

Climate Change and Ocean Uses- Adaptation *from* and *for* what?

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Purpose of talk

- QUICK REMINDERS for current context
 - Review important conclusions on best practices in policy and management
 - Acknowledge importance of science (esp PICES) work on adaptation of fishing (and other ocean uses) to future effects of climate change
- STEP BACK AND LOOK AT WIDER CONTEXT FOR FUTURE OCEAN USES
- CONSIDER IMPLICATIONS FOR SCIENCE BASIS OF ADAPTATION PLANNING

Main Messages – Adaptation Planning

- Climate change will contribute to making the future ocean conditions (physical & biological) different from the present and recent past
- Some of the major differences can be forecast – with uncertainty (of course)
- The differences in ocean conditions WILL affect many ocean uses, including fisheries
- The forecasts do have enough skill to allow some planning for how fishing (and other uses) can adapt to the future ocean

PICES - many contributions to Science basis for Adaptation Planning

PICES has been a major player in providing scientific information on planning of adaptation of ocean uses

- Report of the PICES/ICES Working Group on Forecasting Climate Change Impacts on Fish and Shellfish (45)
- Report of Working Group 20 on Evaluations of Climate Change Projections (40)
- Impacts of Climate and Climate Change on the Key Species in the Fisheries in the North Pacific (35)
- Forecasting Climate Impacts on Future Production of Commercially Exploited Fish and Shellfish (34)
- Report of the Study Group on the Fisheries and Ecosystem Responses to Recent Regime Shifts (28)

Sessions at every annual meeting, WG FUTURE, etc

Main Messages on Coherence and Integration

- There are ALWAYS ecological, economic and social goals for fisheries (and any other use)
- Fisheries are affected BY status of many ecosystem features and have effects ON many features
- Management most effective if the goals, drivers and impacts are made explicit
- Once explicit, the multiple goals must be reconciled (Ostrom SES framework – INTEGRATION)
- Measures to pursue goals, respond to drivers, and manage impacts must be reconciled (COHERENCE)

Ecosystem approach to Integrated Fisheries Management

Need for COHERENCE and INTEGRATION

PICES also stressing need for INTEGRATED and COHERENT Approaches to management

- Report of the PICES/NPRB Workshop on Integration of Ecological Indicators of the North Pacific with Emphasis on the Bering Sea (33)
- Report of the Study Group on Ecosystem-Based Management Science and its Application to the North Pacific (29)

Garcia, Rice & Charles – Governance of Marine Fisheries and Biodiversity Conservation

- Dimensionality of challenge

Adaptation Planning takes account of all this

- Forecast/project future ocean states/scenarios with appropriate uncertainties under plausible climate scenarios
- Consider future possible states of stocks (abundance, distribution, productivity) relative to fishery ability to achieve goals
- Consider how drivers and impacts may change in those future ocean scenarios (wider ecosystem)

WHAT PRACTICES WILL ENHANCE ABILITIES TO
ACHIEVE GOALS,
RESPOND TO DRIVERS,
MITIGATE IMPACTS

What's wrong with this approach

- More than the climate is going to change and climate change is going to affect more than the ocean and its resources
- Some of these changes are so big that they **MUST** be made part of adaptation planning
 - Already have global policy buy-in
- **GLOBAL FOOD SECURITY – SDG 2**
- **GREENHOUSE GAS MITIGATION – Paris Agreement**

GHG Mitigation – Kaya Identity

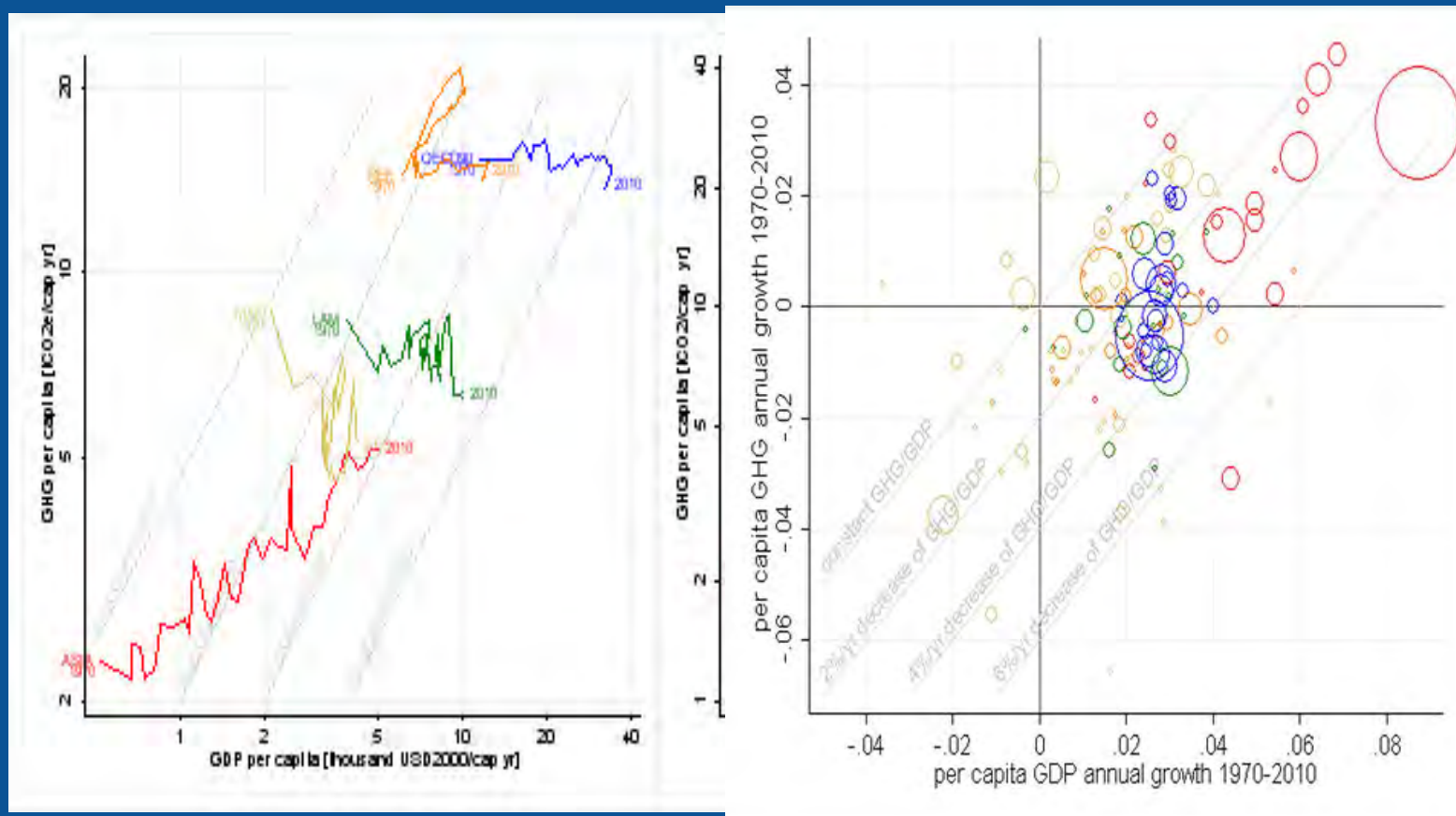
GHG emissions = population x consumption per capita x energy/consumption x carbon/energy

- Population – Increase (low Uncertainty)
 - 7 to 9+ billion (WHO), most in less developed states,
- Consumption per capita – Increase (moderate U)
 - Developed States - some reduction due to greater conservation but “.. Way of life not up for negotiation”
 - Economies in transition – large increases and many more people sharing the economic growth
 - Least developed countries ??? (but no reduction)

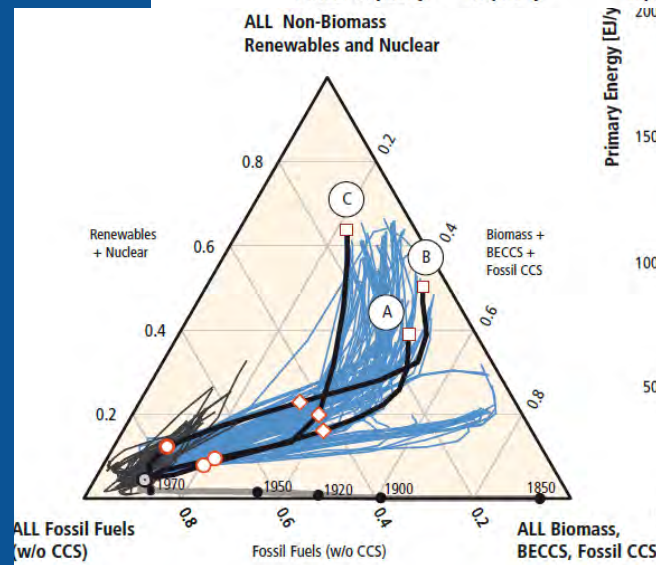
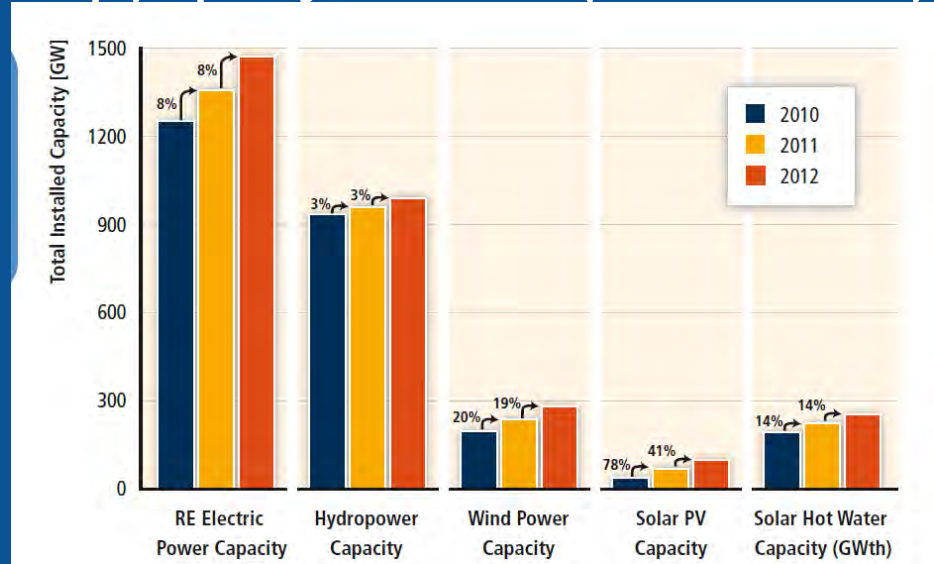
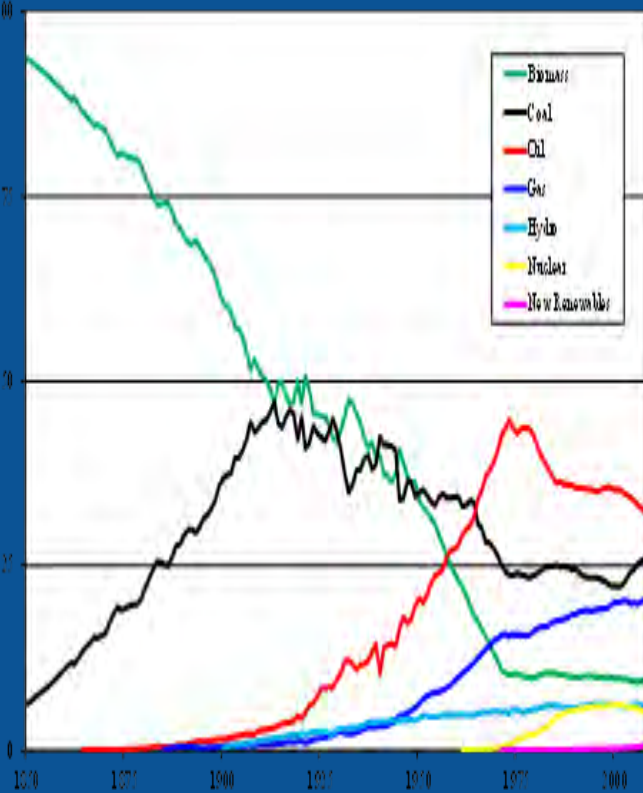
Kaya Identity (2)

- Energy per unit of consumption – Small decrease
 - Energy pricing policies crucial and VERY uncertain
 - Decreases from increasing efficiencies, but globalization makes footprint harder to measure, and adds transportation energy
- Carbon per unit of energy – only hope for large decrease (highly uncertain)
 - Requires anti-carbon policy environment (uncertain)
 - Requires great expansion of capacity of renewables (direction not uncertain – magnitude very uncertain with great potential)
 - Wind - 5X increase 2005-2012 (constant gain 0.3% share / yr; most future growth will be in offshore windfarms)
 - Tidal & Wave – technologies too early for projections, lowest total carbon footprint per unit of energy of any present source

Relationship of GHG emissions increase to per capita (left) and national scale (right) economic growth



Contribution of different energy sources in past (left); growth rate (R-top); projections (R-bottom)



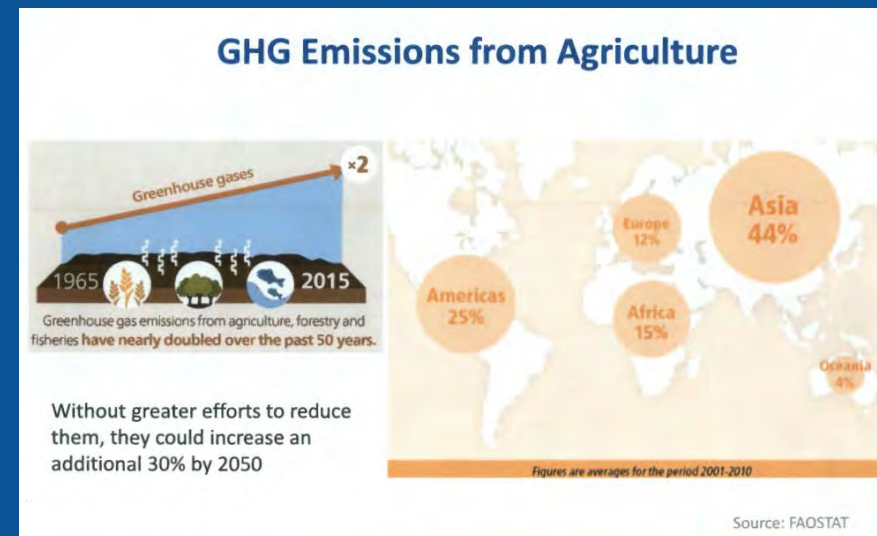
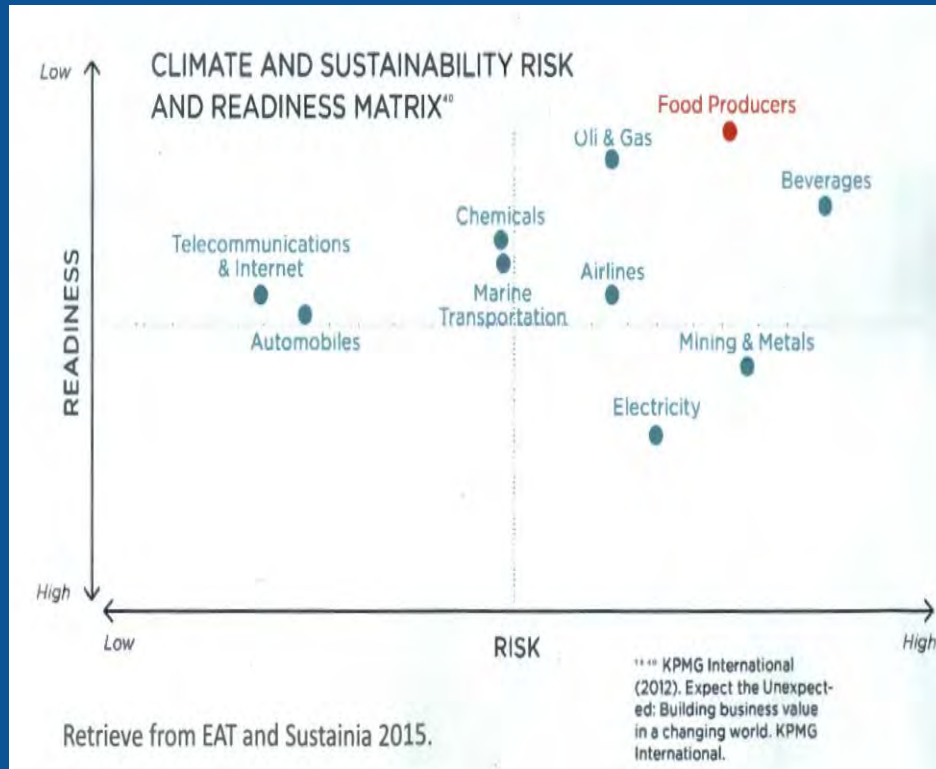
Primary Energy [EJ/y]

200
150
100
50
0

Global Food Security

- **SDG TWO - End hunger, achieve food security and improved nutrition,**
 - 925 MILLION people hungry NOW
 - 14% more food needed per decade to break even
- **APEC Meeting – Climate Change & Food Security (Pura, Peru Oct 2016)**
 - **CURRENT** global declines in crop production - maize 4%, wheat 5%, (less rainfall & higher temperature); rice ? (data not organized and threat is severe storms)
 - Declines greatest in less food secure areas (AF, SA, Asia)
 - GHG emissions from Agriculture & Forestry have doubled since 1960, and **MUST** be reduced
 - 100 MILLION more people undernourished by 2030

Agriculture isn't ready for climate change, but faces high risks, and is major, growing contributor to GHG emissions

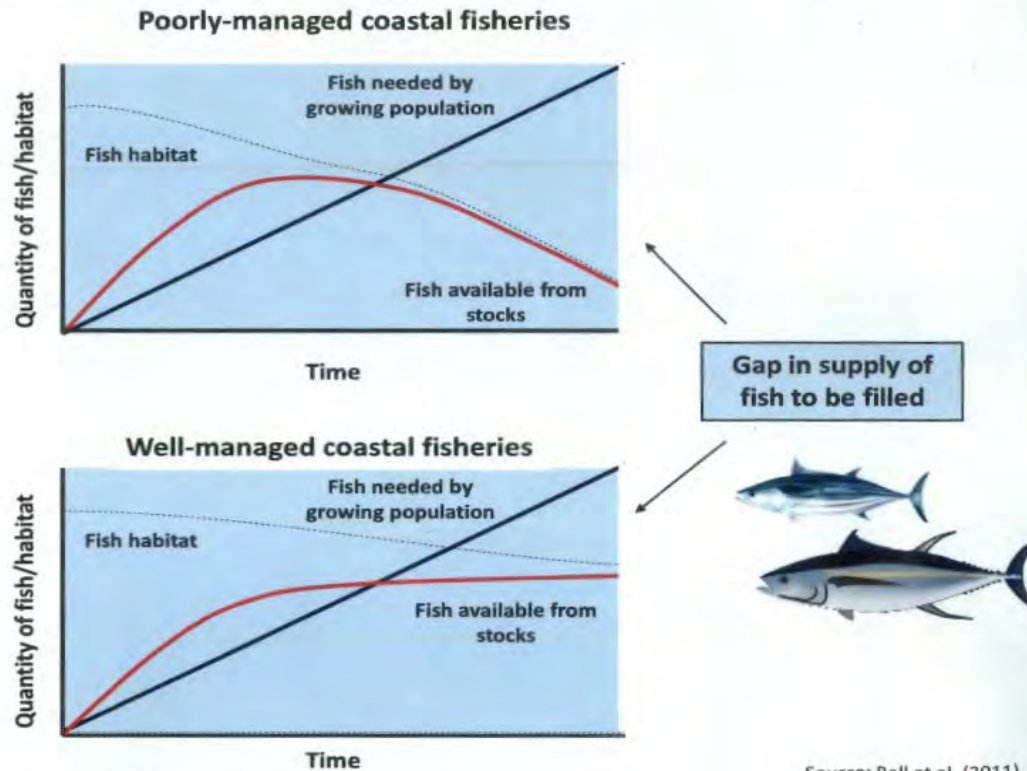


Implications for Fish Production

- Rice & Garcia 2010 – taking account regionally of % of fish in diets and population growth, Projected need for 70 MMT MORE “fish” protein by 2050
 - from 150 MMT in 2010; 60 % from capture fisheries
- Puri Discussions – Far too low- ~90-110 MMT
 - Will Require improved management in poor-mgmt area and some will come from freshwater aquaculture
 - But conventional fisheries CANNOT meet needs

Better management of current practices important, but not enough

Strategic plans to provide more fish



Source: Bell et al. (2011)

Implications for Adaptation Planning

- GHG Gas Emissions:
 - Much coastal “alienation” of space for wind farms and tidal/wave energy facilities
 - Hydropower growth will stagnate and possibly reverse as water needed for irrigation (MORE marine renewables)
- Food Security
 - More coastal alienation for mariculture
 - EXPANDED fisheries – Balanced Harvesting?, more Targeting Lower Tropic Levels?
 - Fewer/smaller no-take MPAS

Messages for Marine Expert Community

- If we believe in necessity of integration of objectives and coherence in selection of measure, Then
- our scenarios for informing adaptation planning **MUST** include
 - Greater pressure on coastal areas for power generation and intensive mariculture
 - 50-75% total increase in production of aquatic protein and micronutrients
- **WHAT WILL A *MEANINGFUL* VISION OF “SUSTAINABLE USE” LOOK LIKE IN THOSE FUTURES**