

# **Fisheries, Food Security, Biodiversity & Climate Change**

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# Purpose of Talk

- Bring separate lines of science-policy dialogue together
- Many setting where there are pair-wise discussions of:
  - Climate Change & Global Food Security
  - Climate Change & Conservation of Biodiversity
  - Climate Change & Fisheries
  - Fisheries & Global Food Security
  - Fisheries & Conservation of Biodiversity
- **What are considered *solutions* to problems in one setting are considered *sources* of problems in others**
- GOAL IS TO OPEN DISCUSSION OF THE INTERSECTION OF THESE CRUCIAL ISSUES AND THE INTERSECTION IS **GOVERNANCE**

## **TYPICAL QUESTIONS FROM ICES/PICES/ETC MEETING**

- Climate change : ocean physics & chemistry : fish populations and aquatic ecosystems (Sessions A2 and B1)
- Climate change : fish distribution and productivity : fisheries (B2 and C1)
- 3. Questions similar to 1, but about components of biodiversity
- 4. What factors affect the vulnerability / resilience of biodiversity / ecosystems to impacts of climate change (B1 and B2)
- 5. What biodiversity conservation policies and measures are expected to be robust to climate change? (P3 and C2)

## **QUESTIONS FROM MEETINGS ON HUMAN FUTURE**

- 6. What implications does climate change have for global and regional food security?
- 7. What are future human demographic trends, and what do they imply for future food security

## **AND THE QUESTION HIDDEN IN ALL OF THEM**

- 8. How can we address these and correct past blatant failures in both fishery management and nature conservation?

# Overarching thesis:

**For any policies and management measures for food security, conservation of biodiversity, and sustainability of fisheries to succeed, they all have to be coherent across institutions.**

**What are the challenges to policy coherence across issues?**

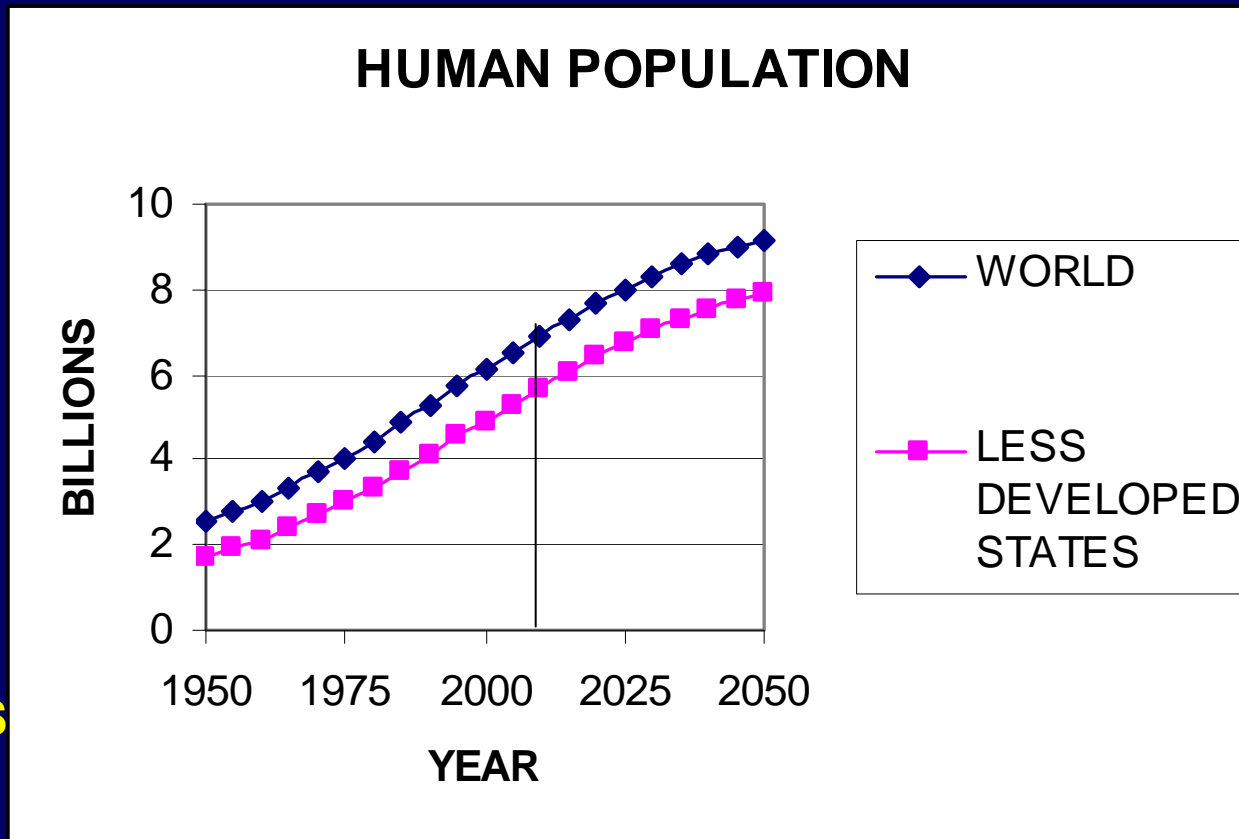
# CLIMATE CHANGE AND FOOD SECURITY

Data from UN - IGO sources –  
W.H.O., O.E.C.D., F.A.O., World  
Population Centre, Agro-Biodiversity

# What is expected for human population growth?

FROM UN  
HUMAN  
POPULATION  
PROSPECTS

70 % IN  
URBAN  
AREAS /  
MEGA-CITIES



Percent in coastal areas increases from ~50 to ~ 70 %

# WHAT DOES THIS MEAN FOR FOOD REQUIREMENTS

W.H.O. human nutritional requirements

- Calories needs largely from grains (and vegetables ?)
- PROTEIN from grains, livestock & FISH
  - Fish provides more than 1.5 billion people with at least 20 % of non-grain protein
  - In poorer island and coastal states fish provides around 50% of the total non-grain protein
  - Also provide essential micro-nutrients & amino acids
- Individual requirements vary with age, gender
  - Assume 60 kg adult (younger = smaller but need more per kg)
- **NEED  $3.65 \times 10^8$  t OF DIETARY PROTEIN BY 2050 for population increase**

# Forecasts for GRAIN production

## Status – quo conditions

- Land in cultivation –
  - will increase at slower rate than 1990-2005 (~ 13%);
  - more marginal lands into production
- Percent dependent on irrigation –
  - Will increase faster than rain-dependent farming
  - With better technology 11% increase in water use
  - “Green Revolution” of genetic improvements, fertilization  $\square$  Will continue, but at 50% of earlier rate
- **NET EFFECT – CROP PRODUCTION INCREASES SLIGHTLY FASTER THAN HUMAN POPULATION (and larger ecosystem footprint from agriculture)**



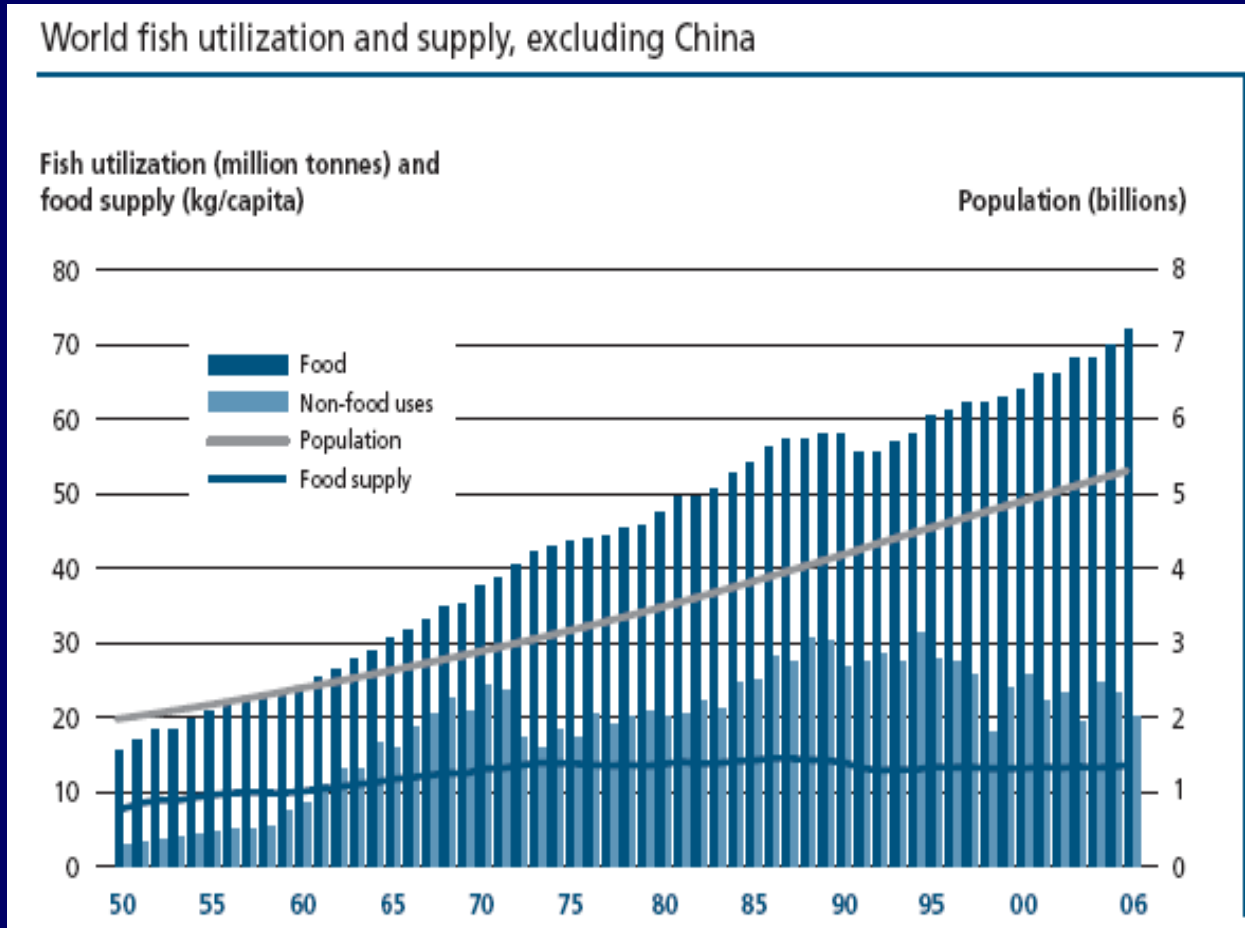
# What does climate change do to terrestrial food production?

- Grains (OECD & FAO, Agro-Biodiversity)
  - Assume “best adapted strains”, CO<sub>2</sub> benefits+fertilization, usually Hadley2 scenario for rainfall and temperature regimes
  - #1: WHEAT– **reductions** everywhere but NA & W.Europe
    - **Down** 43 to 57% CA & SA; 44 to 97% Africa; 43 to 58% Asia
  - #2: RICE – no %age projection; threat is increasing number and intensity of severe storms. FAO-AgroBiv – **1 in 4 crops lost.**
  - #3: MAIZE – *increase* usually 20-30% in Africa, Asia, Europe
- Livestock (OECD) –
  - “moderate” reduction in cattle and swine in temperate latitudes (drought and heat waves)
  - “larger” reductions in tropics – heat stress and poorer pasture
  - Poultry - ??????

# How much food will be fish?

## Present trends

OECD 2009 –  
from SOFIA



**INCREASE  
SINCE 1990 IS  
AQUACULTURE**

**CAPTURE  
FISHERIES  
PEAKED ~1990**

# How much fish in the future

2006 –

- Capture fisheries stabilized at 85-95 mmt.
- Aquaculture ~ 40 mmt and increasing
- 33 mmt used for oil and animal feed, rest consumed.

• 2050 –

- If fish stays 20% percent of dietary protein, 20% of 365 mmt = **73 mmt tonnes MORE fish**
- If it has to replace decreasing grain–**MORE**
- With most of population growth in parts of world where fish is greater % of protein- **EVEN MORE**

# Where can we get 75 – 100 mmt more fish protein?

- **INCREASE CAPTURE FISHERIES?**
  - SOFIA concluded 100 mmt was unsustainable when reached in 1990s
  - Could fish lower trophic levels to get greater yield from primary production (10-fold gains)
- **INCREASE AQUACULTURE?**
  - More intensive mariculture in coastal areas
  - Community-based integrated pond culture
    - Use of specialize strains and species adapted for pond culture and low-protein diets.

# BIODIVERSITY AND CLIMATE CHANGE

Goals from CBD 2010 Resolution  
Targets, Johannesburg WSSD  
Develop Goals, IUCN, Pew Ocean  
Trust

# Challenges to Conservation of Marine Biodiversity now priority issue

All the world's oceans under some stress; often multiple stresses (Halpern et al 2007)

Special Attention to Seamounts, corals etc (FAO DSF etc)

Major declines in all large fish, invertebrates, elasmobranchs etc (Myers and co-authors)

- “Doom” forecasts for fisheries replaced by about a third of stocks improving under more cautious management.

Many Policy Settings for dialogue and action

- UN Biodiversity Beyond National Jurisdiction
- CBD Ocean and Coastal resolution – Doubled in length 2008-10
- IUCN – ONE THIRD of 2008 Resolutions on marine issues

**Gaps from International policy to Domestic policy to implementation are all growing**

# Climate Change and Biodiversity Conservation

- Many papers in this Symposium document details
- Major Messages from science community:
  1. Some species ranges will change in response to changes in oceanographic conditions
  2. Productivities will change as transport mechanisms and larval development conditions change
  3. Community structure will change from 1 & 2
  4. Ocean acidification may reduce abundance and productivity of species with shells & exo-skeletons
  5. Specialized habitats like corals and estuaries face multiple stresses
  6. Coastal habitats face more severe storm stress, but service of coastal protection will be more important

# **“Conventional wisdom” for Fisheries Mgmt measures**

**TO PROTECT ECOSYSTEM PROCESSES MUST  
REDUCE STRESS FROM FISHERIES**

**TO INCREASE RESILIENCE TO CLIMATE CHANGE,  
MUST REDUCE STRESS FROM FISHERIES**

**TO PROTECT ESP. VULNERABLE ECOSYSTEMS  
AND HABITATS REDUCE FISHING EVEN MORE IN  
REEFS, MANGROVES, SEAMOUNTS, ETC**

**TO HELP COASTAL HABITATS REDUCE LAND-  
BASED PRESSURES AS WELL AS FISHERIES**

**REDUCE USE OF ALIEN STRAINS AND SPECIES IN  
AQUACULTURE**

**(IGNORES POSSIBILITY OF COEVOLUTION)**



# POLICIES AND MEASURES TO ACHIEVE THESE OUTCOMES

- WSSD Mill. Development Goals and CBD 2020 targets
  - 15% of all marine areas in effectively managed, low-human-impact MPAs
  - Cease destruction of special coastal habitats (mangroves) by 2015, and restore coastal habitat diversity
  - Cease overfishing (all  $F < F_{msy}$ )
  - All aquaculture has sustainable ecosystem impacts
- Rebuild all SSB above  $B_{msy}$  by 2015
- Reduce harvest of lower trophic levels (2010 Pew)

NOT ENDORSING THESE TARGETS – USING THEM AS  
CONTEXT FOR THE COHERENCE DISCUSSION

# The contradiction

ALL THE MEASURES NEEDED FOR  
CONSERVATION OF BIODIVERSITY REDUCE  
CONTRIBUTION OF FISHERIES TO FOOD  
SECURITY NEEDS, AND VICE VERSA

WHAT PART(S) OF SOCIETY CHOOSES?

Which must compromise – “nature” or “the poor”

The belief in a win-win outcome does not match data

Good fisheries management will allow long-term stock rebuilding and some increase in yield, but AT BEST recovery to levels that could not be sustained in 1990s

Some biodiversity benefits don't “cost” – some DO

# Illustration

- | Activity   | Food Security             | Biodiversity       |
|--|---------------------------|--------------------|
| • Harvest rate                                     | Maxi Sustainable          | Reduce             |
| • Lower trophic level                              | Fish More                 | Fish Less          |
| • High productivity Areas                          | Fish More                 | Extra Protection   |
| • Mariculture                                      | Change species & increase | Reduce             |
| • Freshwater culture                               | Increase                  | Only local species |
| • Freshwater - use of strains bred for aquaculture | Increase                  | Reduce             |

# Messages

- We do not have the “right” society choices
- We are concerned:
  - Science - policy dialogues about climate change and food security and climate change and biodiversity are proceeding in parallel
  - Likely outcomes of dialogues are NOT COHERENT
  - Tension of “Fascist” vs “Socialist” environmentalism

Without a merger of these policy discussions, likely outcome is **failure on both pathways**

OLD problems of fisheries governance – climate change gives new urgency