Vulnerability to impacts of climate change on marine fisheries and food security

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Contents

Introduction

- Marine fisheries make vital contributions to food security – both as a direct source of protein, essential fatty acids and micronutrients, and indirectly via employment and income for food purchases (Hall et al., 2013; McClanahan et al., 2015).

- Global marine fisheries are now underperforming economically, mainly because of overfishing, but also because of habitat loss and pollution (Jackson et al., 2001; Halpern et al., 2012).

- Added to these threats is the looming challenge of **climate change**, which is now considered to pose the greatest long-term threat to marine ecosystems (Sumaila et al., 2011).

Understanding where the impacts of climate change on the fisheries sector have greatest social and economic significance is crucial as fisheries are important for food security, livelihoods and employment (Merino et al., 2012).

Using a vulnerability assessment framework, we examined the level of vulnerability of marine fisheries to climate change in the context of food security in 109 countries, which yielded approximately 92% of global marine catches in 2013 (FAO, 2016).

The aim of this study is to identify areas in greatest need for intervention and understand the drivers of vulnerability to identify future research directions.

Materials and methods

1. Contribution of marine fisheries to domestic food and nutrition security in the global countries.

- Examined the size and direction of the trade balance for each country and compared this with total fishery production, thus understanding the role of domestic fish production and fishery trade as a direct food provider for each country.
- Assessed the contribution of marine fisheries to total fish production in the countries where domestic production was greater than 50% of total fish supply for human consumption.

- All of these fishery production and trade databases were obtained from FAO.

2. Assessing national level vulnerability to potential climate change impacts on marine fisheries from the perspective of food security.

Exposure: the degree of climate stress upon a country's marine fisheries.

Sensitivity: the degree of a country's societies dependent on marine fisheries.

Adaptive capacity: a country's potential ability to respond to and recover from these climate change.

Vulnerability = (Exposure + Sensitivity) -Adaptive Capacity

Summary of variables and data sources used to calculate exposure, sensitivity and adaptive capacity

Component	Interpretation	Variable	Data sources
Exposure	Gross indicator of climate change	Sea surface temperature Ocean acidification UV radiation Sea level rise	Ocean Health Index (2015)
Sensitivity	Food security dependency (2011-2013)	$\frac{\text{fish protein intake/total animal protein intake}}{\text{total animal protein intake/required animal protein intake}}$	FAOSTAT (2016)
	Employment dependency	People working in marine fisheries (2003) as % of total economic active population (2002-2004)	Teh and Sumaila (2013)
	Economic dependency (2008-2010)	Value of marine fish landings as % of GDP	Sea Around Us Project (2016) and World Bank (2016)
Adaptive capacity	Assets (2011-2013)	GDP per capita	FAO (2016)
	Flexibility (2013-2015)	Life expectancy at birth	World Bank (2016)
	Social organization (2012-2014)	Worldwide Governance Indicators	World Bank (2016)
	Learning (2012-2014)	Human Development Index	UNDP (2016)

- ✓ Exposure, Sensitivity, Adaptive capacity were treated equally and each normalized to 0-1 scale.

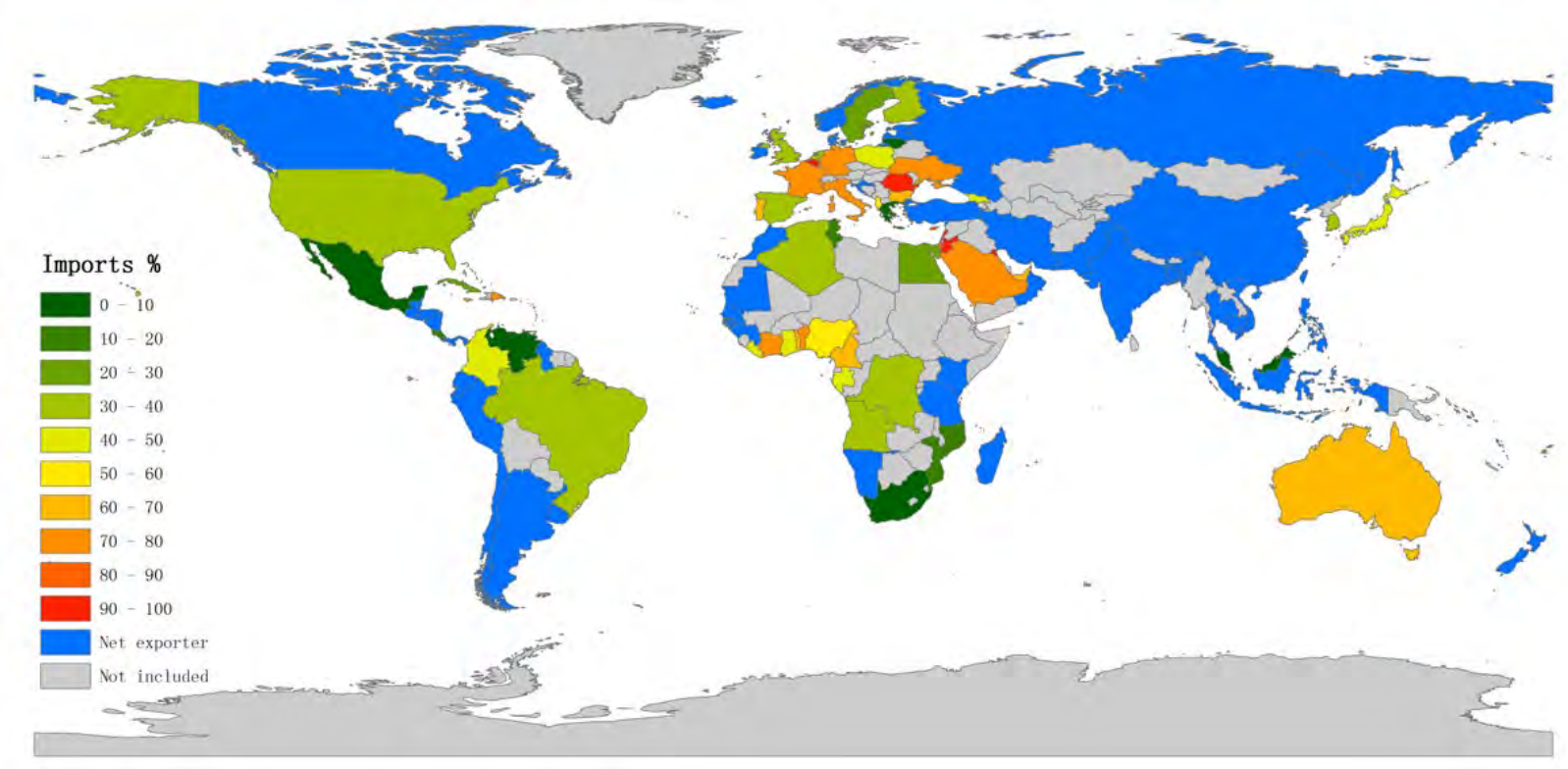
- ✓ Final Vulnerability scores were **highest for the most vulnerable countries** and **lowest for the least vulnerable countries**.

- ✓ For presentation, final indicator scores were categorized into ‘high’, ‘moderate’, ‘low’ and ‘very low’ vulnerability quartiles.

Results and discussion

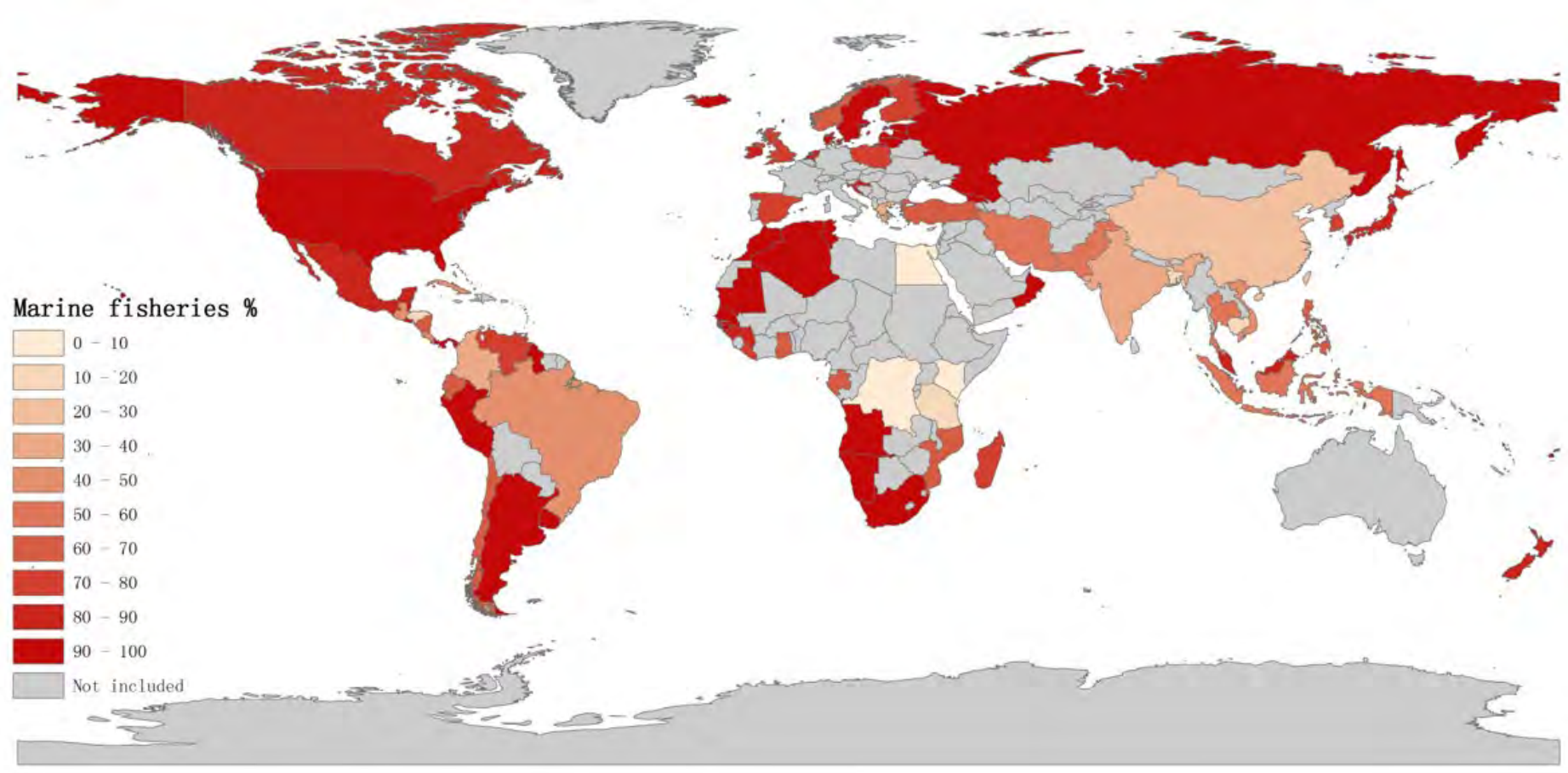
1. Contribution of marine fisheries to domestic food and nutrition security in the global countries

Graph of trade balance against total domestic fish production in the global countries



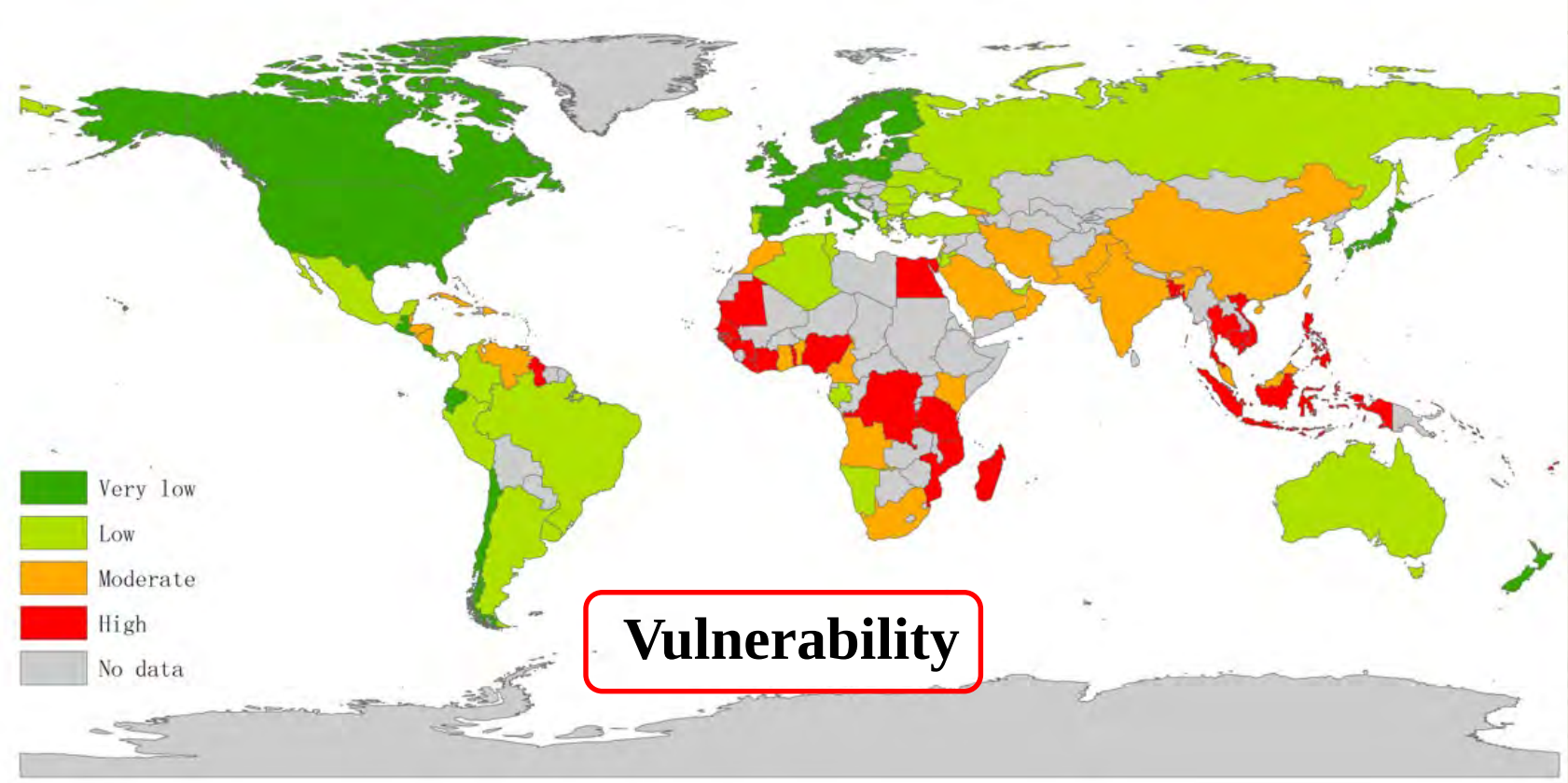
* For the 109 countries: **net fish importers** (**64**) & **net fish exporters** (**45**)
* For 64 net fish importers: net imports **exceeded** domestic supply (**29**) & net imports **not exceeded** domestic supply (**35**)

Graph of marine fisheries production as a proportion of total domestic fish

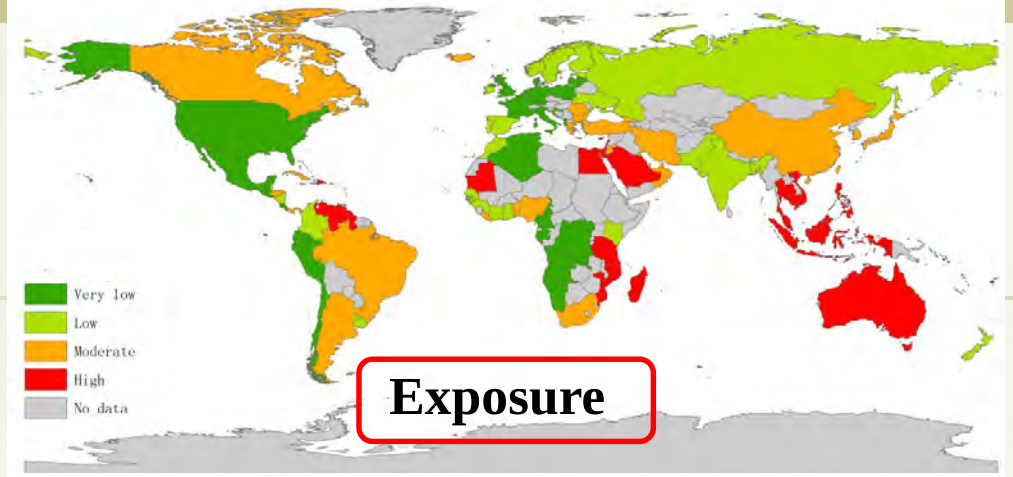


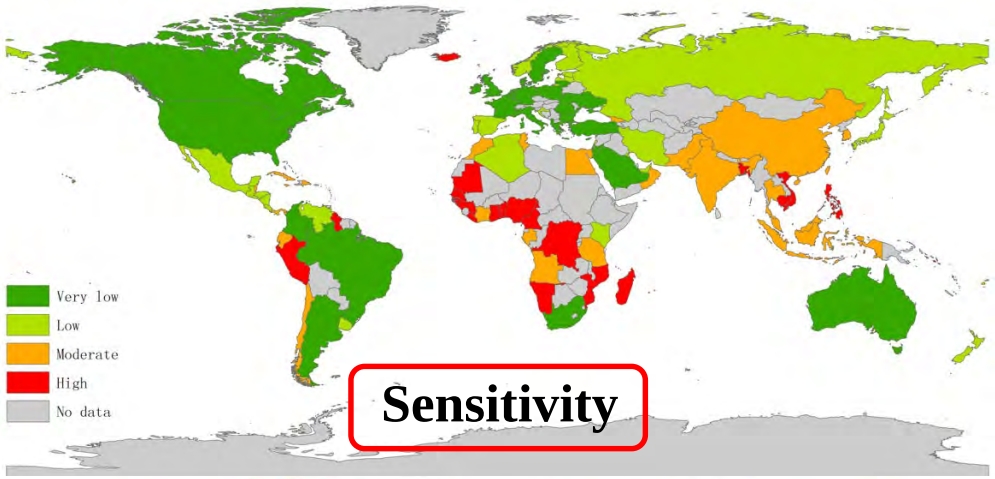
* For the 80 countries where domestic production is the major source of fish, marine fisheries **contributed more than 50%** of total production in **64** countries.

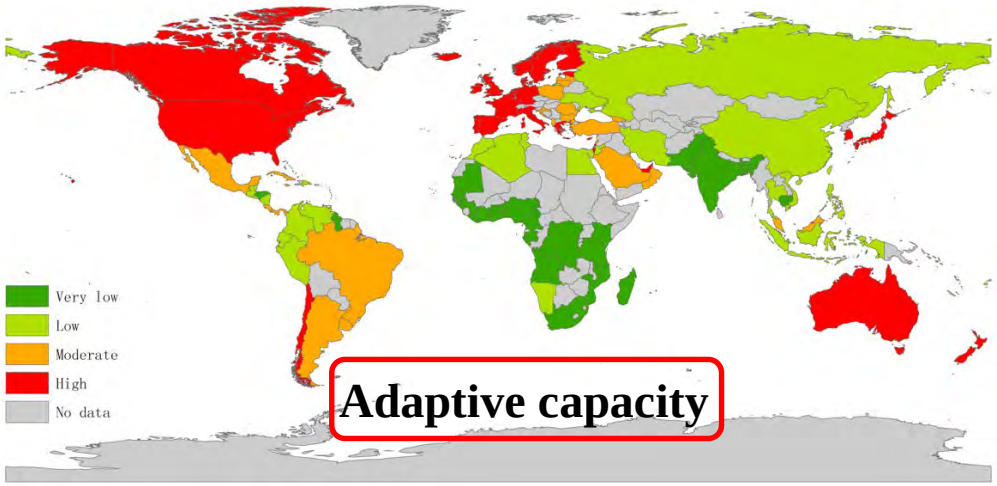
2. Overall vulnerability, exposure, sensitivity, and adaptive capacity of 109 countries to fisheries-related food security risks associated with climate changes, reported in quartiles.



- Vulnerability to marine fisheries related food security as a result of climate change **closely paralleled the national development status**.
- Developing countries in Africa, Asia, Oceania, and Latin America appeared to be most vulnerable, whereas the most developed countries were generally least vulnerable.


Very low
Low
Moderate
High
No data
Exposure


Very low
Low
Moderate
High
No data
Sensitivity


Very low
Low
Moderate
High
No data
Adaptive capacity

Coefficients of determinant for individual indicators in predicting overall country vulnerability to food security risks associated with impacts of climate change on marine fisheries.

Indicator	R^2 value
Exposure	0.42
Sea surface temperature	0.07
Ocean acidification	0.26
UV radiation	0.09
Sea level rise	0.19
Sensitivity	0.57
Food security dependency	0.31
Employment dependency	0.30
Economic dependency	0.26
Adaptive capacity	0.64
GDP per capita	0.46
Life expectancy at birth	0.49
Worldwide Governance Indicators	0.50
Human Development Index	0.64

High vulnerability countries

- Those for whom dominant source of fish consumption come from **imported fish and fishery products**: **Cote d'Ivoire, Nigeria, and Togo**

Changes in trade flows

- Those for whom **aquaculture and/or inland fishery** to be the dominant source of fish consumption: **Bangladesh, Egypt, Vietnam, Cambodia, Democratic Republic of Congo, and Tanzania**

Climate exposure indices relevant to inland fisheries or aquaculture

- Those for whom **marine fishery** makes a major contribution to national fish consumption: 18 countries

Africa: Cape Verde, Gambia, Guinea, Guinea-Bissau, Mauritania, Senegal, Liberia
Asian: Maldives, Indonesia, Philippines, Madagascar, Mozambique, Thailand
Oceania: Fiji, Samoa, Solomon Islands, Vanuatu
South America: Guyana

Key policy actions that can help reduce the vulnerability to the impacts of climate changes

- **High employment dependency**: Cape Verde, Fiji, Guinea Bissau, Guyana, Indonesia, Maldives, Philippines, Samoa, and Vanuatu.
  - **Measures**: Alternative or supplemental livelihood activities; Flexible livelihood strategies.

- **High economic dependency**: Gambia, Guinea, Mauritania, and Senegal.
  - **Measures**: Diversifying highly specialized fisheries to multispecies fisheries.

- **Food security dependency**: Liberia, Madagascar, Mozambique, Solomon Islands, and Thailand.
  - **Measures**: Aquaculture (With the decreasing dependence of aquaculture on wild-caught fishmeal)

- Vulnerability was **most strongly predicted** by country-specific **Human Development Index** and **Worldwide Governance Indicators**, as well as **Life expectancy at birth**. Policy and development efforts to promote food security may benefit most from a primary focus on developing the above three aspects.

- **Measures**: investments in education and literacy, improving governance, poverty reduction and enhance capacities and health status of fishing communities.

Conclusion

- ✓ Country-level vulnerability to marine fisheries-related food security risks as a result of changing climate closely paralleled the national development status, with developing countries in Africa, Asia, Oceania, and Latin America appearing to be most vulnerable. The key sources of vulnerability differed considerably among the countries.

- ✓ For countries most vulnerable to climate-induced effects on marine fisheries, more than two-thirds of them depended on domestic marine fisheries as a main source of fish supply.

- ✓ **Developing appropriate adaptation policies and management plans** to reduce the impacts of changing climate is of great importance to sustain food security in these highly vulnerable and heavy marine fisheries-dependent countries.

Thank you!