FISHERIES

ESTIMATES GLOBAL CARBON IMPACT

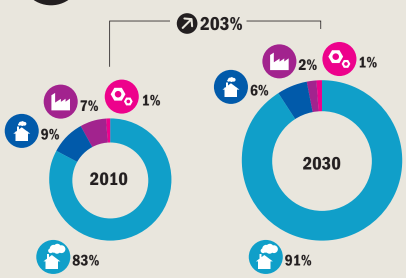
2010 EFFECT TODAY

USD LOSS PER YEAR **10 BILLION**

2030 EFFECT TOMORROW

USD LOSS PER YEAR **75 BILLION**

ECONOMIC IMPACT



CONFIDENCE
INDICATIVE

- One third of all the carbon dioxide burned by the world's economies is being absorbed by the oceans
- This uptake of CO_2 is fundamentally changing the acidity of the planet's oceans, making them less hospitable to aquatic life, especially coral, shellfish and krill
- Acid rain from heavy industrial sources also changes the pH of inland bodies of water, making them more acidic with a wide range of lethal and harmful effects for aquatic life
- These effects all have significant impacts on world fisheries
- They also risk destroying coral reefs, one of the world's most remarkable natural wonders, in a short-term timeframe

SEVERITY

AFFECTED

MDG EFFECT

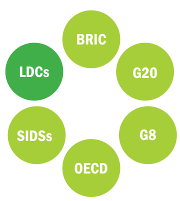
RELATIVE IMPACT

	2010	2030
Losses	63	106
	1	2

HOTSPOTS

2010		2030
6,500	CHINA	65,000
500	VIETNAM	3,250
250	SOUTH KOREA	2,000
200	THAILAND	1,000
200	INDONESIA	800

GEOPOLITICAL VULNERABILITY



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

$ = Losses per 100,000 USD of GDP

Change in relation to overall global population and/or GDP

$ = Millions of USD (2010 PPP non-discounted)

The increase in the acidity of the seas is unprecedented in the Earth's history: a single year's increase in ocean acidity today would have previously taken 100-200 years (Veron, 2008; Hoegh-Guldberg, 2011). When the oceans absorb CO2, corals, shellfish and other marine organisms are stressed and go into decline since acidic seas inhibit the availability of minerals they depend on (Burke et al., 2011). Signs of decline are already visible: when CO2 levels reached a level far below what they are today coral bleaching events became more common; the collapse of Galapagos Islands reefs in 1983 is an example (Baker et al., 2008; Hoegh-Guldberg, 2011). Bleaching is now evident in major reef systems, like the Great Barrier in Australia, that already show signs of serious degradation: a 15% decline in coral growth over several hundreds of monitored reef colonies since 1990 (De'ath et al., 2009). Most of the world's reefs are now in irreversible decline (Veron et al., 2009). Reefs are remarkably productive and act as anchors of the tropical sea ecosystem. Their disappearance would have catastrophic implications for the delicate balance of marine fisheries throughout the world. These negative effects are already beginning to be felt (Crossland et al., 1991; Silverman et al., 2009; Narita et al., 2011). Air pollution generated by the carbon economy has more acute effects still in inland waterways, where CO2 uptake is facilitated by acid rain in areas of heavy industrialization, which has further negative impacts for inland fisheries of all kinds (Ikuta et al., 2008). Research undertaken in Vietnam as a part of the Monitor's country study confirmed the direct relationship between water acidity (pH) and, for instance, disease control and the success of shrimp farming operations.

HAZARD MECHANISM

Two mechanisms are at work: 1) oceans are becoming more acidic as they absorb growing amounts - roughly a third - of the atmosphere's CO2 and other fossil fuel emissions produced through human activities (IPCC, 2007; Sabine and Feely, 2007); 2) acid rain derived from the mainly sulphur and nitrogen emissions released when fossil fuels are burned are increasing the acidity of fresh and brackish bodies of inland water near the source of pollution (Ikuta et al., 2008). Small but consistent increases in ocean acidity negatively affect the production of shellfish and coral since more acidic aquatic environments inhibit formation of mollusc shells, which are made of calcium carbonate (Narita et al., 2011). In krill, higher levels of acidity trigger or extinguish fertility (Kawaguchi et al., 2011). Closed bodies of inland water suffer more severe acidity surges. There is a clear progression of negative impacts from non-lethal to lethal depending on the pH level of the water (Ikuta et al., 2008). The fishing industry is negatively affected as a result.

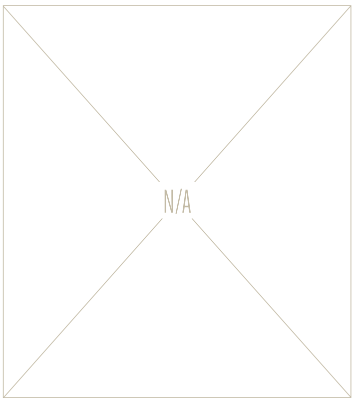
IMPACTS

The global impact of GHG emissions on fishery production due to acidification processes is currently estimated at a relatively negligible ten billion dollars a year. However the impact triples as a share of GDP to 2030, by which time losses are estimated at around 45 billion dollars a year, an indicator of the devastating effects that could occur beyond this date if strong action on climate change is not forthcoming. Emissions will compound the potentially devastating effects of climate change and other unsustainable stresses on the world's waters and aquatic life. Harmfully, ocean acidification stress is most severe outside and at the frontiers of the tropics, perfectly complementing the damaging effects of climate change that are most significant inside the tropics (Burke et al., 2011).

Effects are widespread: approximately 40 countries are acutely vulnerable to the impact of GHG emissions on fisheries. Particularly affected are developing countries with proportionally large fisheries sectors.

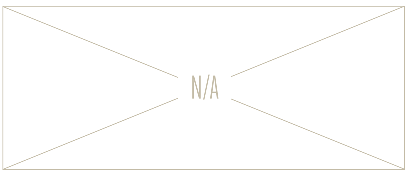
Remarkably, nearly 90% of all losses are estimated to occur in China, mainly as a result of acid rain losses for inland fisheries and aquaculture, over and above ocean acidification effects. Other countries already suffering significant total losses (over 200 million dollars a year) include Vietnam, South Korea and the US.

BIGGER PICTURE

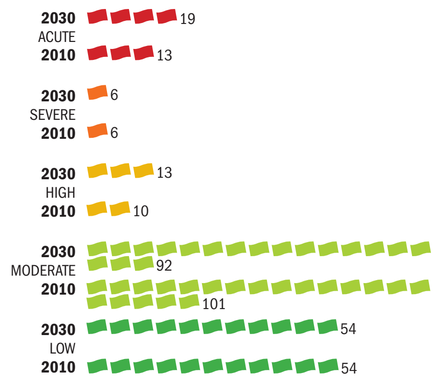


SURGE

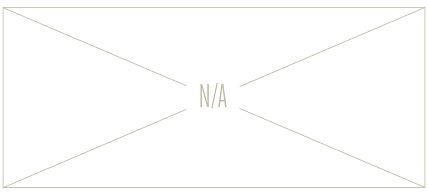
OCCURRENCE



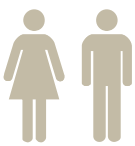
VULNERABILITY SHIFT



PEAK IMPACT



GENDER BIAS



INDICATOR INFORMATION

MODEL: IGBP-DIS SoilData(V.0), 2008; OECD,2012

BASE DATA: FAO FISHSTAT (2012); FAOSTAT (2012); Rubin et al., 1992

= 5 countries (rounded)

Acute Severe High Moderate Low

THE INDICATOR

The indicator relies on two separate studies assessing the effects for aquatic life of both acid rain on inland fisheries and ocean acidification (Ikuta et al., 2008; Narita et al., 2011). The indicator draws on the FAO's fisheries database (FAO FISHSTAT, 2012). The main limitations are that the detailed analysis of inland fisheries was only undertaken in one country and applied to other countries on the basis of emissions and fishery production. Clearly, further research is urgently required. The ocean acidification study enabled regional estimates of losses that were attributed to different countries on the basis of their fishery production. Regional aggregation compromised, to some degree, the accuracy of the results as not all countries in a region will react identically.

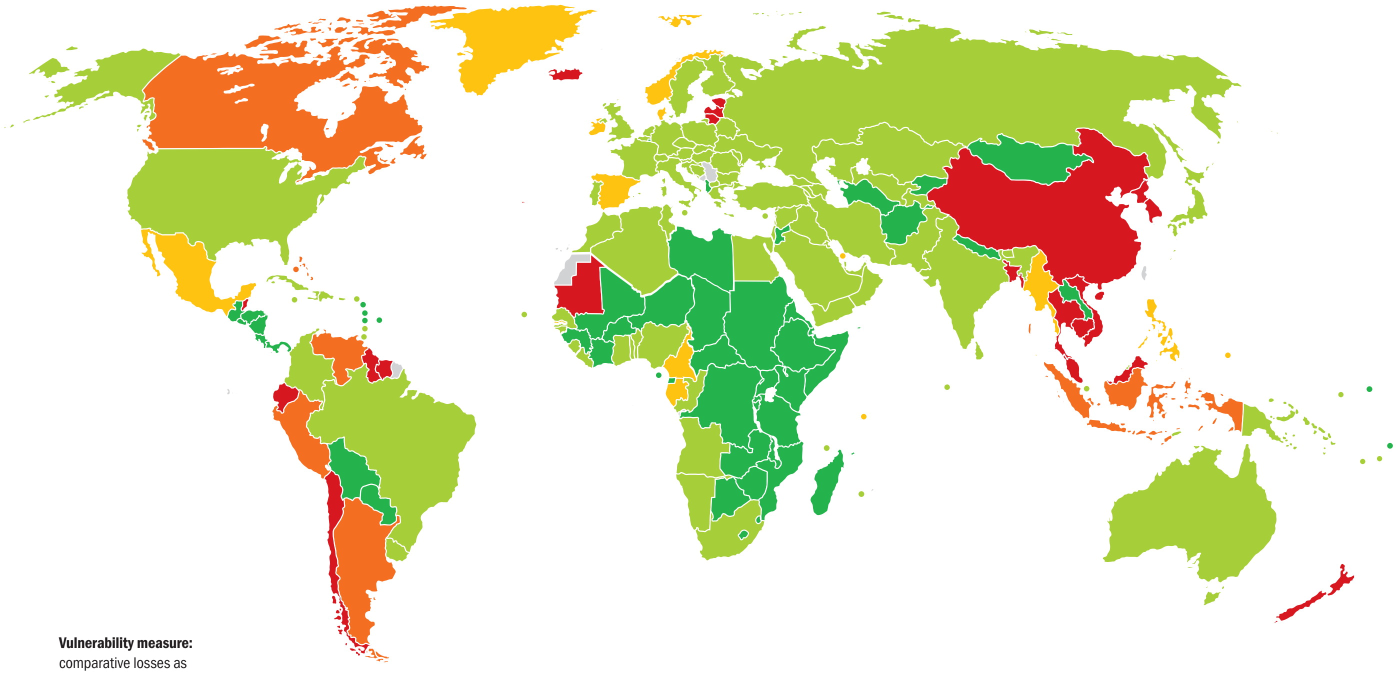
ESTIMATES COUNTRY-LEVEL IMPACT

COUNTRY	2010 $	2030 $
ACUTE		
Bangladesh	65	300
Belize		1
Cambodia	10	50
Chile	80	600
China	6,500	65,000
Ecuador	45	350
Estonia	35	250
Guyana	5	45
Iceland	1	10
Latvia	5	35
Lithuania	10	75
Malaysia	80	500
Mauritania	1	15
New Zealand	20	60
North Korea	10	100
South Korea	250	2,000
Suriname	1	15
Thailand	200	1,000
Vietnam	500	3,250
SEVERE		
Argentina	60	450
Bahamas	1	5
Canada	150	400
Indonesia	200	800
Peru	20	150
Venezuela	25	200
HIGH		
Bahrain	1	10
Cameroon	1	10
Denmark	10	25
Gabon	1	5
Gambia		1
Ireland	10	30
Mexico	45	350
Myanmar	1	15
Norway	15	40
Palau		
Philippines	40	150
Seychelles		1
Spain	35	100
MODERATE		
Algeria		1
Angola	1	1
Antigua and Barbuda		
Armenia		
Australia	10	30
Austria		
Azerbaijan		
Belarus		
Belgium		1
Benin		1
Bhutan		
Bosnia and Herzegovina		
Brazil	5	30
Brunei		1
Bulgaria	1	10
Cape Verde		
Colombia		1
Comoros		
Congo		1
Croatia	1	5
Cuba	1	5
Cyprus		
Czech Republic		
Dominican Republic		1
Egypt	1	5
Fiji		
Finland		
France	35	100
Georgia		
Germany	5	15
Ghana		1
Greece	5	15
Grenada		
Guinea-Bissau		
Haiti		
Hungary	1	1
India	150	550
Iran	5	15
Iraq		
Israel		1
Italy	20	60
Jamaica		
Japan	65	200
Kazakhstan		
Kuwait	1	5
Lebanon		
Liberia		
Macedonia		
Maldives		
Malta		
Mauritius		
Micronesia		
Moldova		
Morocco	1	5

$ Additional economic costs (million USD PPP) - yearly average

CARBON VULNERABILITY

Acute · Severe · High · Moderate · Low



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

$

COUNTRY	2010	2030
Namibia		1
Netherlands	10	35
Nigeria	5	20
Oman		1
Pakistan	1	1
Papua New Guinea		
Poland	1	10
Portugal	1	5
Qatar		1
Romania		
Russia		
Saudi Arabia	5	45
Senegal		1
Sierra Leone		1
Singapore	1	10
Slovakia		
Slovenia		1
Solomon Islands		
South Africa		1
Sri Lanka	1	10
Sweden	1	1
Switzerland		
Syria	1	5
Tajikistan		
Timor-Leste		
Togo		
Tonga		
Trinidad and Tobago		1
Tunisia	1	5
Turkey	5	15
Ukraine	1	10
United Arab Emirates		1

$

COUNTRY	2010	2030
United Kingdom	25	75
United States	250	700
Uruguay	1	10
Uzbekistan		
Vanuatu		
Yemen		
LOW		
Afghanistan		
Albania		
Barbados		
Bolivia		
Botswana		
Burkina Faso		
Burundi		
Central African Republic		
Chad		
Costa Rica		
Cote d,Ivoire		
Djibouti		
Dominica		
DR Congo		
El Salvador		
Equatorial Guinea		
Eritrea		
Ethiopia		
Guatemala		
Guinea		
Honduras		
Jordan		
Kenya		
Kiribati		
Kyrgyzstan		

$

COUNTRY	2010	2030
Laos		
Lesotho		
Libya		
Luxembourg		
Madagascar		
Malawi		
Mali		
Marshall Islands		
Mongolia		
Mozambique		
Nepal		
Nicaragua		
Niger		
Panama		
Paraguay		
Rwanda		
Saint Lucia		
Saint Vincent		
Samoa		
Sao Tome and Principe		
Somalia		
Sudan/South Sudan		
Swaziland		
Tanzania		
Turkmenistan		
Tuvalu		
Uganda		
Zambia		
Zimbabwe		