductions are unavoidable, compensatory measures can be implemented to ensure that there is no loss in community welfare; efforts can also be made to diversify livelihoods (Sumaila and Cheung, 2010). The establishment, expansion, and conservation of fish sanctuaries can also play an important role in sustaining or even increasing the resilience of stressed aquatic ecosystems (Gray, 1997).

In brackish environments and in all managed fishing regimes, the quality of otherwise high-risk hatchery production is vital. Post-larvae fish or shrimp carrying disease as they leave hatcheries have the potential to contaminate whole aquaculture farms or systems in an area. Therefore, system-wide quality controls, from hatcheries through nurseries to pre-marketing grow-out ponds, will improve end-to-end resilience and resistance to disease. Here, water temperature is a principal environmental factor (Gilad et al., 2003).

As with agriculture, affected fisherfolk, if given access to higher levels of disposable income and diversified livelihoods, will have more scope for autonomous action (Teh et al., 2008). With surging global demand for food products, more benefits could be gained through strategies that increase the portion of the global value chain enjoyed by small-scale fisherfolk, as highlighted in the Ghana country study in this report. One example is the promotion of local light industrial processing, such as freezing and packaging works for marketing local fish products through global supply chains.

THE INDICATOR

The indicator relies on a global high resolution bio-climate study that maps the change in preferred water climates due to global warming for over a thousand key commercial species, as compared to their current habitats (Cheung et al., 2010). The main limitation is that the inland aspect of the indicator relies on a study carried out in one area (O'Reilly et al., 2003). Ocean temperature changes are fairly well studied and understood and the economic data from the UN Food and Agriculture Organization is comprehensive and accurate, all of which contributes to the robustness of the indicator (Domingues et al., 2008; FAOSTAT, 2012). Economic data on various segments of global fishery production could have been of a higher standard for the purpose of this analysis.

ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	2010 ($)	2030 ($)
ACUTE		
Bangladesh	500	7,750
Benin	25	350
Burundi	15	200
Cambodia	150	3,000
Central African Republic	10	150
DR Congo	150	1,750
Ecuador	300	3,250
Gambia	45	450
Ghana	200	2,250
Guinea	55	550
Guyana	25	300
Madagascar	65	700
Malawi	60	900
Mali	60	850
Micronesia	15	150
Morocco	650	7,250
Mozambique	65	700
Myanmar	600	7,500
Oman	200	2,000
Palau	1	5
Papua New Guinea	95	1,250
Peru	1,250	15,000
Samoa	5	40
Senegal	90	950
Seychelles	70	700
Sierra Leone	65	650
Tuvalu	1	15
Uganda	200	3,000
Vanuatu	80	950
Vietnam	1,500	25,000
Zambia	35	500

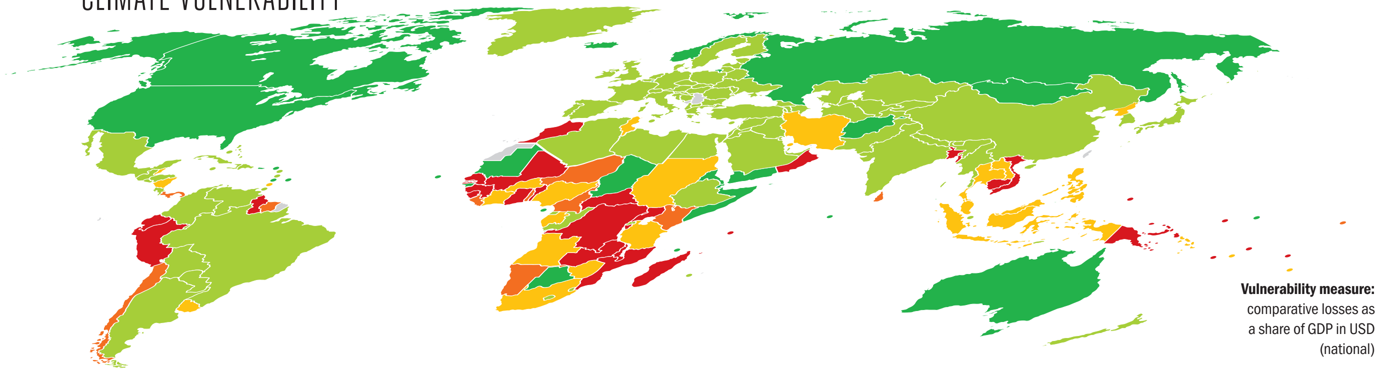
COUNTRY	2010 ($)	2030 ($)
SEVERE		
Cameroon	70	850
Chile	850	6,500
Kenya	90	1,250
Kiribati	1	10
Liberia	1	25
Namibia	30	300
Niger	15	200
Panama	85	1,000
Sri Lanka	150	2,000
Suriname	10	100
Togo	10	150
HIGH		
Angola	80	800
Bahrain	20	200
Belize	1	20
Burkina Faso	10	150
Cote d,Ivoire	20	200
Fiji	5	65
Gabon	20	200
Grenada	1	10
Indonesia	650	7,750
Iran	450	5,000
Laos	5	150
Malaysia	500	5,750
Nicaragua	15	200
Nigeria	300	3,750
North Korea	20	300
Philippines	450	5,000
Solomon Islands	1	20
South Africa	300	3,000
Sudan/South Sudan	40	650

COUNTRY	2010 ($)	2030 ($)
Tanzania	20	300
Thailand	700	8,500
Tonga	1	10
Tunisia	90	1,000
Uruguay	30	350
Zimbabwe	5	70
MODERATE		
Albania	1	20
Algeria	30	350
Argentina	80	950
Armenia		1
Austria		
Azerbaijan		5
Bahamas	1	35
Belarus	1	5
Belgium	1	5
Bhutan		1
Bolivia	5	65
Bosnia and Herzegovina	1	10
Brazil	55	500
Brunei	1	30
Bulgaria	1	25
China	1,500	15,000
Colombia	40	500
Congo	1	20
Costa Rica	5	55
Croatia	5	65
Cuba	5	35
Cyprus	1	5
Czech Republic	1	10
Denmark	35	100
Dominica		1

($) Additional economic costs due to climate change (million USD PPP) - yearly average

CLIMATE VULNERABILITY

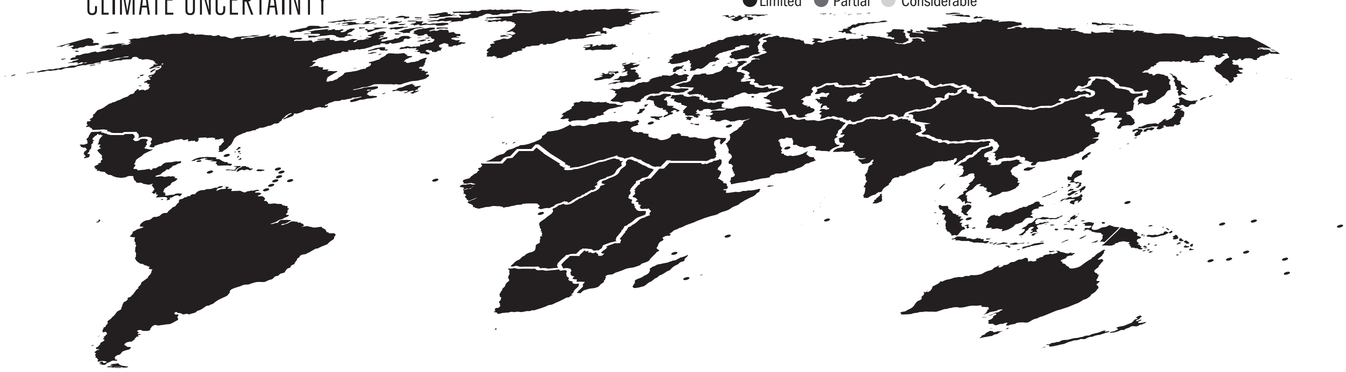
Acute · Severe · High · Moderate · Low



Vulnerability measure: comparative losses as a share of GDP in USD (national)

CLIMATE UNCERTAINTY

Limited · Partial · Considerable



COUNTRY	2010	2030
Dominican Republic	5	65
Egypt	150	2,250
El Salvador	5	85
Equatorial Guinea	1	25
Estonia	15	90
Ethiopia	15	200
Finland	15	55
France	30	90
Georgia	10	95
Germany	15	55
Greece	10	25
Guatemala	5	85
Haiti	1	15
Honduras	5	65
Hungary	1	15
India	650	6,000
Iraq	20	250
Ireland		
Israel	1	15
Italy	20	60
Jamaica	5	65
Japan	200	600
Jordan		5
Kazakhstan	5	85
Kuwait	5	40
Kyrgyzstan		
Latvia	15	150
Lebanon	5	35
Lesotho		
Libya	25	300
Lithuania	15	150
Macedonia		1

COUNTRY	2010	2030
Malta		1
Mauritius	5	55
Mexico	100	950
Moldova		5
Nepal	5	75
Netherlands	15	45
New Zealand	30	90
Pakistan	100	1,250
Paraguay		5
Poland	25	200
Portugal	20	60
Qatar	10	150
Romania	1	10
Rwanda	5	55
Saint Lucia	1	10
Saudi Arabia	85	950
Singapore	1	10
Slovakia	1	5
Slovenia		1
South Korea	200	1,750
Spain	35	100
Swaziland		
Sweden	10	25
Switzerland		1
Syria	5	80
Tajikistan		1
Timor-Leste		5
Trinidad and Tobago	1	25
Turkey	400	1,250
Turkmenistan	5	65
Ukraine	55	600
United Arab Emirates	40	450

COUNTRY	2010	2030
United Kingdom	1	1
Uzbekistan	1	10
Venezuela	65	800
LOW		
Afghanistan		
Antigua and Barbuda		
Australia	-10	-25
Barbados		
Botswana		
Canada	-45	-100
Cape Verde		
Chad		
Comoros		
Djibouti		
Eritrea		
Guinea-Bissau		
Iceland	-350	-1,000
Luxembourg		
Maldives		
Marshall Islands		
Mauritania		
Mongolia		
Norway	-900	-2,750
Russia	-1,250	-8,250
Saint Vincent		
Sao Tome and Principe		
Somalia		
United States	-300	-1,000
Yemen		