JAPAN's APEC Project

Asia-Pacific Economic Cooperation

APEC Workshop on the Climate Change Impact on Oceans and Fisheries Resources

Edited by Akima Umezawa

Opening
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Opening Key Remarks
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Impacts on Marine Environment

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Stresses on Marine Biodiversity

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APEC Workshop on the Climate Change Impact on Oceans and Fisheries Resources

PREFACE

The Workshop on the Climate Change Impact on Oceans and Fisheries was held in Boracay, Aklan, Republic of the Philippines, on 9 May 2015, in the margins of the 2nd Senior Official Meetings of the Asia-Pacific Economic Cooperation (APEC), which coincided with the Philippine's celebration of the Month of the Ocean. This is the APEC Project, planned and implemented by Japan, co-sponsored by Republic of the Philippines, Peru and Viet-Nam, which had been endorsed and approved as an APEC funded Project in June 2014 (Project Code: OFWG 02 2014). It was successfully implemented, participating about 100 participants from 15 economies [1] and four international governmental organizations[2] as well as 12 prominent lectures[3] under the intensive one day program.

APEC Projects are a vital part of APEC's efforts to support sustainable economic growth and prosperity in the Asia-Pacific region[4], for achieving the APEC Mission: "APEC is the premier Asia-Pacific economic forum. Our primary goal is to support sustainable economic growth and prosperity in the Asia-Pacific region." The Workshop (This Project was approved in 2014.) delivered the immediate responses to the APEC 2013 Leaders' Declaration which highlighted the sustainability of our oceans in terms of grave economic consequences of natural and human-caused disaster such as the climate change impact[5]. Sustainability is a key challenge, then the Fourth APEC Ocean-Related Ministerial Meeting (AOMM4) Joint Statement established the key policy concept, "Blue Economy" in 2014, as "an approach to advance sustainable management and conservation of ocean and coastal resources and ecosystems and sustainable development, in order to foster economic growth." In a meanwhile, there had not been any remarkable

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[1] 15 economies are; Chile, China, Hong Kong China, Indonesia, Japan, Korea, Malaysia, Papua New Guinea, Peru, Philippines, Russia, Chinese Taipei, Thailand, the United States of America, Viet-Nam

[2] 4 international governmental organizations are; ASEAN Centre for Biodiversity (ACB), Food and Agriculture Organization of the United Nations (FAO), Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Asia-Pacific Economic Cooperation (APEC)

[3] 12 prominent lecturers are listed in Appendix I.

[4] Guidebook on APEC Projects, paragraph 1-1.

[5] The APEC 2013 Leaders' Declaration, paragraph 18.

development, since the Third APEC Ocean-related Ministerial Meeting (AOMM3) adopted the Paracas Declaration in 2010, which manifested the impact of climate change on the oceans as a main area of strengthened implementations for addressing key oceans-related challenges. Since the Project strengthens the policy coherence and evolves comprehensive preparedness on sustainable growth of economic and social activities benefitted from oceans in the approach to climate change adaptations, it contributes the development of the AOMM4's Blue Economy, a long-term integrated ocean policy for the sustainable development, as well as accomplishes the priority challenge tasked by the AOMM3. In addition, the 2014 APEC Ministerial Meeting, held in Beijing, welcomed this Project as boldly stated in its "Joint Ministerial Statement", paragraph 52.

Today, APEC economies account for 70% and 80% of global consumptions of "fishery" and "aquaculture" products, respectively, those of which are contributing vitally to the crucial food security and economic growth in this region. However, the oceans and the benefits derived from oceans are being heavily threatened through disastrous environment degradations caused by the climate change. The climate change impact is nonreversible to the ocean environmental gradation and will bring increasing uncertainty in the fishery and aquaculture. An approach to climate change adaptations will need to be well integrated with the processes of improving fisheries and aquaculture governance. The Workshop has two purposes. The first one is to share our advanced knowledge based on most updated scientific data and information. The second one is to strengthen the policy coherence in the approach to social and economic adaptation to the impact of climate change.

The Workshop first focused on the climate change mechanism and earth environmental implications and its impact on ocean and coastal ecosystem, including ocean warming, sea level rises, and even the distribution changes of living marine resources (Chapter 1). Next, it touched upon striking features such as ocean acidification and stresses on marine biodiversity (Chapter 2). The Workshop addressed properly the climate change which seriously affects not only on the integrity of marine ecosystem but also on the sustainable marine use (Chapter 3). The Workshop also drew the attention to the Arctic (Chapter 4). First, it addresses sea-ice melting caused by the climate change. The Arctic has been impacted more quickly than the rest of oceans, having seriously the repercussions on the global earth environment as well as the global trade and distributions because of the Arctic Sea Route. The Workshop, then, penetrated the impact of climate change which has increased uncertainty in every sustainable use of marine resources, consequently not only endangering fisheries and aquaculture industry, but also posing serious risk on human life (Chapter 5). The Workshop concluded by vigorous discussions with regard to the adaptation strategy onto the climate change impact on ocean (Chapter 6), in order to strengthen the policy coherence for addressing the climate change impact in the APEC region. At the APEC Ocean and Fisheries Working Group held just after the Workshop in the Philippines, many economies applauded discussions and outcomes and expressed a desire to share the outcomes broadly[6].

Acknowledgements

I gratefully acknowledge the numerous significant supports from the Government of the Republic of the Philippines, headed by Attorney Asis Perez, Under Secretary, Bureau of Fisheries and Aquatic Resources. They extended us warmest hospitality during the Workshop. My sincerest appreciation is further extended to all prominent lecturers and speakers; Prof. Nobuaki Okamoto, Dr. Ruby Leung, Prof. Victor Ariel Gallardo, Dr. Shaobo Chen, Dr. Christopher Sabine, Dr. Sheila G. Vergara, Dr. Yoshihisa Shirayama, Dr. Koji Shimada, Dr. Natsuhiko Otsuka, H.E. Mr. Árni Mathiesen, Mr. Masanori Miyahara, and Dr. Achmad Poernomo, for their prestigious presentations based on their rich knowledge and experiences. The successful achievement of the Workshop as an APEC Project was brought by many significant and productive contributions made by all participants[7] of experts and officers. I always thank the Philippines' APEC 2015 National Organizing Council (NOC), supervised by Ma. Angelina M. Sta. Catalina, Ambassador, Deputy Director-General of NOC, including its young officers JJ and Tata. I also would like to name Mr. Yukio Kato (Secretary-General), Mr. Masahiro Minami and Mr. Akihisa Yamaguchi, Cabinet Secretariat (Headquarters of Oceans Policy), Government of Japan, for their tremendous supports behind the scene. Finally, I extend

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[6] Report of the APEC 5th Meeting of the Ocean and Fisheries Working Group (OFWG), Session VIII.

[7] Participant list is attached in Appendix II.

my appreciation to the APEC Secretariat, Mr. Alex Rogers, assisted by Ms. Joyce Yong, for his dedicated professional assistances and advices more than a year.

Akima UMEZAWA
Project Overseer and Moderator of the Workshop
Cabinet Counsellor, Cabinet Secretariat (Oceans Policy)
Government of Japan

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Office of Project Overseer
Cabinet Secretariat (Oceans Policy)
Government of Japan

Asia-Pacific
Economic Cooperation

APEC PROJECT (OFWG 02 2014)

Implemented by JAPAN, Co-sponsored by Peru, Philippines, & Viet Nam

PROGRAM

Workshop on the Climate Change Impact on Oceans and Fisheries Resources

9th May 2015, Boracay Island, Philippines

Opening[1]

- **Welcome Remarks**
  Atty Asis G. Perez, Department of Agriculture Undersecretary for Fisheries and Bureau of Fisheries and Aquatic Resources Director
- **Opening Key Remarks**
  Prof. Nobuaki Okamoto, President, Tokyo University of Marine Science and Technology, Japan

1. Impact of Climate Change on Marine Environment

- **Meteorological Views about Climate Change**
  Dr. Ruby Leung, Pacific Northwest National Laboratory, United States
- **Impact on Marine Environment**
  - The Case of the Climatically Variable Humboldt Eastern Boundary Upwelling Ecosystem -
  Prof. Victor Ariel Gallardo, Professor of the Department of Oceanography, Universidad de Concepcion, Chile
- **Impact of Climate Change on Coastal Ecosystem and Practice for Adapting**
  Dr. Shaobo Chen, Professor, Zhejiang Mariculture Research Institute, China

2. Striking Feature of Impacts

- **Ocean Acidification**
  Dr. Christopher Sabine, Director, Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration (NOAA), United States
- **Stresses on Marine Biodiversity**
  Dr. Sheila G. Vergara, Director of Biodiversity Information Management of ASEAN Centre for Biodiversity

3. Luncheon Speech

- **Implications for Marine Ecosystem**
  Dr. Yoshihisa Shirayama, Executive Director, Japan Agency for Marine Earth Science and Technology (JAMSTEC), Japan

4. Arctic, as the Most Affected Ocean

- **Sea Ice Decline**
  Dr. Koji Shimada, Associate Professor, Department of Ocean Science, Tokyo University of Marine Science and Technology, Japan
- **Implications for Global Trade and Distribution System**
  Dr. Natsuhiko Otsuka, Manager, North Japan Port Consultations Co. Ltd.

5. Vulnerability of Fisheries

- **Climate Change Effects on Fisheries**
  H.E. Mr. Árni Mathiesen, Assistant Director General, Food and Agriculture Organization of the United Nations (FAO), Fisheries and Aquaculture Department
- **Adaptations to Ecosystem Affects and Marine Environmental Shifts**
  Mr. Masanori Miyahara, President, Fisheries Research Agency, Japan
- **Blue Carbon**
  Dr. Achmad Poernomo, Director General, Ministry of Marine Affairs and Fisheries, Indonesia

6. Evening Session: Adaptation, as a Key Role in Decreasing Risks

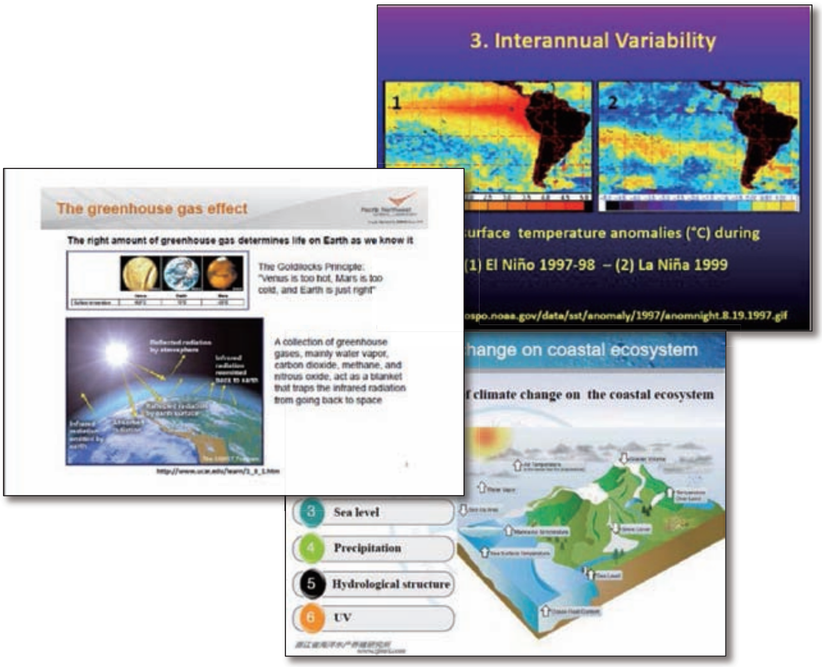
Panel Discussions on the Adaptations to the Environmental Shifts Caused by Climate Change, by All Lecturers

Closing

[1] Moderator (APEC Project Overseer): Dr. Akima Umezawa, Cabinet Counsellor, Government of Japan

Chapter I

Impact of Climate Change on Marine Environment



1-1. Meteorological Views about Climate Change

L. Ruby Leung
Pacific Northwest National Laboratory, Richland, WA 99354, USA

The Earth maintains its thermal equilibrium by emitting longwave radiation that balances the energy absorbed from the sun. Since the dawn of the industrial era, energy consumption and land use change have significantly increased the emission of carbon dioxide (CO_2) to the atmosphere. As a greenhouse gas, CO_2 perturbs the thermal equilibrium of the Earth by reducing the longwave radiation emitted to space. The increase in net energy absorbed by the Earth leads to warming, with potential serious consequences to human society and ecosystem.

Although greenhouse gas effects are well established by radiative transfer calculations, there has been little direct observational evidence of the radiative impact of increasing CO_2 due to instrument uncertainty. A recent study by Feldman et al. (2015) analyzed the atmospheric emitted radiance spectra measured at the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) sites in the Southern Great Plains and North Slope of Alaska. They confirmed the theoretical predictions of the clear-sky CO_2 surface radiative imbalance of 0.2 W m^{-2} per decade that results from the 22 parts per million atmospheric CO_2 increase due to anthropogenic emissions between 2000 and 2010. These results further the needs to understand and predict future changes in the climate system as it responds to increasing CO_2 in the future.

A direct effect of the radiative impact of CO_2 is surface warming. As summarized in the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5), observations of surface temperature between 1901 and 2012 show surface warming in the entire globe, but warming is larger over land and generally increases in the higher latitudes. To project climate changes in the future, comprehensive Earth system models are used to simulate the evolution of the atmosphere, land, ocean, and sea ice, following emission scenarios based on socio-economics, energy technology, and land use. From a multi-model ensemble, the global mean surface temperature is projected to increase by 1 – 4^{o}C by 2100 compared to the present, with uncertainty after the mid-century contributed mainly by uncertainty in greenhouse gas emission scenarios. Accompanying the warming is a reduction of frost days, an increase in tropical nights and heat waves, melting of glaciers and mountain snowpack, and sea level rise due to thermal expansion of the ocean and melting of sea ice.

Greenhouse warming also has consequences for precipitation. A warmer atmosphere can hold more moisture evaporated from the surface. This follows the Clausius-Clapeyron relationship of about 7% increase in water vapor per each degree of warming. However, this translates to only about 2% increase in global mean precipitation for each degree of warming. This is because globally, precipitation is balanced by surface evaporation, which is limited by the energy input to the surface. Historical records of precipitation show that past changes in precipitation have been more variable spatially than the warming pattern, with both increases and decreases in different regions. The projections of future changes in precipitation generally display a pattern resembling the spatial distribution of precipitation in the current climate. These changes reflect the fact that areas experiencing more precipitation are associated with convergence of atmospheric moisture, such as along the intertropical convergence zone and the tropical western Pacific Ocean, both characterized by strong upward motion or convergence of moist air that produces precipitation. In a warmer climate, moisture convergence would increase as the atmosphere holds more moisture, hence increasing precipitation. The opposite can also be inferred for regions currently experiencing dryness or divergence of moisture; that is, in a warmer climate, more moisture will be diverged to reduce precipitation even further. These changes often referred to as "the wet gets wetter", have emerged as a first order global pattern of precipitation changes projected by Earth system models (Held and Soden 2006).

On a more regional basis, however, precipitation changes are more complex than what was described above because moisture convergence that produces precipitation can be modified not only by changes in atmospheric moisture, but also changes in the circulation that produces convergence and divergence regionally. By arguments of the energy constraint that limits the global precipitation increase to 2% per degree of warming compared to the 7% increase in moisture per degree of warming, the tropical circulation must weaken for the suite of changes to be self consistent. Indeed, analysis of climate projections by Earth system models shows a weakening of the tropical circulation, leading to a more complex spatial pattern of regional precipitation changes (Vecchi and Soden 2007).

The Asian monsoon is associated with major precipitation that affects a large population. As a key feature of the tropical circulation, the Asian monsoon circulation is projected to weaken in the future. However, there are some consensus by Earth system models that the increase in moisture due to warmer temperatures can compensate for the circulation changes to produce a net increase in summer precipitation (Kitoh et al. 2013; Mei et al. 2015). During winter, midlatitude regions are influenced by synoptic storms, which are projected to shift poleward (Lu et al. 2007), thus enhancing precipitation poleward of the current storm tracks, and reducing precipitation on their southern flank. Lastly, global warming can increase extreme precipitation, as they are produced by storm systems with intense vertical motion that can extract moisture effectively from the moister atmosphere in the future (O'Gorman and Schneider 2009). At the same time, however, global warming is also expected to increase aridity in the dry land margins, as the limited moisture availability over land cannot meet the increased saturation vapor deficit in a warmer climate (Sherwood and Fu 2014).

The aforementioned changes in temperature and regional and global water cycle must be considered in adaptation planning to improve societal resilience to climate change. With respect to the oceans, sea level rise is a direct consequence of warmer temperatures, and changes in precipitation can alter ocean salinity (Durack et al. 2011), with implications to ocean circulation and thermal structure that influence marine ecosystems.

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Durack, P. J., S. E. Wijffels, and R. J. Matear, 2012: Ocean salinities reveal strong global water cycle intensification during 1950-2000. *Science*, 336, 455-458.

Feldman, D. R., W. D. Collins, P. J. Gero, M. S. Torn, E. J. Mlawer, and T. R. Shippert, 2015: Observational determination of surface radiative forcing by CO_2 from 2000 to 2010. *Nature*, 519, 339-345.

Held, I. M., and B. J. Soden, 2006: Robust responses of the hydrological cycle to global warming. *J. Clim*., 19, 5686-5699.

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Meteorological Views about Climate Change

L. Ruby Leung, Laboratory Fellow
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APEC Workshop on the Climate Change Impact on Oceans and Fisheries Resources

Boracay Island, the Philippines
May 9, 2015

The greenhouse gas effect

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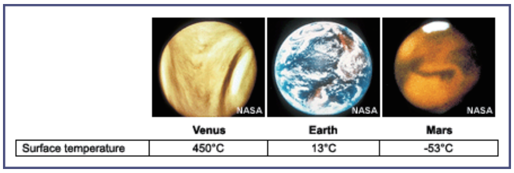
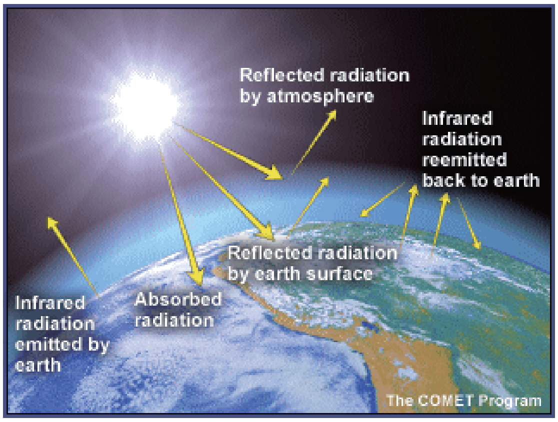
The right amount of greenhouse gas determines life on Earth as we know it



The Goldilocks Principle: "Venus is too hot, Mars is too cold, and Earth is just right"



http://www.ucar.edu/learn/1_3_1.htm

A collection of greenhouse gases, mainly water vapor, carbon dioxide, methane, and nitrous oxide, act as a blanket that traps the infrared radiation from going back to space

CO_2 surface radiative forcing determined

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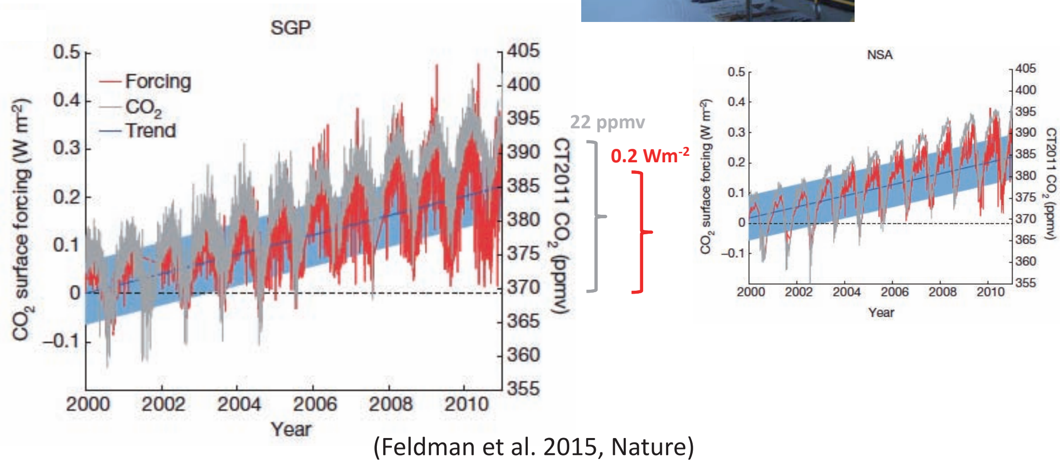
- First direct observation of carbon dioxide's increasing greenhouse effect at the Earth's surface

Spectroscopic instruments operated by the Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility



(Feldman et al. 2015, Nature)

Observed climate changes

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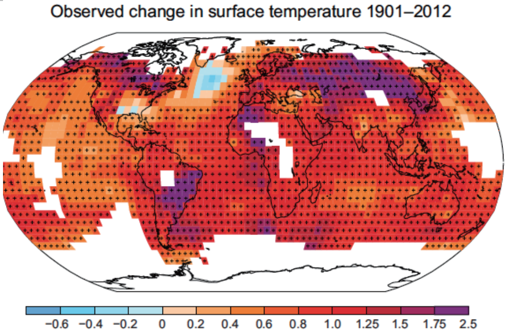
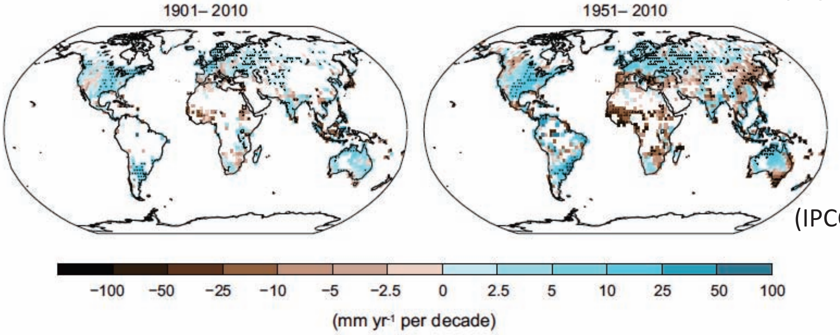
Observed change in surface temperature 1901–2012



Almost the entire globe has experienced surface warming since 1901

Observed change in annual precipitation over land



Medium confidence in precipitation change after 1951

(IPCC AR5 WGI report)

Projected global mean temperature changes

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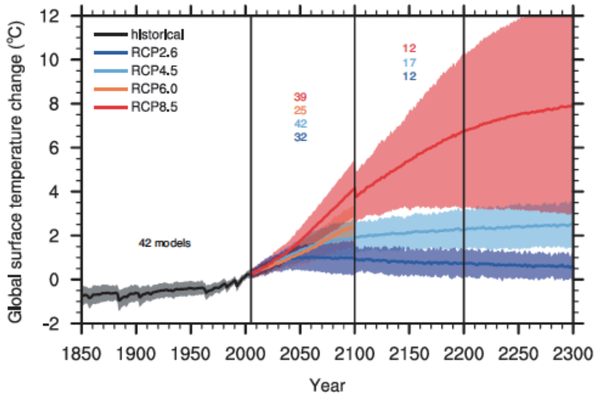
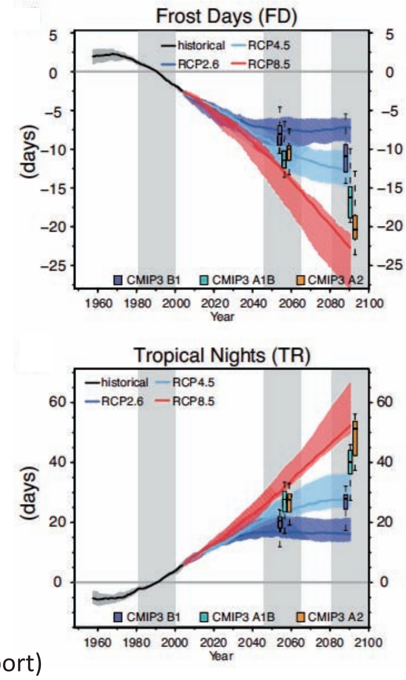
Uncertainty driven by emission scenarios

Uncertainty driven by emission scenarios and climate feedback





(IPCC AR5 WGI report)

Projected global mean precipitation changes

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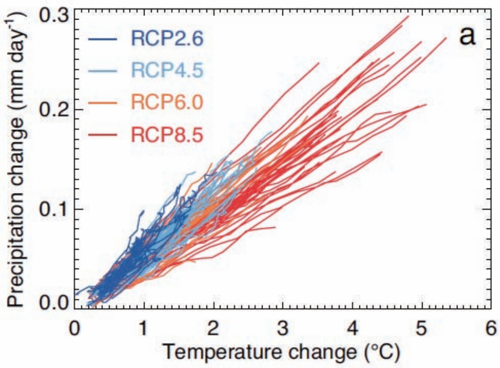
- The atmosphere can hold more moisture in a warmer climate (~ 7% increase per degree of warming (Clausius-Clapeyron (C-C) relationship)
- But energy constraint limits precipitation to increase at a lower rate (~ 2% increase per degree warming)

Globally precipitation and temperature changes are strongly related!

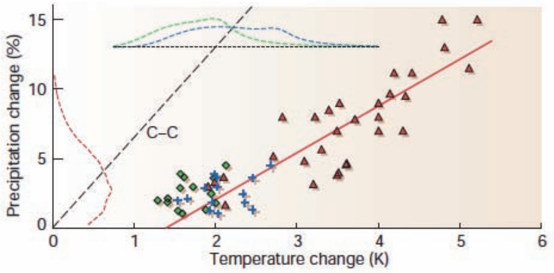
$P \approx E$
$L E \approx R$
$R \approx W^b$, $b < 0.5$
$dP/P \sim b\, dW/W$

(Stephens and Hu 2010 ERL)



W ~ 7%/K

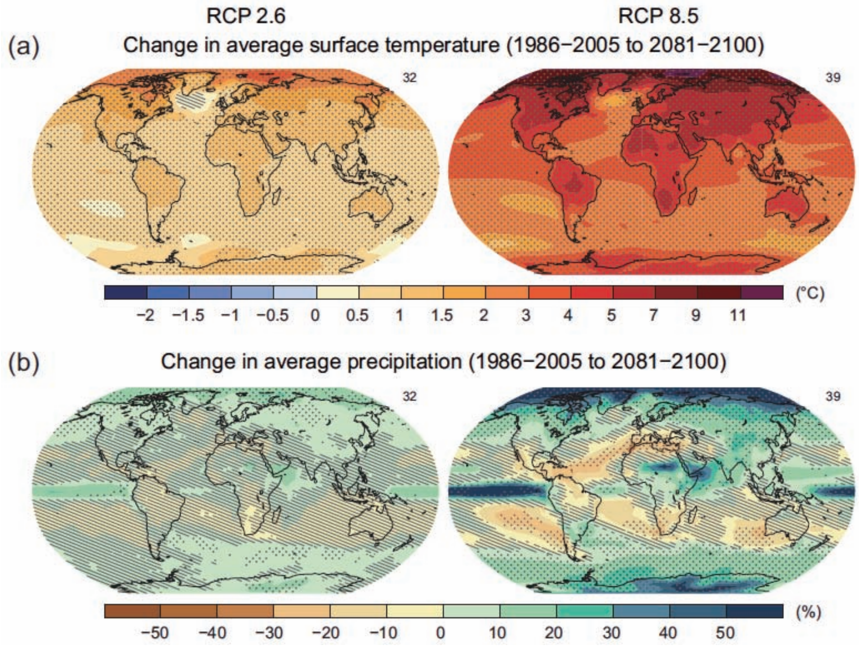
P ~ 2%/K



(IPCC AR5 WGI report)

(Allen and Ingram 2002 Nature)

Projected large-scale patterns of change



(IPCC AR5 WGI report)

Large-scale atmospheric circulation

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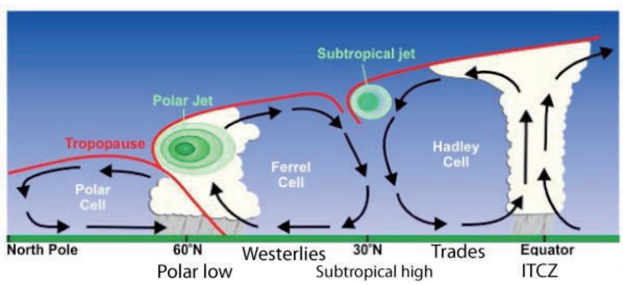
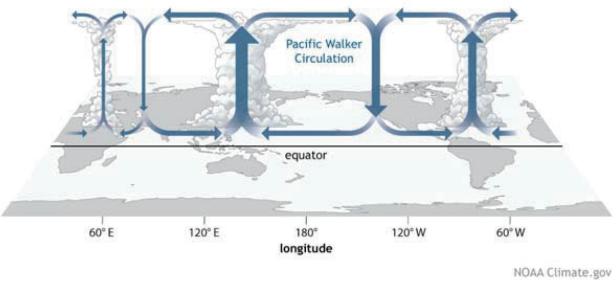
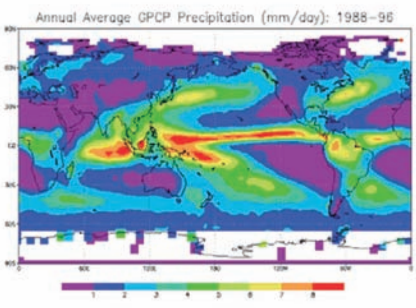
Zonally symmetric circulation



Zonally asymmetric circulation



Precipitation pattern reflects the large-scale zonally symmetric and asymmetric overturning circulation



Can we explain the large scale pattern of precipitation change?

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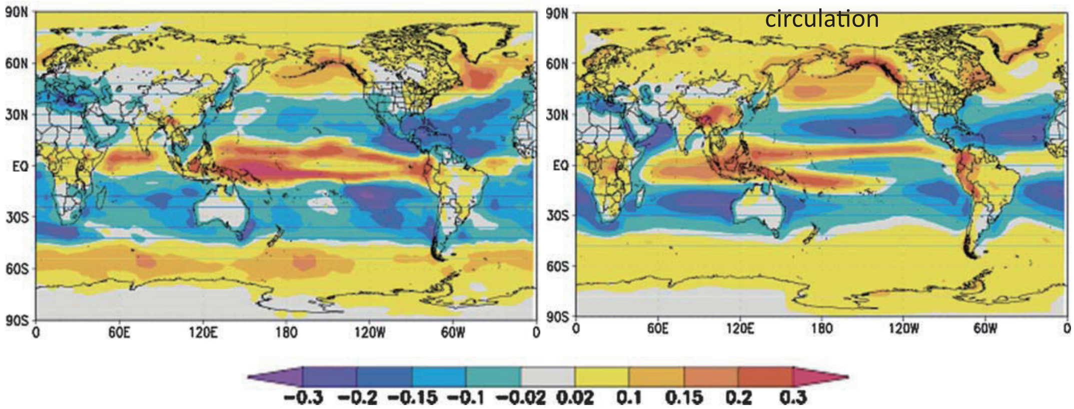
- "Wet gets wetter, dry gets drier" explains important features of large scale precipitation changes

Model projected P – E changes

P – E changes based on increasing moisture imposed on large-scale circulation



(Held and Soden 2006 J. Climate)

What about large-scale circulation changes?

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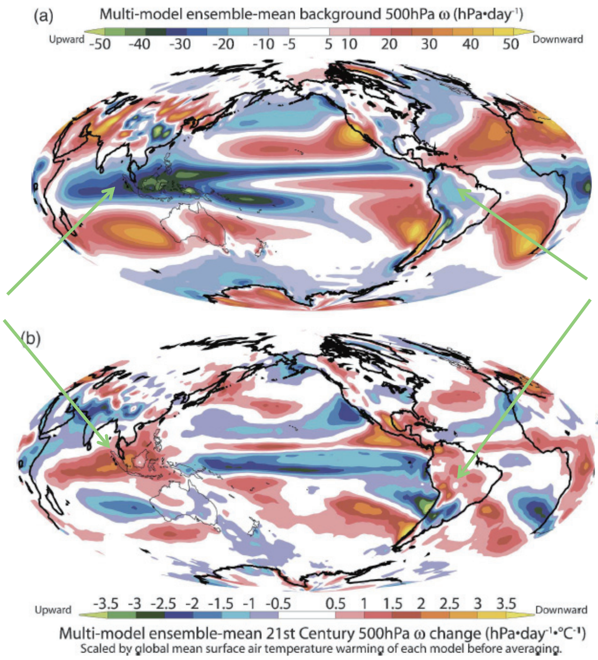
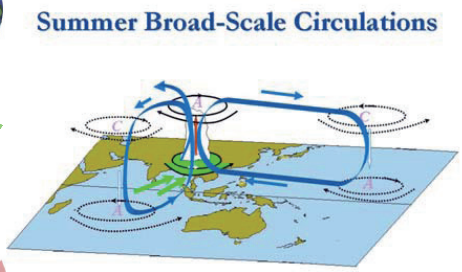


Large-scale circulation weakens with warming



(Vecchi and Soden 2007 J. Climate)

South Asian monsoon as an example

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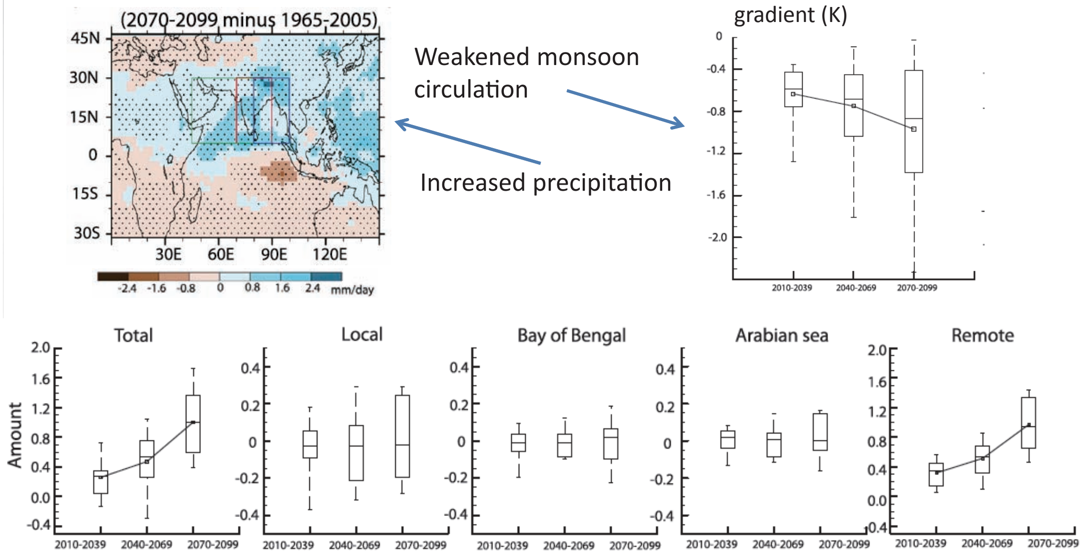
- Monsoon circulation is projected to weaken, but precipitation can still increase when more moisture converges



(Mei et al. 2015 J. Climate)

Another robust feature is the shift of storm tracks

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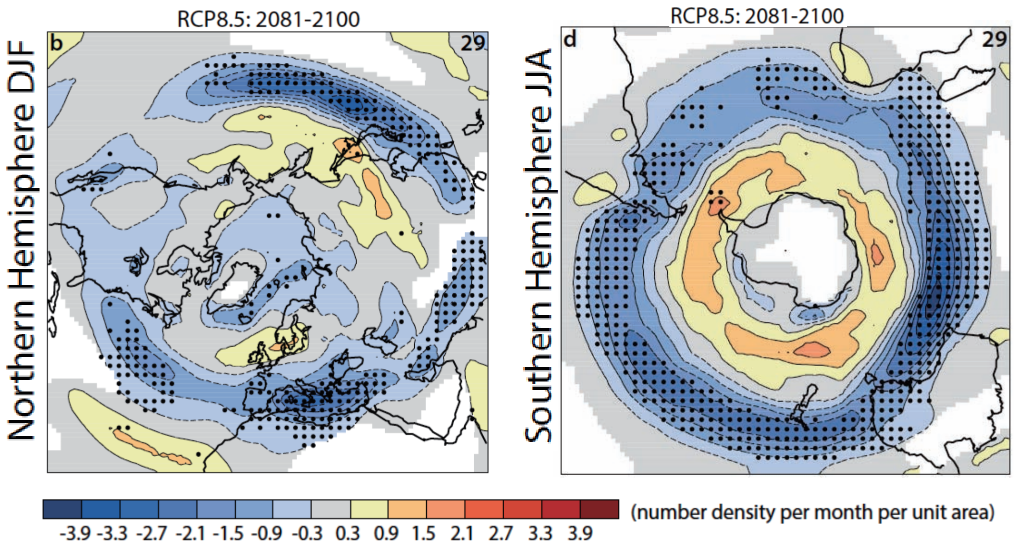
- Mainly affects winter precipitation – a poleward shift



(IPCC AR5 WGI report)

Increasing hydrologic extremes in a warmer world

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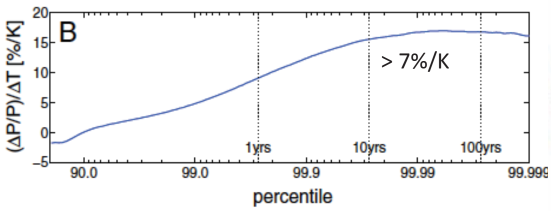
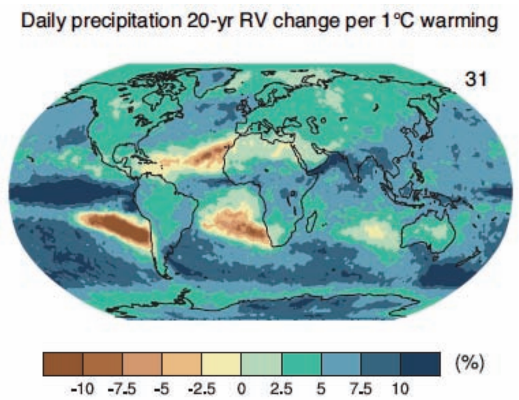
- Globally, water vapor, precipitation, and extreme precipitation follow different scaling (~7%, ~2%, > 7%) per degree warming
- Accompanied by changes in frequency and phase of precipitation, global warming may alter hydrologic regimes



(Sugiyama et al. 2010 PNAS)



(IPCC AR5 WGI report)

Increasing aridity in a warmer world

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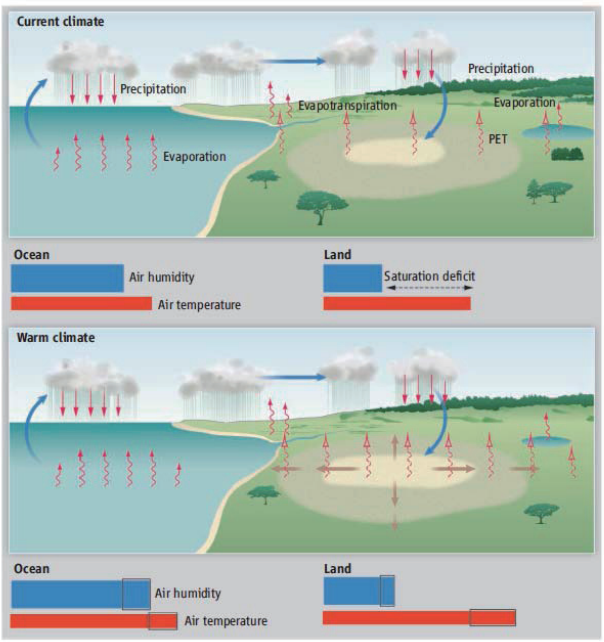

- Land warms about 50% more than the ocean because of limited availability of surface water
- Water vapor over land does not increase fast enough relative to the warming
- Larger saturation deficit increases PET and enhances aridity (P/PET)
- Regional changes are more complicated

(Sherwood and Fu 2014, Science)

Implications of precipitation changes to ocean

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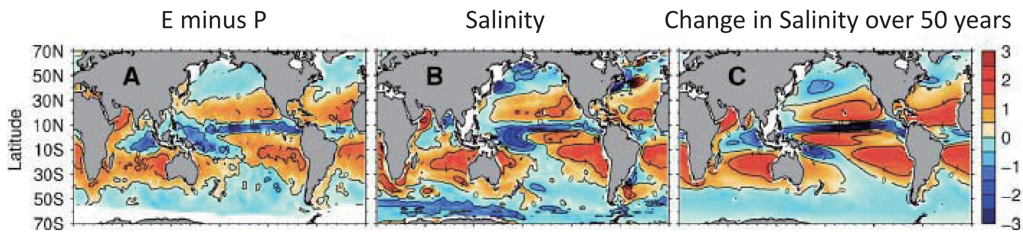
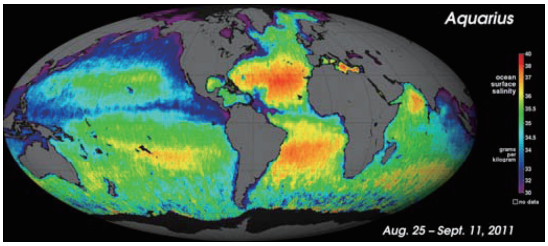
- “Wet gets wetter and dry gets drier” has a fingerprint in ocean salinity



(Durack et al. 2011)

Global map of salinity from Aquarius, Launched in 2011



Summary

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- The radiative forcing of carbon dioxide has been confirmed by observations
- The entire globe has experienced surface warming since 1901, with myriads of consequences
- Although precipitation changes are less certain in the past, certain key patterns of changes are nevertheless rather robust and their mechanisms have been revealed:
  - A global 7% and 2% increase per degree of warming for moisture and precipitation, respectively
  - Adding moisture to the large scale circulation - “wet gets wetter and dry gets drier”
  - Changes in large-scale circulation – weakening of overturning circulation and poleward shift of storm tracks
  - A higher rate of increase in extreme precipitation and expansion of arid regions
- How will “meteorological changes” affect the ocean? What are the implications of crop production changes to the demand of fishery?

1-2. Impact of Climate Change on the Marine Environment

"The Case of the Climatically Variable Humboldt Eastern Boundary Upwelling Ecosystem (HEBUE) and its potential as a contributor to marine food security."

Víctor A. Gallardo, Ph. D., Master of Marine of Affairs (M.M.A.)
Department of Oceanography
University of Concepcion, Concepcion, Chile

The purpose of this presentation is to call the attention that given the world´s need to adapt to, and mitigate, the negative effects of climate change on food security certain large marine ecosystems offer considerable opportunities because of their high primary production and resilience to climate stresses. These are the so called Eastern Boundary Upwelling Ecosystems (EBUEs).

Present day oceans contain four of these, i. e., the California, the Canary, the Benguela, and the Humboldt EBUEs. Among these the best known and most naturally productive one is the Humboldt EBUE (HEBUE) which in the last years has contributed with between 10 and 15% of the total world wild fish catch, although involving both minor parts of the world ocean´s surface area and of the world´s human population.

EBUEs owe their high productivity to an immutable planetary forcing, i. e., the eastward rotation of the Earth, which together with other factors such winds, induces the upwelling towards the lit surface, of deeper nutrient-rich coastal waters of eastern boundary oceans augmenting their photosynthetic production. But, it is not only because of the nutritive upwelling conditions that the EBUEs are major actual food producing ecosystems, this is also due to the extreme climate variability prevailing in these regions. The best known in this connection is the HEBUE where a host of more of less recurring, demanding, climatic changes, some at times extremely violent, occur. At different time-scales the following variabilities are here recognized, i. e., intra-annual (seasonal), inter-annual (El Niños and La Niñas), inter–decadal, and multi-decadal variabilities, involving major water mass exchanges and sea temperature fluctuations, dissolved oxygen, nutrient and thus primary food production variations. While these environmental fluctuations were in the past considered negative for society, modern ecology recognizes their positive side. Each one of these variabilities mean a sort of a periodic resetting in the composition and structure of prevailing communities within the ecosystems which, through eons, have tailored communities consisting of a very limited number of particularly well adapted species, in fact favoring species that produce large quantities of offspring rather than of many specialized ones but less abundant, typical of more stable marine ecosystems like those of the tropical and deep-sea regions.

Society has thus followed suit stablishing mechanisms for the exploitation of such abundant off-springs and there are the statistics showing for example large amounts of fish-meal obtained from vary abundant pelagic plankton-eating schooling small fish, negotiating the oceans to feed cattle and poultry in far-away lands. In fact, under normal ecosystem conditions, a large part of the exceedingly high photosynthetic primary production of the HEBUE, also of the Benguela EBUE, goes unconsumed and sinks down depleting dissolved oxygen underway and at the bottom where the usual animal oxygen-dependent communities are replaced by highly species-rich bacterial mats living on the energy provided by the resulting hydrogen sulfide. This latter situation reminds that of

Precambrian oceans and on itself constitutes an untapped treasure trove of genetic resources. It could actually be stated that in these EBUEs, the eons prevailing anaerobic sulfur-dependent life, today shares the same space as the modern oxygen-dependent life. These systems are called *sulfuretums* and thus the Humboldt Sulfuretum and the Benguela Sulfuretum are recognized.

In relation to food security however it is suggested that these upwelling ecosystems are good opportunities not only in relation to the effects of climate change on food security, i. e., availability of food and food systems stability, but also as a source of biotechnological resources. In relation with the first, the way in which the Humboldt EBUE has for ages responded to climate variability is a good indication of what might be the outcome of anthropogenic-induced climate change. In fact experts suggest that climate change will increase the productivity of the EBUEs augmenting their supply of primary food not only to the coastal seas but also to the high seas through large coastally-formed open ocean-ward migrating eddies. While this outcome is good news for high seas fishers it also represents an untapped opportunity to coastal communities where we foresee a successful application of a today not much mentioned sea-food production technology, that of artificial-reef-based marine farming.

Eastern countries have long practiced artificial-reef-based marine farming but surprisingly it has never been tried in a large scale in the most productive ecosystems in the world such as the EBUEs. Reasons for this failure could be find in the huge supplies of a few small plankton-eating pelagic fish species such as anchovy and sardine, the prey of more valuable fish species, a situation that is now questionable. During several decades the abundance of small pelagic schooling fish sustained a huge salmon pen culture industry based on cheap fish-meal a situation that is now encountering difficulties and a sure demise. Thus, not only for natural bio-oceanographic reasons but also for social reasons the artificial reef-base marine farming should in large scale be exported into the EBUEs probably starting with the HEBUE.

In this connection, the APEC organization is seen as having the potential of contributing to a paradigmatic change in the way of using the ocean food producing capability of the EBUEs. It is thus suggested that the application along the HEBUE of marine biomass production systems long-practiced in the Eastern APEC economies - artificial reef-based farming - could in the mid-term, not only replace the traditional output from this marine ecosystem while the overexploited species recover, but also replace in the midterm environmentally unfriendly practices and add up to the traditional use of the HEBUE´s productivity with a methodology so far not used there and thus transform it into a significant contributor to world marine food security.

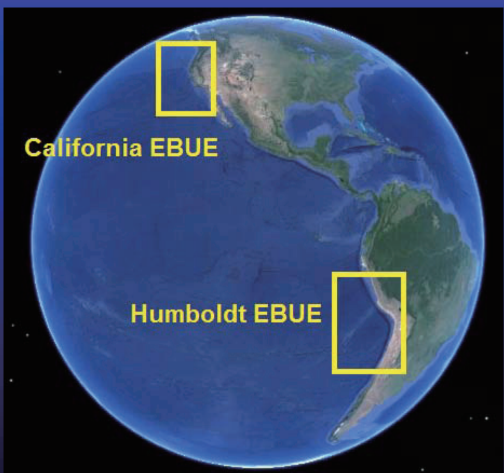
As a conclusion, it is posited that the HEBUE, an Eon-old large marine ecosystem, well tested along the geological history, should withstand the on-going climate change process, maintaining and perhaps even increasing its primary productivity to the benefit of society at large. The possible contribution of APEC´s OFWG´s could go long ways in advancing the above proposition of helping stablishing artificial-reef-base marine farming which in the HEBUE would not only favor the increased production of coastal fish but also and particularly of shell-fish and algae.

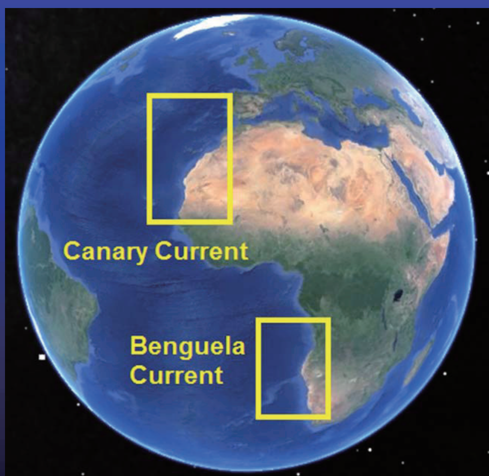
“Workshop on the Climate Change Impact on Oceans and Fisheries Resources”
“ Impact of Climate Change on the Marine Environment”
Boracay, Philippines, May 9, 2015

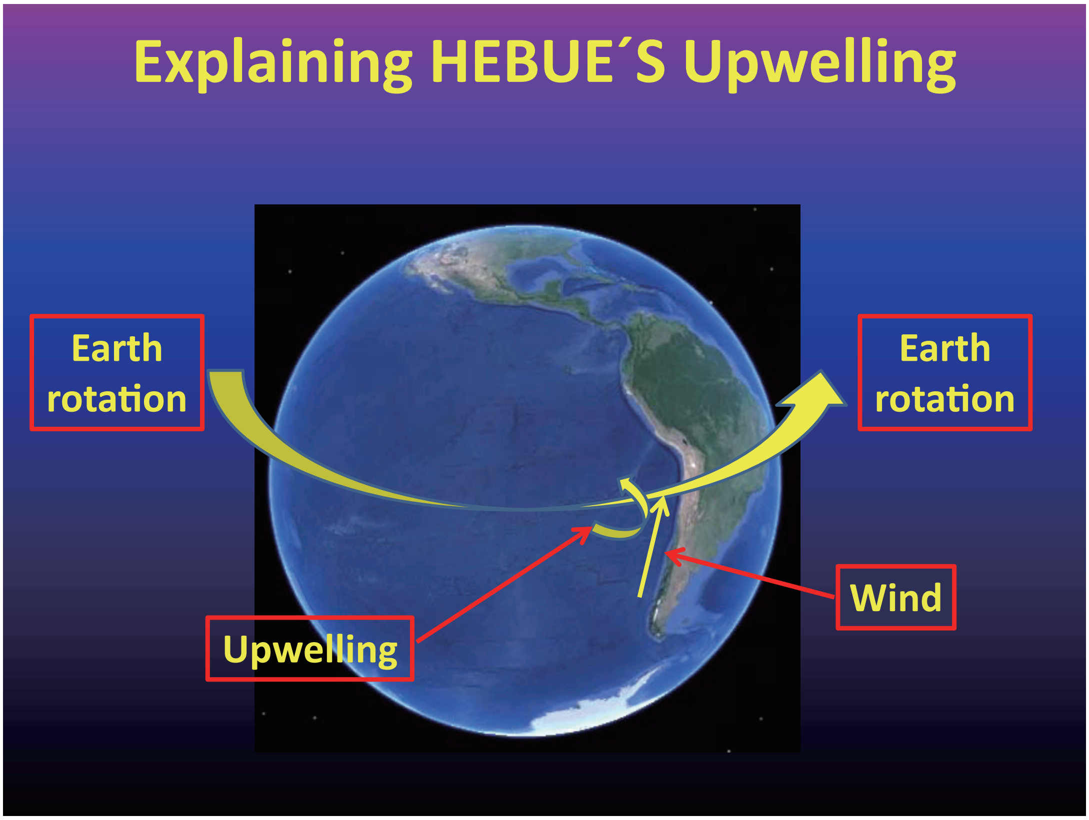
The Case of the Climatically Variable Humboldt Eastern Boundary Upwelling Ecosystem

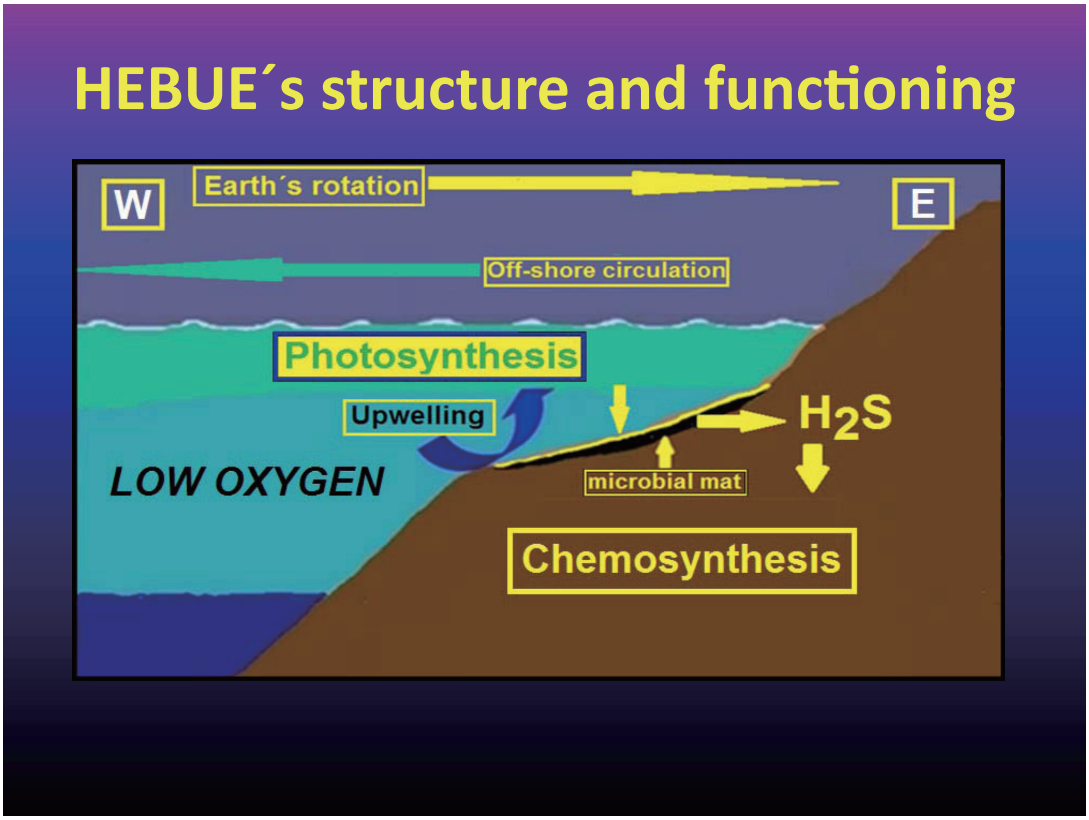
Víctor A. Gallardo
Department of Oceanography
University of Concepcion, Concepcion
Chile

Eastern Boundary Upwelling Ecosystems (EBUEs)



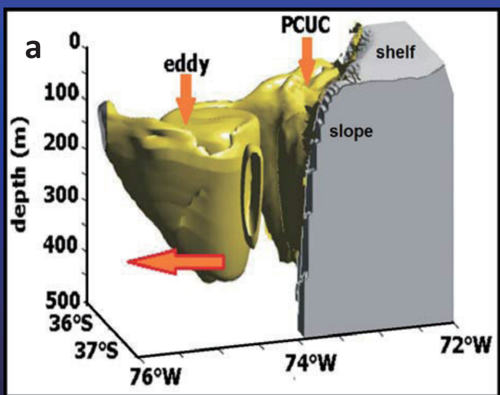



Explaining HEBUE´S Upwelling
Earth rotation
Earth rotation
Wind
Upwelling

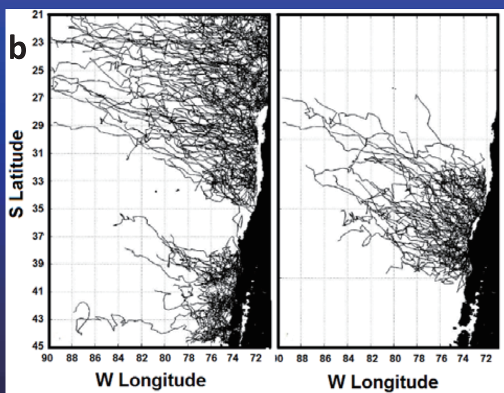

HEBUE´s structure and functioning
W
Earth´s rotation
E
Off-shore circulation
Photosynthesis
Upwelling
H2S
LOW OXYGEN
microbial mat
Chemosynthesis

HEBUE´s Chemosynthetic System

The HEBUE feeds also the seas off shore through wandering eddies



(Hormazábal et al. 2013)



(Andrade et al. 2014)

Environmental Variability

1. Weekly: upwelling events
2. Intra-annual: seasonality
3. Inter-annual: ENSO cycle (EN – LN)
4. Decadal: EN- or LN-dominated cycles
5. Multidecadal:

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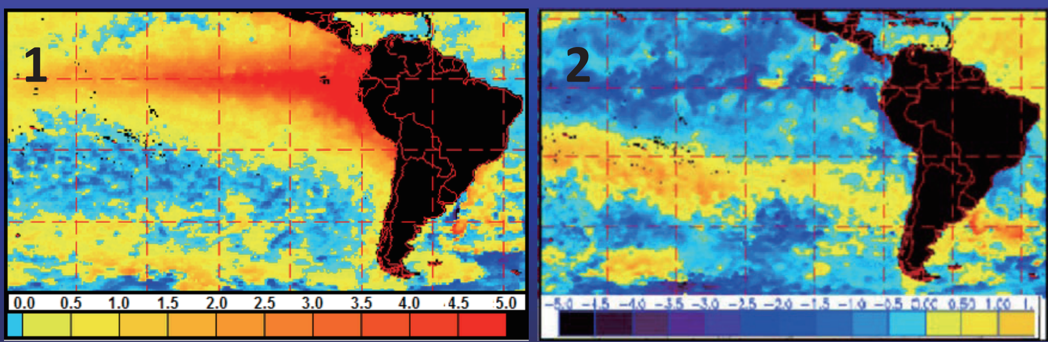
3. Interannual Variability

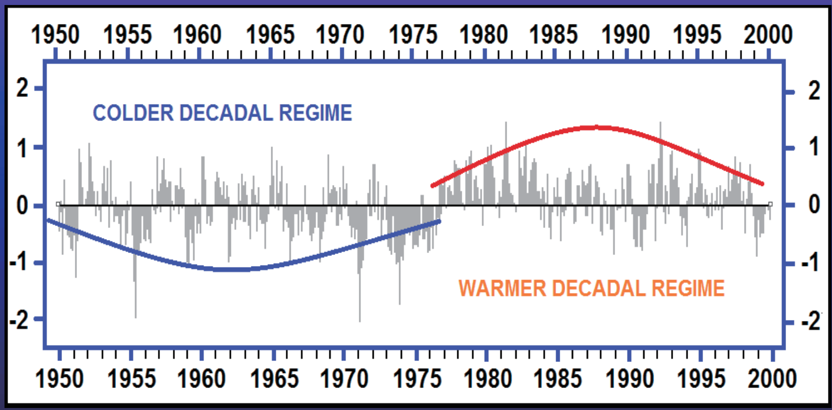


Sea surface temperature anomalies (°C) during

(1) El Niño 1997-98 – (2) La Niña 1999

http://www.ospo.noaa.gov/data/sst/anomaly/1997/anomnight.8.19.1997.gif

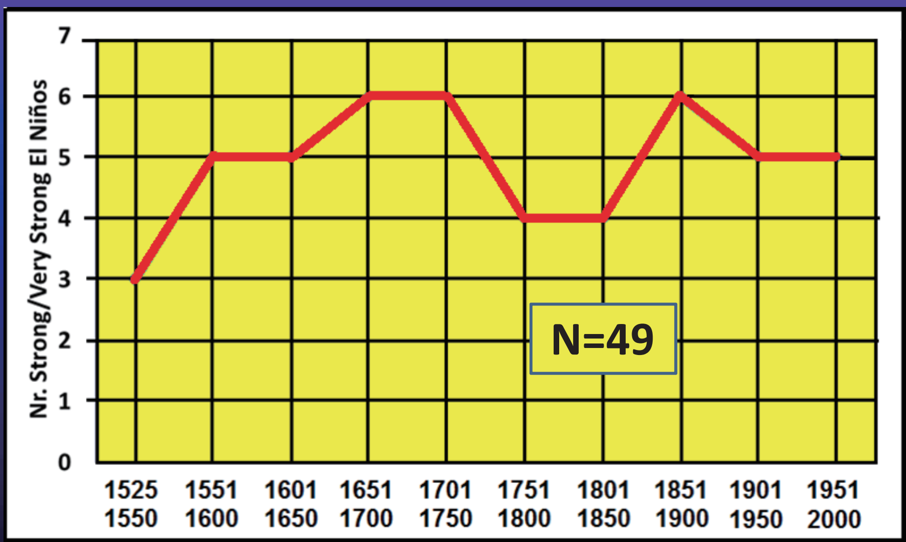
4. Decadal Variability



Two decadal regimes off Valparaiso

(Ribbe 2001)

5. Multidecadal Variability



(From: Quinn et al. 1987 and the MEI of Colorado University)

Which could be the expected effects of Climate Change on the HEBUE?

1. <u>On its functioning:</u>
   - Changes in primary productivity: both by the photosynthetic and chemosynthetic systems,

and

2. <u>On its structure:</u>
   - Changes in the composition of the pelagic (water colum) and benthic (sea-bottom) assemblages.
   - Changes in the biomass of both.

What does the litterature and experience suggest?

1. Primary productivity:
   - Increments are already reported for the pelagic primary productivity offPeru. (We have no information on the benthic system as yet).

2. Secondary production:
   - According to previous experience the pelagic schooling species, *Engraulis ringens* (anchovy) would be favored over sardine (*Strangomera bentincky*).
   - Bottom resources both over and below the oxygen minimum zone could be favored by the increased photosynthetic primary production.

1-3. Impact of Climate Change on Coastal Ecosystem and Practice for Adapting

Dr. Shaobo Chen
Professor, Zhejiang Mariculture Research Institute, China

Climate change has caused various negative effects on coastal ecosystems, including: (1) temperature increment, which may impact coastal biogeographical distribution and cause species composition changes; (2) CO_2 concentration increase, which leads to the acidification area expansion in oceans; (3) sea level rise, which greatly affects the coastal (e.g. mangrove and saltmarshes); (4) precipitation pattern shift, which increases both the intensity and frequency of droughts and floods; (5) hydrological structure change, which may also change the path and pattern of oceanic circulation, thereby influencing larvae transportation to estuarine nurseries; (6)UV-B radiation enhancement, which leads to the abnormal changes of coastal biological structure and function and may damage animals at the genetic level. All these changes impact the global biodiversity at gene, species and ecosystem levels and the impacts will be stronger in the future based on the forecasting data，which may cause big disasters to the coastal ecosystems.

In China, coastal areas account for 12% of the land area, carry more than 40% total population, and create 70% total GDP. Therefore, the coastal zones are the important foundation both for coastal biodiversity regional social-economic development. However, the coupling effects of human activities and climate change has further increased the vulnerabilities and sensitivities of the coastal ecosystems. Formulating scientific adapting strategies and adopting efficient adapting measures to improve the coastal ecosystems' resilience has become an urgent need for the coastal sustainability. China's countermeasures to climate change for coastal ecosystems are generalized briefly as follows: (1) Management of the sea areas and coastal resources in a scientific and rational way; (2) Carrying out projects on coastal ecosystem conservation and rehabilitation; (3) Conducting studies to figure out the climate change impacts on coastal ecosystems; (4) Strengthening international coordination and communication on the related researches and case studies.

As an institute engaging in ocean and fisheries public programs, Zhejiang Mariculture Research Institute (consisting of one headquarter and four stations, namely Ximen Island Station, Qingjiang Station, Dongtou Station and Yongxing Station) has been very active in the research of coastal ecosystems' adaptation to climate change in the past few years. It has also conducted several case studies in putting proper adapting strategies in practice. These studies and practices mainly include: (1) holding a climate change themed forum – "Marine Eco-civilization Forum"; (2) carrying out two major projects of "Northward Transplantation of Mangrove Adapting to Climate Change", and "Reconstruction of Macro-algal Field";

(3) investigation of fishery resources in southeast coast of China and application of an Integrated Multi-Trophic Aquaculture (IMTA) in several coastal aquaculture farms; (4) construction of a “Long-term Ecological Research Site” and establishment of several joint laboratories studying climate change simulation and eco-rehabilitation; (5) conducting a Sino-Italian climate change cooperation program- “Ecosystem Adaptation to Climate Change in Coastal Areas of China”. It could be seen that the researches carried out by Zhejiang Mariculture Research Institute covers various aspects, which could provide a snapshot for what China has been doing on climate change and coastal ecosystems.

Impact of Climate Change on Coastal Ecosystem and Practice for Adapting

Shaobo CHEN, Ph.D., Professor

Email: chenshaobo@hotmail.com

Zhejiang Mariculture Research Institute
(ZMRI)

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CONTENTS

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Ⅰ.Impact of climate change on coastal ecosystem

Climate change

United Nations
Framework Convention on
Climate Change

"Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Ⅰ.Impact of climate change on coastal ecosystem

Coastal Ecosystem

The coastal zone, broadly defined as near-coast waters and the adjacent land area, forms a dynamic interface of land and water of high ecological diversity and critical economic importance.

From: Climate Change Impacts and Adaptation: A Canadian Perspective

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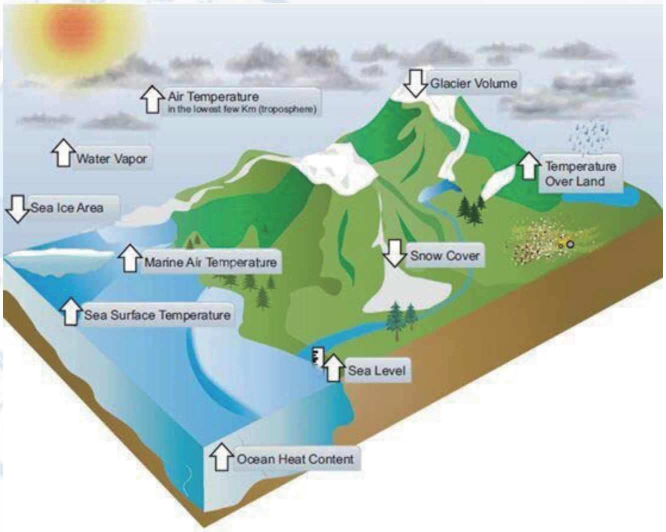
Ⅰ.Impact of climate change on coastal ecosystem

Impact of main eco-factors of climate change on the coastal ecosystem

1. Temperture
2. CO_2
3. Sea level
4. Precipitation
5. Hydrological structure
6. UV



Climate change impacts global biodiversity in gene, species and ecosystem levels.

•In gene level, organisms have to change their gene sequences in order to adapt to new climate conditions and thus affect the genetic diversity.

• In species level, studies shows that 24% species will be extinct in 2050.

•In ecosystem level, ecosystem boundaries change.

Endangered species—Polar Bear

Recent investigation on the fish species in northern Taiwan Strait shows

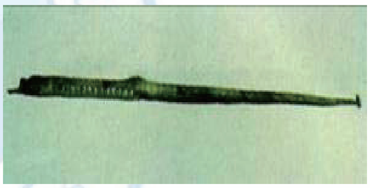
fish species diversity is decreasing, from 366 species in mid-1980s to 246, i.e., 120 species disappeared. However, 13 species of newly-recorded fish adapting higher temperature appeared

---

美鳐 ***Raja pulchra*** **Liu**

孔鳐 ***Raja porosa*** **Günther**

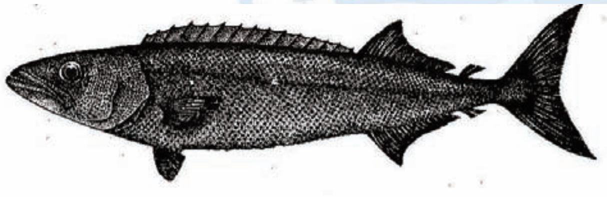
尖牙鲈 ***synagrops japonicus***
（Steindachner et Doderlein）



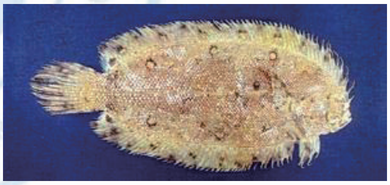
海蠋鱼 ***Halicampus koilomatodon*** **(Bleeker)**

尖尾黄姑鱼 *Nibea acuta* Tang

慧琪豆娘鱼***Abudefduf vaigiensis*** （**Quoy et Gaimard**）



棘鳞蛇鲭 ***Ruventtus tydemani*** **Weber**



褐斜鲽 ***Plagiopsetta glossa*** **Franz**

豹鳎 ***Pardachirus pavominus*** **(Lacépède)**

栉鳞鳎 ***Aseraggodes kobensis*** **(Steindachner)**

蛾眉条鳎 ***Zebrias quagga*** **(Kaup)**

拟三刺鲀 ***Triacanthodidae anomalus*** **(Temminck et Schlegel)**

Study on long-term changes of phytoplankton community in Xiagu Sea waters of Xiamen, China, shows

- species composition of the phytoplankton community changed greatly since the 1950s.
- The succession of dominant species in phytoplankton community is obvious:
  large-size dominant species were gradually replaced by small-size ones. Cell density of phytoplankton community increased greatly, among which cell density of the most dominant species *Skeletonema costatum* have been increasing in exponent function.
- Biodiversity of phytoplankton community declined, The structure of the entire phytoplankton community is becoming more and more singular and unstable, which makes the occurrence of red tides more frequent.
- The succession in the phytoplankton community is related to the long-term changes in marine environment, influenced by human activities and global climate changes, especially the increases of nutrient content.

Ⅱ. Adaptation & practice

1. Adaptation
1.1 Foreword

- In China, coastal areas account for 12% of the land area, carry more than 40% total population, create 70% GDP. Coastal ecosystem is the important foundation for regional sustainable social-economic development.

- China's coastal water continues to warm, coastal species composition and biogeographical distribution change obviously, large scale red tides appear continuously and fisheries resources deplete seriously. This may has affected the health and service of coastal ecosystem, and thus threaten the sustainable development of coastal social economy.

The coupling effects of human activities and climate change has further increased the vulnerabilities of the coastal ecosystem

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Extreme weather and eco-disaster

The snow disaster and freezing rain in Southern China, 2008

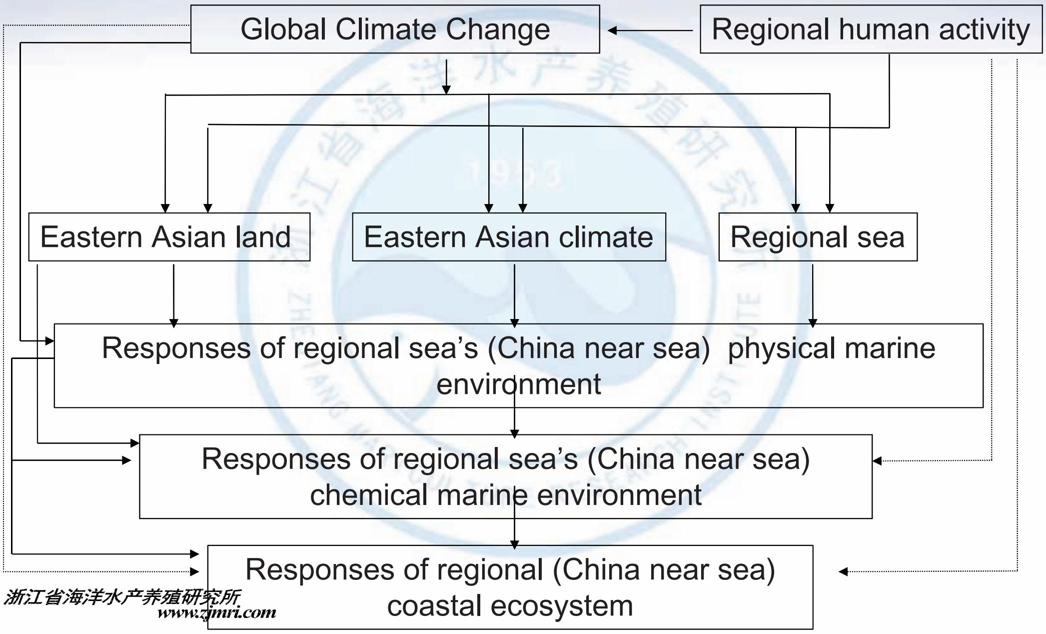
Algal bloom in Tsingdao, 2008

Sandstorms in Xinjiang , 2012

浙江省海洋

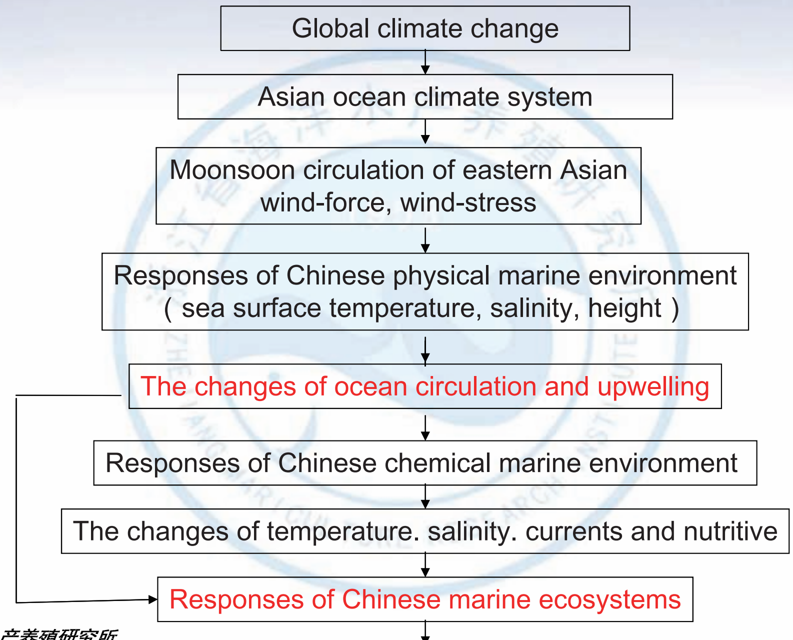
1 .2 Ecological response and critical path

Response of China's costal environment and ecosytem to Climate change



1 .2 Ecological response and critical path

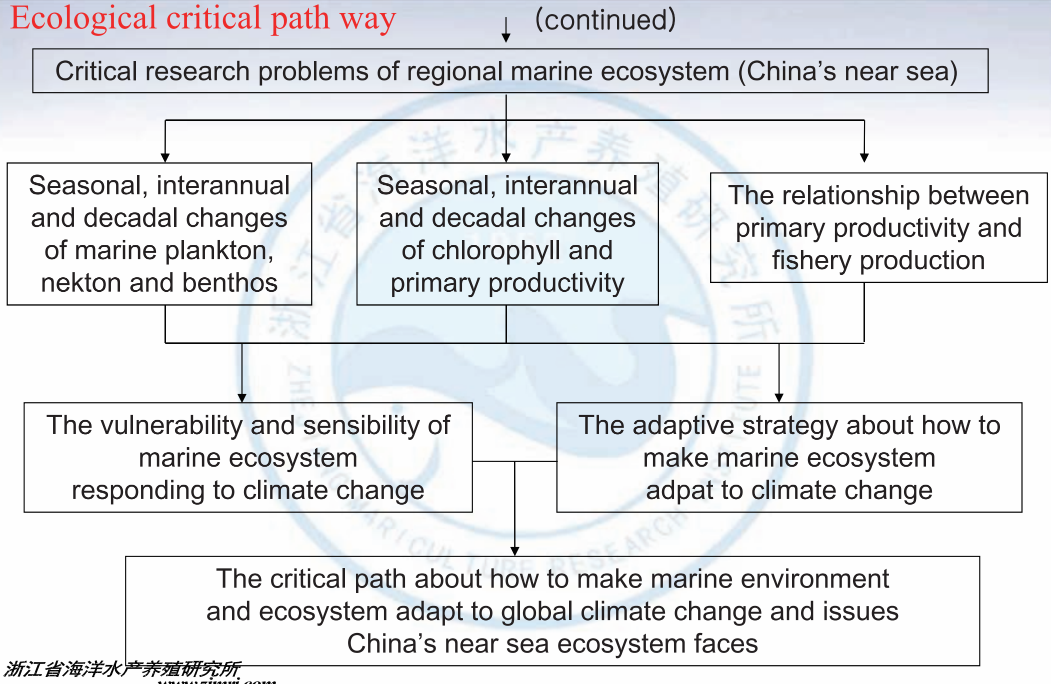
Ecological critical path way



(To be continued)

1 .2 Ecological response and critical path

Ecological critical path way



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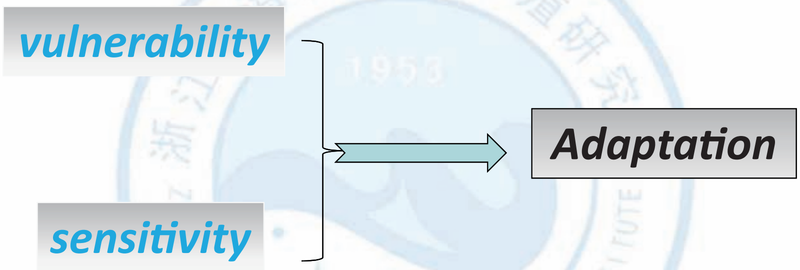
1 .2 Ecological response and critical path

The Coastal Ecosystem to Climate Change



Countermeasures of Adaptation of China's coastal ecosystem to climate change

1. Making use of the sea areas in a scientific and rational way

(1) Apply coastal and ocean zoning
(2) Implementation of ICM/EBM
(3) Adoption of Marine Spatial Planning

2. Conservation and rehabilitation of coastal ecosystem

(1) Rehabilitation and conservation of typical ecosystem
(2) Protection of water quality and ecology of coast, estuary and bay
(3) Fisheries resource reservation (including R&D of eco-aquaculture)

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Countermeasures of Adaptation of China's coastal ecosystem to climate change

3. Strengthening study on the impact of climate change on coastal ecosystem

(1) Enhancing basic research and scientific understanding
(2) Developing technologies concerning eco-rehabilitation, biodiversity conservation ,pollution prevention and control, disposal contaminants
(3) Conducting study on coastal sustainable strategy, ICM/EBM, and marine spatial planning.

4. Strengthening international coordination and communication

(1) Enhancing regional cooperation in marine investigation and observation
(2) Jointing exploitation and conservation in coastal bio-resource and marine environment.

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2. ZMRI's practice

1. Introduction to ZMRI
2. Marine Eco-civilization (Wenzhou) Forum
3. Mangrove Northward Transplantation
4. Reconstruction of Macroalgal ground
5. Investigation of fishery resources
6. Eco-Aquaculture (IMTA)
7. Ocean Acidification Simulation Laboratory
8. Sino-Italian Climate Change Cooperation

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2.1 Introduction to Zhejiang Mariculture Research Institute (ZMRI)

What are we ?

•Supervised by Zhejiang Ocean and Fisheries Bureau

•A provincial research institute engaging in ocean and fisheries public programs, applied marine technologies and achievement transfers

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Geographical localizations

Stations

- Qingjiang Station
- Dongtou Station
- Yongxing Station
- Ximen Island Station

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Qingjiang Station

Area : 17.5*ha*;

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Qingjiang Station

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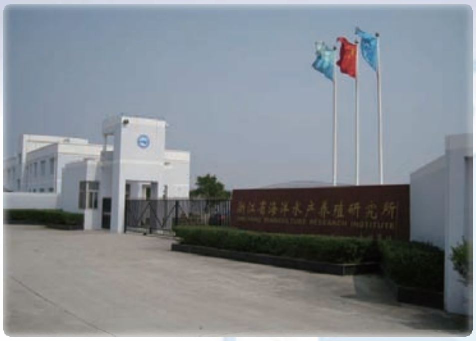
Yongxing Station



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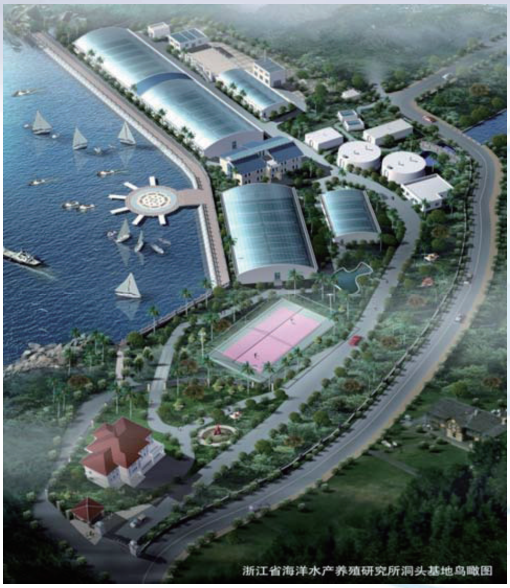
Dongtou Station

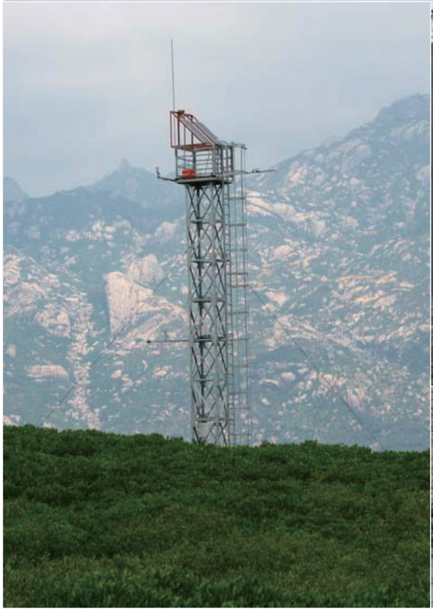


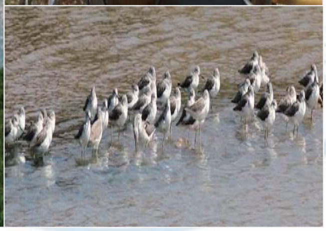
Area : 1.6 *ha.*

Dongtou Station

- Marine Algae Research Center
- Fine laver species farm
- Marine Aquarium Fish Research Center

Ximen Island Station





Long Term Ecological Research (LTER) Site in Ximen Island

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Research area:

Mariculture

Coastal ecology

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Mariculture

1. Aquaculture Germplasm Resources Survey (Protection) and Sustainable Utilization

2. Research and Development of New Aquaculture Species Selection and Breeding Techniques

3. Dominant Aquaculture Species Improvement Techniques

4. Efficient and Healthy Aquaculture Model and Techniques

5. Aquaculture Disease Warning and Green Prevention Techniques

6. Industralization and Systematization of Aquaculture

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Coastal ecology

1. Ecological Survey and Evaluation of Island & Coastal Area

2. Ecological Restoration Technology in Coastal Area

3. Climate Change Impacts on Coastal Area

4. Ocean Planning & Evaluation of Sea Area Utilization

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2.2 Marine Eco-civilization (Wenzhou) Forum

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2.2 Marine Eco-civilization (Wenzhou) Forum

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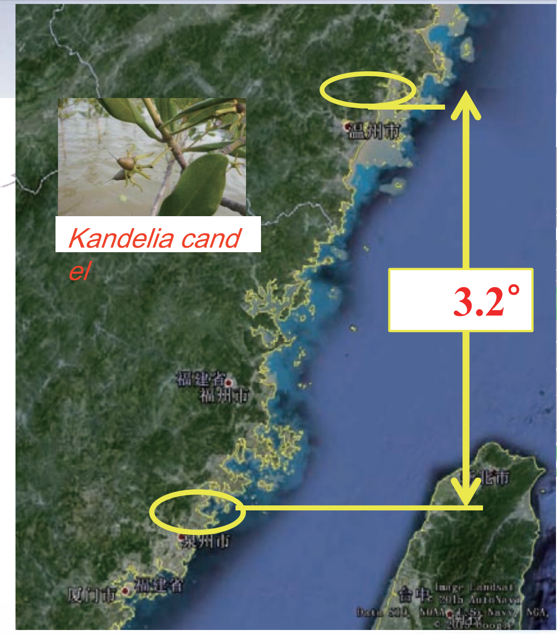
2.3 Mangrove Northward Transplantation



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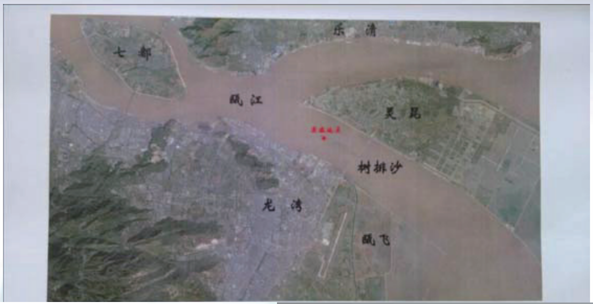
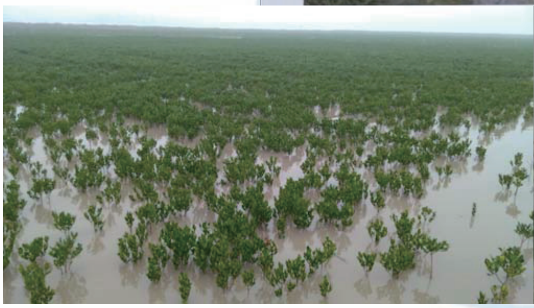
2.3 Mangrove Northward Transplantation

2.3 Mangrove Northward Transplantation





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2.3 Mangrove Northward Transplantation

PUBLICATION

Ecology of Northward Transplantation of Mangrove Adapting to Climate Change

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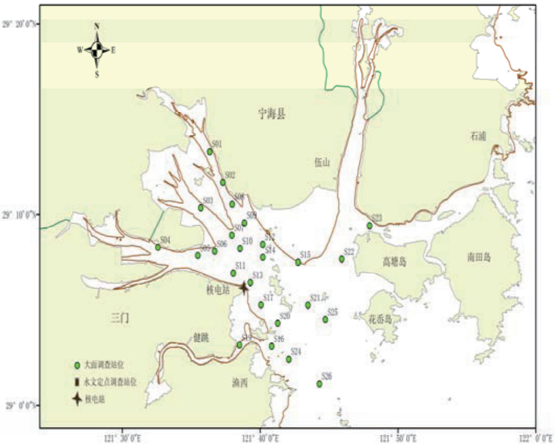
2.4 Reconstruction of Macroalgal ground

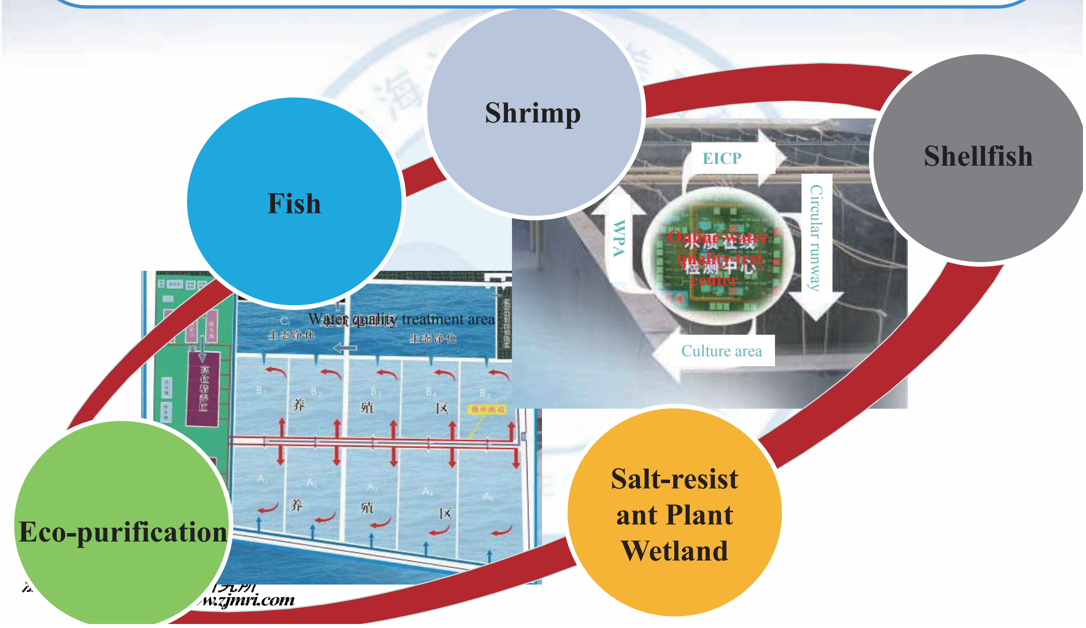
Sargassum horneri

2.5 Investigation of fishery resources



2.6 Eco-Aquaculture, Integrated Multi-Trophic Aquaculture System(IMTA)

Ecological circulating model for coastal aquaculture –
efficiency, ecology, security, energy saving and emission reduction



Circulating aquaculture system satellite map

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Benefits of the circulating model

- Energy conservation.
- Low emission - comparing to the intensive cultivation mode, it reduces the aquaculture sewage more than 80%.
- Safety - avoiding marine pollution, reducing the spread of pathogens.
- High yield - net income per hectare is more than 225000 RMB, whereas traditional cultivation mode is 90000 RMB.

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2.7 Climate change simulation and eco-rehalibitaiton labs

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2.7 Climate change simulation and eco-rehalibitaiton labs

Setting up simulation systems for studying the impact of climate change on marine organism

- Warm(finished)
- Acidification (under construction):
  - Phytoplankton Mesocosm
  - Benthos research system
- UVR(planed)
- nutrients(planed)

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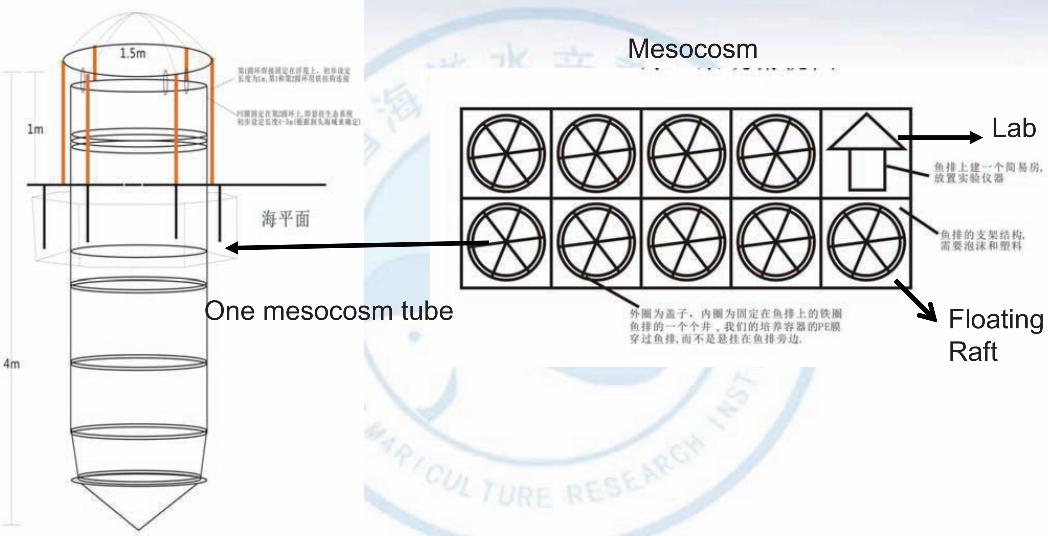
2.7 Climate change simulation and eco-rehalibitaiton labs

Phytoplankton Mesocosm



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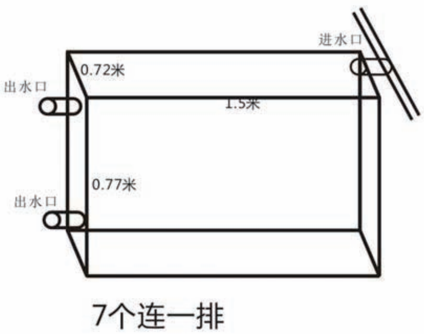
2.7 Climate change simulation and eco-rehalibitaiton labs

Benthos research system



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2.8 Sino-Italian Climate Change Cooperation

Ecosystem Adaptation to Climate Change in Coastal Areas of China (ECOADAPT)

1. Project Background
2. Objective and Activities
3. Project Management
4. Project Implementation
5. Project Achievements
6. Future Actions

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Ⅰ. Project Background

Wenzhou is a valid site for the project implementation：

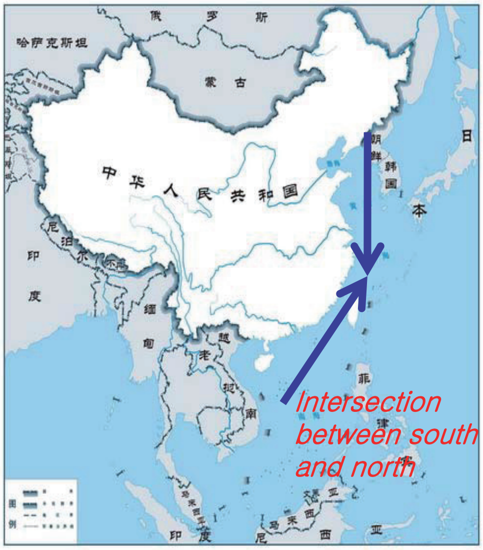
1）Wenzhou has a special geographical position and unique ecological environment with great biodiversity; ；

2）Wenzhou is the interchange of north and south currents, and the transitional zone of temperate, subtropical, tropical ；

3）Wenzhou has the most northern mangrove ecosystem in China ；

4）Wenzhou has been listed as China Marine Economy Experiment Area ；

5）Wenzhou has local economic and the employees related which highly depend on marine activities 。



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Project Organization Construction

- The project is under the guidance of the National Development and Reform Commission and the State Oceanic Administration of China. The project coordinator of Chinese side is Professor Wen Quan (National Center of Marine Environment Monitoring, China), and Mr. Augusto Pretner (DFS Engineering Consultants Co., Ltd., Italy),. Professor Chen Shaobo (Zhejiang Mariculture Research Institute, China) and Mr. Fabio Frascella (DFS Engineering Consultants Co., Ltd., Italy) are the assistant coordinators.

Implementing Partner：

- **Zhejiang Mariculture Research Institute,China**
- **DFS Engineering Consultants Co., Ltd.,Italy**

Participating Partner：

Peking University,China

Zhejiang University,China

Xiamen University,China

Wenzhou Medical University,China

Shanghai Jiaotong University,China

Euro-Mediterranean Center on Climate Change (CMCC), Italy

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Ⅱ.Project Objective and Activities

- Evaluate the climate change effect on the coastal and marine environment, identify indicators for the monitoring of the climate change and the environment;
- Identify measures for the protection of the coastal and marine environment, make Action Plan for Ecosystem Adaptation to Climate Change in Coastal Areas
- Capacity building of climate change adaptation, extend lessons and experience

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Ⅱ.Project Objective and Activities

- Work Package 1 Baseline Assessment:
- Work Package 2 Action Plan for Eco-system Adaptation to Climate Change in Coastal Areas
- Work Package 3 Capacity building of Ecosystem Adaptation to Climate Change
- Work Package 4 Follow up and Dissemination

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Ⅲ.Project Management

3.1Project steering committee

Director：

Zhang Zhanhai, Former DG of Department for International Cooperation, State Oceanic Administration

Member：

Huang Wenhang, Division Director of Department for Climate Change, National Development and Reform Commission

Yi Xiaolei, Deputy DG of Department for Oceanic Forecast and Disaster Relief, State Oceanic Administration

Wei Quanmiao, Deputy DG of East China Sea Branch, State Oceanic Administration

Yu Yongyue , Deputy DG of Zhejiang Provincial Ocean and Fisheries Bureau

Ren Yuming, Deputy Mayor of People's Government of Wenzhou

Alessandro Celestino, Program Supervisor of Sino-Italian Cooperation Program for Environmental Protection

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3.2 Project Implementation Office

- **Chief：**

Huang Tao, Director of Wenzhou Ocean and Fisheries Bureau

- **Deputy Chief：**

Wen Quan, National Center of Marine Environment Monitoring

Xie Qilang, Director of Zhejiang Mariculture Research Institute

Augusto Pretner, Chairman of DFS Engineering Consultants Co., Ltd.Italy

Chen Haipeng, Deputy Director of Wenzhou Ocean and Fisheries Bureau

- **Member：**

Wang Feng, Department for International Cooperation, State Oceanic Administration

Hu Xuejun, Division Director of Department for Oceanic Forecast and Disaster Relief, State Oceanic Administration

Chen Shaobo, Deputy Director of Zhejiang Mariculture Research Institute

Gao Yuansen, Chief of Environment Division, Wenzhou Ocean and Fisheries

Fabio Frascella, General Manager of DFS Engineering Consultants Co., Ltd.Italy

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3.3 Project Kick-off Meeting

- The project kick-off meeting was held on 14th - 15th September 2012 in Wenzhou with representatives of Ministry for the Environment, Land and Sea of the Republic of Italy, National Development and Reform Commission, State Oceanic Administration, Zhejiang Provincial Ocean and Fisheries Bureau, Wenzhou Municipal Government, Zhejiang Mariculture Research Institute, and DFS Engineering Consultants Co., Ltd.Italy.

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3.4 Project Management Meeting

During the project implementation, several project management meetings were held to evaluate project progress, with representatives of National Development and Reform Commission, State Oceanic Administration, , Program Supervisor of Sino-Italian Cooperation Program for Environmental Protection.

3.5 Workshop in Italy

- International Workshop of Ecosystem Adaptation to Climate Change in Coastal Areas of China had been held in Italy between June 24-26, 2014. The main content of the workshop embodied keynote speeches and field visits, aiming at presenting the outputs of ECOADAPT Project and at highlighting some important case studies related to management of coastal areas in view of a changing environment.

IV. Project Implementation

- **Work Package 1 Baseline Assessment:**
- **Work Package 2 Action Plan for Eco-system Adaptation to Climate Change in Coastal Areas**
- **Work Package 3 Capacity building of Ecosystem Adaptation to Climate Change**
- **Work Package 4 Follow up and Dissemination**

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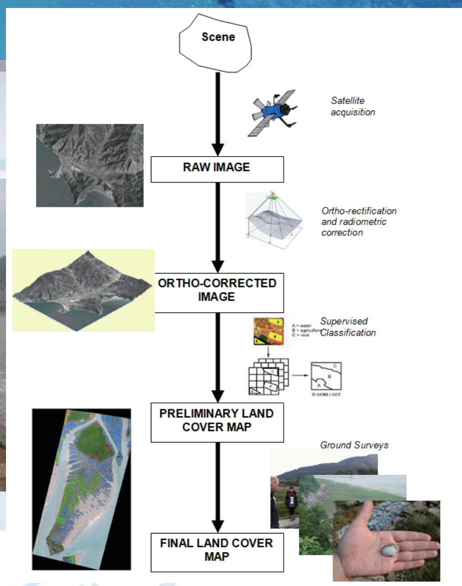
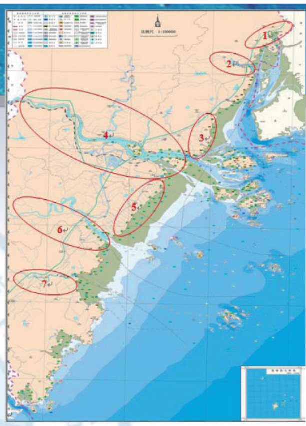
(1) .Baseline Assessment

1.Data collection and analysis, complementary survey

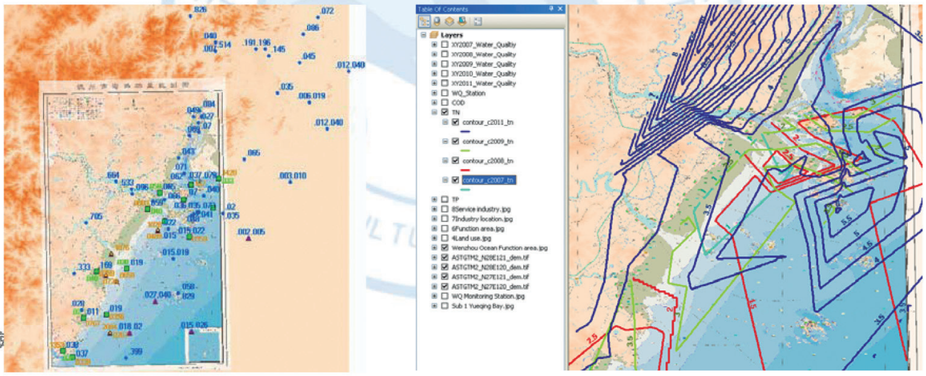


(1).Baseline Assessment



2.Evaluation of Climate Change Effect

Based on data collection and analysis, a baseline database and GIS were developed for the project area, with map overlayer technology, which was used to analyze human activity and climate change effect on coastal ecosystem.



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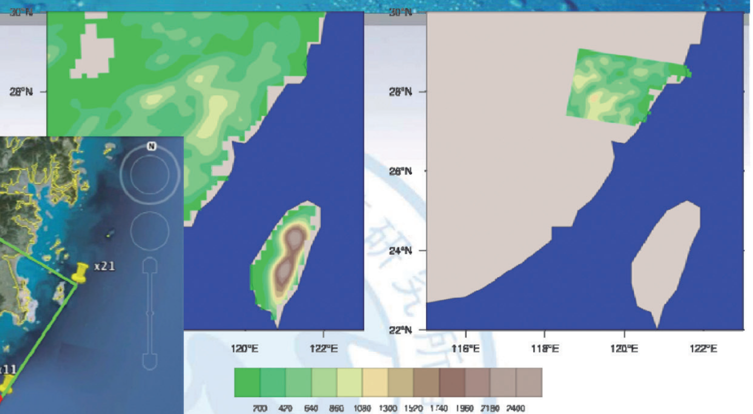
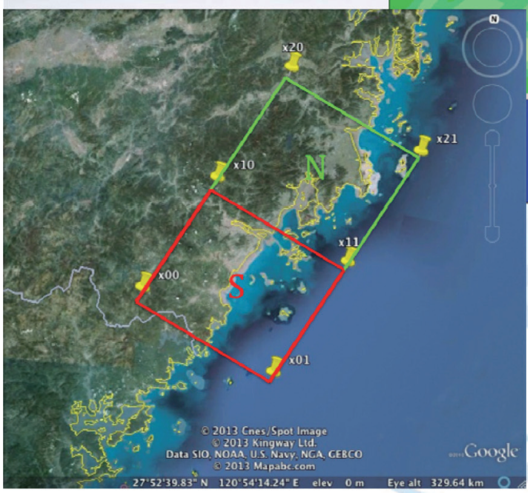
(1).Baseline Assessment

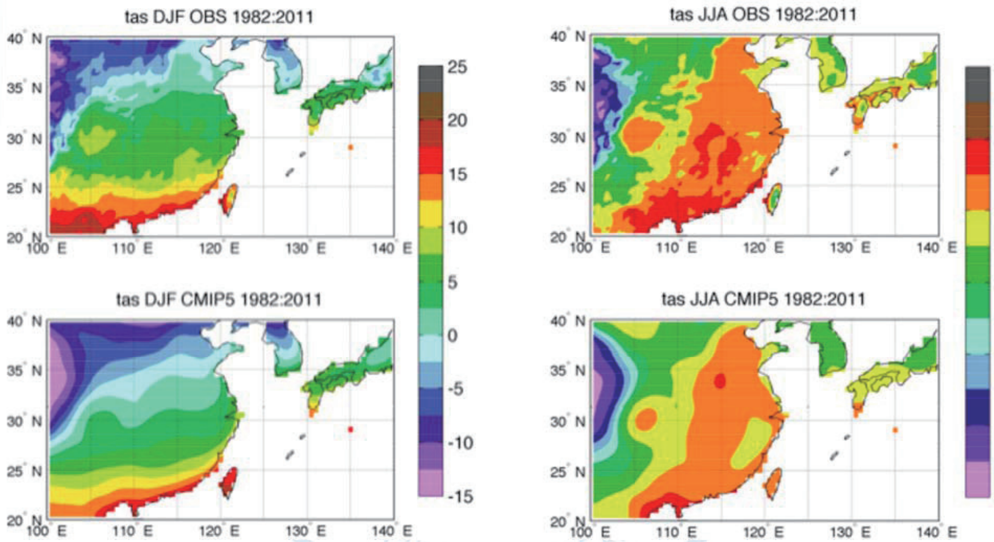
3.Climate Change Model and Forcast



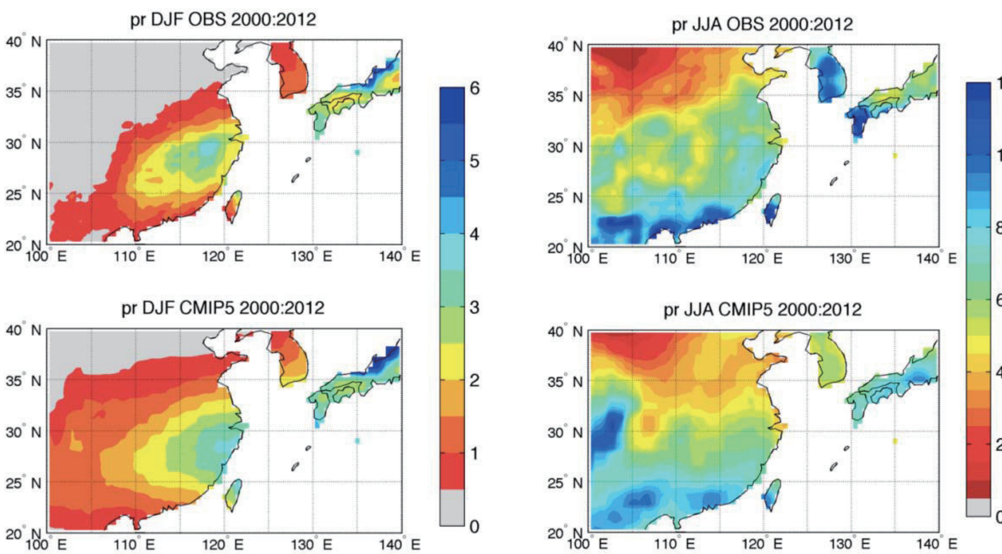


RCM model domains: the 14km resolution version (top left panel) and the 8km resolution version (right top panel). The pictures show the representation of geography. The right panel shows the two domains defined for the computation of the monthly mean time-series used to characterize the climate change signal in the area of interest and to produce the data.

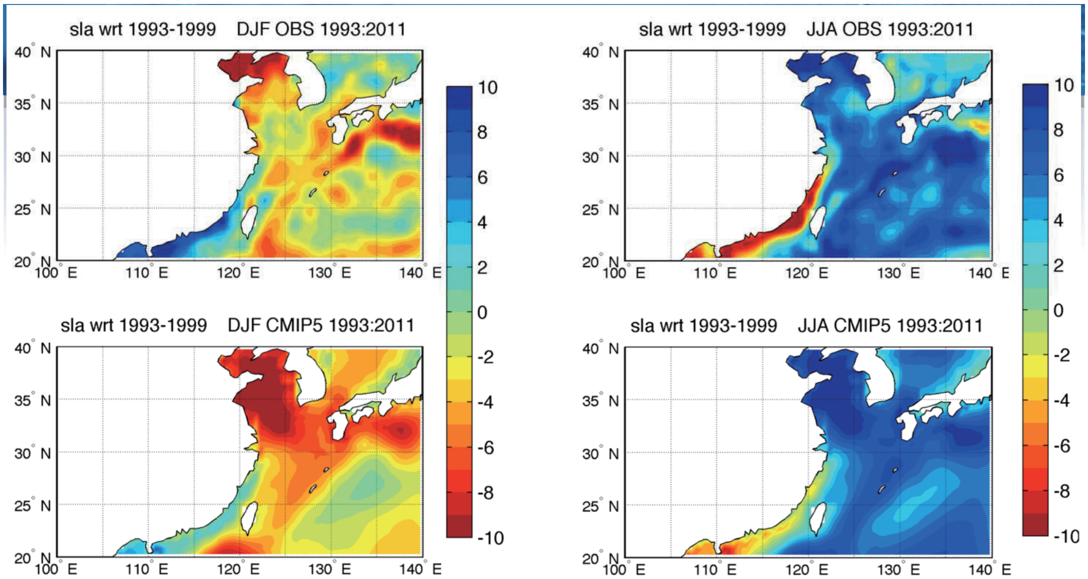
(1) .Baseline Assessment



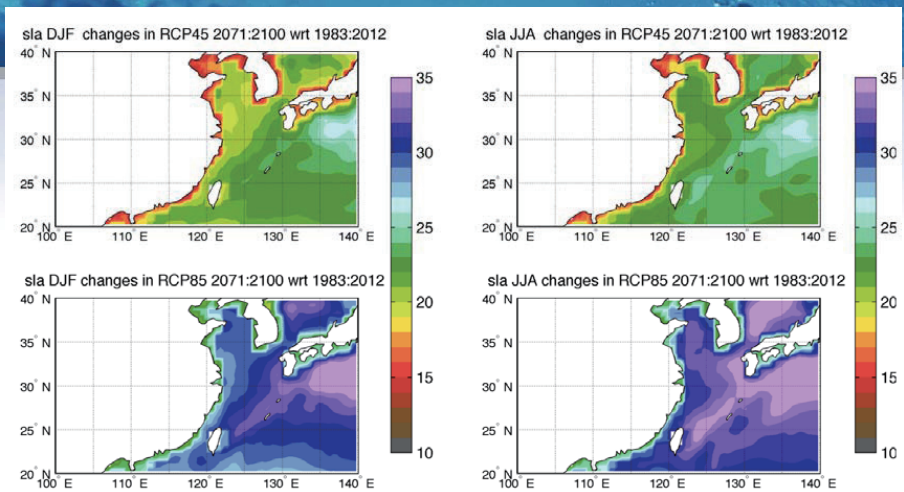
2-meter air temperature (TAS) seasonal means as represented by CMIP5 models (lower panels), compared to CRU observations (upper panels), during the present period.



Seasonal mean precipitation (PR) as represented by CMIP5 models (lower panels), compared to TRMM-NASA observations (upper panels), during the present period. Left panels: winter mean (DJF); right panels: summer (JJA) mean. Units are [mm/d]. Color interval is 0.5 mm/d.



Seasonal means of Sea Level Anomaly (SLA) as represented by CMIP5 models (lower panel), compared to AVISO observations (upper panel), during the present period. Anomalies are computed with respect to 1993-1999 averaged values. Color interval is 1 cm.



June-August changes in sea level anomaly (colours) at the end of simulated RCPs (2071-2100) with respect to the present period (1983-2012, contours) under RCP4.5 (upper panel) and RCP8.5 (lower panel). Units are [cm]. Colour contour interval is 1 cm.

The sea level of Wenzhou coast will rise up to 25-30 cm(2071-2100/1983-2012) according to the model forcast.

(1) .Baseline Assessment

4.Identification of Indicators

- Human activity indicators, including ecological deficit, population density, land use, industrial sector, pollution load
- Climate change indicators, including sea level rise, temperature, precipitation,acidification
- Ecological indicators, including seawater quality, sediment quality, biodiversity, marine protected area, mangrove

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(2) Action Plan for Eco-system Adaptation to Climate Change in Coastal Areas

Based on:

- National Strategy on Climate Change Adaptation
- National Program on Climate Change
- Zhejiang Action Plan on Climate Change
- Baseline assessment of project Work package 1

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(2) Action Plan for Eco-system Adaptation to Climate Change in Coastal Areas

Actions for Adaption to Climate Change

•Strengthen comprehensive prevention and treatment of land and sea pollutions.
•Strengthen water conservancy infrastructure construction, and improve overall agricultural productivity.
•Intensify adaptive capacity of forest and other eco-systems.
•Improve the ability of comprehensive allocation of water resources in Wenzhou City.
•Implement coastal engineering, and improve standards for tide protection in coastal and estuary areas.
•Carry out long-term ecological monitoring on eco-systems in coastal areas, and establish and improve monitoring system and mechanism.

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(2) Action Plan for Eco-system Adaptation to Climate Change in Coastal Areas

Policies for Adaption to Climate Change

•Set up relevant plans, and improve local regulations.
•Enforce department management, and increase administrative coordination.
•Implement organizational guarantees, and define main responsible bodies.
•Pay attention to overall planning, and tighten up evaluation management.
•Expand money input, and improve fund-raising mechanism.
•Highlight scientific studies, and improve support ability.
•Promote International communication, and deepen scientific and technological cooperation.
•Intensify publicity and education, and advance public participation.

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(3) Capacity building of Ecosystem Adaptation to Climate Change

1.Long term monitoring system improved

4 rotors helicopter

Water quality monitoring buoy

Air monitoring station

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(3) Capacity build of Ecosystem Adaptation to Climate Change

2. Simulation climate change system

Heating system

数据记录时间	1号模拟加热箱		2号模拟加热箱		加热箱外对照	
	空气温度 ℃	空气湿度 %	空气温度 ℃	空气湿度 %	空气温度 ℃	空气湿度 %
2013/4/16 14:20	24.9	59.73	24.89	59.74	21.39	70.43
2013/4/16 14:25	24.6	60.18	24.61	60.18	21.46	69.71
2013/4/16 14:30	24.6	60.04	24.6	60.03	21.62	68.86
2013/4/16 14:35	25.19	58.08	25.17	58.08	21.94	68.08
2013/4/16 14:40	25.74	55.57	25.75	55.58	22.05	66.45
2013/4/16 14:45	26	54.9	26	54.9	22.11	65.82
2013/4/16 14:50	25.56	56.24	25.55	56.23	22.08	66.01
2013/4/16 14:55	25.3	56.44	25.3	56.45	22.02	65.49
2013/4/16 15:00	25.76	54.49	25.77	54.49	22.3	63.75
2013/4/16 15:05	26.11	53.6	26.11	53.59	22.61	62.36
2013/4/16 15:10	26.05	54.21	26.03	54.21	22.67	62.73
2013/4/16 15:15	26.57	52.43	26.58	52.44	22.71	62.69
2013/4/16 15:20	26.84	51.74	26.84	51.74	22.87	61.8
2013/4/16 15:25	26.55	52.55	26.54	52.54	22.91	61.33
2013/4/16 15:30	26.7	53.52	26.69	53.53	23.42	61.25
2013/4/16 15:35	27.55	51.19	27.56	51.2	23.51	61.13
2013/4/16 15:40	28.05	49.06	28.05	49.05	23.48	60.33
2013/4/16 15:45	28.19	48.99	28.17	48.98	23.5	60.94
2013/4/16 15:50	28.12	49.57	28.13	49.58	23.65	61.77
2013/4/16 15:55	27.98	49.94	27.98	49.94	23.09	62.72
2013/4/16 16:00	27.49	51.49	27.48	51.48	22.8	63.68
2013/4/16 16:05	27.21	52.07	27.21	52.08	22.94	62.88
2013/4/16 16:10	27.15	51.61	27.15	51.61	23.05	61.56
2013/4/16 16:15	27.16	51.89	27.16	51.88	23.03	62.68
2013/4/16 16:20	26.84	53.08	26.83	53.09	22.64	64.75

(3) Capacity build of Ecosystem Adaptation to Climate Change

3. Aquaculture adaptation

Climate change has already shown its impacts on China's coastal environment and ecosystems .Impact of climate change on macro-algae farming in Zhejiang has been observed in recent years. This task aims at developing a new adaptive farming technology for coastal macro-algae farming employees to improve the ability of coastal communities to adapt to climate change.

Measurements：

✓Seed collection by cooling
✓Seed cultivation in different sea area
✓Breeding in North and Farming in South

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(4) Follow-up and Dissemination

1.Knowledge Dissemination for public

•Science Talk Show(TV)

•Ouyue Science Popularization Program(TV)

•Books on Marine Popularization

(4) Follow-up and Dissemination

2.Train on Aquaculture Technology Adaptation to Climate Change

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(4) Follow-up and Dissemination

3.Public education

- Painting Competition and Specimen Exhibition
- Debate competition
- Dissemination by volunteers

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4.Dissemination by volunteers



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(4) Follow-up and Dissemination

5.International Science Camp





(5) Project Achievements

（1） The indicators to evaluate effect of human and climate change pressure on coastal environment has been established

（2） A climate change model has been developed to evaluate climate change current effect and future scenario.

（3） Based on climate change evaluation and cost benefit analysis, an action plan for Eco-system Adaptation to Climate Change in Coastal Areas has been formulated.

（4） Long term monitoring system has been established.

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(5) Project Achievements

（5） Macro algae breeding technology adapting to climate change has been developed

（6） Technical train has been carried out to improve adaptive capacity of local community

（7） Public education and publicity programs have been implemented, and the public awareness of climate change and marine environmental protection has been strengthened

（8） Project effect has been extended. A book titled Practices of Coastal Ecosystem Adaptation to Climate Change will be Published in this year.

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Acknowledgements

Special thanks to the authors of the following publications:

(1)Rongshuo Cai ,et al.(2010).The impact of climate change in China’s offshore ecosystems. Marine press, Beijing.

(2)Baohong Chen,Qiulin Zhou, & Shengyun Yang. (2009). The influence of climate change on Marine biodiversity. Journal of applied oceanography.

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1-4. Discussions

1. Dr. Leung presented recent observational evidence of the increasing trend of carbon dioxide as a greenhouse gas and its radiative forcing that warms the earth's surface. However, in terms of precipitation, there is a medium confidence in its changes after 1951. Certain key patterns of changes are nevertheless robust and can be explained regarding the relationship of precipitation to the global temperature. Dr. Leung explained that a degree increase in temperature translates to about 2% increase in global mean precipitation.

2. She explained further that though it may not seem to have high impact, on a global scale and in the long run, models showing large scale precipitation changes that can be explained by "wet gets wetter, and dry gets drier". It was also emphasized that global warming may alter hydrologic regimes resulting in a higher rate of increase in extreme precipitation.

3. Moreover, Dr. Leung also mentioned that the land warms about 50% more than the ocean because the land surface has a limited availability of surface water compared to the ocean to evaporate and cool the surface. Because water vapor over land does not increase fast enough relative to the warming, a warmer climate leads to a larger water vapor saturation deficit and enhances aridity at the peripheral of arid regions. Lastly, Dr. Leung underlined the implications of meteorological changes to food production through the impacts of surface temperature and precipitation on agriculture and impacts of temperature, precipitation, and salinity on marine ecosystem.

4. Prof. Víctor Ariel Gallardo of the Department of Oceanography, University of Concepcion, Concepcion, Chile presented the Case of the Climatically Variable Humboldt Eastern Boundary Upwelling Ecosystem (HEBUE).He introduced the four Eastern Boundary Upwelling Ecosystem in the world, with focus on the Humbolt EBUE. He mentioned that HEBUE has high productivity.

5. He described photosynthesis and chemosynthesis of the upwelling in terms of structure and functionality in the HEBUE. He showed a video on the seawater bottom in Chile showing its chemosynthetic system.

6. He likewise expounded on the environmental variability of the HEBUE enumerating periodic weather changes in events, seasonality's and cycles. He also stated the expected effects of Climate change on the HEBUE. He cited the suggestions based from literature and experience on primary and secondary production.

7. The presentation given by Prof. Shaobo Chen from Zhejiang Mariculture Research Institute (ZMRI) of China focused on two aspects: one is on the impact of climate change on coastal ecosystem and the other is on its adaptation and practice. On the impact of climate change on coastal ecosystem, he shared the following key points: climate change impacts on global biodiversity in gene, species and ecosystem levels; key results of the recent investigation on the fish species in northern Taiwan Strait; highlights of the study on long-term changes of phytoplankton community in Xiagu Sea waters of Xiamen, China;

8. On its adaptation and practice, Prof. Chen emphasized that coupling effects of human activities and climate change have further increased the vulnerabilities of the coastal ecosystem. One of the sub-topics that Prof. Chen shared under this aspect was the response of China's coastal environment and ecosystem to climate change and ecological critical path way. He suggested several countermeasures including making use of the sea areas in a scientific and rational way, conservation and rehabilitation of coastal ecosystem, strengthening the studies on the impact of climate change on coastal ecosystem, and strengthening international coordination and communication.

9. Prof. Chen also shared the following practices and initiatives carried out by ZMRI of China related to climate change adaption: Marine Eco-civilization (Wenzhou) Forum; Mangrove Northward Transplantation; Reconstruction of Macro algal ground; investigation of fishery resources; climate change simulation and eco-rehabilitation labs; and the Sino-Italian Climate Change Cooperation Project.

10. On the question on the possible impacts of climate change (el nino and la nina) in the pacific area, Dr. Leung shared that there are evidence that the impact intensity of extreme weather conditions will continue to increase in the future.

11. On the inquiry on impact of el nino in the central Pacific area, Prof. Gallardo explained that though their focus is in Chile, the study results has a considerable

impact on the Central Pacific Area since the ecosystem of Chile feeds the ecosystem of the high seas.

12. A Vietnamese delegate suggested for the Prof. Chen's book "practice on ecosystem's adaptation to climate change" to be translated in English. He then inquired on the next steps of the program. Prof. Chen responded that they will continue and have more joint projects related to climate change. He also responded the inquiry on bio-indicator species to be studied, such as migrating sweetfish(or ayu). He shared that the sweetfish was once considered by some researchers as a bio-indicator of the rivers leading to sea. He further explained that different areas may use different bio-indicators.

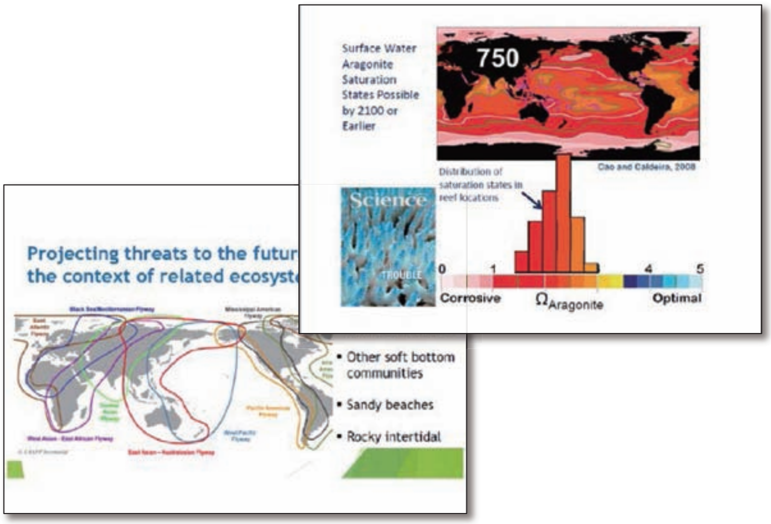
13. On the inquiry if upwelling may cause hypoxia, red tide and eutrophication, Professor Gallardo clarified that upwelling increases oxygen in the waters which causes increased nutrient concentration in the area.

14. Dr., Umezawa inquired whether the current warming will continue to go up. In response, Dr. Leung explained that there are three possible scenarios: First is that temperature will continue to go up, second- it will reach a point where it will stabilize; and third, it will eventually decline.

15. Peru shared their ongoing related studies which include decreasing trend of sea surface temperature, however they observed that mechanism is still unclear and needs to be verified. Thus he emphasized the importance of comparing and collaborating studies such as comparison of effects of El Nino in the Central and Eastern Pacific.

Chapter II

Striking Feature of Impacts



2-1. Potential Economic Implications of Ocean Acidification

Dr. Christopher Sabine

NOAA's Pacific Marine Environmental Laboratory, Seattle, WA USA

Understanding of the Earth's carbon cycle is an urgent societal need as well as a challenging intellectual problem because of its intimate connection with the Earth's climate system. The ocean plays a major role in the global carbon cycle through the uptake and redistribution of atmospheric carbon dioxide (CO_2). Atmospheric CO_2 was steady at ~280 parts per million (ppm) for longer than ten thousand years prior to the industrial revolution. Since about 1800, CO_2 has increased to more than 400 ppm because of human activities. Over the last two centuries the ocean has absorbed over 550 billion metric tons of CO_2 from the atmosphere. This absorption has resulted in measurable ocean chemical changes, including a decline in seawater pH, termed ocean acidification. Increasing acidity and related changes in seawater chemistry can affect reproduction, behaviour, and general physiological functions of many marine organisms and lead to significant shifts in marine ecosystems.

Impacts in some species are already being observed today. For example, the coral coverage of the Great Barrier Reef off Australia has seen a 50% decline over the last three decades. The US West Coast has also experienced a dramatic decrease in the natural recruitment of oysters associated with corrosive waters brought onto the continental shelf and estuaries by coastal upwelling. The effects are not just limited to organisms that produce calcium carbonate shells or skeletons. Other species, including fin fish are vulnerable, though in some cases the impacts may be indirect. For example, Salmon are able to control their internal blood chemistry and therefore are not as directly susceptible to changing ocean chemistry, but they can be negatively impacted by the loss of a primary food source, pteropods, that are directly affected by ocean acidification. Studies have also seen changes in fish behaviour under acidified conditions. Some reef fish, for example, appear to lose their ability to sense predators in high CO_2 environments and wander farther away from their shelter where they are more likely to be eaten. The Intergovernmental Panel on Climate Change (IPCC) 5th assessment report stated that a wide range of economically important marine species including corals, molluscs, crustaceans, echinoderms, and fish will likely be negatively affected by ocean acidification over the coming decades. They give a high certainty on the impact on corals, but the certainty of the effects decrease with the non-calcifying species, like fish.

There have been relatively few efforts to translate these impacts into socio-economic consequences, but the potential implications are quite large since global primary fishery sales have been estimated to be hundreds of billions of US dollars per year. Scientific understanding of the ocean chemical changes is very high. The effect of those changes on ecosystem services is less well known. Very little work has been done to assess the impact of ocean acidification on the global economy, but some initial estimates suggest it could cost over one trillion US dollars per year by the end of this century. This is an area where the APEC community can make a significant difference by helping to link the physical sciences with the economics. The latest reports from the IPCC begin to assess the societal risk of climate change and ocean acidification. They conclude that the tropical and polar oceans have among the highest risk and the lowest potential for adaptation to reduce risk, but more research needs to be done in these areas.

The international research community is coordinating its efforts to understand the global impact of ocean acidification through organizations like the Global Ocean Acidification Observing Network (http://goa-on.org). In the Western Pacific we are working with groups like the IOC sub-commission for the Western Pacific (http://iocwestpac.org/) and the Secretariat for the Regional Environment Program (http://www.sprep.org/) to expand the observing system and build ocean acidification research capacity. However, more should be done to relate this work to the local and regional economies so we can better understand the economic implications of ocean acidification in the Asia Pacific region. By linking up with existing and developing research programs in the region, the APEC community could leverage those research and monitoring opportunities to move beyond regional hazard studies to a more thorough investigation of the financial impact of ocean acidification and potential socio-economic drivers for adaptation.

APEC Project (OFWG 02 2014)

Implemented by JAPAN

APEC
Asia-Pacific Economic Cooperation

Workshop on the Climate Change Impact on Oceans and Fisheries Resources

Date & Venue : May 2015, Philippines

Potential Economic Implications Of Ocean Acidification

Dr. Christopher L. Sabine
Oceanographer and Director
NOAA's Pacific Marine Environmental Laboratory

Asia-Pacific Nations are Extremely Vulnerable to a Changing Climate in the Coming Decades

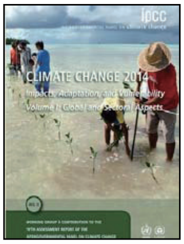
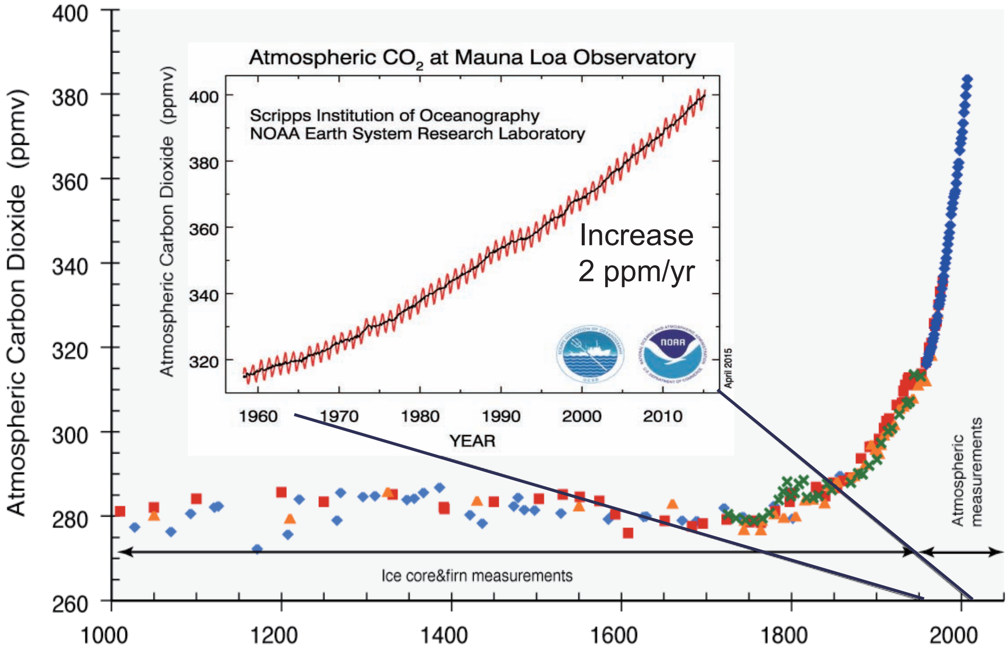


Table 29-5: Top ten countries in the Asia-Pacific region based on absolute and relative physical exposure to storms and impact on GDP (between 1998 and 2009) (after ESCAP and UNISDR, 2010).

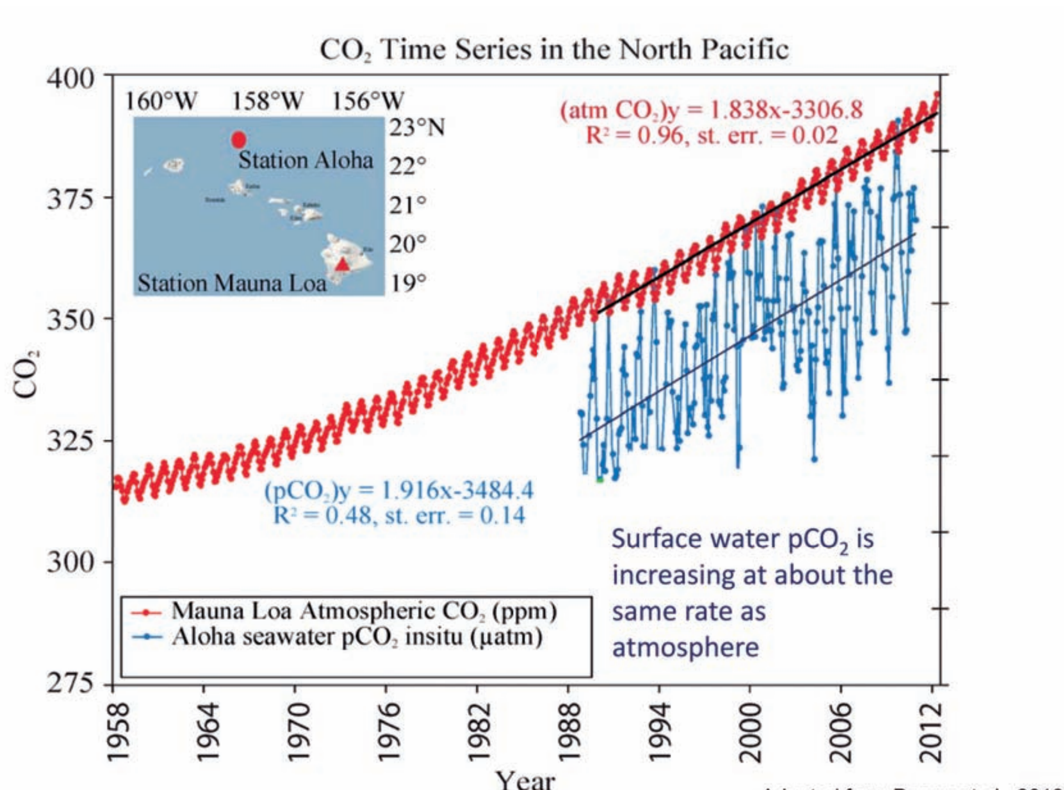
Rank	Absolute exposure (millions affected)	Relative exposure (% of the population affected)	Absolute GDP loss ($billions)	Loss (as a % of GDP)
1	Japan (30.9)	**North Mariana Islands (58.2)**	Japan (1,226.7)	**North Mariana Islands (59.4)**
2	Philippines (12.1)	**Niue (25.4)**	Rep. of Korea (35.6)	**Vanuatu (27.1)**
3	China (11.1)	Japan (24.2)	China (28.5)	**Niue (24.9)**
4	India (10.7)	Philippines (23.6)	Philippines (24.3)	**Fiji (24.1)**
5	Bangladesh (7.5)	**Fiji (23.1)**	Hong Kong (13.3)	Japan (23.9)
6	Rep. of Korea (2.4)	**Samoa (21.4)**	India (8.0)	Philippines (23.9)
7	Myanmar (1.2)	**New Caledonia (20.7)**	Bangladesh (3.9)	**New Caledonia (22.4)**
8	Viet Nam (0.8)	**Vanuatu (18.3)**	**North Mariana Islands (1.5)**	**Samoa (19.2)**
9	Hong Kong (0.4)	**Tonga (18.1)**	Australia (0.8)	**Tonga (17.4)**
10	Pakistan (0.3)	**Cook Islands (10.5)**	**New Caledonia (0.7)**	Bangladesh (5.9)

Note: Small islands are highlighted in **bold**

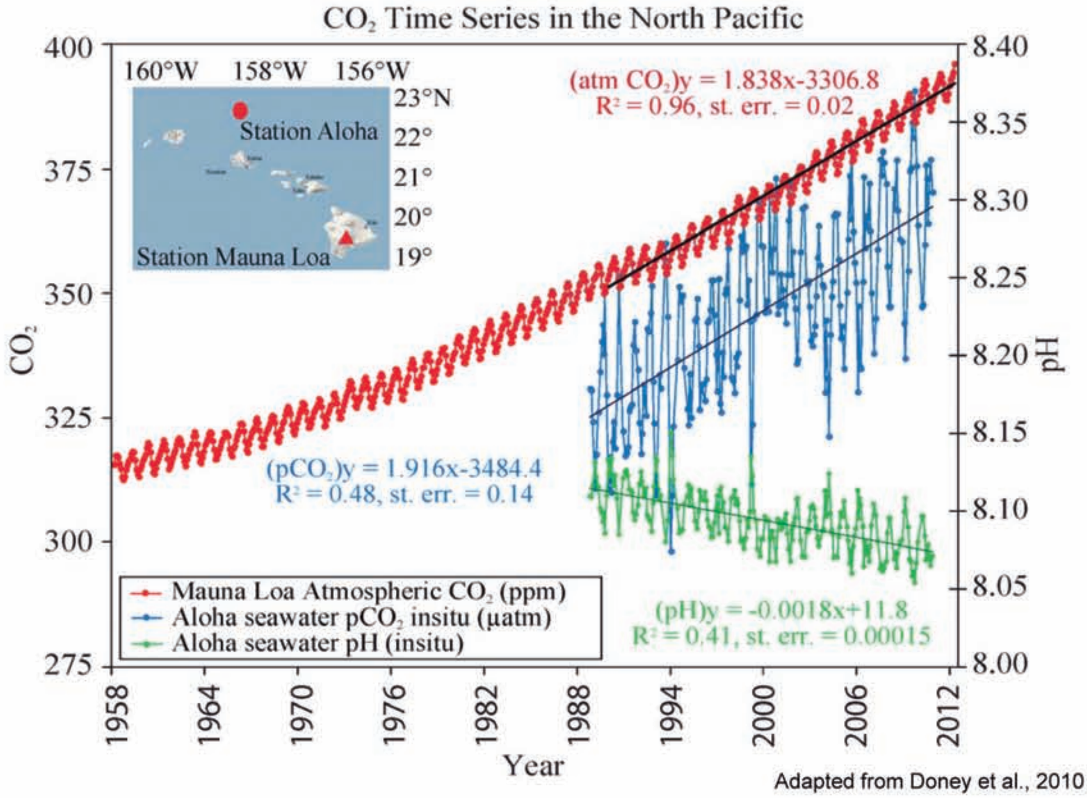
Atmospheric CO_2 was steady for at least 1,000 years before the industrial revolution.

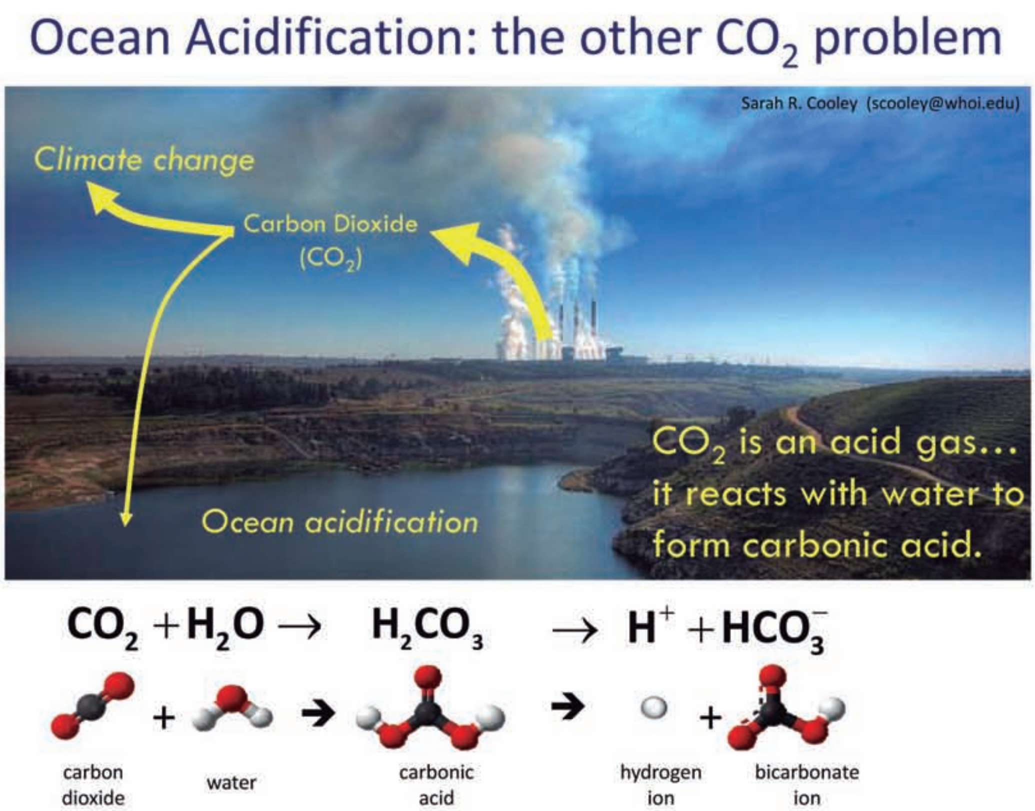


Adapted from Sarmiento and Gruber 2002 using Trends online data

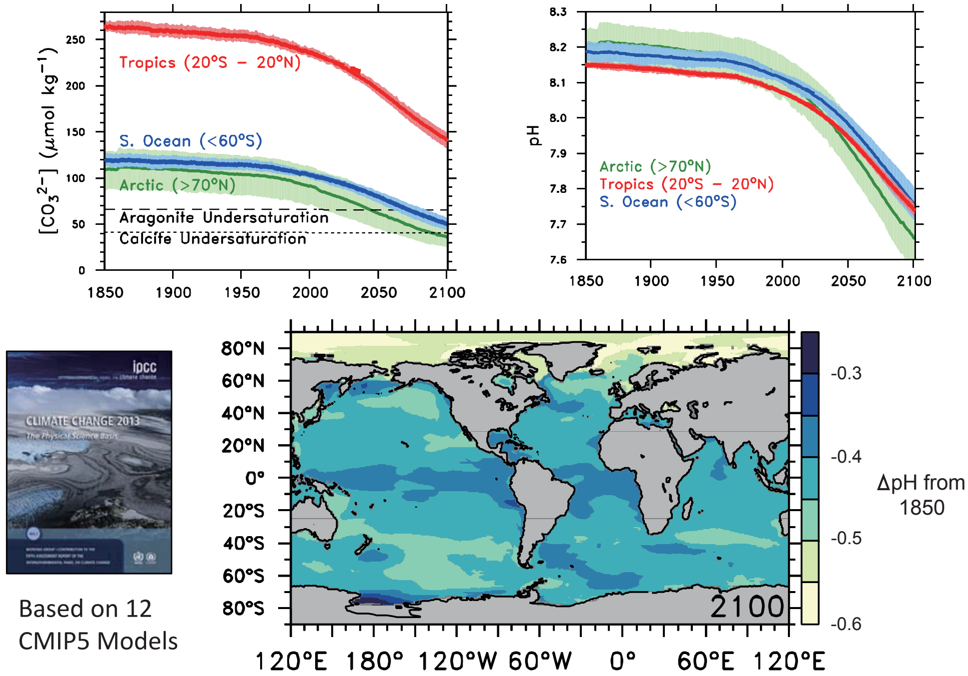


Adapted from Doney et al., 2010


CO2 Time Series in the North Pacific
160°W 158°W 156°W
23°N
22°
21°
20°
19°
Station Aloha
Station Mauna Loa
(atm CO2)y = 1.838x-3306.8
R2 = 0.96, st. err. = 0.02
(pCO2)y = 1.916x-3484.4
R2 = 0.48, st. err. = 0.14
(pH)y = -0.0018x+11.8
R2 = 0.41, st. err. = 0.00015
Mauna Loa Atmospheric CO2 (ppm)
Aloha seawater pCO2 insitu (µatm)
Aloha seawater pH (insitu)
CO2
pH
Year
400
375
350
325
300
275
8.40
8.35
8.30
8.25
8.20
8.15
8.10
8.05
8.00
1958
1964
1970
1976
1982
1988
1994
2000
2006
2012
Adapted from Doney et al., 2010

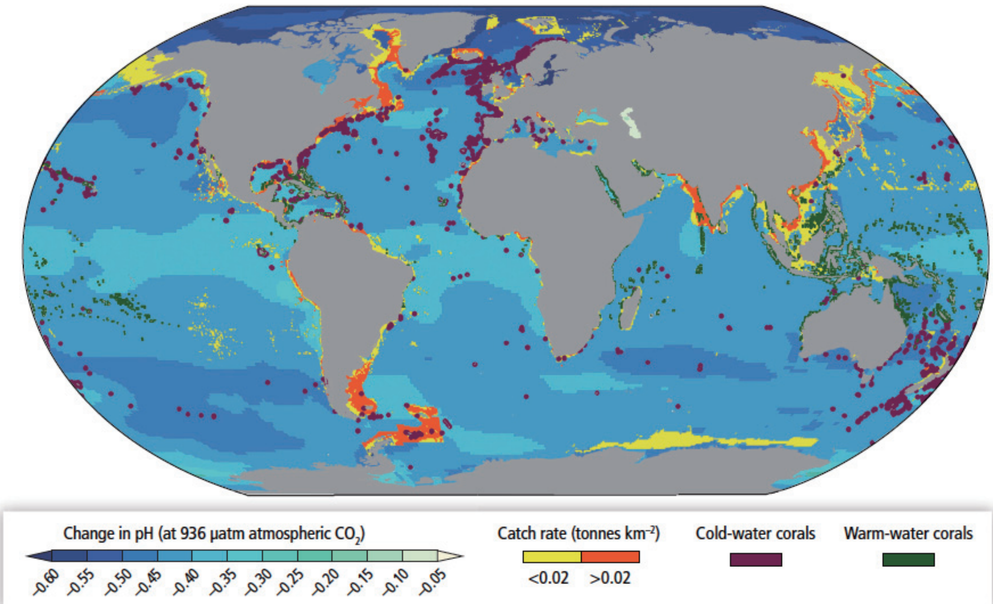

Ocean Acidification: the other CO2 problem
Sarah R. Cooley (scooley@whoi.edu)
Climate change
Carbon Dioxide
(CO2)
Ocean acidification
CO2 is an acid gas...
it reacts with water to
form carbonic acid.
CO2 + H2O → H2CO3 → H+ + HCO3−
carbon dioxide
water
carbonic acid
hydrogen ion
bicarbonate ion

Future Ocean Acidification Changes Under RCP 8.5

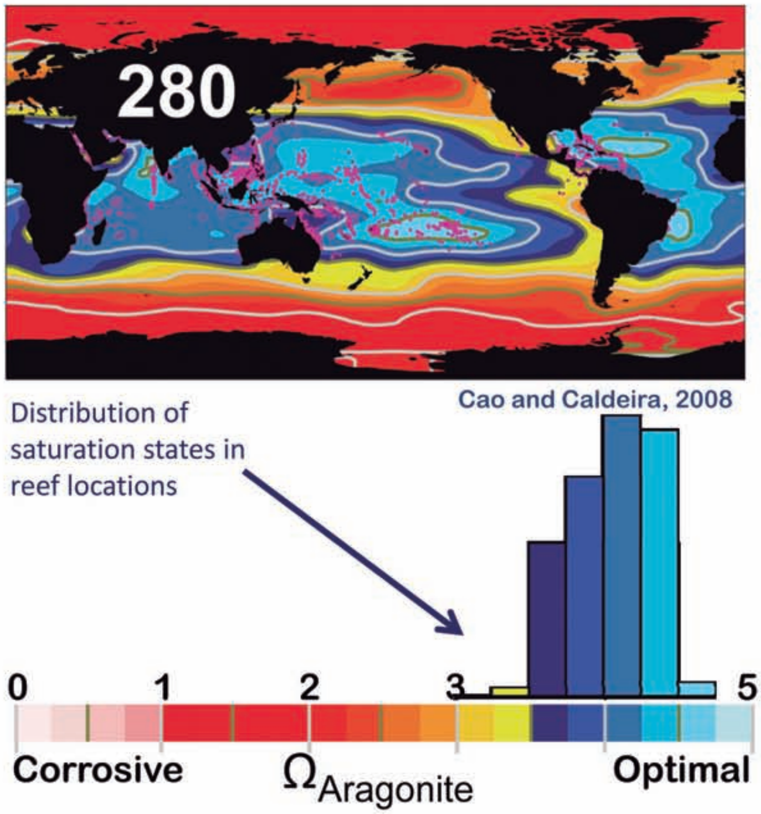


Based on 12 CMIP5 Models

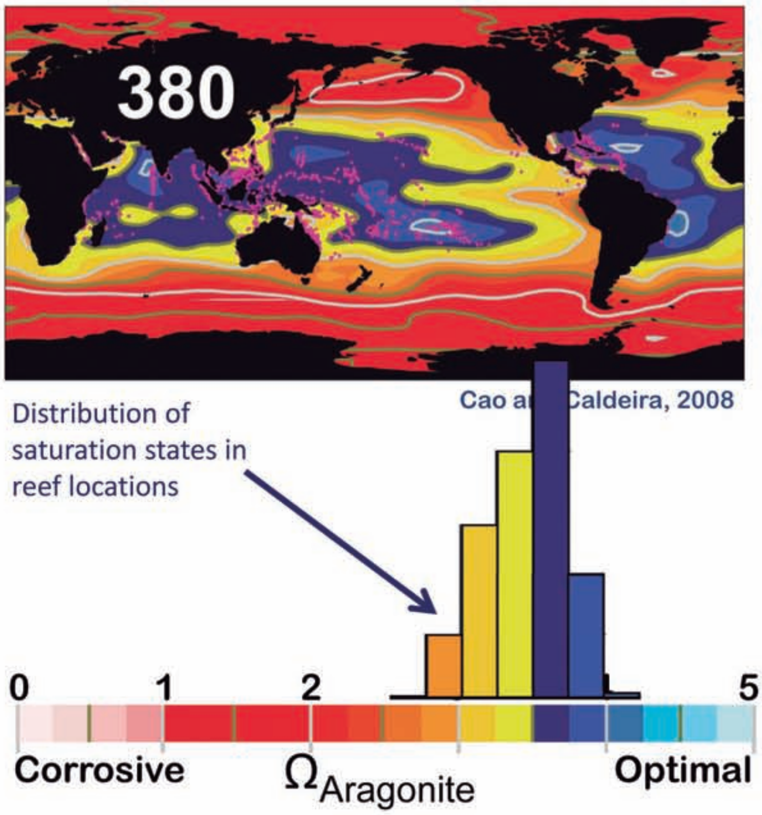
Distribution of Societally Important Calcium Carbonate Species



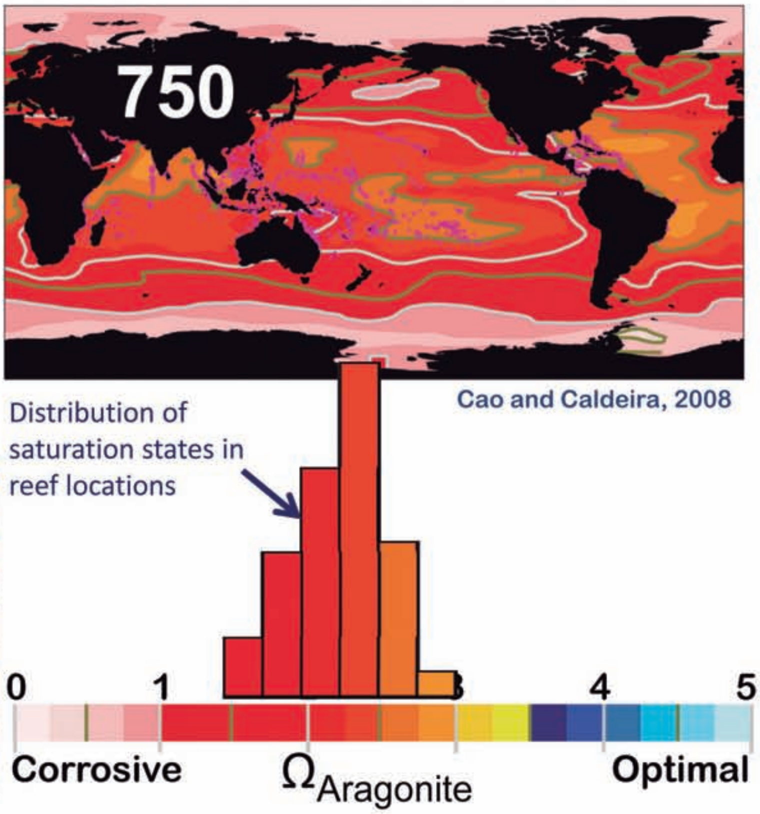
Surface Water Aragonite Saturation States in Preindustrial Times



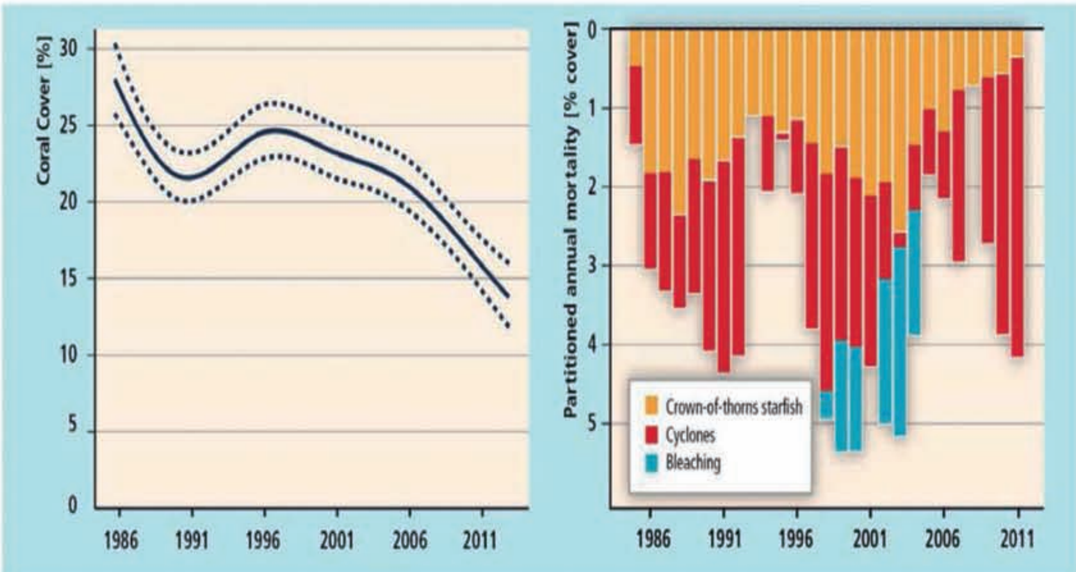
Surface Water Aragonite Saturation States Circa 2000



Surface Water Aragonite Saturation States Possible by 2100 or Earlier



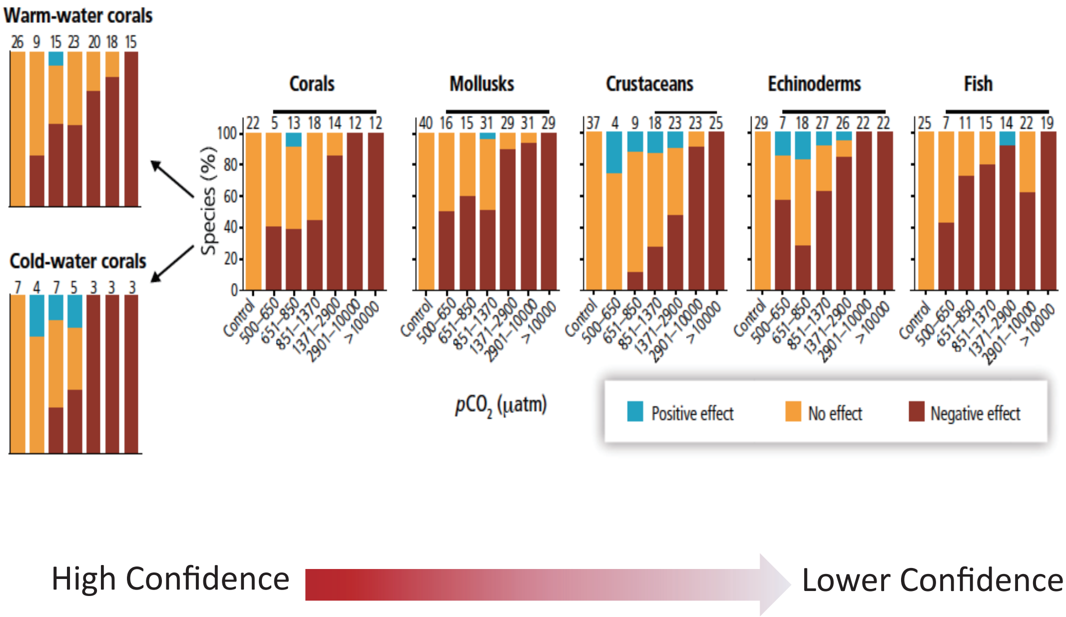
Multiple Stressors on the Great Barrier Reef



The Great Barrier Reef has seen a 50% reduction in coral cover over the last three decades

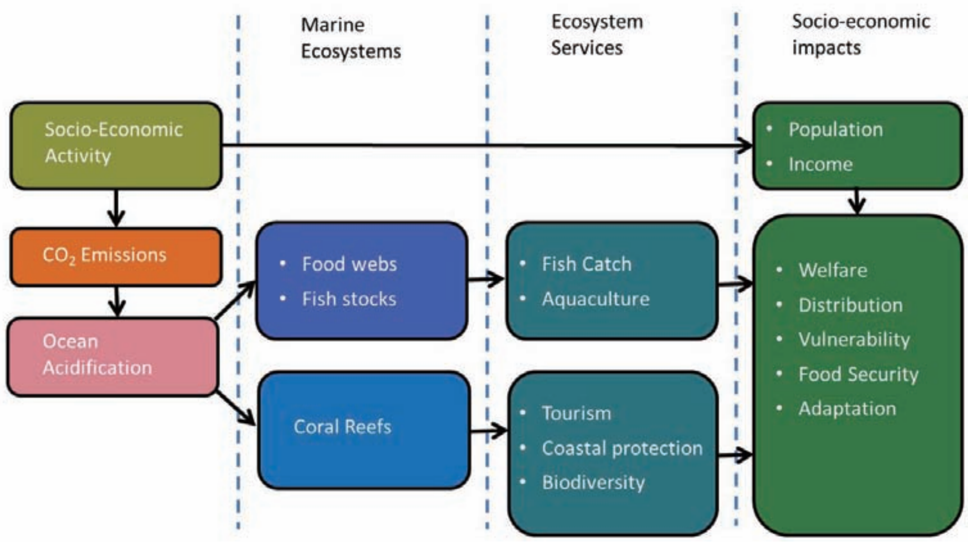
ipcc
INTERGOVERNMENTAL PANEL ON climate change

Sensitivity to Ocean Acidification Across Phyla



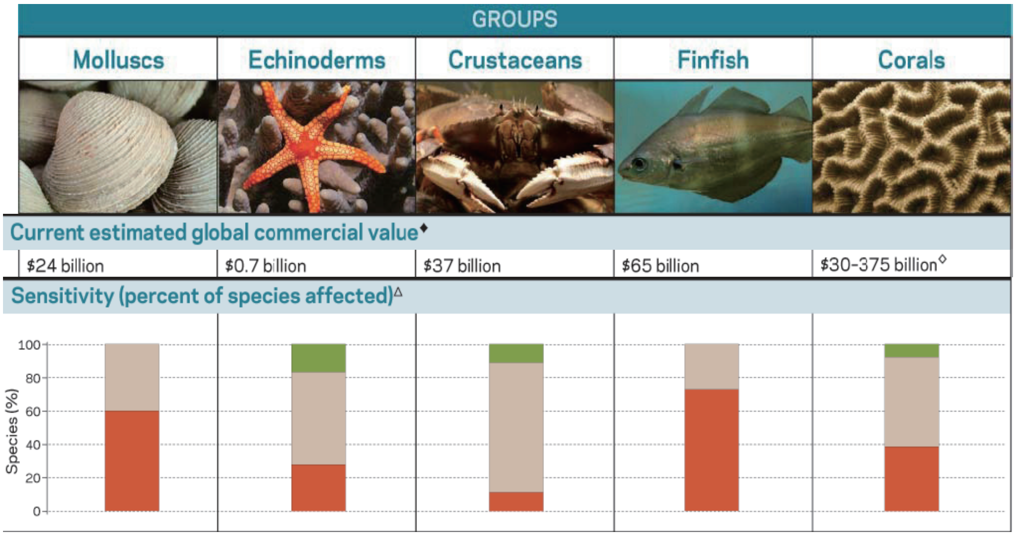
ipcc
INTERGOVERNMENTAL PANEL ON climate change

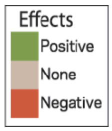
Environmental Changes Are Linked to Socio-Economic Impacts



Source: Brander et al. (2014) The Economic Impacts of OA

Ocean Acidification is a Concern for Many Commercially Important Species





IGBP, IOC, SCOR (2013). Ocean Acidification Summary for Policymakers – Third Symposium on the Ocean in a High-CO_2 World. International Geosphere-Biosphere Programme, Stockholm, Sweden

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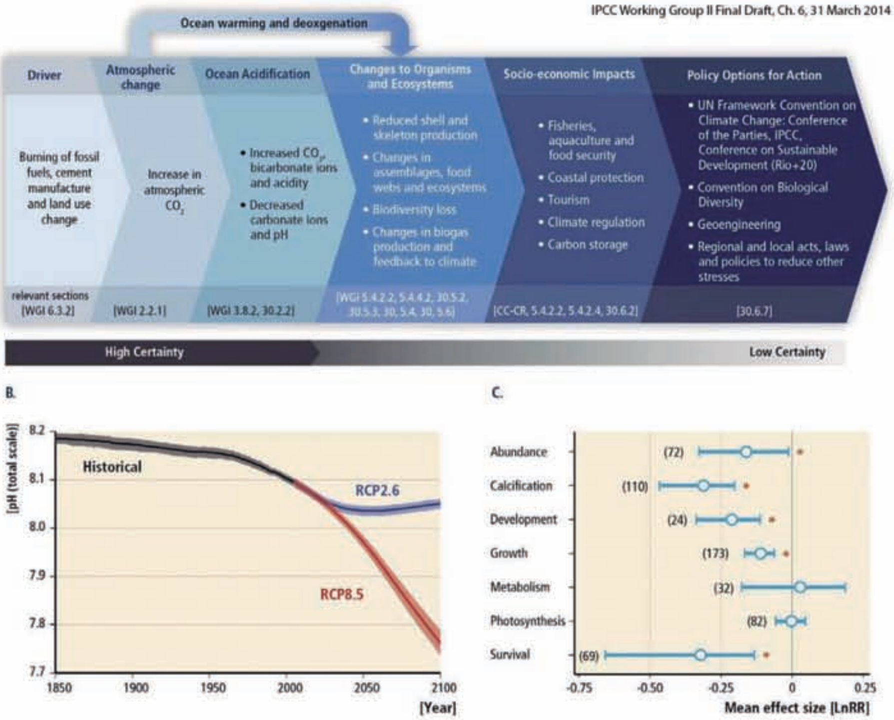
Only a Handful of Studies Have Looked at the Economic Impacts of Ocean Acidification

Study	Impacts	Geographic scope	Emissions scenario	Period of analysis	Welfare measure[1]	Annual value (US$; billions)[2]
Armstrong et al. (2012)	Fisheries	Norway	pH decrease 0.5	2010 – 2110	Revenue	0.01
	Carbon storage	Norway	pH decrease 0.5	2010 – 2110	Damage Cost	3
Brander et al. (2012)	Coral reefs	Global	SRES A1B	2000 - 2100	Mixed	1,093
Cheung et al. (2011)	Fish and invertebrates	N-E Atlantic	SRES A1B	2005 - 2050	-	-
Cooley and Doney (2009)	Mollusks	United States	IPCC A1F1	2007 - 2060	Revenue	0.07
Cooley et al. (2012)	Mollusks	Global	CCSM3	2010 - 2060	-	-
Finnoff (2010)	Fisheries; non-use values	Baring Sea	-	-	-	-
Harrould-Kolieb et al. (2009)	Coral reefs; fisheries	Global	SRES A1B	2009 - 2050	-	-
Hilmi et al. (2012)	All	Global	-	-	-	-
Kite-Powell (2009)	Coral reefs; fisheries	Global	IS92a	-	-	-
Moore (2011)	Mollusks	United States	RCP8.5; RCP6	2010 - 2100	CV	0.31
Narita et al. (2012)	Mollusks	Global	IS92a	2000 - 2100	CS, PS	139
Rodrigues et al. (2013)	Use and non-use values	Mediterranean	-	-	-	-
Sumaila et al. (2011)	Capture fisheries	Global	-	-	-	-

[1] CV: compensating variation; CS: consumer surplus; PS: producer surplus
[2] Impact estimates are standardised to annual values for the terminal year in each analysis (i.e., 2060 for Cooley and Doney (2009) and 2100 otherwise) in US$ 2010 price levels.

By the end of this century, Ocean Acidification could cost the global economy more than $1T USD per year

Source: Brander et al. (2014) The Economic Impacts of OA

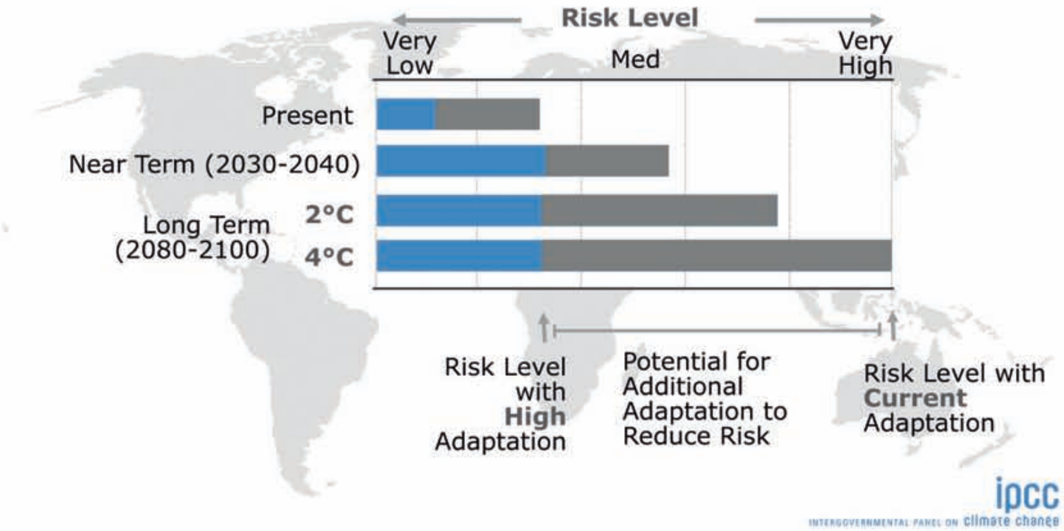


Assessing Risk in AR5

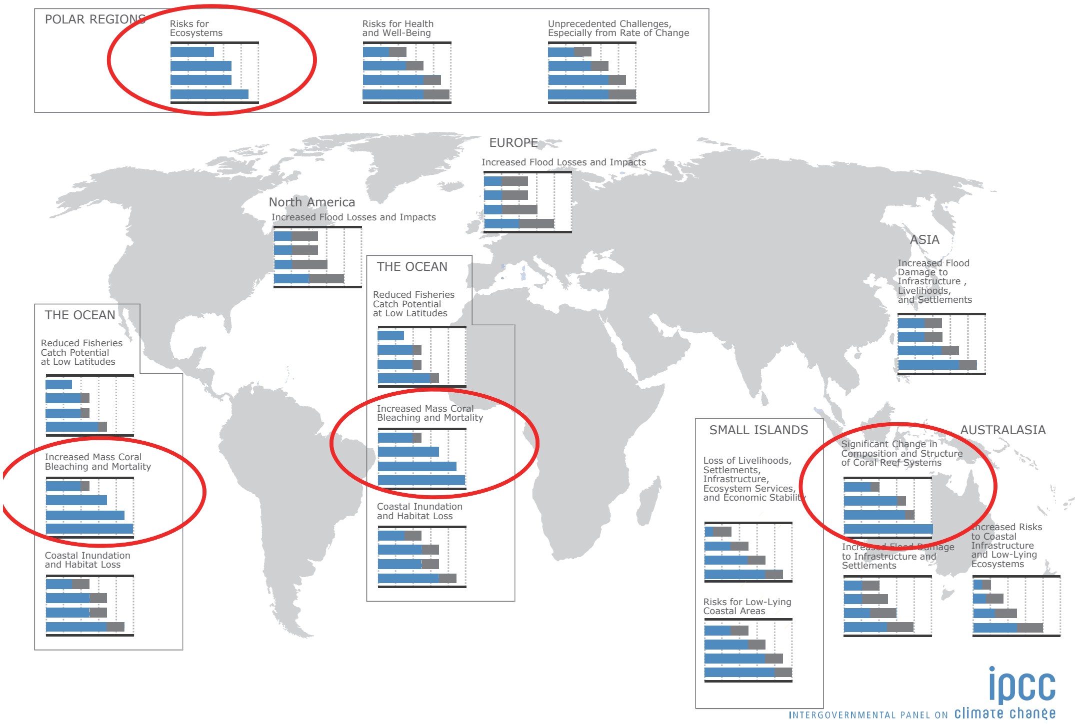
key risks are those relevant to article 2, UNFCCC

" dangerous anthropogenic interference with the climate system"

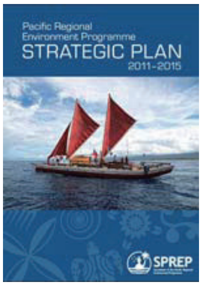
PRINCIPLES



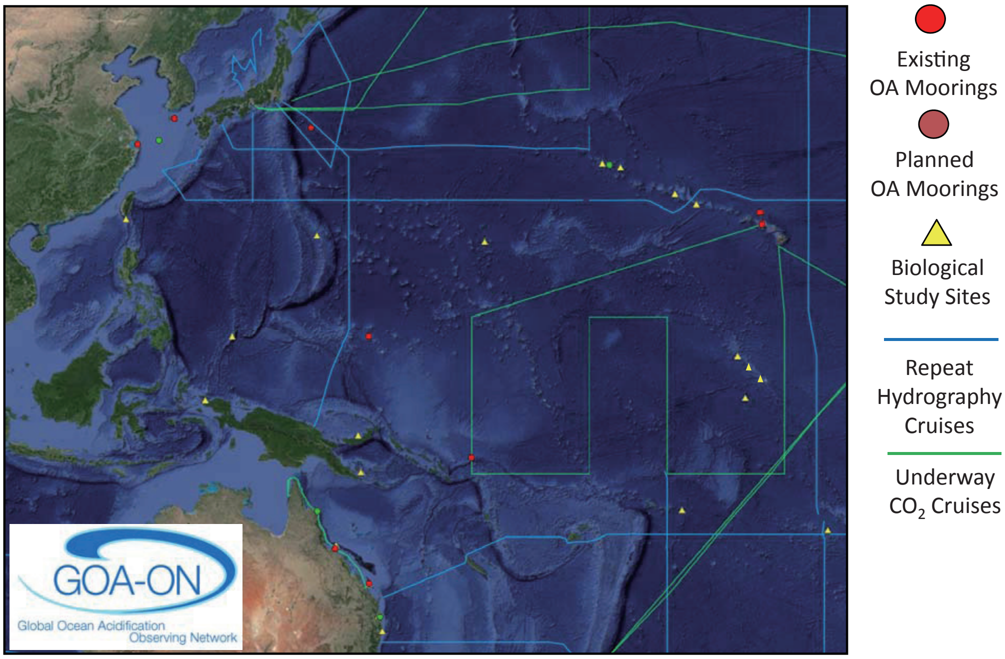
Risks involving the oceans, a global perspective:...is there risk reduction by adaptation?



GOA-ON.org



International Community is Developing a Global Observing Network, but a Stronger Connection to the Economic Implications is Needed



Conclusions

1. **Humans are already having a profound impact on the environment and marine ecosystems.**
2. **Scientific understanding of the ocean chemical changes is very high, changes on ecosystem services is less well known, and very little is known of the impact of OA on the global economy.**
3. **The economic cost of ocean acidification could be >$1T per year globally.**
4. **More detailed and coordinated studies at regional and local levels are required to document and predict the vulnerability and economic impacts on the Asia Pacific economies.**


Thank You for your
Time and Attention!!

2-2. Stresses on the Marine Environment

Dr. Sheila G. Vergara
Director of Biodiversity Information Management of
ASEAN Centre for Biodiversity

The importance of marine biodiversity in the ASEAN Region cannot be under emphasized as nine of the ten ASEAN Member States in Southeast Asia are endowed with extensive coastlines, providing an aggregate total of some 173,000 kilometers of shoreline. The region hosts the highest biodiversity of coastal and marine fauna and flora in the planet. Despite this endowment, the region is a hotspot of biodiversity as it is also one, if not the most threatened.

Drivers of Biodiversity Loss

Causes and factors that directly or indirectly influence the loss of biodiversity such as reduction in numbers and species extinctions are called drivers. The ASEAN Biodiversity Outlook (2010) identified six major drivers of biodiversity loss in both the terrestrial and marine environments in the ASEAN Region to include: habitat change, climate change, over exploitation, poverty, pollution and invasive species. Habitat changes in the marine environment are brought about by the use of destructive practices in fishing or direct disturbance of habitats such as trampling on reefs and seagrasses or deliberate cutting of mangrove trees; overharvesting is driven by the opportunity to collect with only the tools of the trade as investment and fishing with illegal means coupled with ineffective enforcement due to several limitations; diminished water quality due to all forms of land-based run-off, sea level rise and ocean acidification and a general lack of consciousness on environmental stewardship. Common to these drivers are human use and abuse. This presentation articulated that all five other drivers contributed to habitat change. The significance of this relationship is that the survival of coastal and marine biodiversity will depend on their ability to weather these habitat changes. The alternatives are for them to move to other areas or perish.

Relevant coastal and marine processes

This presentation emphasized the values of each of the habitat building species of the coastal environment: mangroves, seagrasses and coral reefs. In addition, their ecosystem services as providers of food and other material human needs and habitats to associated species, as economic support ecosystems to local livelihoods and their ecological functions as carbon sinks to abate the impacts of climate change were underscored.

The synergistic effects of exchanges in biodiversity and nutrients among these habitats were observed to result in increased productivity and thus a demonstration of scaled up ecological and economic contributions, for which the corollary may likewise be true. The mechanics of the ridge to reef interaction was explained in the context of linked habitats from the mountains to the ocean and by virtue of their physical and biological connections, the value of their ecosystem services may be likewise linked. Another pattern of connectivity was articulated in the context of larval migration patterns that suggest the conservation needs of particular habitats where such larvae would settle. The need to understand these connections and patterns was emphasized as a necessity to decision making and policy.

Coastal and marine ecosystems by way of natural circumstances are always located 'sea-ward' with respect to all other habitats such that they are the recipient of all land-derived threats that may consist of siltation, pollution loads from domestic, agricultural and industrial sources.

Threats and Stresses to marine biodiversity

The drivers of change for each of the habitat building species was explained.

Modifications in mangrove habitats in the ASEAN region are in general caused by

a) land clearing for coastal development to address increasing needs and wants for housing, roads, resorts and ports and

b) needs to increase food production and thus clearing for fishponds and agriculture.

Contributory factors include harvesting of mangroves for domestic uses such as for house posts, fuel wood and charcoal production. Non-domestic but equally destructive is the removal of mangrove bark for use in the tanning industry. Bark removal that is more popularly called "tan barking" subsequently kills the trees. Sea level rise brought about by climate change is also a major factor to note. As these threats continue to proliferate, emerging issues have now become evident. The increase in the incidence of storms and typhoons and the inability of watershed and uplands to retain the water due to deforestation are bringing about more freshwater to the coastal environment. This change in salinity may impact mangrove populations in South and Southeast Asia (CBD 2010). The increase in temperature in the equatorial zones may cause some mangrove associated species to evacuate to habitats northward and may reduce such ecological interactions. The single-species approach to mangrove reforestation does not support such ecological interactions either. These current and emerging issues may marginalize the ability of mangroves to survive and with their loss, ecological functions such as storm, sediment and pollution buffering, carbon sequestration and habitat function may ultimately be lost.

Seagrasses are equally if not more threatened as their sizes, location and reputation are not as evident compared to mangroves and coral reefs. The ABO (2010) lists threats to seagrasses to include: land reclamation, coastal development, sediments from land based activities like agriculture, aquaculture and various forms of pollution, direct threats such as dredging, clearing by resorts to make way for swimming areas and trawling. In some way, the increase in temperatures of coastal areas due to climate change may benefit seagrasses but as truly marine organisms, seagrasses may likewise be affected by the reduction of salinity in coastal areas from increased freshwater from heavy rains.

Coral reefs are the most well-known of the coastal and marine habitats and is the focus of most marine conservation initiatives in the ASEAN Region. However, threats from destructive means of fishing are not abated outside of well managed marine protected areas (MPAs). Emerging climate change related threats such as ocean acidification as explained by the previous presentation is on its way to becoming a blatant reality and will reduce the ability of corals to build themselves and subsequently render them unable to fulfill their functions of abating storm surges and providing habitats to associated fish and invertebrates.

The future of related habitats such as intertidal ecosystems, other soft bottom communities, sandy beaches and rocky intertidals depend on the development of strategies and their implementation at appropriate skills. Responsible governance, committed partnerships, skilled coastal conservation workers and appropriate fund levels are necessary to make these all happen.

Proposed strategy for marine biodiversity conservation in the ASEAN Region

How has the region organized its conservation priorities? At current, conservation effort in the ASEAN Region is six times as invested in terrestrial compared to coastal and marine areas, and way less in terms of areas covered in inland waters. If the region is to move towards achieving the Aichi Target 11 by 2020 and fulfill the ten percent coverage for effectively managed coastal and marine areas, efforts have to be scaled up. The ASEAN Centre for Biodiversity (ACB) in collaboration with the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) have proposed to 'Achieve the Aichi Targets through Integrated Coastal Management'. Both organizations will endeavor to develop the necessary science behind establishing necessary networks of marine protected areas (MPAs) in the region, implement ICM in such priority areas and share experiences derived from such implementation.

Stresses on Marine Biodiversity

Presented at the Workshop on the Climate Change Impact on Oceans and Fisheries Resources, 9 May 2015, Boracay Island, Aklan, Philippines by SGVergara, ASEAN Centre for Biodiversity

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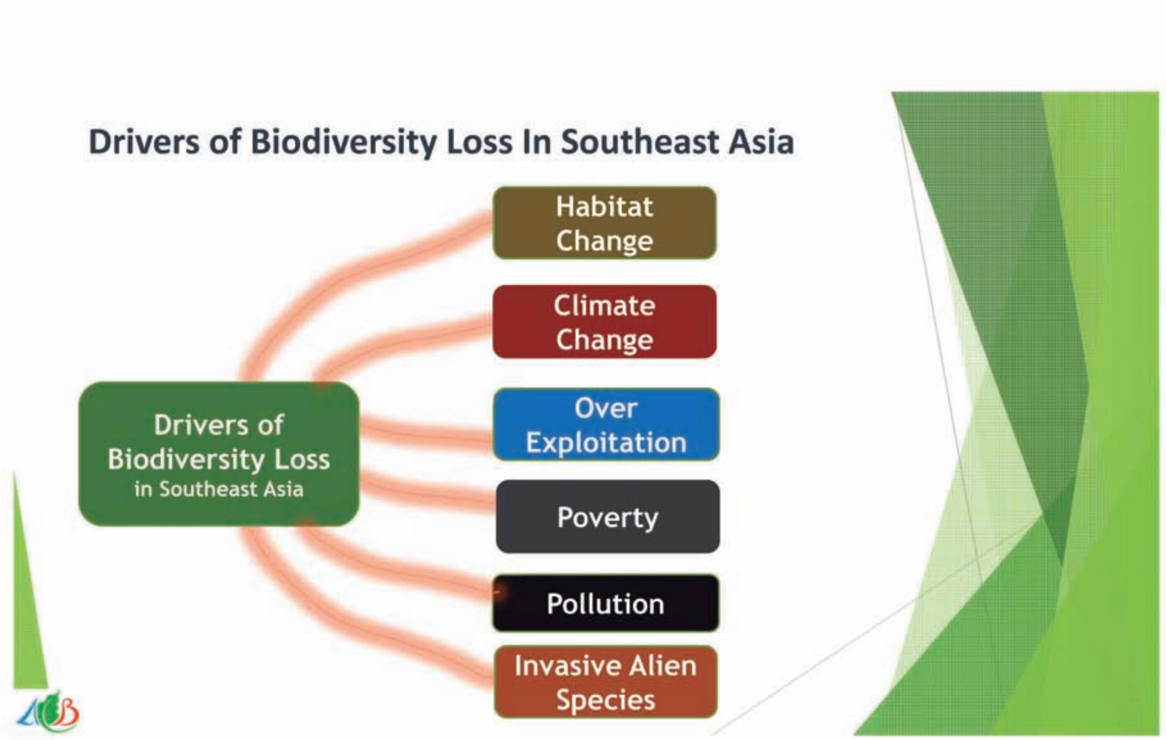
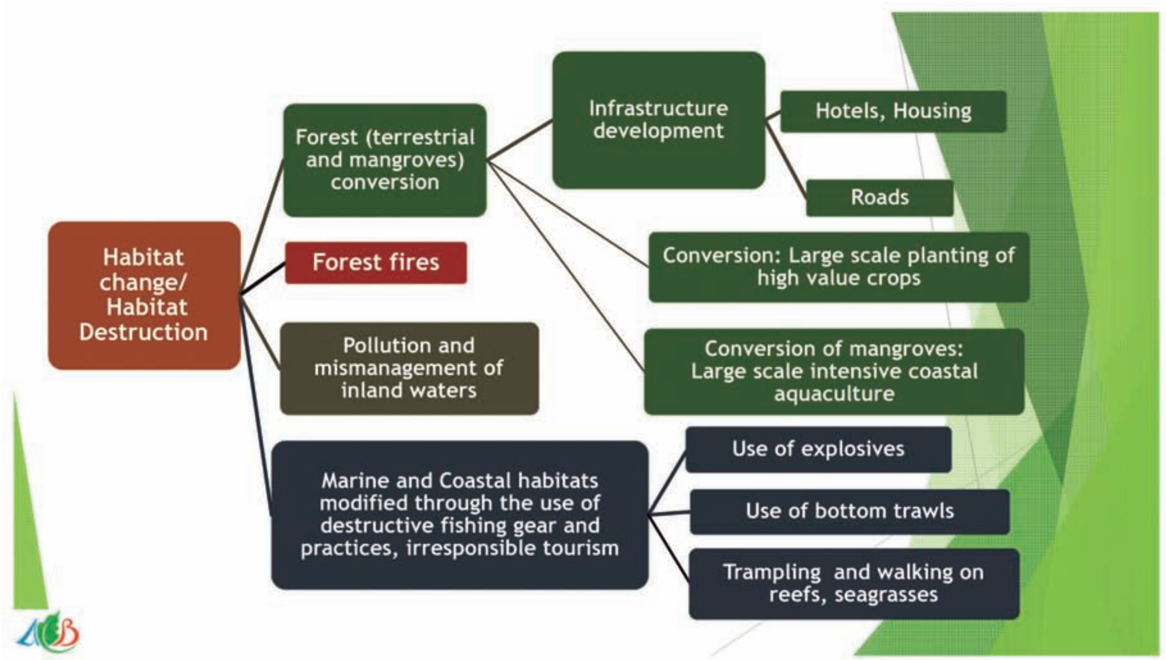
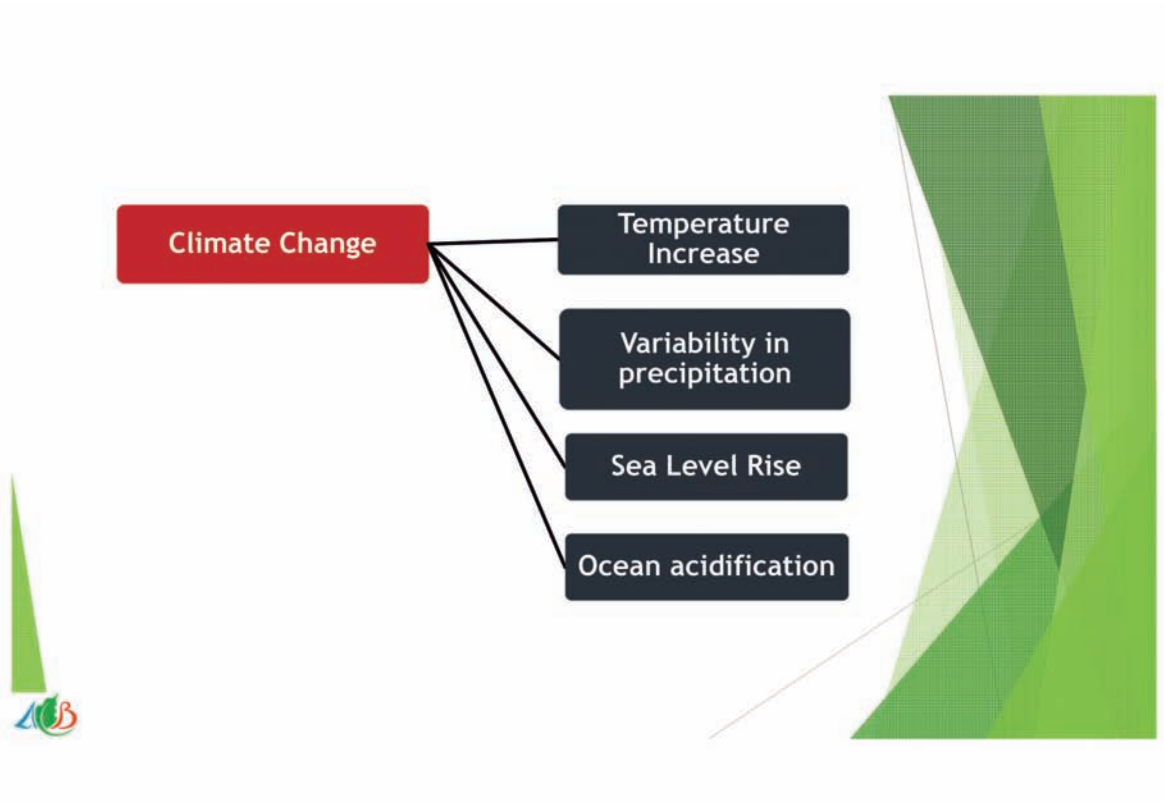
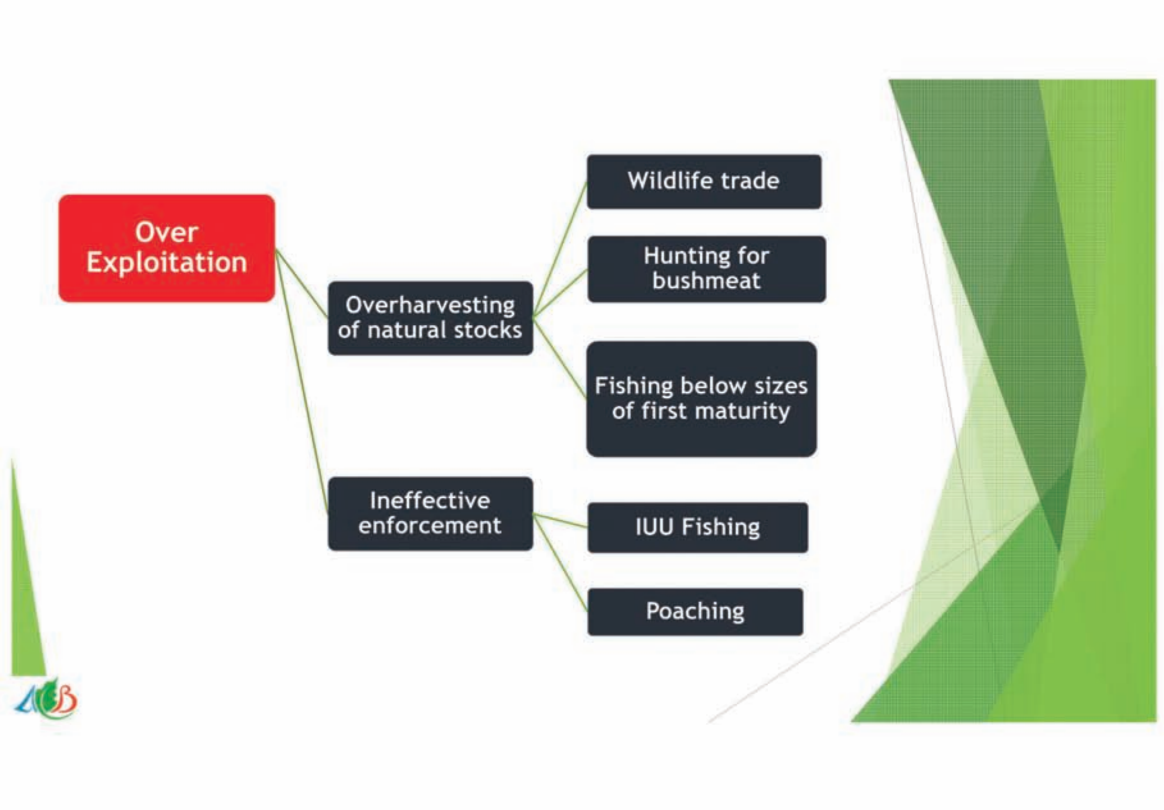
Outline

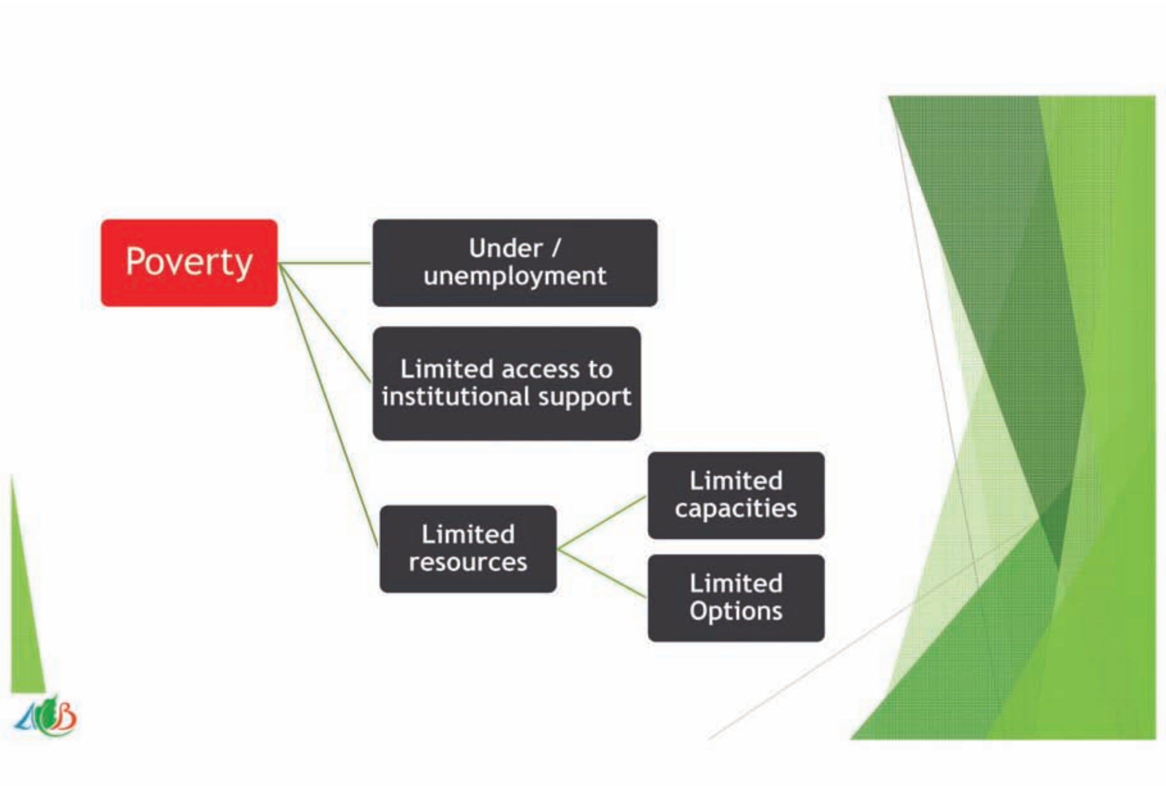
- Drivers of Biodiversity Loss
- Relevant coastal and marine processes
  - Land to sea
  - Habitat interactions
  - Connectivity
- Threats and Stresses to marine biodiversity
- Projecting threats to the future
- Proposed strategy for marine biodiversity conservation in the ASEAN Region

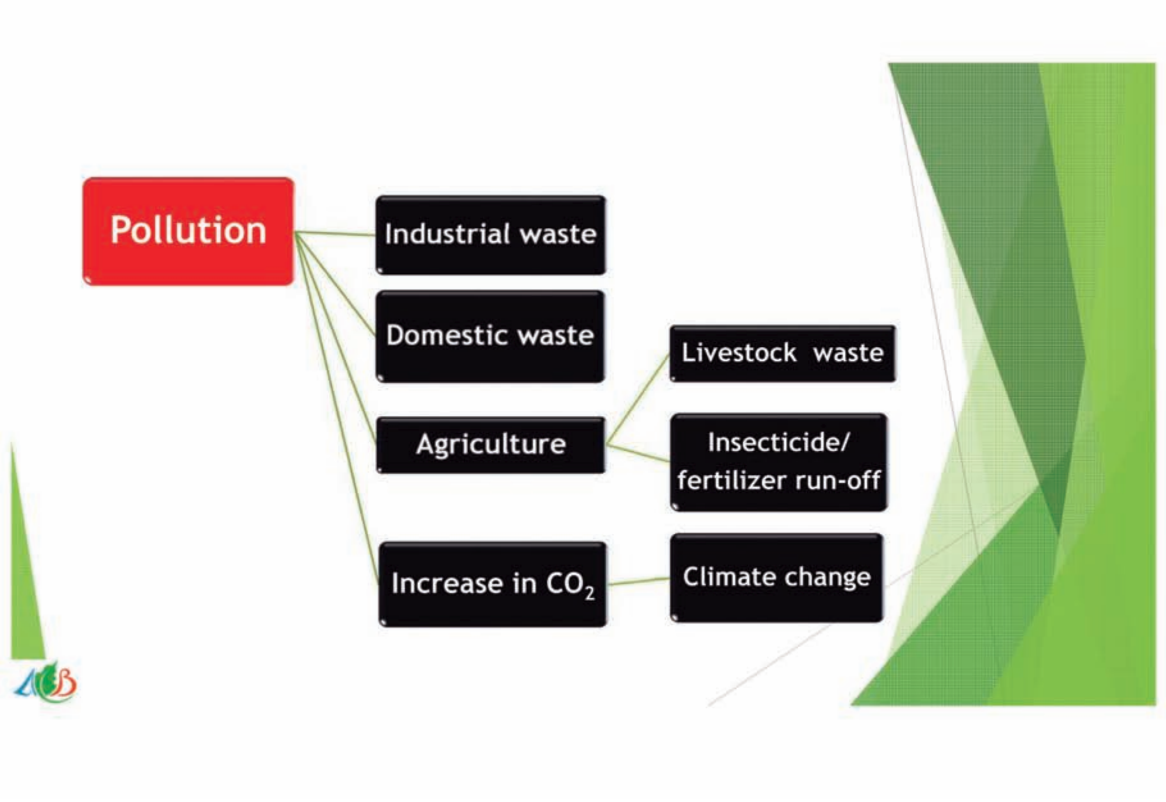

Drivers of Biodiversity Loss In Southeast Asia
Drivers of Biodiversity Loss in Southeast Asia
Habitat Change
Climate Change
Over Exploitation
Poverty
Pollution
Invasive Alien Species

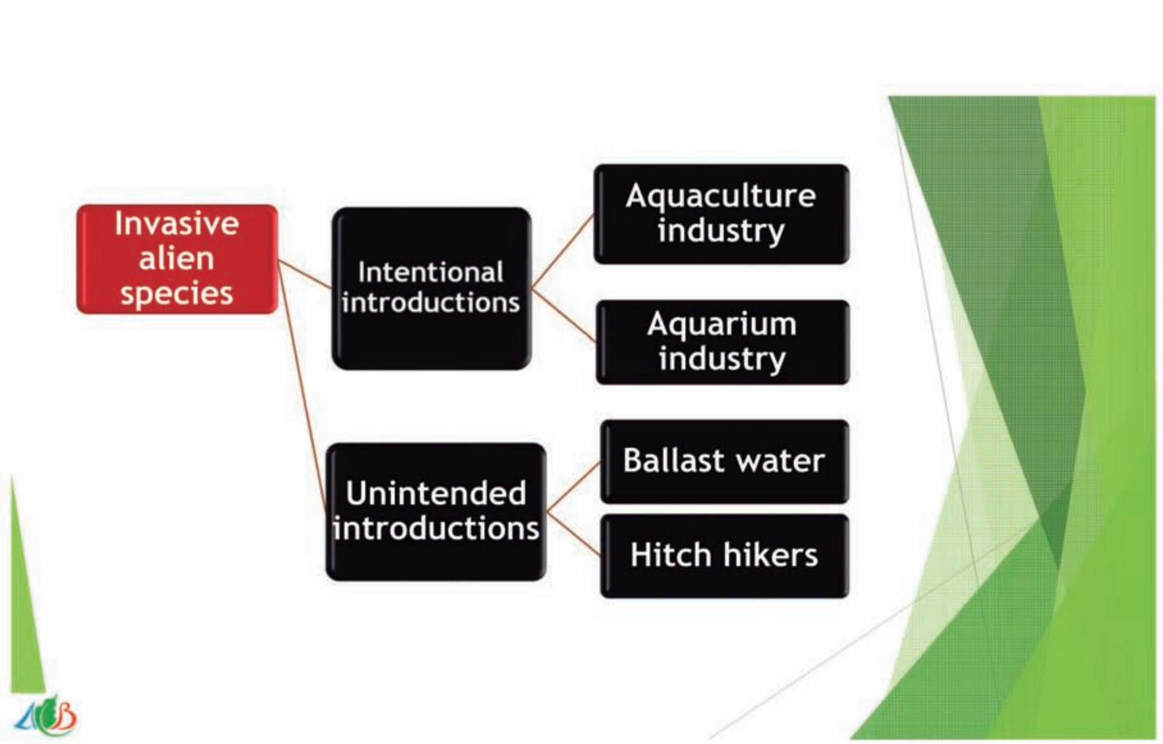

Habitat change/ Habitat Destruction
Forest (terrestrial and mangroves) conversion
Infrastructure development
Hotels, Housing
Roads
Conversion: Large scale planting of high value crops
Conversion of mangroves: Large scale intensive coastal aquaculture
Forest fires
Pollution and mismanagement of inland waters
Marine and Coastal habitats modified through the use of destructive fishing gear and practices, irresponsible tourism
Use of explosives
Use of bottom trawls
Trampling and walking on reefs, seagrasses

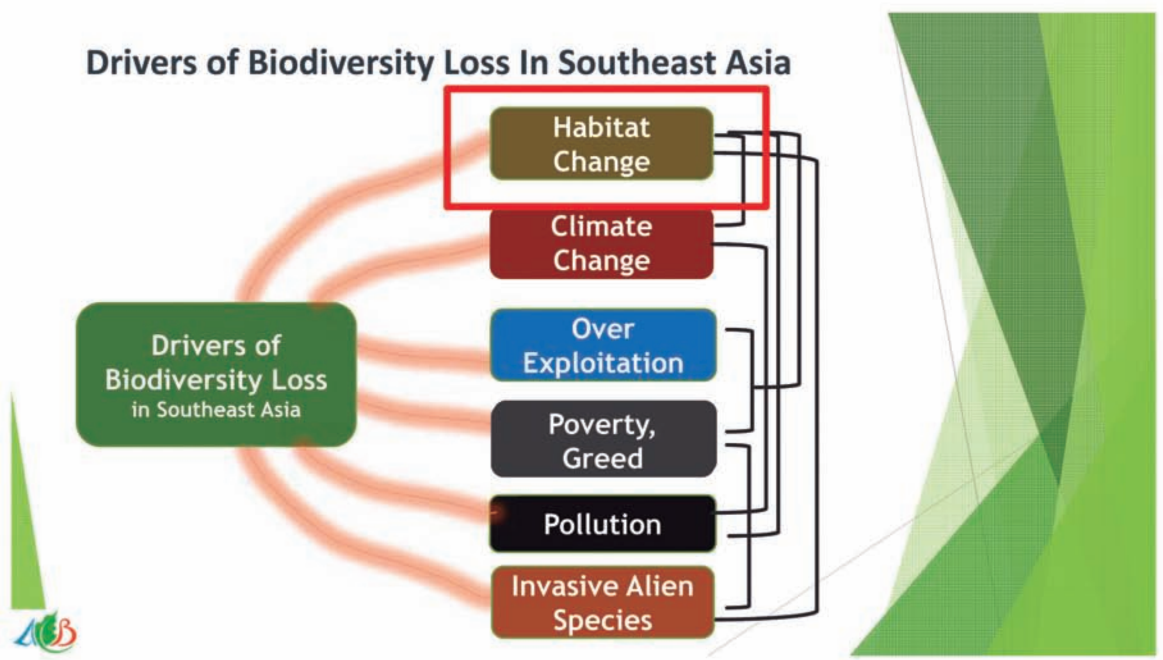

Climate Change
Temperature Increase
Variability in precipitation
Sea Level Rise
Ocean acidification


Over Exploitation
Overharvesting of natural stocks
Wildlife trade
Hunting for bushmeat
Fishing below sizes of first maturity
Ineffective enforcement
IUU Fishing
Poaching


Poverty
Under / unemployment
Limited access to institutional support
Limited resources
Limited capacities
Limited Options


Pollution
Industrial waste
Domestic waste
Agriculture
Livestock waste
Insecticide/ fertilizer run-off
Increase in CO2
Climate change


Invasive alien species
Intentional introductions
Aquaculture industry
Aquarium industry
Unintended introductions
Ballast water
Hitch hikers


Drivers of Biodiversity Loss In Southeast Asia
Drivers of Biodiversity Loss in Southeast Asia
Habitat Change
Climate Change
Over Exploitation
Poverty, Greed
Pollution
Invasive Alien Species

Outline

- Drivers of Biodiversity Loss
- **Relevant coastal and marine processes**
  - **Habitat interactions**
  - **Land to sea**
  - **Connectivity**
- Threats and Stresses to marine biodiversity
- Projecting threats to the future
- Proposed strategy for marine biodiversity conservation in the ASEAN Region

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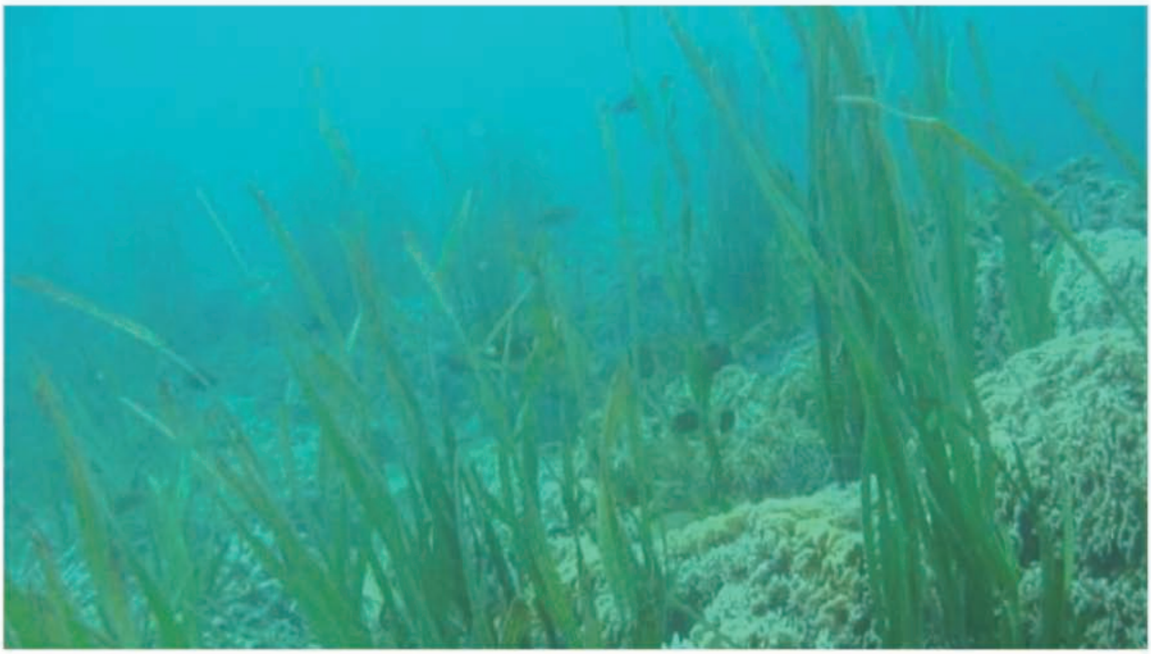
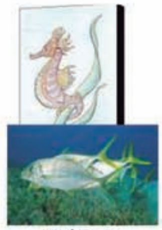
Mangroves

- Tropical
- Salt tolerant
- Live in intertidal zones and around estuaries and lagoons
- Habitat building, roots attract marine species
- Serve as buffer zone in coastal areas
- Regulates impacts of strong storm surges
- Good carbon sinks
- Mitigate sedimentation and pollution
- Good source of fuel wood but
- Bark important in tanning industry but
- Trunk good for house posts but





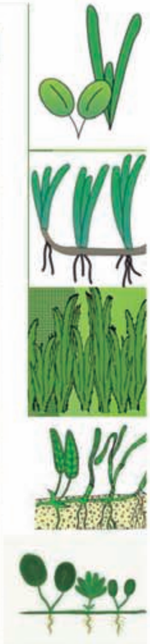
Habitat

Food

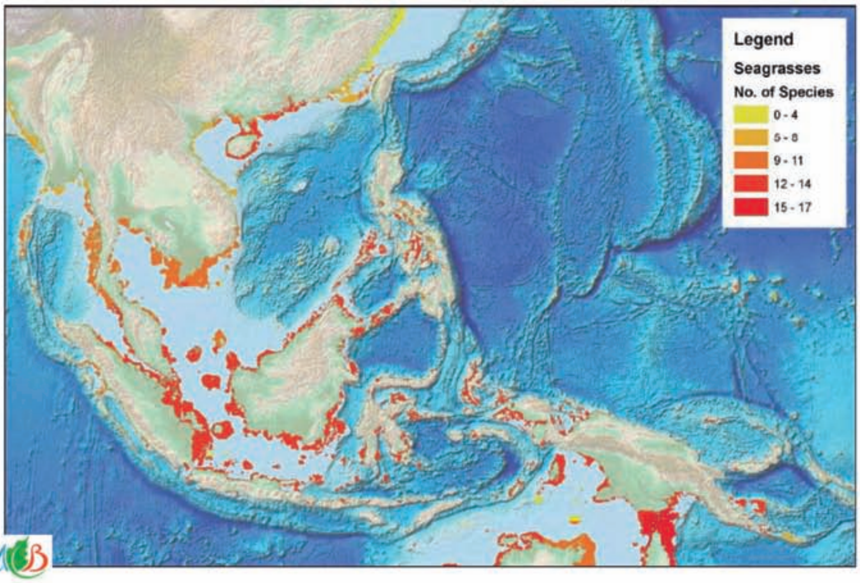
Livelihood

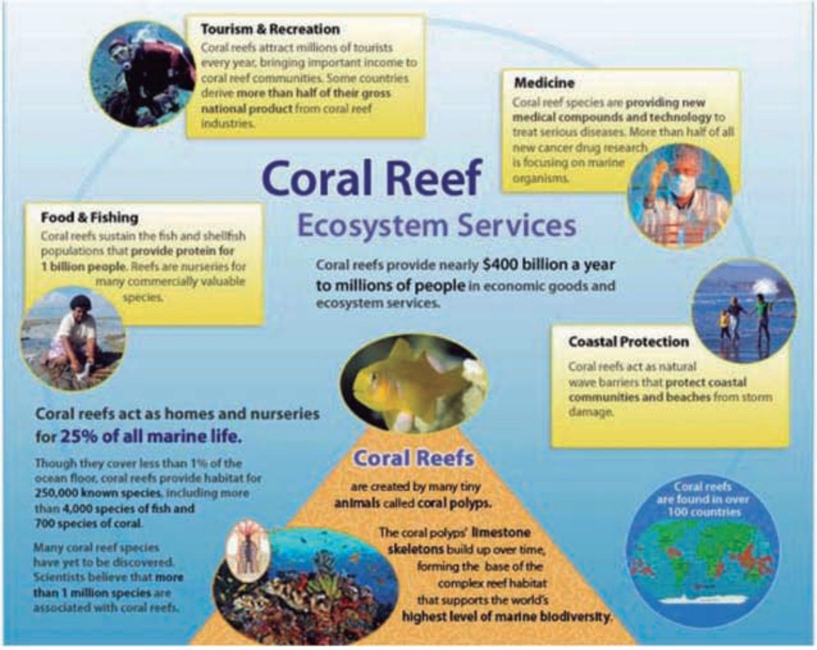
Table 23. Types of seagrass species and extent of seagrass areas in the ASEAN region, 1990 and 2004

Family and Species	BRU[1]	CAM[2]	IND[2]	MAL[2]	MYA[3]	PHI[2]	SIN[1]	THA[2]	VIE[2]
Zosteraceae									
Zostera japonica									●
Hydrocharitaceae									
Halophila spinulosa	●		●	●	●	●	●		
Halophila decipiens			●	●	●	●	●	●	●
Halophila minor			●	●	●	●	●	●	●
Halophila beccarii			●	●	●	●	●	●	●
Halophila ovalis	●	●	●	●	●	●	●	●	●
Enhalus acoroides	●	●	●	●	●	●	●	●	●
Thalassia hemprichii	●	●	●	●	●	●	●	●	●
Cymodoceaceae									
Cymodocea serrulata		●	●	●	●	●	●	●	●
Cymodocea rotundata		●	●	●	●	●	●	●	●
Halodule pinifolia		●	●	●	●	●	●	●	●
Halodule uninervis		●	●	●	●	●	●	●	●
Syringodium isoetifolium		●	●	●	●	●	●	●	●
Thalassodendron ciliatum			●	●		●			●
Ruppiaceae									
Ruppia maritima				●		●		●	●
Undescribed taxa									
Halophila minor, new variety						●			
Halophila sp.1*						●			
Halophila sp.2**				●					
Total per country	4	8	13	15	9	16	11	12	14
Area (sq km)	NAD	324.944	18,688.9-30,000.5	NAD	NAD	27,282.6	NAD	149.97[7]	68-96.5[8]



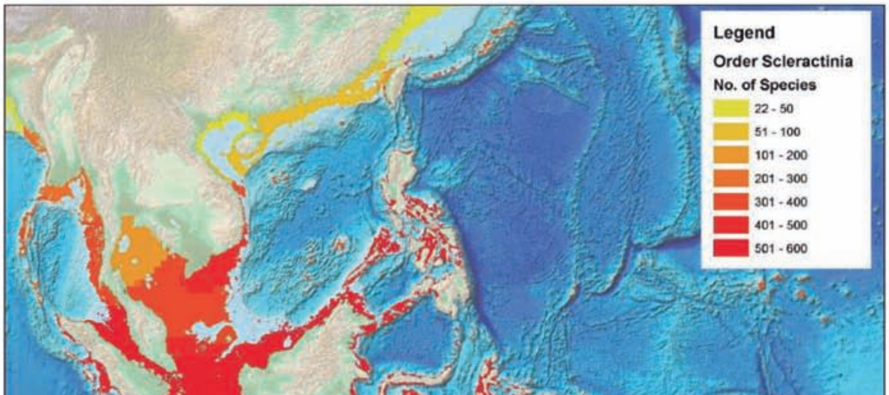
Seagrass diversity in the ASEAN region based on their occurrence ranges from IUCN data, filtered with bathymetric values (0 to 27 m), 2010

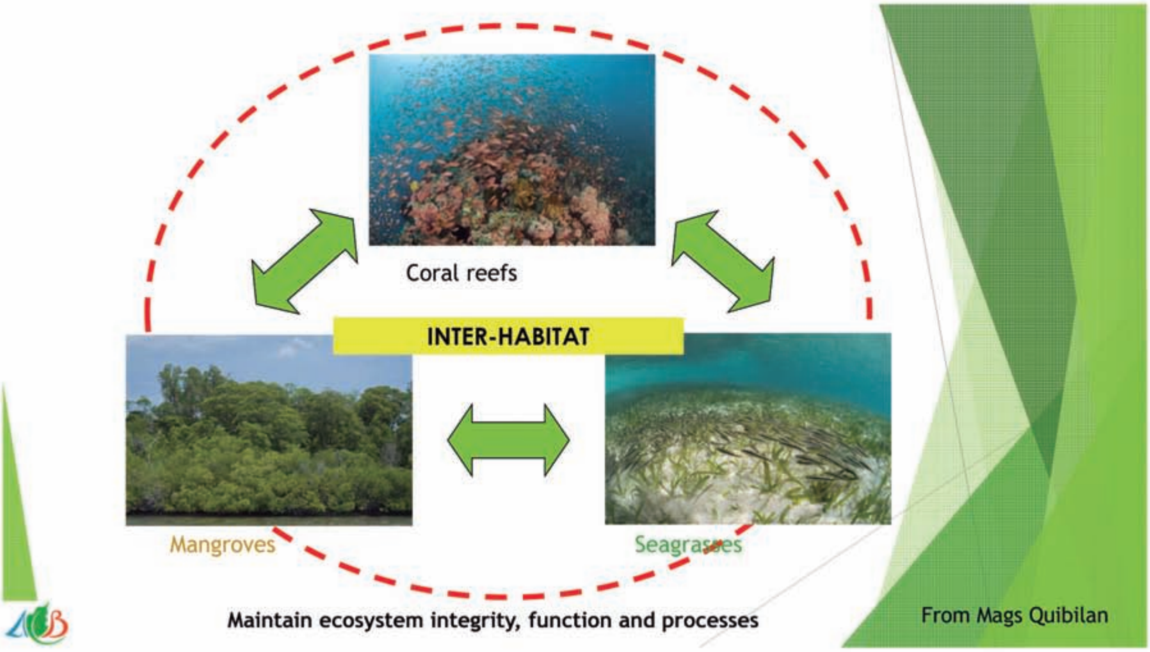


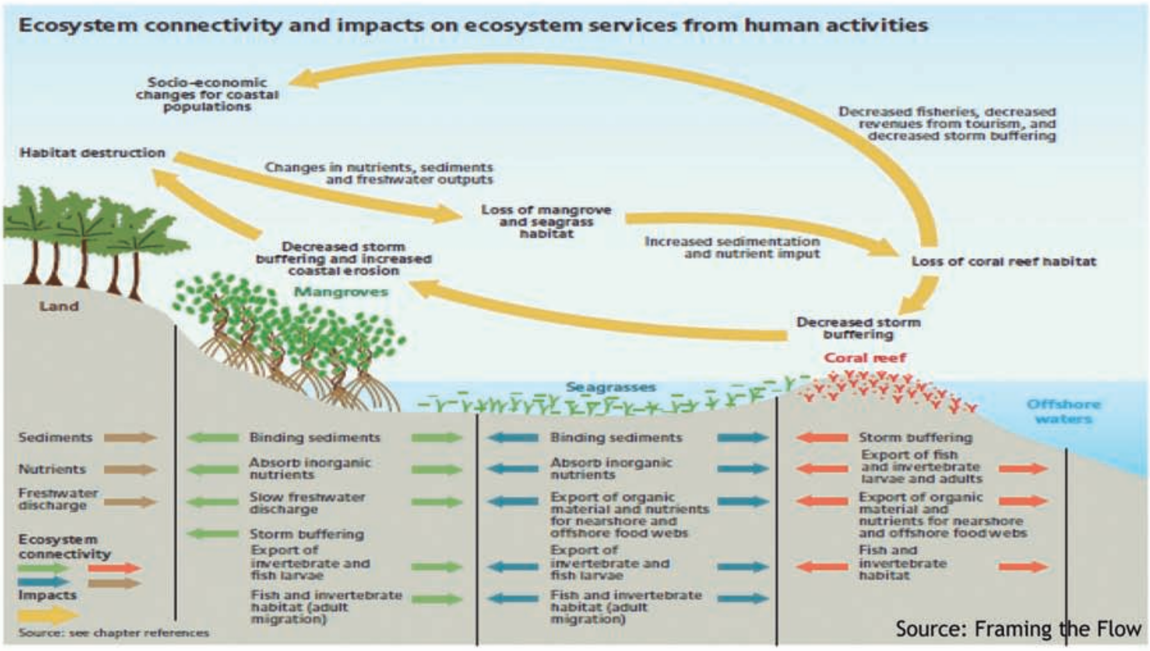


Source:
https://www.google.com.ph/search?q=threats+to+coral+reefs&biw=1309&bih=723&source=lnms&tbm=isch&sa=X&ei=dNRKVdr1O4fGmQWp5oG4CA&ved=0CAYQ_AUoAQ&dpr=1.1#imgrc=G1UAjj87yxju-M%253A%3BH1tEAZjel5dVEM%3Bhttp%253A%252F%252Fwww.coral.org%252Ffiles%252Fimages%252Fcoral-reef-graphic.jpg%3Bhttp%253A%252F%252Fcammyscomiccorner.com%252Fphotowfd%252Fthreats-to-coral-reefs%3B598%3B462

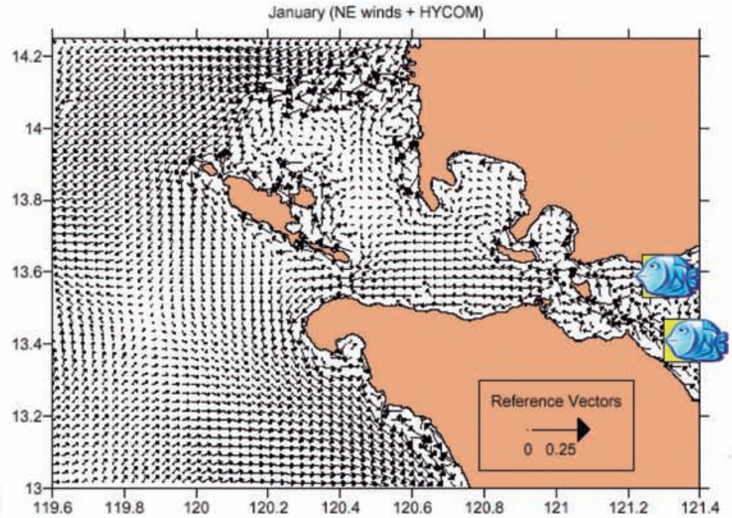
Distribution of hard coral species in the ASEAN region based on their occurrence ranges from IUCN data, filtered with bathymetricvalues (0 to 76 m), 2010

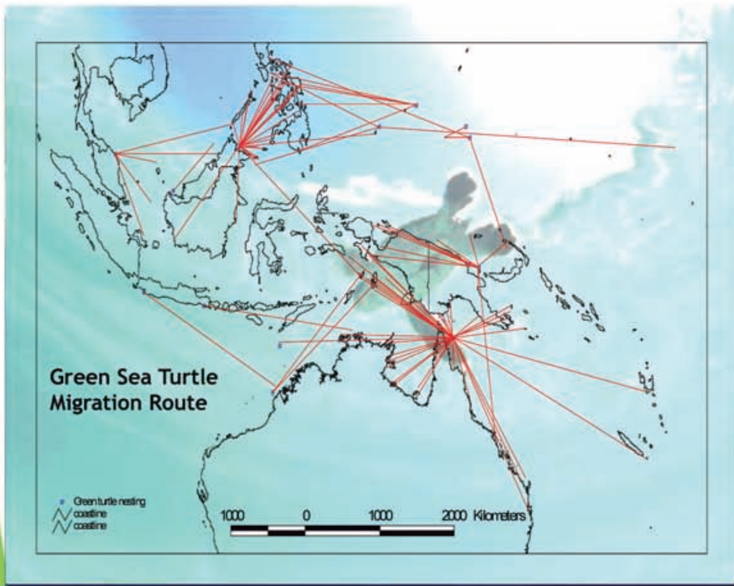


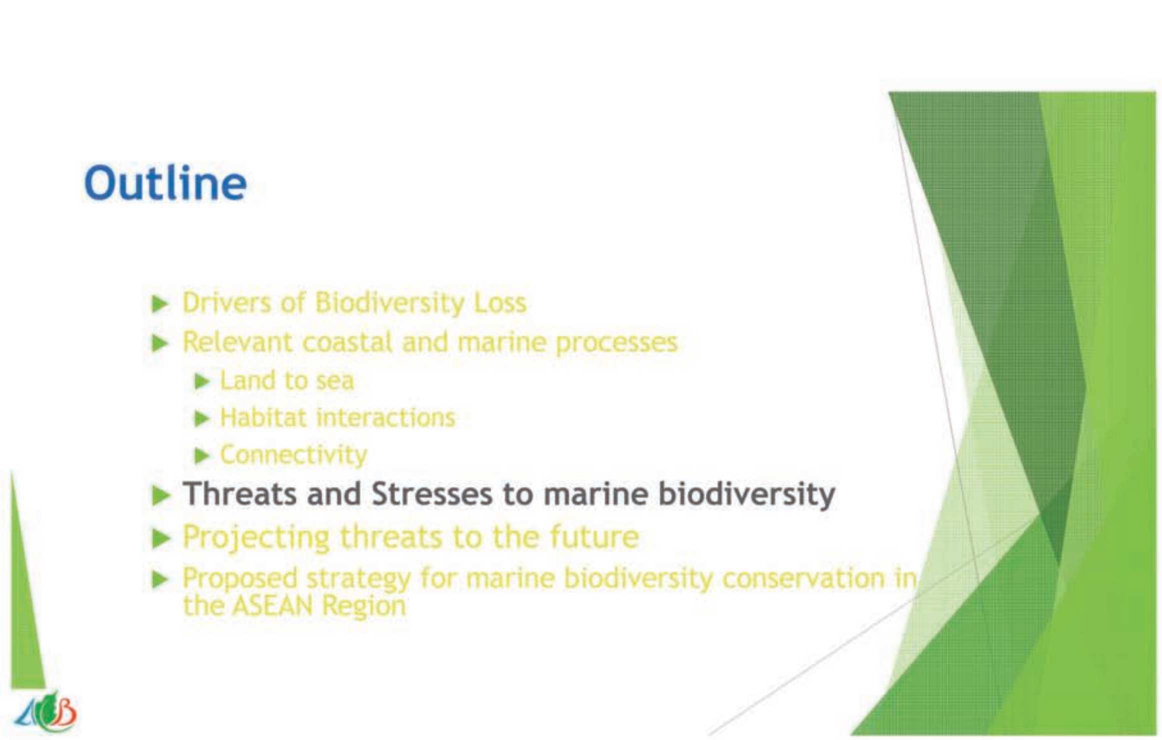

Coral reefs
INTER-HABITAT
Mangroves
Seagrasses
Maintain ecosystem integrity, function and processes
From Mags Quibilan

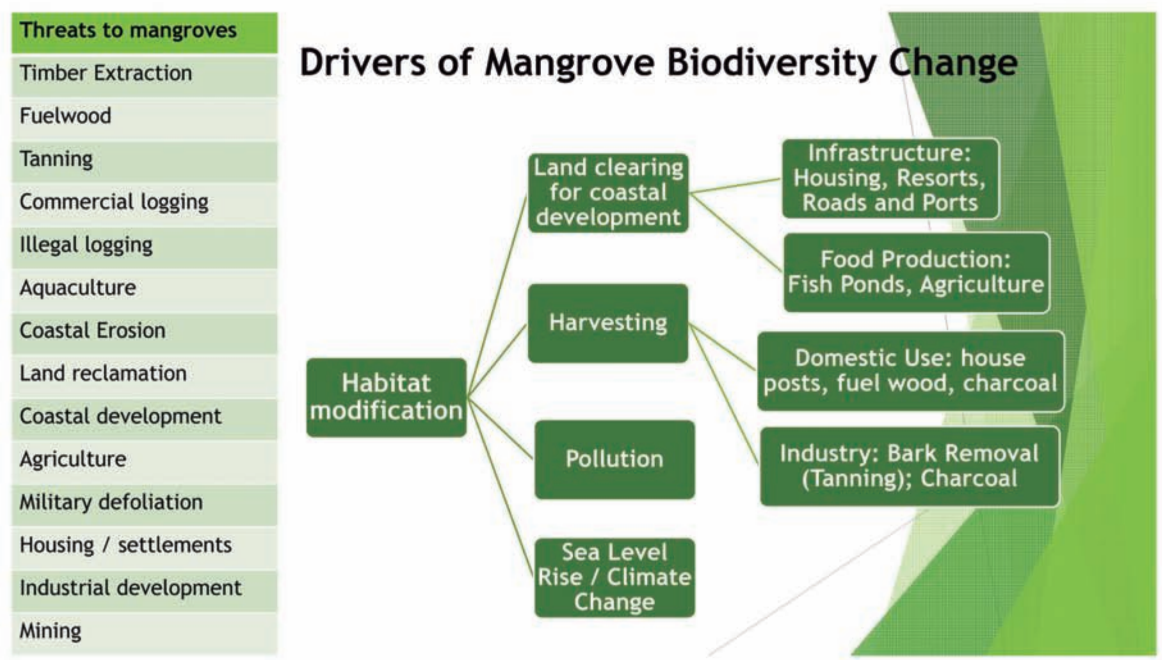

Ecosystem connectivity and impacts on ecosystem services from human activities
Socio-economic changes for coastal populations
Decreased fisheries, decreased revenues from tourism, and decreased storm buffering
Habitat destruction
Changes in nutrients, sediments and freshwater outputs
Loss of mangrove and seagrass habitat
Increased sedimentation and nutrient imput
Loss of coral reef habitat
Decreased storm buffering and increased coastal erosion
Decreased storm buffering
Land
Mangroves
Coral reef
Seagrasses
Offshore waters
Sediments
Nutrients
Freshwater discharge
Ecosystem connectivity
Impacts
Binding sediments
Absorb inorganic nutrients
Slow freshwater discharge
Storm buffering
Export of invertebrate and fish larvae
Fish and invertebrate habitat (adult migration)
Binding sediments
Absorb inorganic nutrients
Export of organic material and nutrients for nearshore and offshore food webs
Export of invertebrate and fish larvae
Fish and invertebrate habitat (adult migration)
Storm buffering
Export of fish and invertebrate larvae and adults
Export of organic material and nutrients for nearshore and offshore food webs
Fish and invertebrate habitat
Source: see chapter references
Source: Framing the Flow

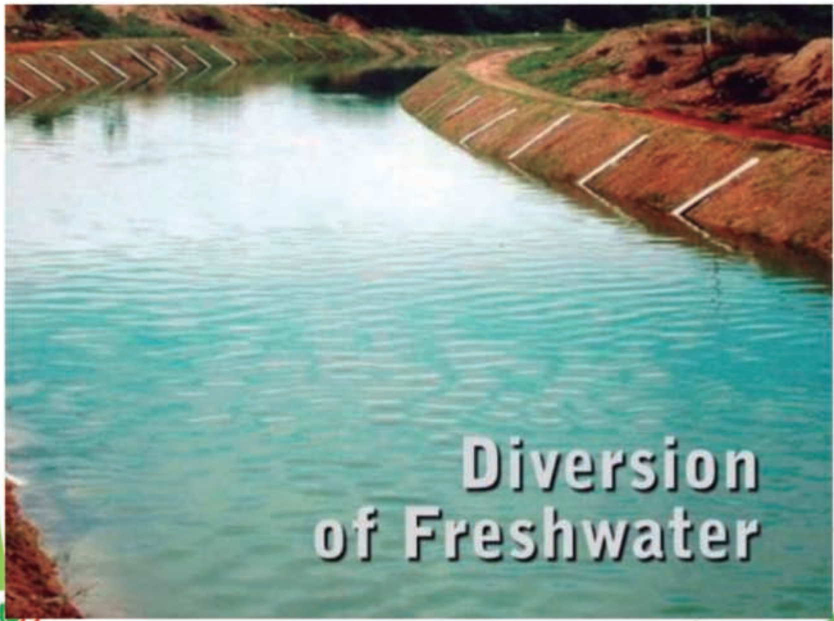
Connectivity Patterns






Outline
Drivers of Biodiversity Loss
Relevant coastal and marine processes
Land to sea
Habitat interactions
Connectivity
Threats and Stresses to marine biodiversity
Projecting threats to the future
Proposed strategy for marine biodiversity conservation in the ASEAN Region


Threats to mangroves
Timber Extraction
Fuelwood
Tanning
Commercial logging
Illegal logging
Aquaculture
Coastal Erosion
Land reclamation
Coastal development
Agriculture
Military defoliation
Housing / settlements
Industrial development
Mining
Drivers of Mangrove Biodiversity Change
Habitat modification
Land clearing for coastal development
Harvesting
Pollution
Sea Level Rise / Climate Change
Infrastructure: Housing, Resorts, Roads and Ports
Food Production: Fish Ponds, Agriculture
Domestic Use: house posts, fuel wood, charcoal
Industry: Bark Removal (Tanning); Charcoal



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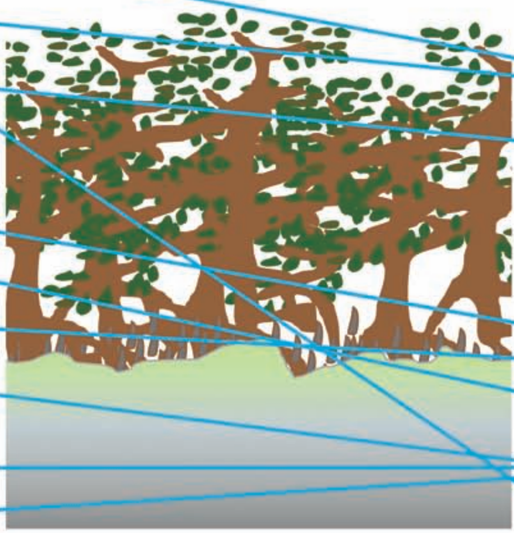


- Increase in temperatures in Equatorial zone, species migrations northward, reduced mangrove to associates interactions
- Ocean waters have become more fresh in South and South-East Asia (CBD 2010)
- Single species mangrove reforestation efforts do not support biodiversity of associated species (birds, mammals, invertebrates)
- Rampant and large scale harvesting marginalizes
  - storm buffering function,
  - ability to mitigate sedimentation and pollution
  - Ability to mitigate CC impacts
  - Availability of materials for local consumption
  - Reduces available habitats

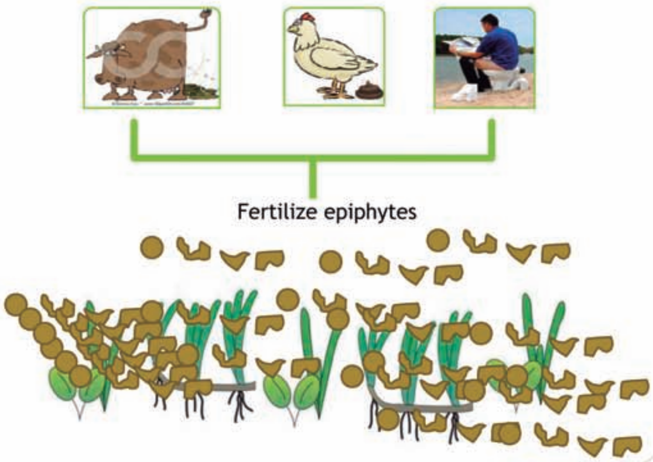
Summary of threats and stresses to mangroves in the ASEAN Region

Threat	CAM	IND	MAL	MYA	PHI	SIN	THA	VIE
Timber extraction	●			●				
Fuelwood	●			●	●		●	
Tanning								
Commercial logging		●			●			
Illegal logging		●			●			
Aquaculture	●	●	●	●	●		●	●
Coastal erosion		●		●				
Land reclamation	●	●	●			●	●	
Coastal development			●	●	●	●		
Agriculture		●	●	●	●		●	
Military defoliants								●
Housing/settlements			●		●	●		
Salt pan construction	●							
Industrial development					●			
Mining					●			

Legend: ● - Indicates presence of threat in the country.

Sources:
Burke, Loretta, Elizabeth Selig and Mark Spalding. 2002. Reefs at Risk in Southeast Asia. World Resources Institute. 2002 accessed on 5 April 2010 at from http://pdf.wri.org/rrseasia_full.pdf .
Giesen, Wim , Stephan Wulffraat, Max Zieren and Liesbeth Scholten. 2006. Mangrove Guidebook for Southeast Asia, RAP Publication 2006/07. FAO and Wetlands International 2007, pp 7-8, accessed on 9 April 2010 at ftp://ftp.fao.org/docrep/fao/010/ag132e/.
Ministry of Environment, Cambodia. 2009. Report on National Marine Gap Analysis for Cambodia. Kingdom of Cambodia. November 2009.
National Parks Board Singapore 2010. 4th National Report to the Convention on Biological Diversity. Singapore. September 2010.

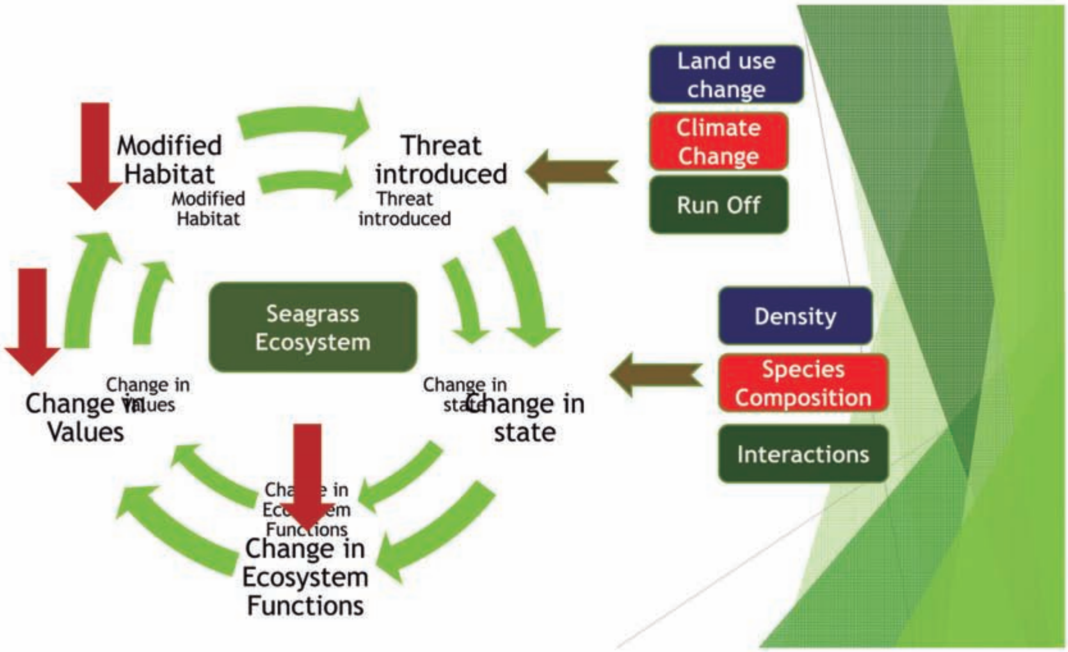
Threats to Seagrasses

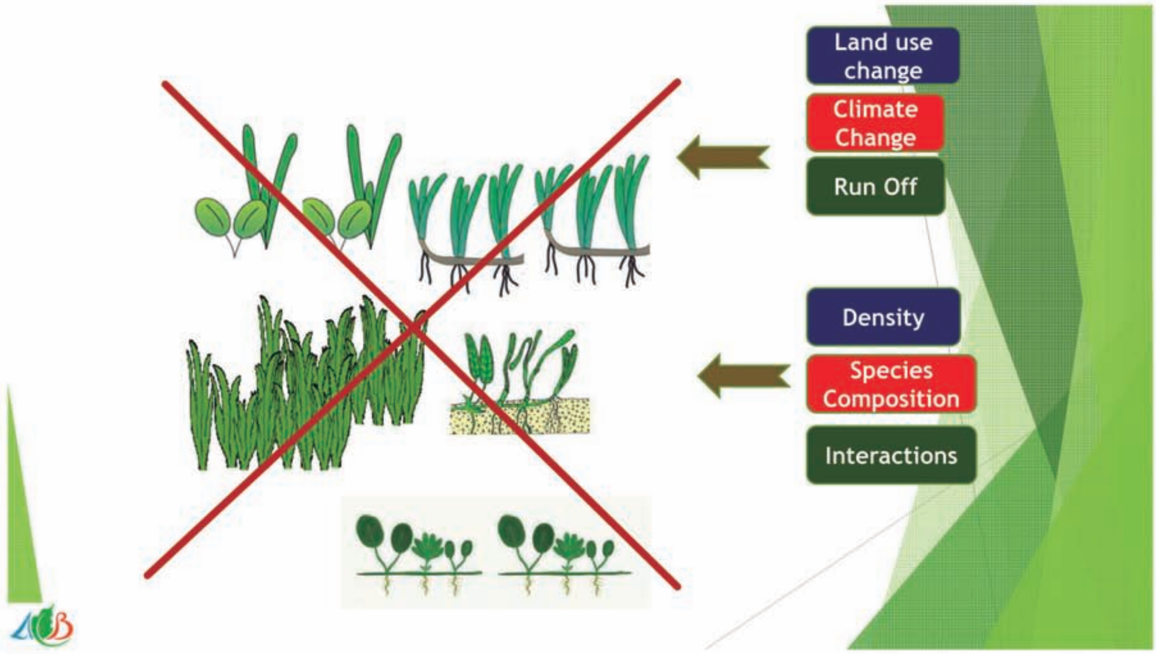


- Domestic, industrial and agricultural wastes promote excessive epiphytic growth on the leaves and the lack of grazers may deprive seagrasses of sunlight that may ultimately kill them
- Earth moving activities (mining, infrastructure) reduce water quality
- Clearing
  - by resorts for swimming areas (dredging)
  - From destructive means of fishing
- Change in coastal land uses
  - Conversion to fishponds
- Diseases

Threats to Seagrasses in Southeast Asia

Threats	BRU	CAM[1]	IND[2]	MAL[2]	MYA[3]	PHI[2]	SIN[4&5]	THA[2&6]	VIE[2&7]
Land reclamation					●		●		
Coastal development							●		●
Land-based activities								●	
Agriculture		●				●		●	●
Aquaculture		●		●	●	●		●	●
Pollution			●					●	
Sedimentation						●	●		
Siltation			●			●			
Dredging									
Trawling								●	●
Blast fishing			●	●		●			●
Illegal fishing								●	
Destructive fishing practices		●						●	
Over/ unsustainable fishing						●			
Eutrophication						●			
Domestic waste		●							
Industrial waste		●							
Mining		●	●	●	●	●		●	
Tourism					●				●
Nutrient loading						●			
Solar salt Production					●				





Implications of Seagrass loss

Loss of wave buffering function

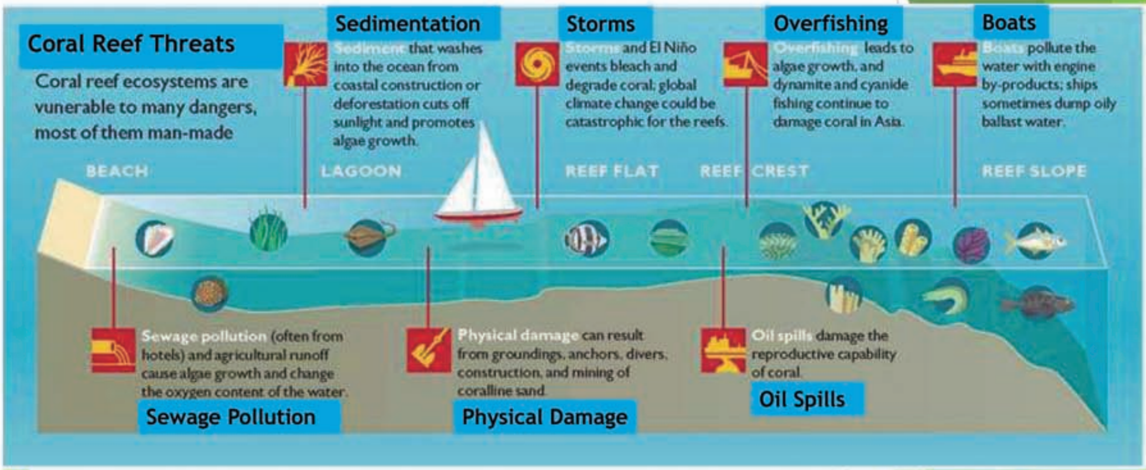
Loss of substrate integrity

Loss of nursery function

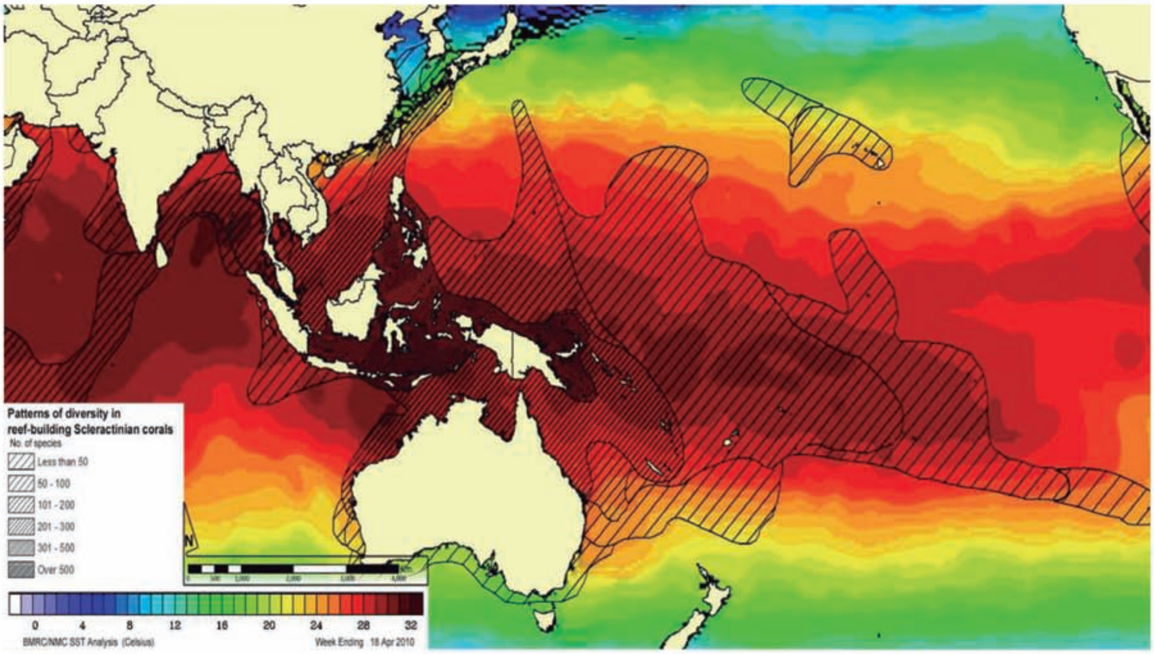
Reduced species composition, diversity

Loss of seagrass-related fisheries resources

Coral Reef Threats



Source:
https://www.google.com.ph/search?q=threats+to+coral+reefs&biw=1309&bih=723&source=lnms&tbm=isch&sa=X&ei=dNRKVdr1O4fGmQWp5oG4CA&ved=0CAYQ_AUoAQ&dpr=1.1#imgrc=NlhbwSzyi2DLCM%253A%3BgtbTUQu75Rq-JM%3Bhttp%253A%252F%252Fthebaumfoundation.org%252Fwp-content%252Fuploads%252FReef-diagram.jpg%3Bhttp%253A%252F%252Fthebaumfoundation.org%252Fenvironment%252Freef-resilience%3B800%3B323



Functions / Non $ Values	Area Estimates Sq Km	Annual $ Value Estimates	Threats
▪ Provides habitat → sustains food sources and livelihoods	284,000	30 Billion	Thermal Stress a) threatens symbiosis b) warms the ocean and cause coral bleaching
▪ Coastal Protection from storm waves and surges			Increase in dissolved C02 reduced ocean pH (acidification) is expected to have corrosive effects and alter coral, phytoplankton and invertebrates calcification rates (reduces growth, compromises structure) - reduced BD
▪ Tourism			Pollution, heavy sedimentation (related to loss of seagrasses and mangroves), sewage, agrochemicals → algal overgrowth; swimming pool water
			Use of destructive means of fishing (nets, explosives, chemicals)
			Careless tourism (boating, diving, coral collection, scraping, dropping of anchors)
			Coral mining
			Climate Change: Increase in CO2, ocean acidifications

27% of coral reefs have been permanently lost and with current trends, a further 30% is at risk of being lost in the coming thirty years.

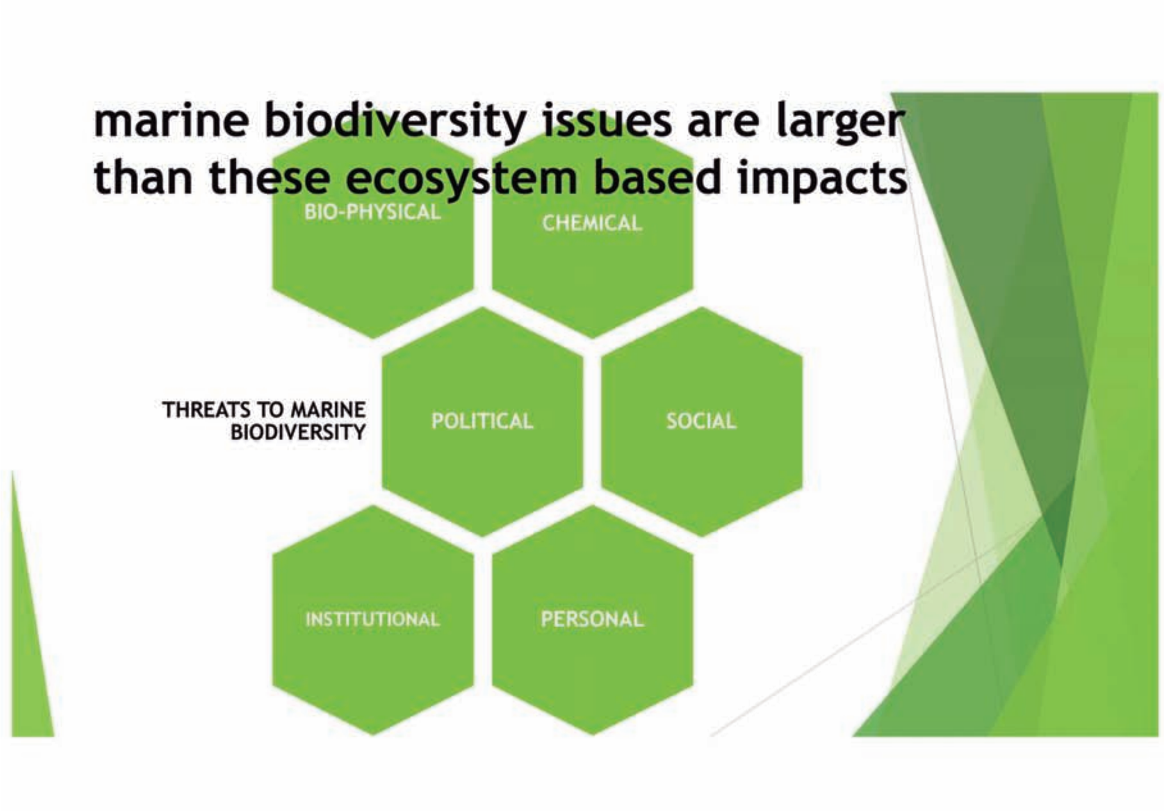
Financial damage from overfishing more than 21,000 km2 of reefs in the Philippines is estimated at US$1.2 billion (R@R)

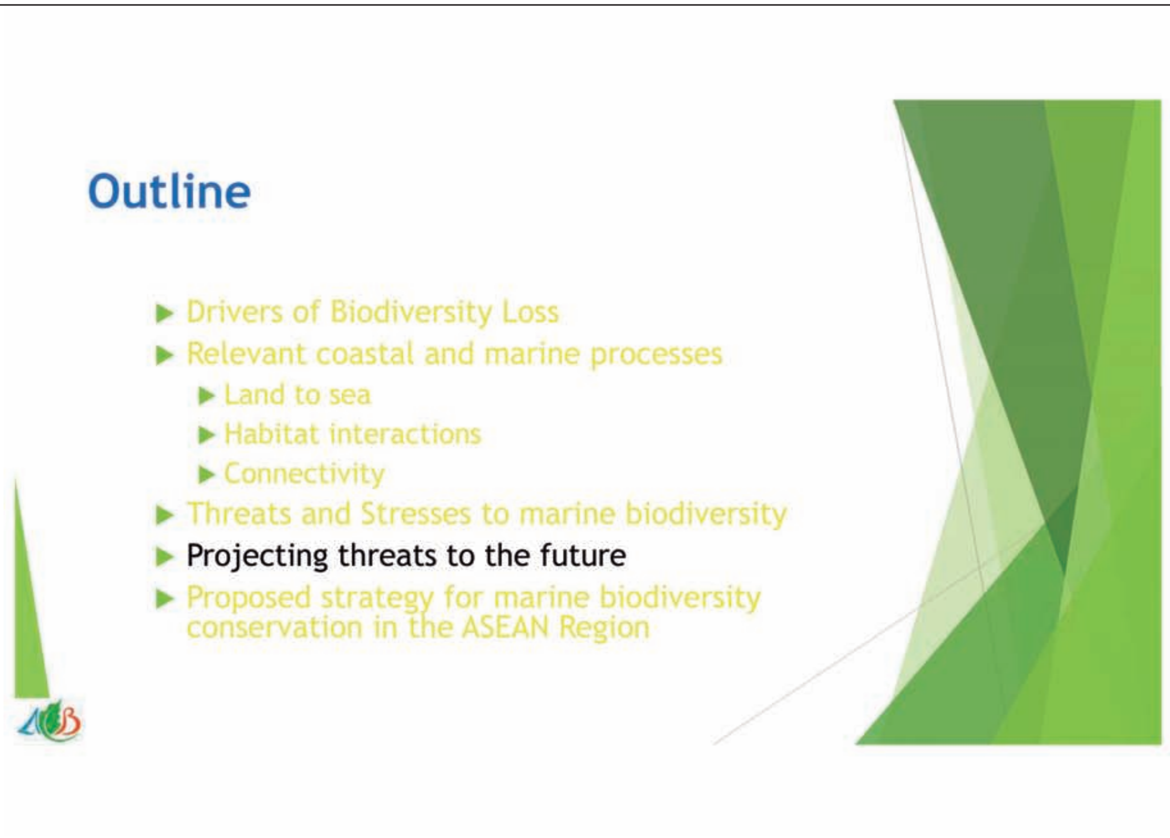
Summary of Threats and Stresses on Coral Reefs in the ASEAN Region

Location/Country	BRU[1 & 2]	CAM[1]	IND[1]	MAL[1]	MYA[1]	PHI[3]	SIN[1&4]	THA[1&5]	VIE[1]
Overfishing	●	●	●		●	●		●	●
Destructive Fishing			●	●	●	●		●	●
Muro Ami						●			
Blast Fishing		●	●	●		●			
Cyanide Fishing			●	●	●	●			
Trawling								●	
Sedimentation from land-based sources	●		●	●	●	●	●	●	●
Coastal Development					●	●	●	●	●
Agriculture			●	●		●			
Aquaculture						●			
Land-cover change/ Development	●		●		●	●			
Deforestation			●						
Bleaching*/Climate Change	●	●	●			●	●	●	
Domestic Wastes						●		●	
Industrial Wastes/ Pollution						●			
Encroachment	●								
Tourism								●	
Storms								●	

Legend: ● - Indicates presence of threat in the country.

Sources:
[1] Burke, Loretta, Elizabeth Selig and Mark Spalding. 2002. Reefs at Risk in Southeast Asia. World Resources Institute. 2002 accessed on 5 April 2010 at http://pdf.wri.org/rrseasia_full.pdf.
[2] Forestry Department, Ministry of Industry and Primary Resources, Brunei Darussalam, undated. 4th National Report to the Convention on Biological Diversity. Government of Brunei Darussalam.
[3] Bureau of Fisheries and Aquatic Resources. 2000. Philippines. 2000 accessed on 30 March 2010 at http://www.bfar.da.gov.ph/infocorner/fast_facts.htm.
[4] National Parks Board, Singapore. 2010. Singapore – 4th National Report to the Convention on Biological Diversity. September 2010. pp18.
[5] Ministry of Natural Resources and Environment, Thailand. 2010. Marine Gap Analysis for Thailand. Bangkok, Thailand.


marine biodiversity issues are larger than these ecosystem based impacts
BIO-PHYSICAL
CHEMICAL
THREATS TO MARINE BIODIVERSITY
POLITICAL
SOCIAL
INSTITUTIONAL
PERSONAL


Outline
Drivers of Biodiversity Loss
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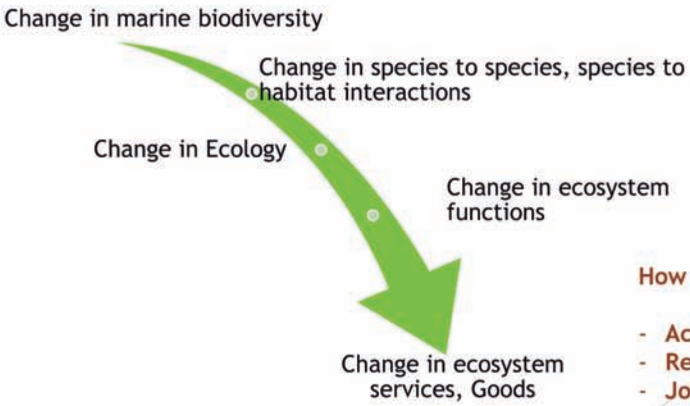
Proposed strategy for marine biodiversity conservation in the ASEAN Region

Projecting threats to the future



?

How will these affect:

- Access to natural products
- Resilience of natural habitats
- Jobs
- Lives

Projecting threats to the future in the context of climate change

- Shifts in distributional ranges of marine species
- Change in ocean primary productivity
- Shifts in timing of peak abundance, migration and interaction of biological communities
- Increase in fequency and severity of coral bleaching
- Mass mortalities of coastal marine life
- Ocean acidification

Projecting threats to the future in the context of climate change

- Global sea levels may rise by as much as 69cm during the next 100 years due to melting of glaciers and polar ice, and thermal expansion of warmer water.
- Rising water levels will have serious impacts on marine ecosystems. The amount of light reaching offshore plants and algae dependent on photosynthesis could be reduced, while coastal habitats are already being flooded.
- Rapid sea level rise will likely be the greatest climate change challenge to mangrove ecosystems, which require stable sea levels for long-term survival.
- One of the most visually dramatic effects of climate change is coral bleaching, a stress response caused by high water temperatures that can lead to coral death. Recent years have seen widespread and severe coral bleaching episodes around the world, with coral mortality reaching 70% in some regions.

Projecting threats to the future in the context of transboundary issues

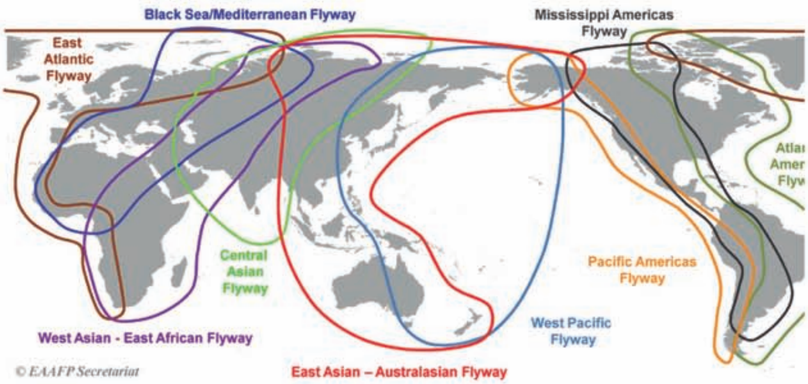
- **Pollution**
  - Wastes related to growth, production, shipping
  - Oil accidents
- **Introduction of alien species**
  - International shipping, ballast water
- **Over exploitation**
  - Of shared or straddling stocks
- **Destructive Fishing practices**
  - Destructive fishing in one country can impact viability of migratory fish in another
- **Change in consumption and use patterns and international trade**
  - Increase in disposable income, increase demand for specialized marine products (CR, EN, VU species)
  - Affordability of resorts

Transboundary Issues

Pattern of Oil Tanker Routes and Oil Spills in East Asia

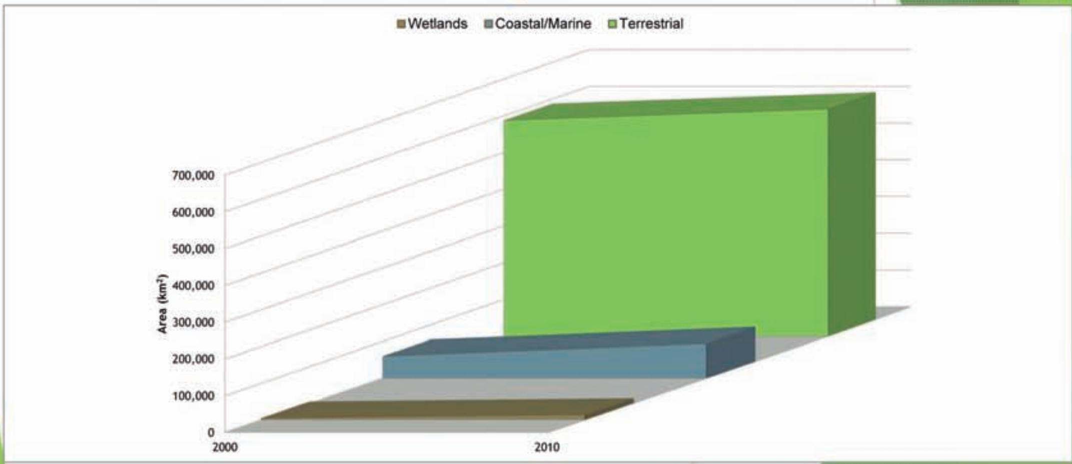
Over 220 million gallons of oil were spilled in the Asia-Pacific region since 1965; about 96% of this (212 million gallons) occurred in East Asia.

Projecting threats to the future in the context of related ecosystems



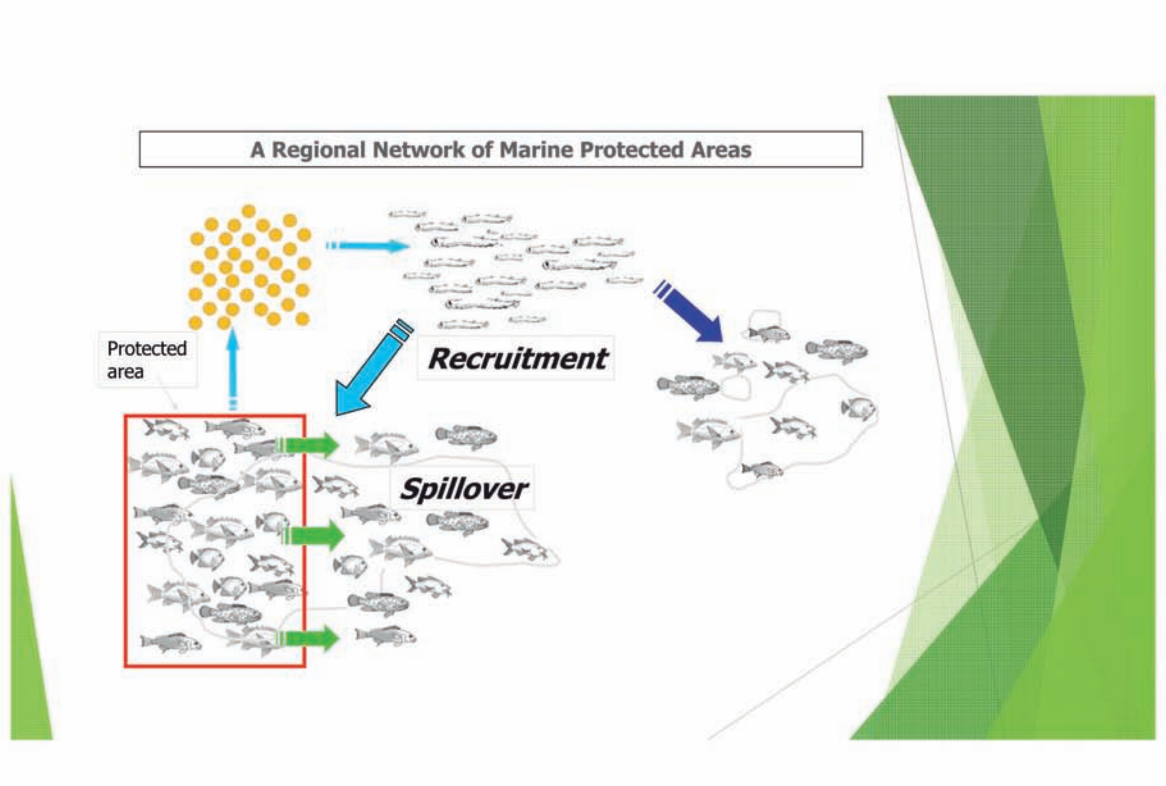
- Intertidal habitats
- Other soft bottom communities
- Sandy beaches
- Rocky intertidal

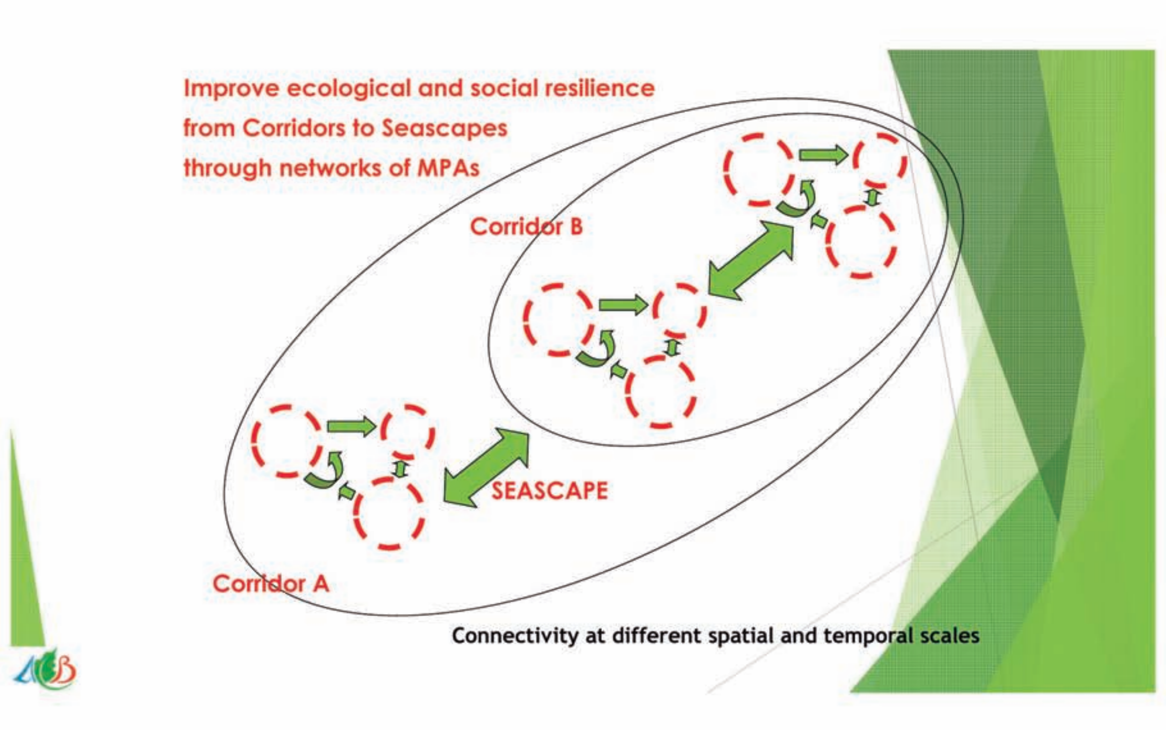
Projecting threats to the future in the context of conservation priorities

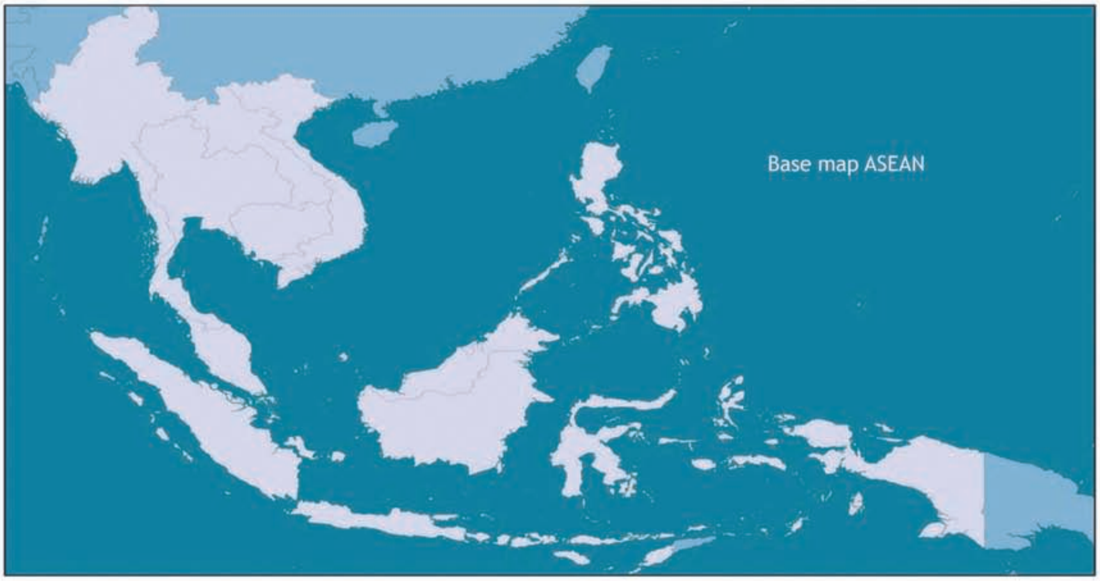


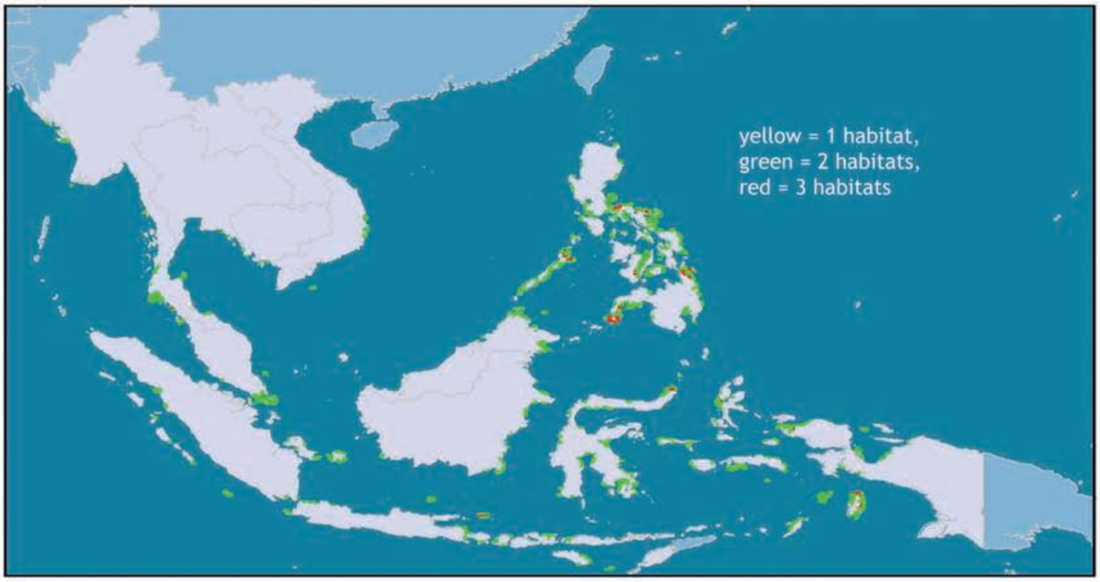
Outline

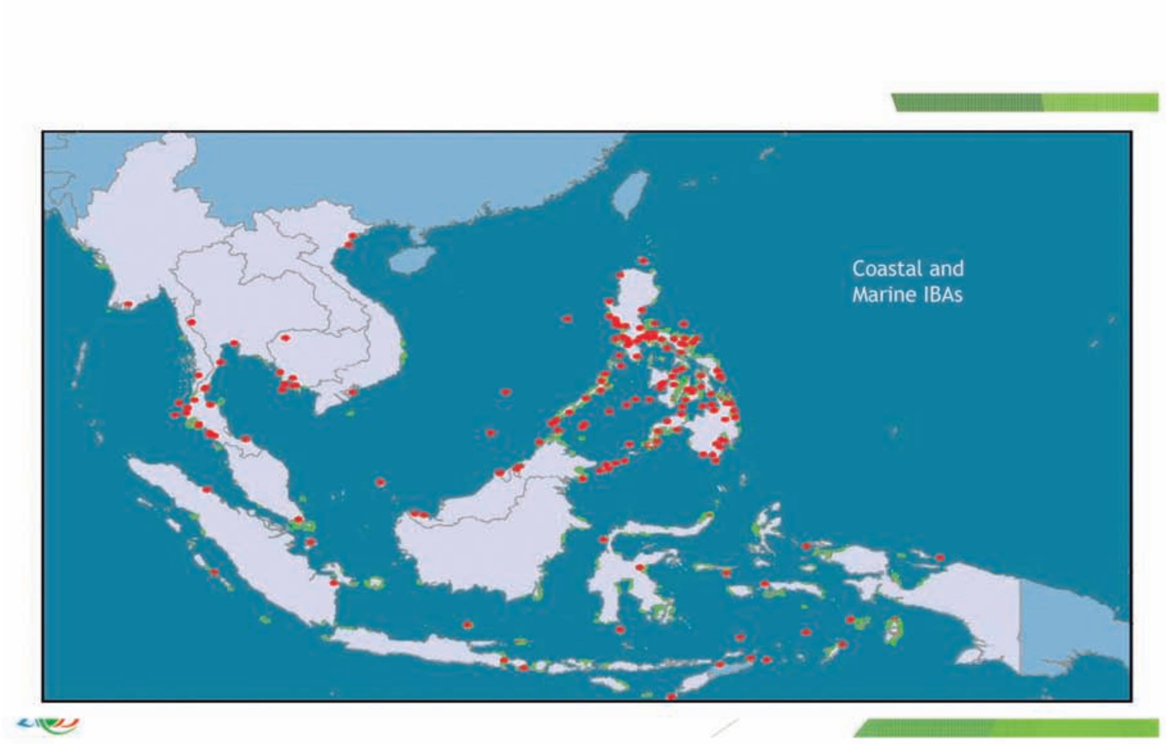
- Drivers of Biodiversity Loss
- Relevant coastal and marine processes
  - Land to sea
  - Habitat interactions
  - Connectivity
- Threats and Stresses to marine biodiversity
- Projecting threats to the future
- Proposed strategy for marine biodiversity conservation in the ASEAN Region

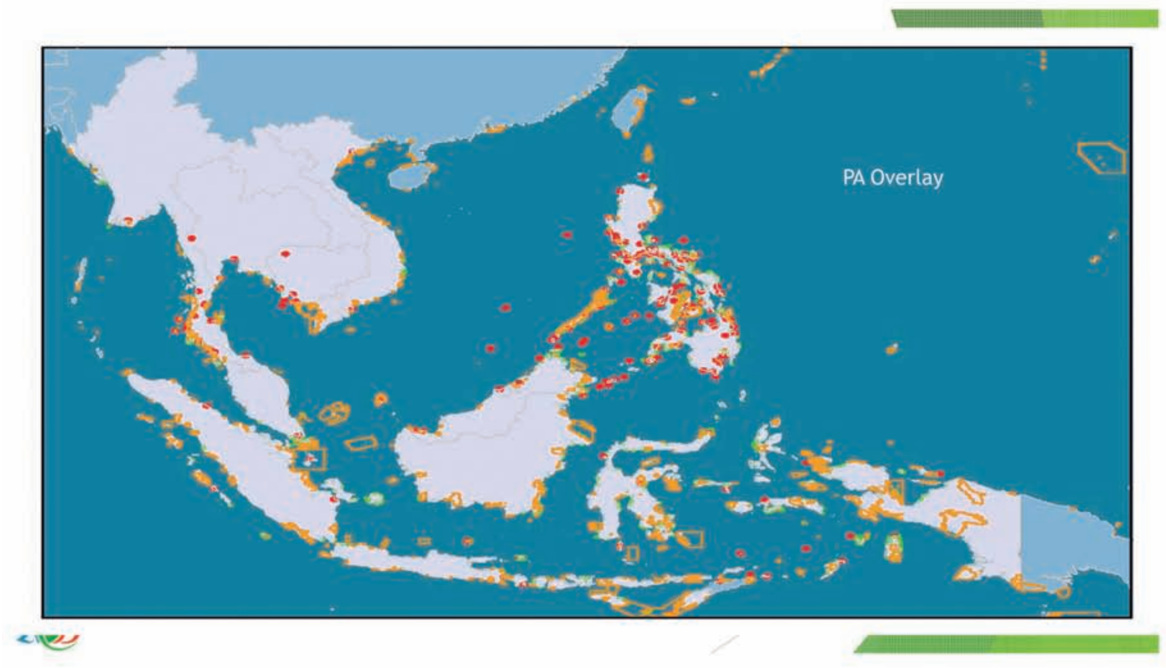

A Regional Network of Marine Protected Areas
Protected area
Recruitment
Spillover

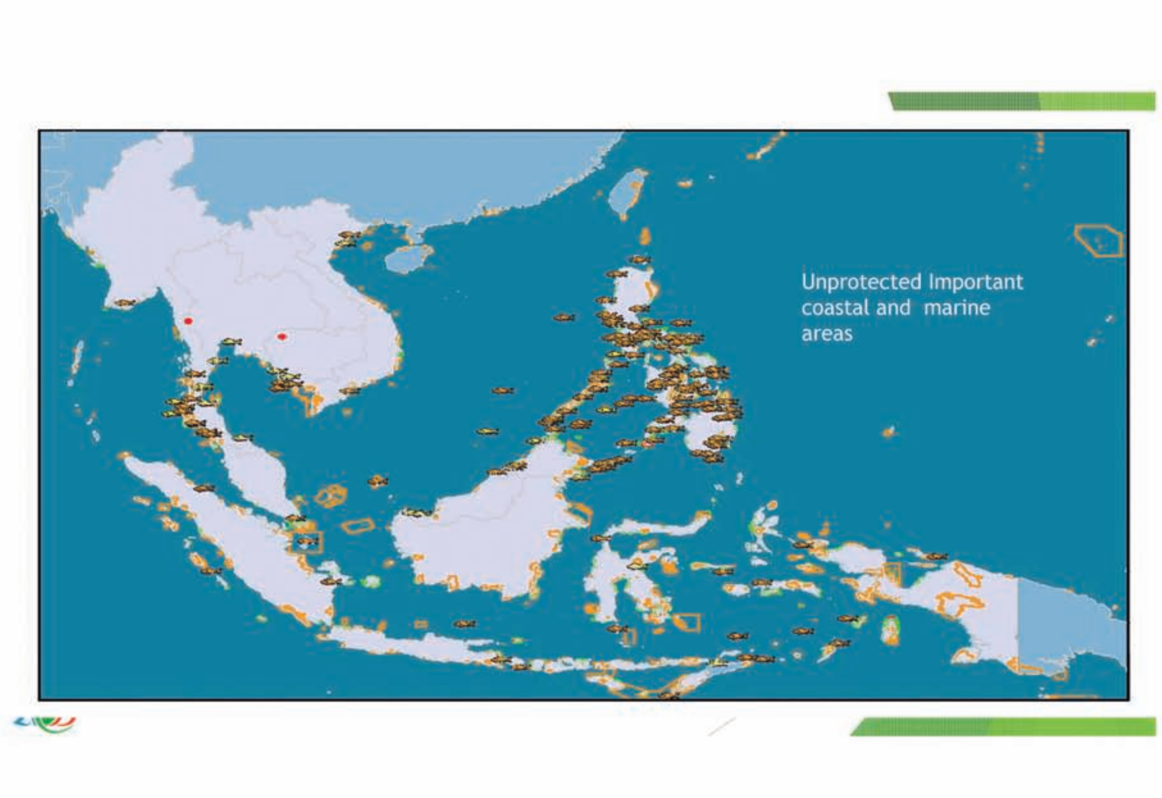

Improve ecological and social resilience
from Corridors to Seascapes
through networks of MPAs
Corridor B
SEASCAPE
Corridor A
Connectivity at different spatial and temporal scales

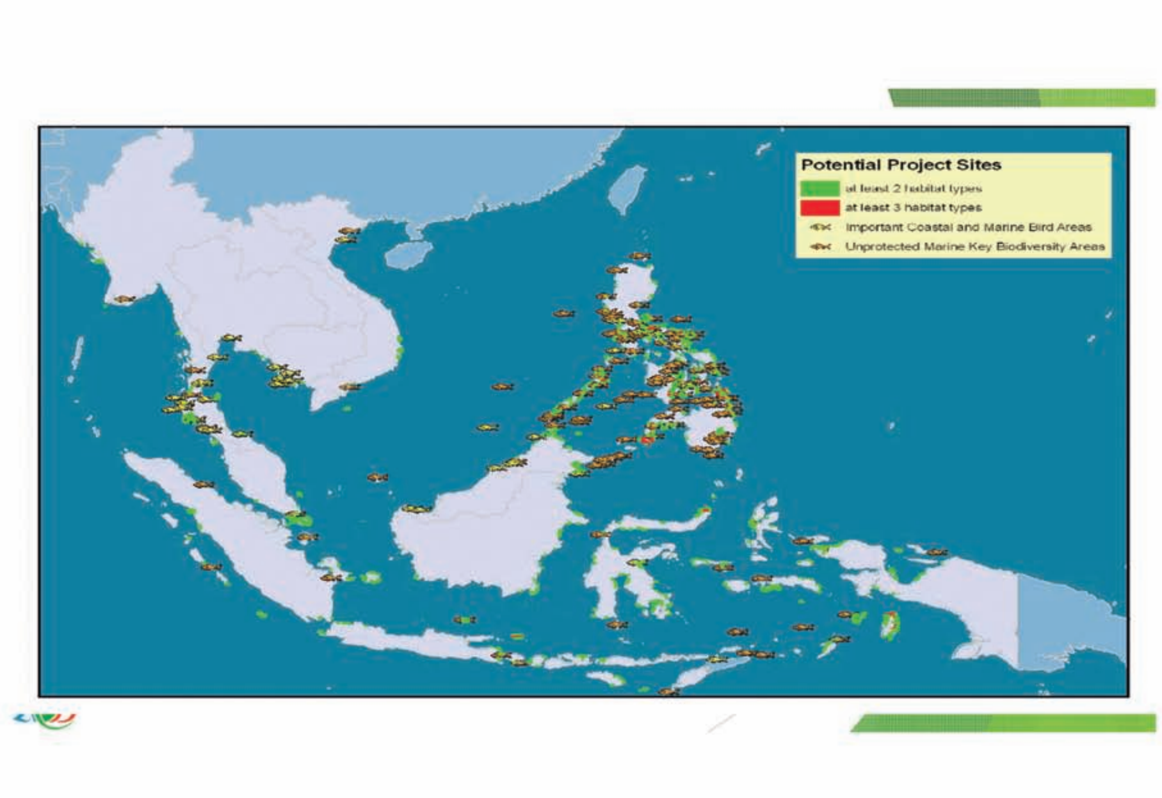

Base map ASEAN

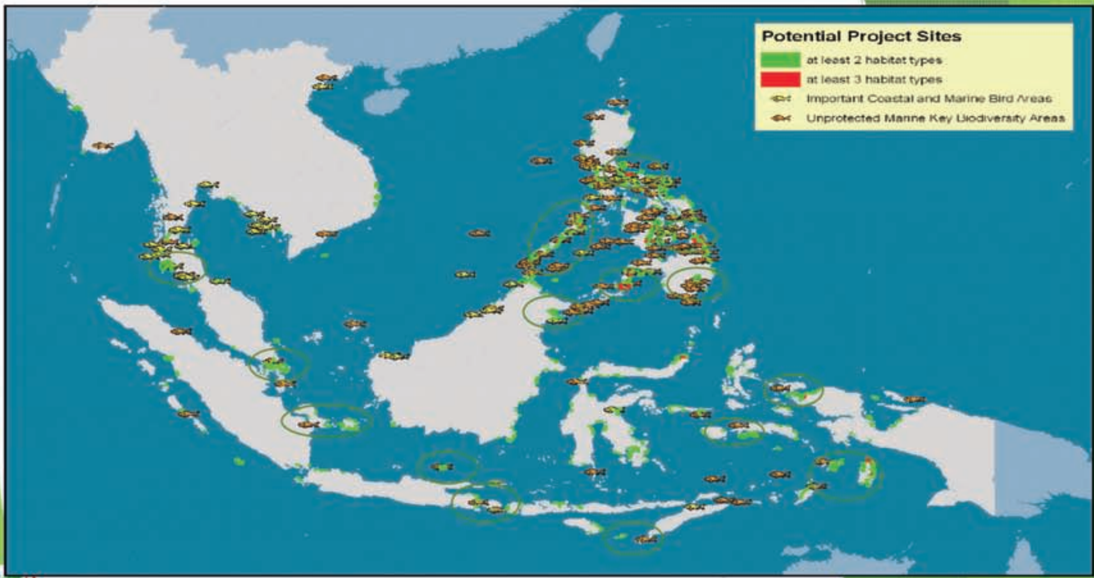

yellow = 1 habitat,
green = 2 habitats,
red = 3 habitats


Coastal and
Marine IBAs

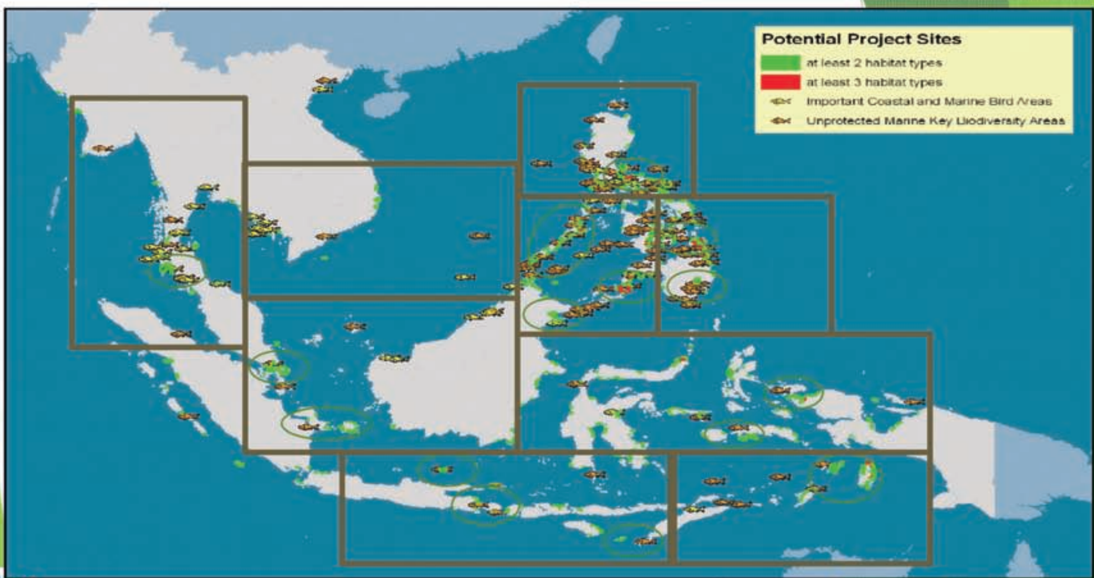

PA Overlay


Unprotected Important coastal and marine areas


Potential Project Sites
at least 2 habitat types
at least 3 habitat types
Important Coastal and Marine Bird Areas
Unprotected Marine Key Biodiversity Areas



Map – based selection of potential project areas



Planning Areas for ICM sites


Thank You
chm.aseanbiodiversity.org
ASEAN CENTRE
FOR BIODIVERSITY

2-3. Discussions

1. Dr. Christopher L. Sabine, Oceanographer and Director from NOAA's Pacific Marine Environmental Laboratory presented potential economic impacts of ocean acidification. In his presentation, he emphasized that Asia-Pacific Nations are extremely vulnerable to a changing climate in the coming decades.

2. He explained that like climate change, ocean acidification occurs when atmospheric CO_2 dissolves in seawater. He also presented the time series which shows that surface water pCO_2 is increasing at about the same rate as atmosphere, and that PH in the ocean is also decreasing along time, which will cause acidity in the ocean.

3. He informed the workshop that increasing acidity and related changes in seawater chemistry can affect reproduction, behaviour and general physiological functions of marine organisms, and it will likely cause negative impacts in economically important marine species including corals, molluscs, crustaceans, echinoderms and fish.

4. He then shared that ocean acidification is a concern for many commercially important species, with the impact on the global economy estimated to cost over one trillion US dollars per year by the end of the century, and that International Community is Developing a Global Observing Network which still need stronger to local economies. Finally, he raised that more detailed and coordinated studies at regional and local levels are required to document and predict the vulnerability and economic impacts on the Asia Pacific economies.

5. Dr. Vergara discussed the different drivers of biodiversity loss with focus on habitat destruction. Characteristics of and benefits from the coastal ecosystems namely mangroves, sea grass, and coral reefs were also presented. Dr. Vergara also highlighted the abundance of the coastal and marine biodiversity in the ASEAN region.

6. Dr. Vergara explained the connectivity of these ecosystems and impacts on ecosystem services from human activities. Moreover, connectivity patterns of the coastal and marine resources were also discussed making mention of how the Philippines came with the identified sites to be established as Marine Protected Areas using this pattern.

7. Threats to biodiversity were also presented and the implications of the degradation of coastal and marine ecosystems. Dr. Vergara also provided projections of the threats in the future and in the context of climate change. She mentioned of the need for the ASEAN Member States to increase their conservation focus for wetlands and coastal and marine environments.

8. On the concern on the impact of ocean acidification on the deep sea, Dr. Sabine admitted that their studies is focused on surface waters, and that the benthic area is an area of study that need to work on.

9. Viet Nam shared that ASEAN members have their own systems of organizing MPA and explored possibility with ACB to create an MPA network at the regional level. ACB responded that their current initiatives are focused on establishing ASEAN heritage parks, which comprise 80 % terrestrial, however current efforts are moving towards MPAs. She then pointed out that organized data and focal points for establishing an MPA regional network which is estimated to cost 35 M Euro.

10. Viet Nam also recommended to study further inland freshwater resources, especially in Greater Mekong River area since some species go upstream to spawn. ACB expressed the interest to work with Viet Nam on the matter.

11. USA inquired if other stressors, aside from ocean acidification are being looked at, she also inquired on how these observations were able to help local communities adapt to climate change. On the first query, Dr. Sabine replied that they are working on combining physico-chemical with biological aspects. On the assistance to local communities, He also shared their experience on oyster culture wherein they provide assistance to oyster hatchery operators in terms of changes of procedures e.g. Water treatment, testing water acidity, etc, resulting to an increase of survival rate from 20-80 %, generating an annual savings of 35 M USD.

12. On another note, Dr. Sabine stressed that the concern is not on the total volume of CO_2, but on the rate in which CO_2 is adding up in the atmosphere. He enjoined the member economies to reduce their emissions to allow the ocean to cope in neutralizing dissolved carbon.

13. Philippines raised that aside from reducing carbon emission, there is also a need to improve biodiversity, to improve resilience of ecosystems. Considering that increase in

temperature/warming of oceans may affect biological calendar of fishes and marine animals, making them less resilient.

14. Dr. Sabine clarified that though there are winners with ocean acidification (i.e. Sea grasses), overall biodiversity is reduced.

15. Chinese Taipei sought clarification on how to address overcapacity for economic development, as APEC member economies are directed towards strengthening economic cooperation, and may need to discuss on how to incorporate climate change and sustainability concerns in their objectives. In response, Dr.Umezawa suggested that the issue will be brought up to OFWG for discussions.

16. On the nature of the Global Observing Network, Dr. Sabine shared that it started as a collaboration among scientist, and is now working towards extending its value at the IOC level.


APEC
orkshop on the Climate Change Impact on
Oceans and Fisheries Resources
May 9, 2015 | Boracay, Aklan, Phili

Chapter III

Implications for Marine Ecosystem

3-1. Implication on Marine Ecosystem

Yoshihisa Shirayama
Executive Director
Japan Agency for Marine-Earth Science and Technology

In the end of this century, the atmospheric concentration of carbon dioxide (CO2) may become twice as large as the level before industrial revolution. In such high CO2 world, the marine environment will change dramatically due to climate change and ocean acidification.

From the point of view of global warming, the marine ecosystem will change to be lesser primary production due to strengthening of ocean stratification, lesser primary production in the coasts due to reduced rain fall, larger impacts of flood, more serious in "Isoyake" phenomena and coral bleaching.

From the point of view of ocean acidification, the environmental change will favor some species, whereas serious negative impact will damage especially on those species that have calcareous shell. The loosers include many fisheries species such shells, snails, abalones, clams, oysters, scallops, and sea urchins. Recently fishes are also reported to be potential looser. Algae and sea grasses will be benefitted by higher concentration of CO2 in the sea water. Soft corals will overturn reef building corals in the future, because for the latter, the area favorable for the growth probably will disappear around 2060, because high sea-water temperature causes coral bleaching, whereas in lower temperature area, ocean acidification will be more serious.

To overcome the problem, several mitigation options have been proposed, such as carbon capture and sequestration (CCS). In addition, many projects to utilize marine resources such as manganese nodules, methane hydrate, and deep-sea fishes are under planning. These human action however may damage the marine ecosystem seriously, and various sectors are arguing about implementation of these plans.

For the continuous development of human society, sustainable use of marine resources and conservation of the health of the ocean are both essential, and to realize both these two issues, it is the most important that the uncertainty of the prediction regarding the future of marine environment should be minimal and well reliable based on holistic scientific knowledge.

One of good example for sustainable use of marine ecosystem services is traditional fisheries method. Such indigenous local knowledge is considered as key information in preparing assessment report by IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services).

Even though science made significant progress, the knowledge should be available by policy makers. Thus continuous and fruitful dialogue among scientists and policy makers is a key for sustainable use of marine resources. Participants of the workshop from both policy side and academy side agreed the importance of the dialogue. The way to enhance such dialogue was discussed during the presentation. The speaker emphasized that the evaluation system of scientific society has not paid enough attention to the effort made by scientists on public outreach. However in Japan, after the big earthquake in 2011, public outreach became one of essential duty of scientists. To encourage scientists to play the role, it is important to include such activities as one of key item in the accomplishment evaluation. Many participants agreed this idea, and policy side also acknowledged the need of changing social systems to realize more rigorous dialogue among academia and policy.

Implication on marine ecosystem

Yoshihisa SHIRAYAMA

Japan Agency for
Marine-Earth Science and Technology
(JAMSTEC)

Manned Submersible “Shinkai 6500”

1

Contents

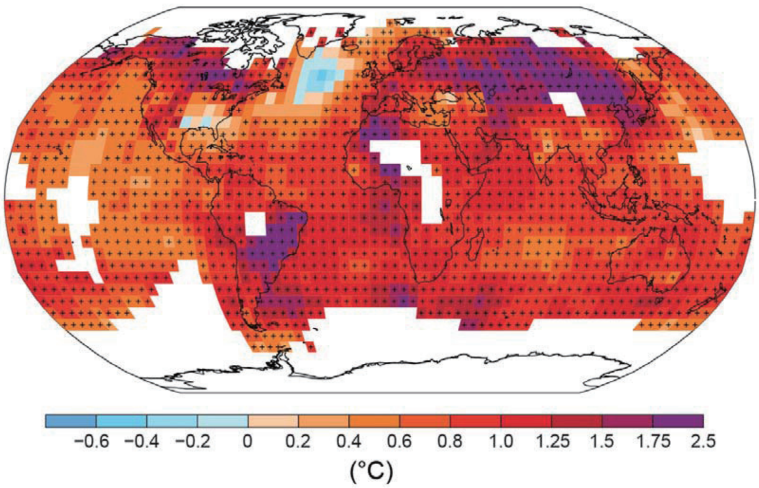
- Review of impacts of climate change on marine ecosystem
- Future Scenarios
- Mitigation Options
- Future developments
  - More environmental impacts
- Science and Policy Dialogue

Marine ecosystem in high CO2 world

- Global warming
  - Lesser primary production due to strengthening of ocean stratification
  - Lesser primary production in the coasts due to reduced rain fall
  - Larger impacts of flood
  - Change of geographic distribution
  - Isoyake phenomena
  - Coral bleaching

Global Warming

Observed change in surface temperature 1901-2012



Marine ecosystem in high CO_2 world

- Global warming
  - Lesser primary production due to strengthening of ocean stratification
  - Lesser primary production in the coasts due to reduced rain fall
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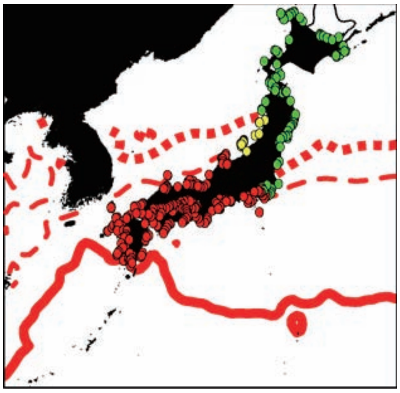
  - Coral bleaching



Ministry of Environment Japan, S-9 project

Future distribution of an eel grass (*Zostera marina*)

Marine ecosystem in high CO_2 world

- Global warming
  - Lesser primary production due to strengthening of ocean stratification
  - Lesser primary production in the coasts due to reduced rain fall
  - Larger impacts of flood
  - Change of geographic distribution
  - Isoyake phenomena
  - Coral bleaching

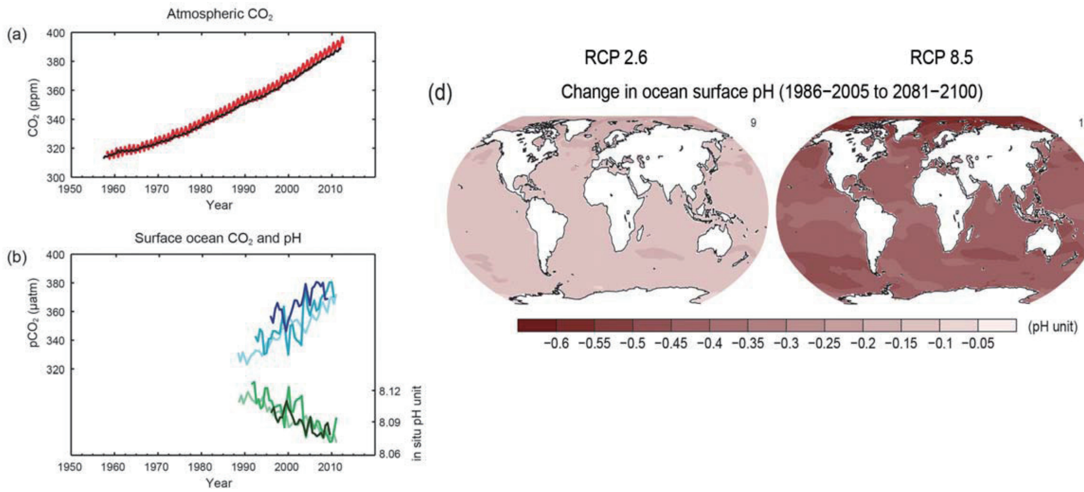
http://fish-exp.pref.shizuoka.jp/izu/0004/0001-isoyake.html

https://sangakukan.jp/journal/journal_contents/2009/11/articles/0911-03-2/0911-03-2_article.html

Marine ecosystem in high CO2 world

- Ocean Acidification
  - Looser
    - Shells, snails, abalones
    - Clams, oysters, scallops,
    - Sea urchins, sea stars, brittle stars
    - Calcareous phytoplankton
  - Maybe looser
    - Fishes
    - Shrimps, crabs,
  - Winner
    - Algae
    - Sea grasses
    - Diatoms
    - Soft corals

Multiple observed indicators of a changing global carbon cycle



Marine ecosystem in high CO2 world

- Ocean Acidification
  - Looser
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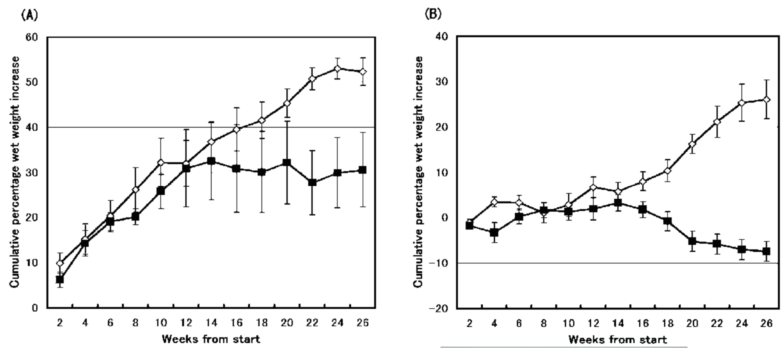
    - Calcareous phytoplankton
    - Reef Building Coral
  - Maybe looser
    - Fishes
    - Shrimps, crabs,
  - Winner
    - Algae
    - Sea grasses
    - Diatoms
    - Soft corals

Growth of Snail and Sea Urchin in the condition of P_{CO2}560ppm



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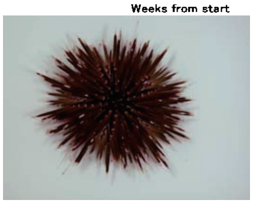


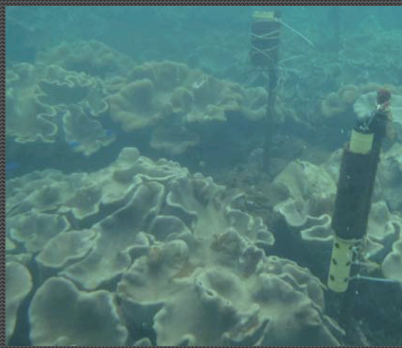
(n=30)

(Shirayama and. Thornton, 2005)

Change from hard to soft coral community

Control site

CO_2 vent site



Courtesy of Haruko Kurihara

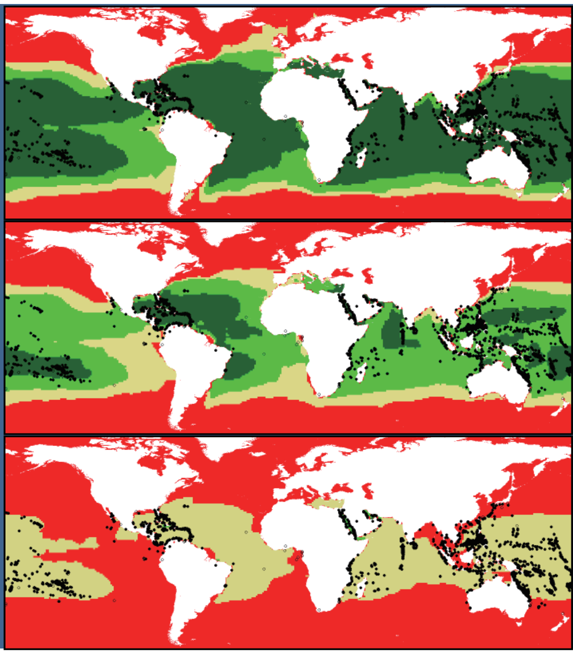
(Inoue et al. 2013 Nature Climate Change)

Future scenarios

- Business as usual
  - Coral Reef
    - Disappearance of reef-building corals
    - Increase of soft corals
    - Lower biodiversity
  - Temperate region
    - Disappearance of eel grass
    - Decrease of macro algae
    - Increase of short sea grass
    - Faunal change associated with floral change

Combination

Future environment for corals Predicted based on Temperature And pH



1880

2004

2065

Dark green	> 4.0	Optimal
Green	3.5 - 4	Adequate
Tan	3 - 3.5	Marginal
Red	< 3.0	Extremely Low

www.iobis.org

Future scenarios

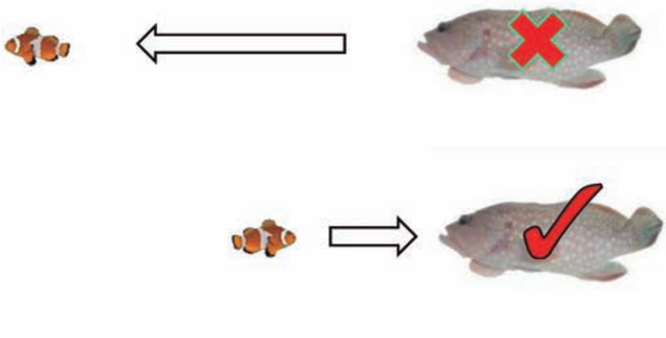
- Business as usual
  - Boreal region
    - Decrease of macro algae
    - Decrease of shells
    - Decrease of phytoplankton
    - Decrease of fisheries resource
  - Polar region
    - Decrease of phytoplankton
    - Decrease of fisheries resources

Sensory ability and behaviour

- Impaired ability to discriminate between chemical cues
  - Settlement habitat
  - Family v non-family
  - Predators v non-predators

Courtesy of Phil Mundy

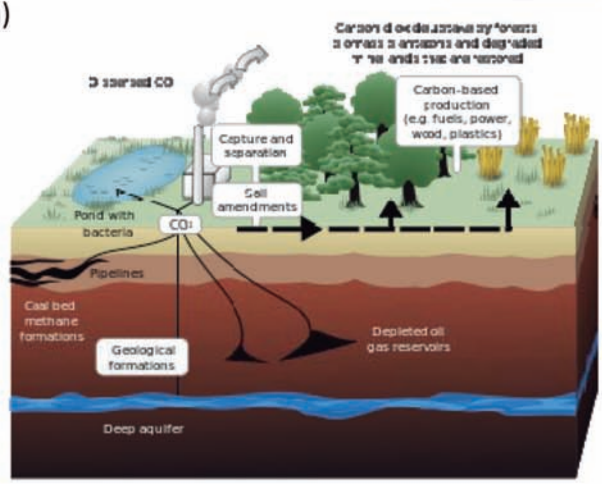
Attracted to predator odour



Courtesy of Phil Mundy

Mitigation options using marine area

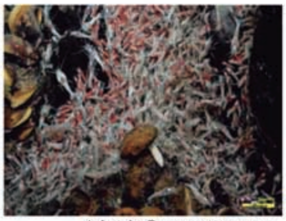
- CCS (Carbon Capture and Sequestration)
  - Sub seabed
  - Sea floor
  - Mid water
- Iron fertilization
- Renewable energies
  - Wind
  - Current
  - Tide
  - Wave



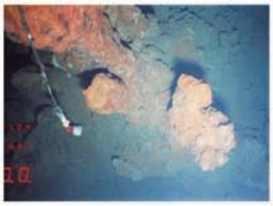
http://en.wikipedia.org/wiki/Carbon_capture_and_storage

Development of Marine Resources

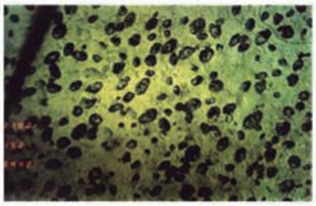
- Mineral resources
- Hydrocarbon resources
- Genetic resources
- Fisheries resources
- Renewable energy resources



Ashazde © Ifremer/Serpentine



Hydrothermal Deposit



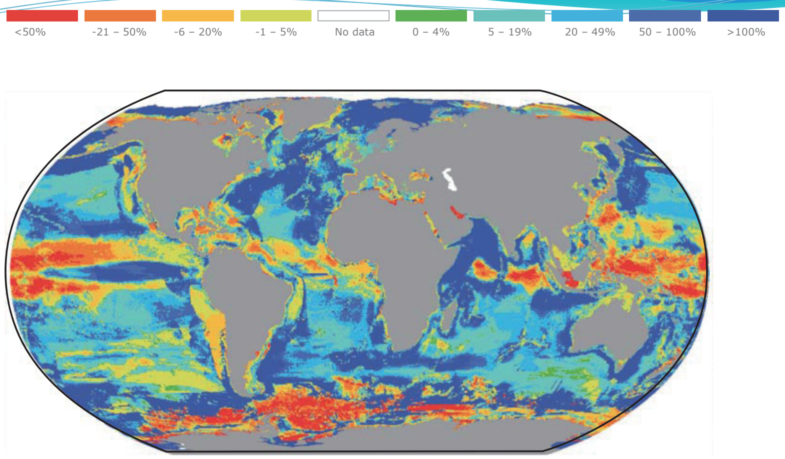
Manganese Nodule

Cobalt Rich Crust

Risks associated with development

- Mineral resources
  - Discharging of clay
  - Discharging of heavy metal
- Hydrocarbon resources
  - Discharging of oil
- Genetic resources
  - Benefit sharing
- Fisheries resources
  - overfishing
- Renewable energy resources
  - Change of current system

CHANGE IN MAXIMUM CATCH POTENTIAL (2051-2060 COMPARED TO 2001-2010, SRES A1B)



IPCC AR5

IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services)

- Science and policy interface regarding biodiversity and ecosystem service
- For sustainable use of ecosystem service
- Conceptual framework
- Assessment Report drafting
- Function similar to IPCC
- Respecting Indigenous Local Knowledge

http://ja.wikipedia.org/wiki/%E7%9F%B3%E5%B9%B2%E8%A6%8B

ishihimi or stone tidal weir (Okinawa Prefecture)

Needs of continuous dialogue between science and policy

- A lot of uncertainties
- Huge gaps among necessary data and existing data
- Future prediction may change
- Needs timely international agreement
- Establishment of governance system of open ocean

JAMSTEC

WORLD OCEAN COUNCIL

The International Business Alliance for Corporate Ocean Responsibility

Science and Technology in Society *forum*

Global Ocean Commission

Thank you for your attention

JAMSTEC Drilling Ship
“Chikyu”

3-2. Discussions

1. Dr. Yoshihisa Shirayama, Executive Director, Japan Agency for Marine Earth Science and Technology (JAMSTEC), Japan presented the Climate Change Implications on Marine Ecosystem. He mentioned the observed impact of the 2011 earthquake in Japan on marine areas, particularly deep-sea ecosystem.

2. He provided a review of the impacts of climate change on the marine ecosystem. Specifically, he discussed and gave examples on the impacts of increase in carbon dioxide and its effect on ocean stratification, rainfall, and occurrence of floods, geographic distribution of important marine species, Isoyake phenomenon, and coral bleaching.

3. He enumerated the various species labeled as losers, maybe losers and winners amidst global warming, ocean acidification, and changing global carbon cycle. He described the future scenarios for coral reefs as predicted based on the changes in temperature and salinity. In addition, he stated the possible changes in sensory ability and behavior of marine species. Also, he mentioned the future salient scenarios in the Temperate, Boreal and Polar Regions.

4. He provided options to mitigate the effects of climate change to the marine area such as carbon capture sequestration, iron fertilization and the use of renewable energy. He also emphasized the developments of marine resources as well as the corresponding risks associated with such developments.

5. In addition, he presented the comparative data on the change in maximum catch potential from 2051 to 2060 compared to 2001 to 2010. He also mentioned the initiatives/functions of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in Japan. Among others, he pointed out that IPBES respects the data and inputs from indigenous and local knowledge for the sustainable use of marine resources.

6. Finally, he emphasized the need for continuous dialogue between science and policy to address the various uncertainties and gaps, as well as encourage information sharing through continued study, timely international agreements, and establishment of governance systems.

7. An inquiry on the proper approach to address uncertainties in the future was raised in plenary. Dr. Shirayama responded that we need to invest in science for better predictions, and advised the scientific community to be honest with their findings and maintain their credibility for policy makers to take on.

8. Philippines agreed to continue policy dialogue between scientist and policy makers and inquired whether the present dialogues are enough, and how much is still need (both financial and effort) are still required. In response, Dr. Shirayama mentioned that the variation of activities among scientist is commonly measured on the number of papers being published. He advised to add contribution to dialogue as another evaluation point to motivate scientist to be involved in policy advisory bodies and other related endeavours.


Workshop on the Climate Change Impact on
Oceans and
Resources
May 9, 2015 |
Aklan, Philippines

Chapter IV

Arctic, as the Most Affected Ocean

4-1. Sea ice decline

Koji Shimada
Tokyo University of Marine Science and Technology

Recent Arctic sea ice reduction in summer is not spatially uniform, but is disproportionally large in the Pacific sector of the Arctic Ocean (Fig.1). This asymmetric reduction is a key to understand the acceleration of reduction of sea ice and future state of the Arctic Ocean. The center of the maximum retreat in recent years is north of the Bering Strait, so called Chukchi Borderland region, where the warm Pacific Summer Water enters the central Canada Basin. The upward heat flux from the warm Pacific Summer Water retards the sea ice formation during winter. In this region, sea ice thickness at the melt onset is much less than the surrounding region. As the results, the sea ice in the oceanic hot spot was easy to be disappeared there under the nearly the same atmospheric condition and solar radiation.

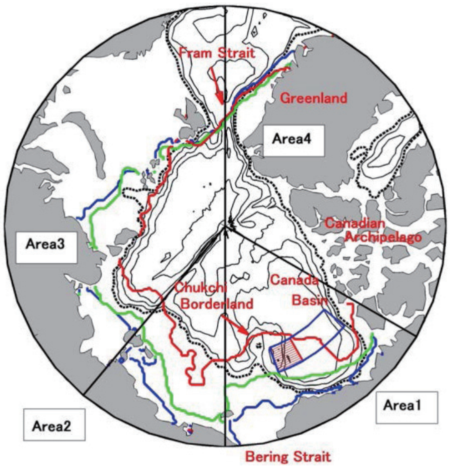


Figure 1. Sea ice edge in September. blue: 1979-1997, green: 1998-2006, red: 2007-2012. From Yoshizawa et al., (2015)

Why the warming of the upper Arctic Ocean was initiated. This is a key issue to understand the initiation of positive feedback loop for no-rebound sea ice reduction. Shimada et al. (2006) proposed a new ice-ocean feedback system to understand the recent catastrophic reduction of sea ice (Fig. 2). The warming of the Pacific Summer Water in the Canada Basin is not directly associated with warming of upstream inflow through the Bering Strait. The oceanic heat is crucially controlled by the volume transport of the oceanic Beaufort Gyre in the Arctic Basin. In the Arctic Ocean, the upper ocean is not directly driven by the wind stress, but by the motion of sea ice. Although the sea ice is driven by the wind forcing, but the amplitude of the motion is also affected by the stress from the coastal boundary. If the Arctic Ocean is completely covered by sea ice, the wind forcing hardly penetrates into the sea ice due to friction of sea ice at the coastal boundary. However, less sea ice cover just near the coastal boundary establishes more free-slip condition for large-scale sea ice motion. This means that the sea ice motion depends not only on the wind forcing but also on the sea ice cover itself.

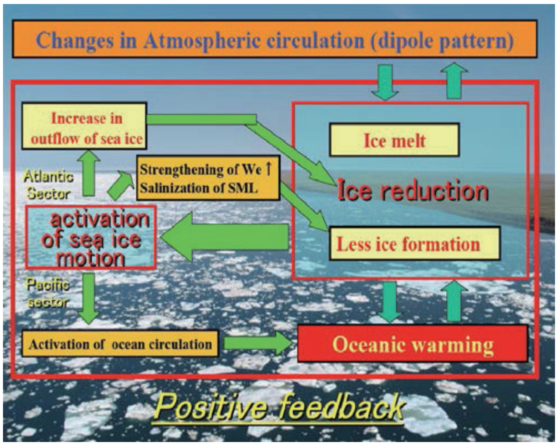


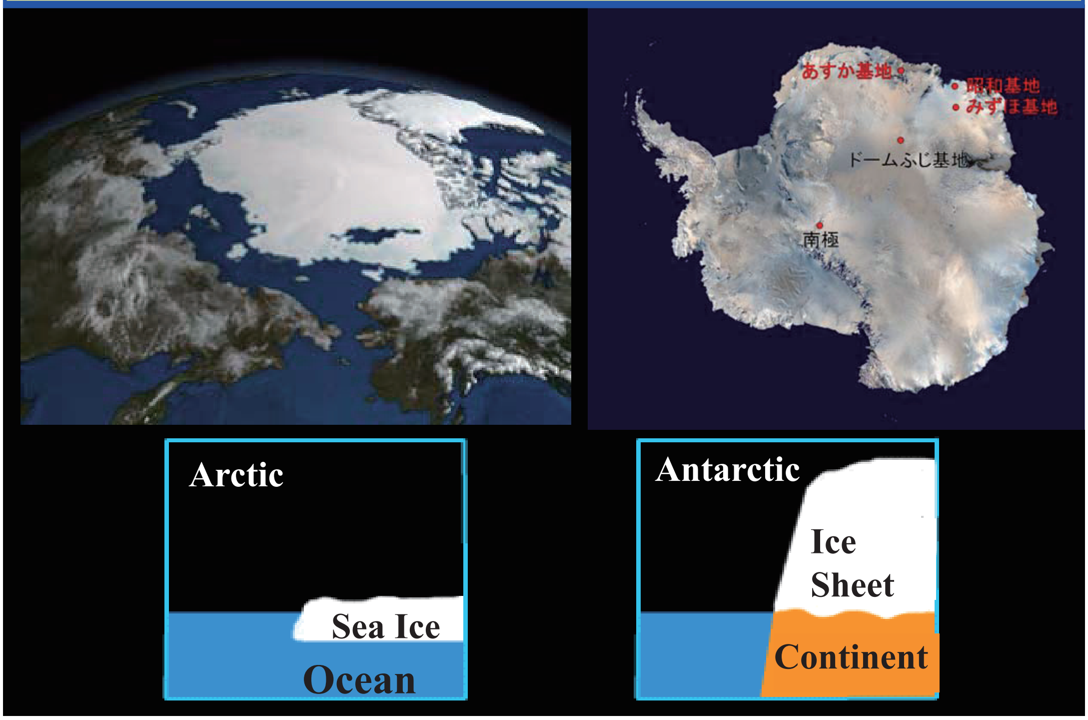
Figure 2. New positive feed back system for no-rebound sea ice decline in the Arctic Ocean.

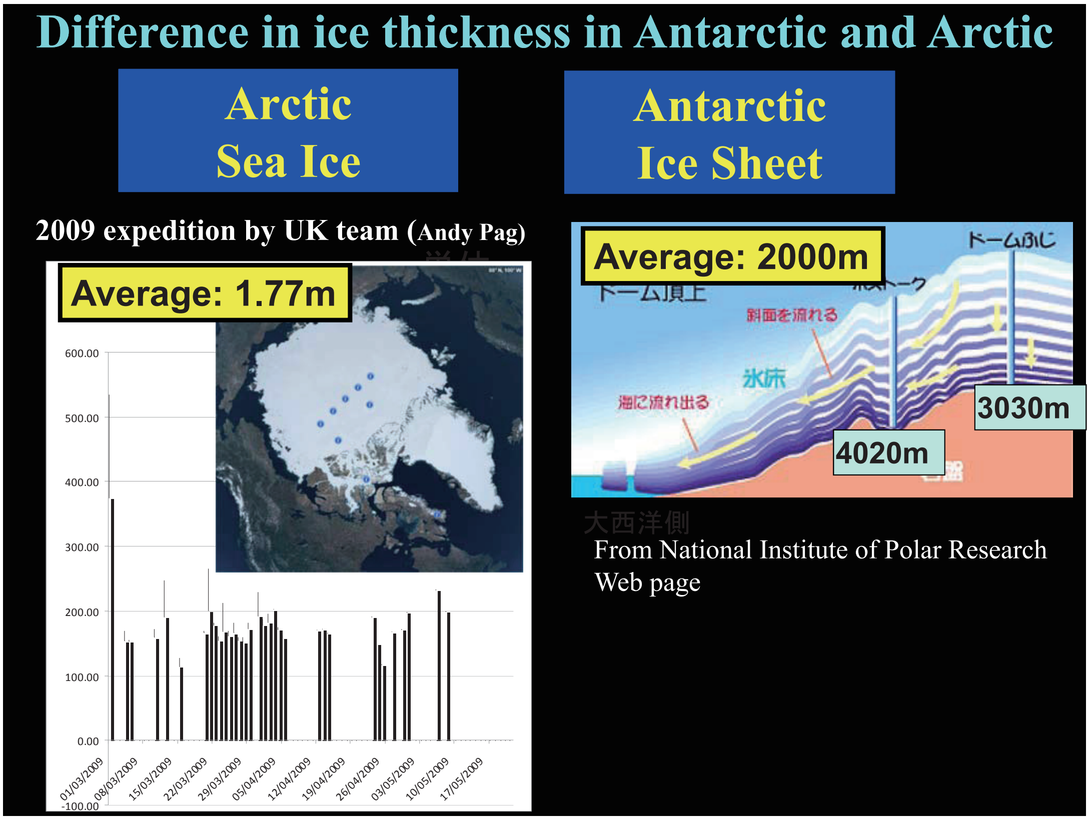
Reference

Shimada et al. (2006): Pacific Ocean Inflow: influence on catastrophic reduction of sea ice cover in the Arctic Ocean. Geophys. Res. Lett., Vol. 33, L08605, doi:10.1029/2005GL025624.

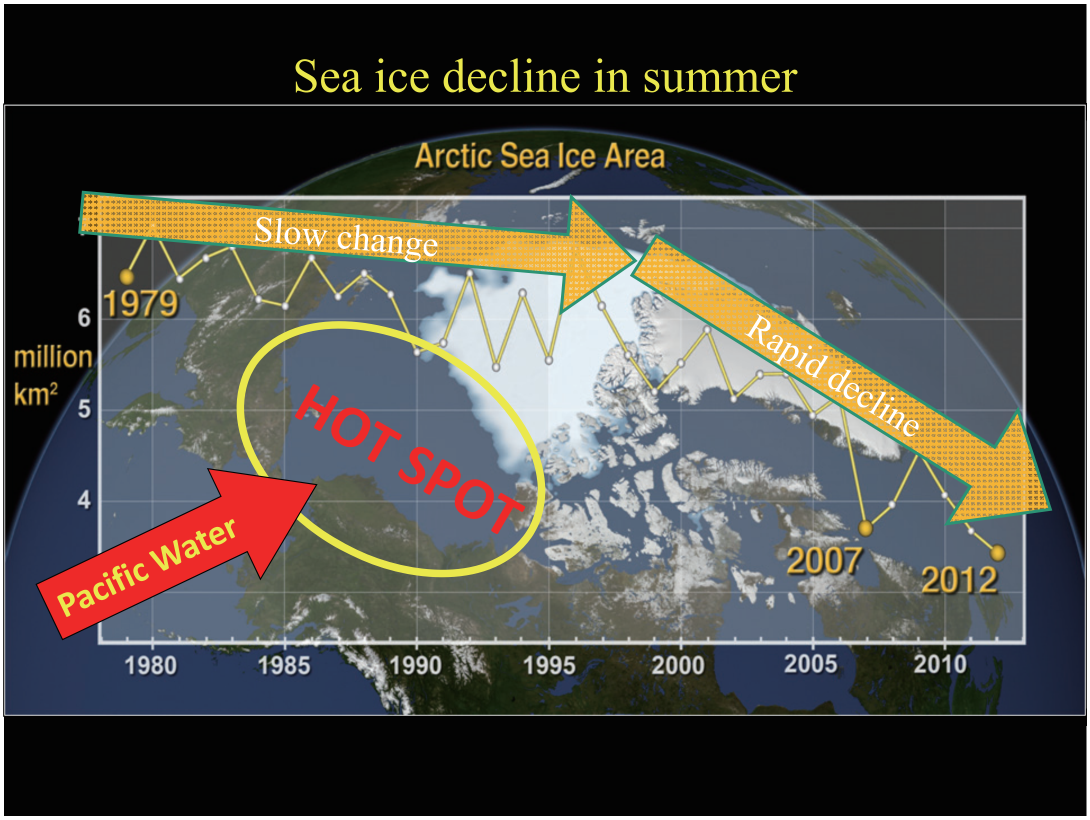
Yoshizawa et al. (2015): Delayed responses of the oceanic Beaufort Gyre to windsand sea ice motions: influences on variations of sea ice cover in the Pacific sector of the Arctic Ocean, J. Oceanogr. Vol. 71, 187-197.

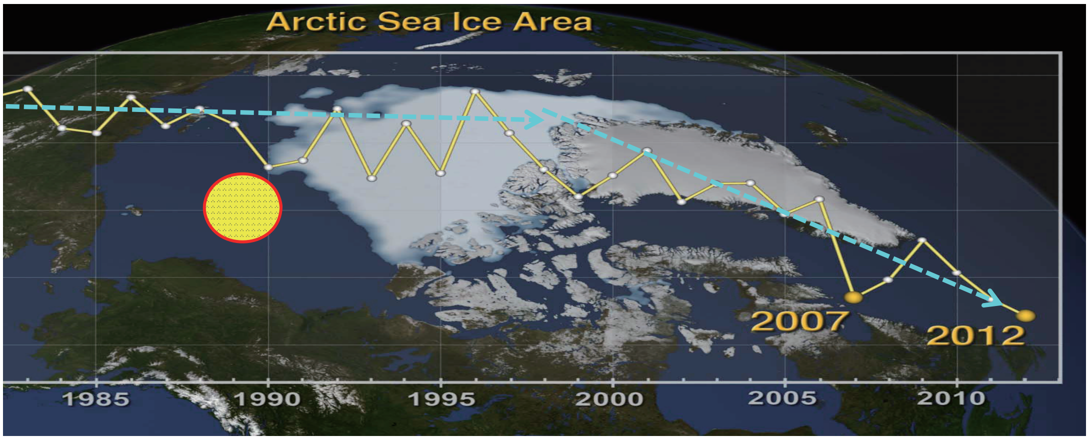
Qualitative difference of ice in Arctic and Antarctic

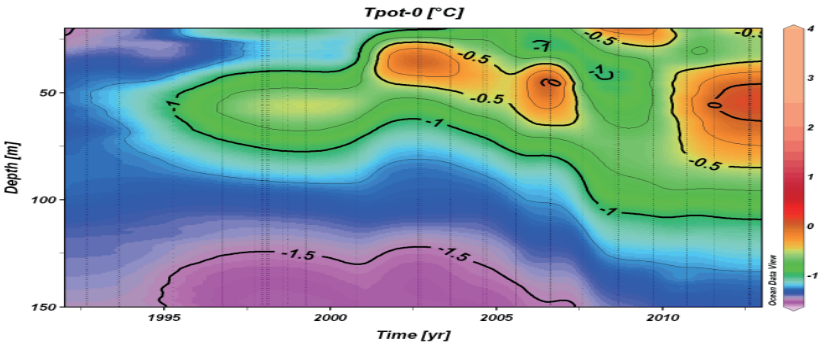



Difference in ice thickness in Antarctic and Arctic
Arctic
Sea Ice
Antarctic
Ice Sheet
2009 expedition by UK team (Andy Pag)
Average: 1.77m
600.00
500.00
400.00
300.00
200.00
100.00
0.00
-100.00
01/03/2009
08/03/2009
15/03/2009
22/03/2009
29/03/2009
05/04/2009
12/04/2009
19/04/2009
26/04/2009
03/05/2009
10/05/2009
17/05/2009
Average: 2000m
ドームふじ
斜面を流れる
氷床
海に流れ出る
4020m
3030m
大西洋側
From National Institute of Polar Research
Web page

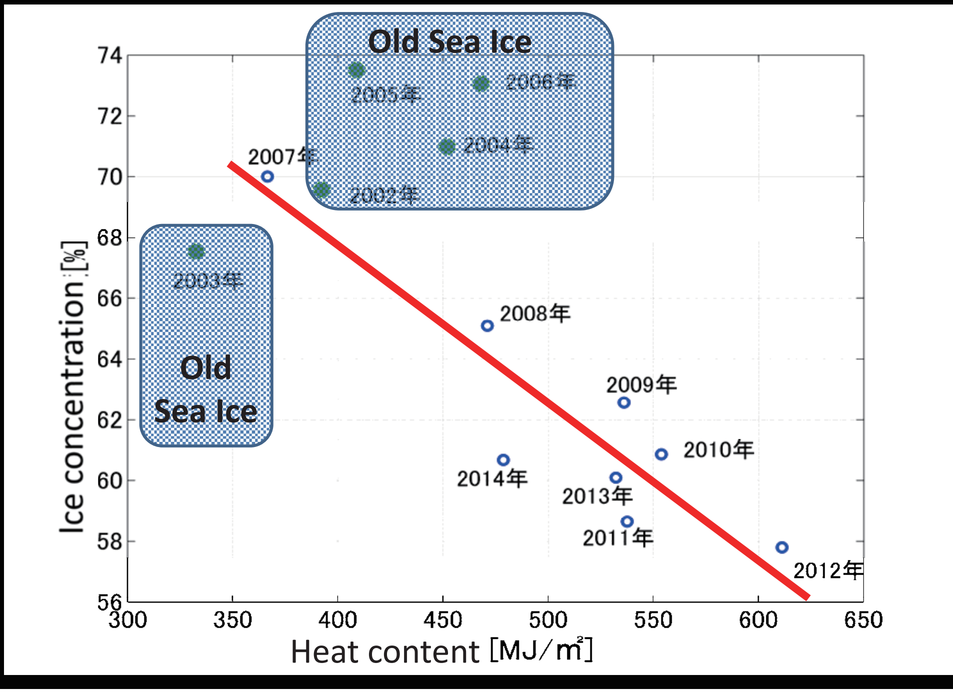

Antarctic Ice Sheet:
Soap
Slow motion & change
Arctic Sea Ice
Bubble Soap
Rapid motion & change

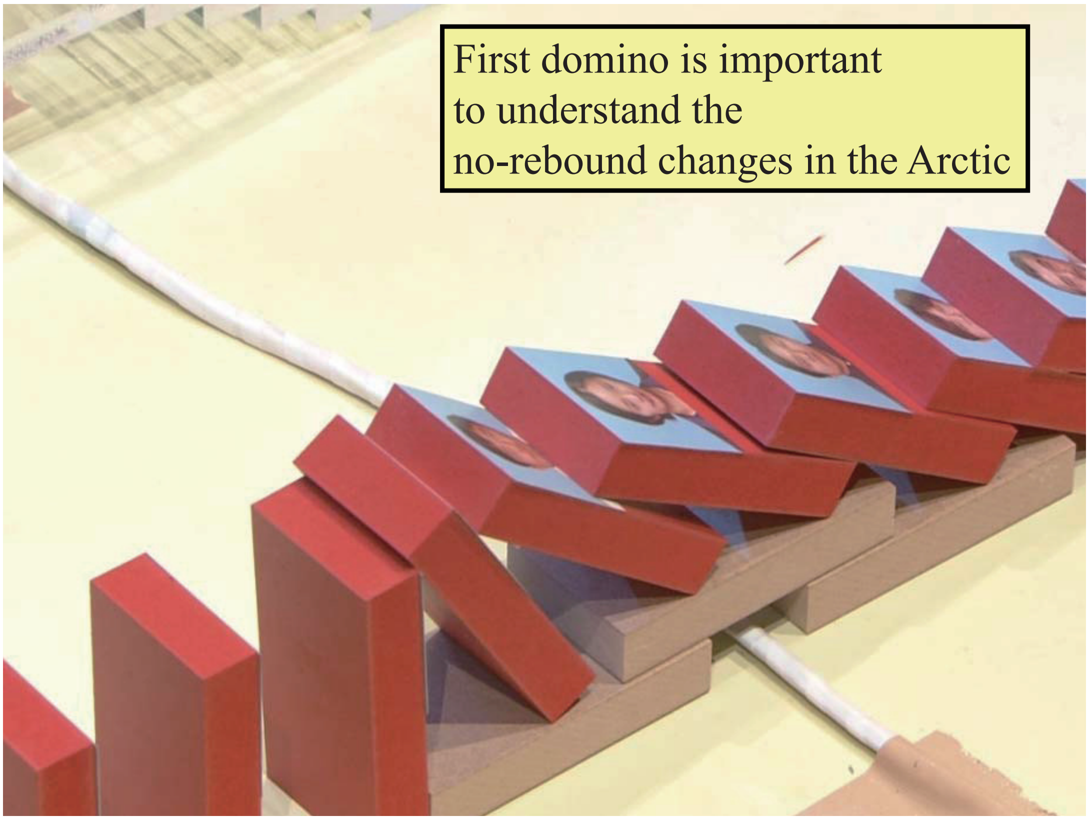

Sea ice decline in summer
Arctic Sea Ice Area
Slow change
Rapid decline
HOT SPOT
Pacific Water
1979
2007
2012
6
5
4
million
km²
1980
1985
1990
1995
2000
2005
2010

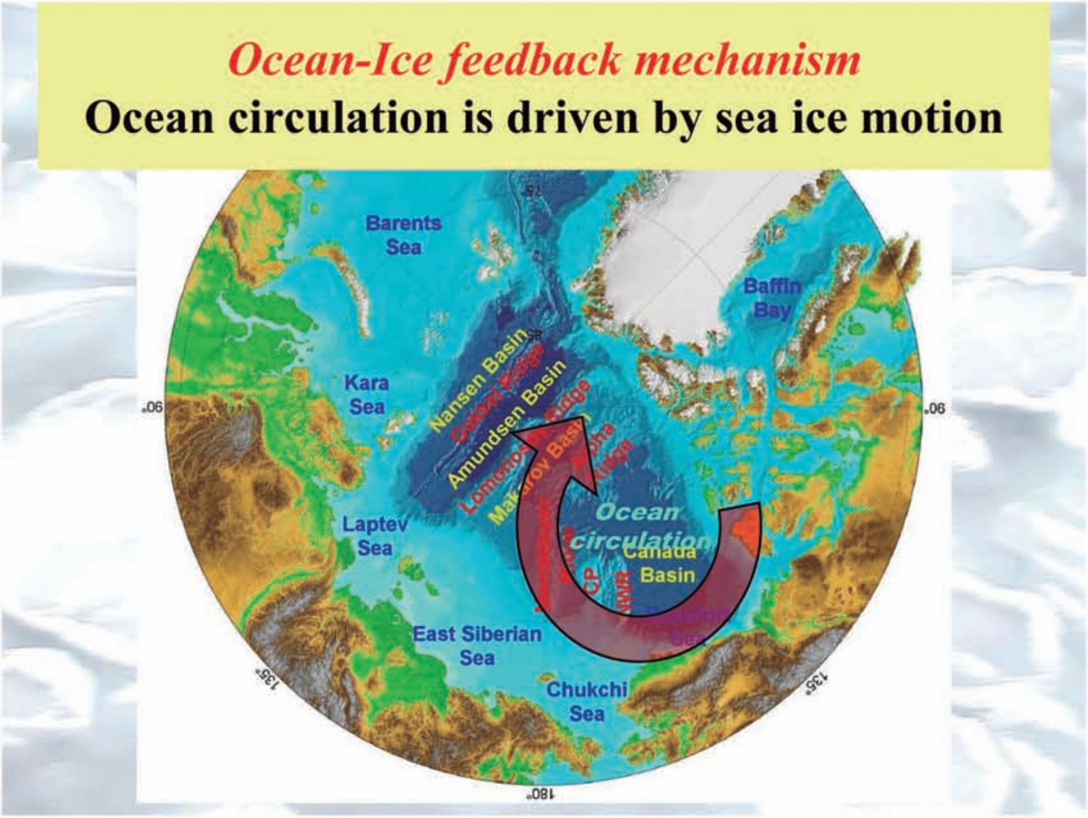

Arctic Sea Ice Area
2007
2012
1985
1990
1995
2000
2005
2010

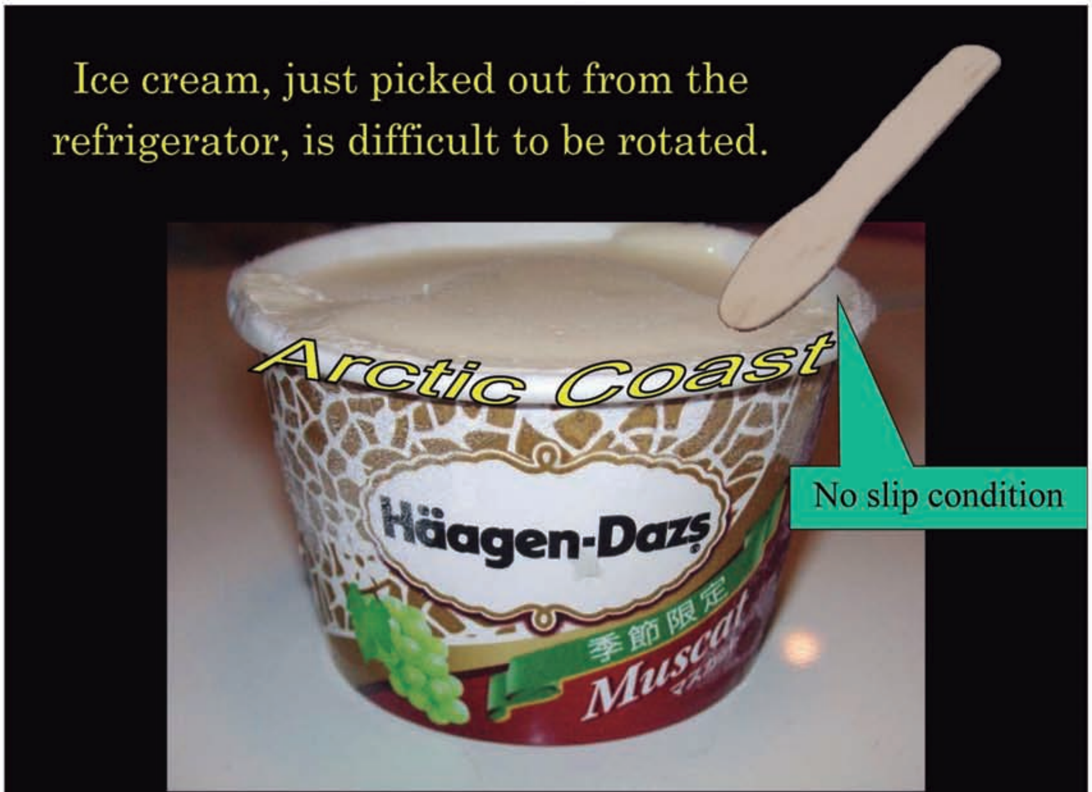

Tpot-0 [°C]
Depth [m]
Time [yr]
50
100
150
1995
2000
2005
2010
-0.5
-1
-1.5
Ocean Data View

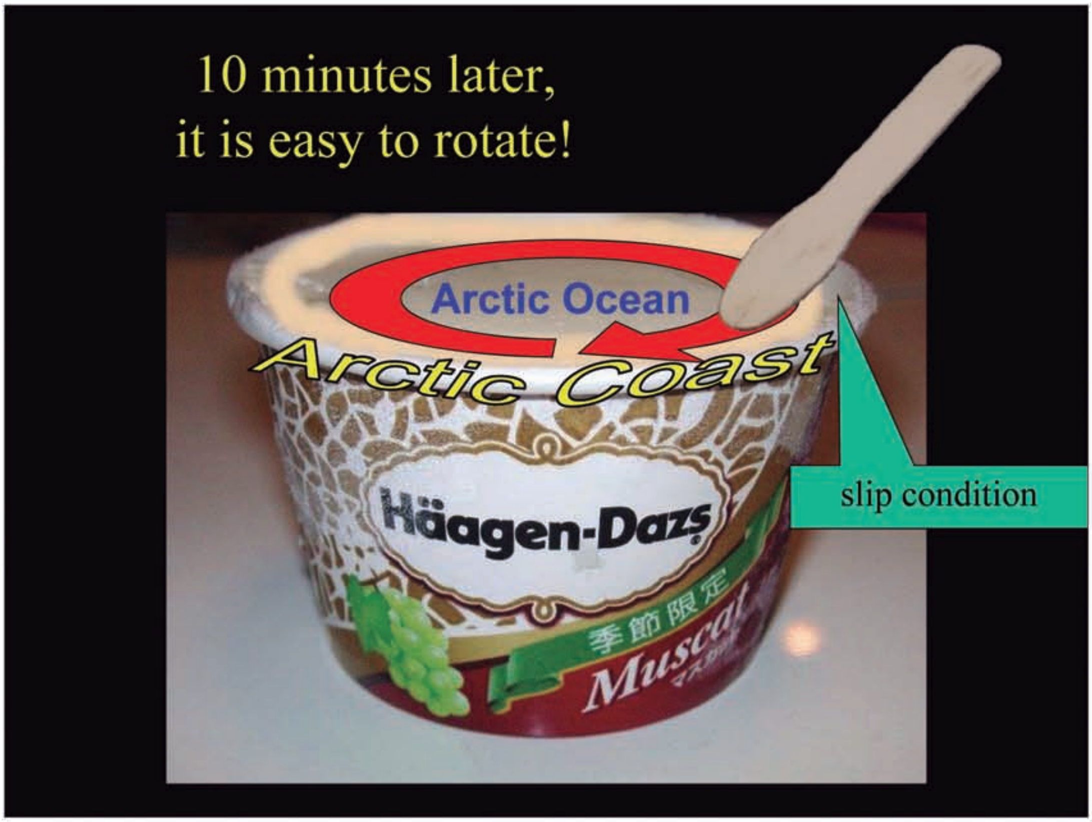
Recent changes in Sea ice cover is well explained by oceanic heat

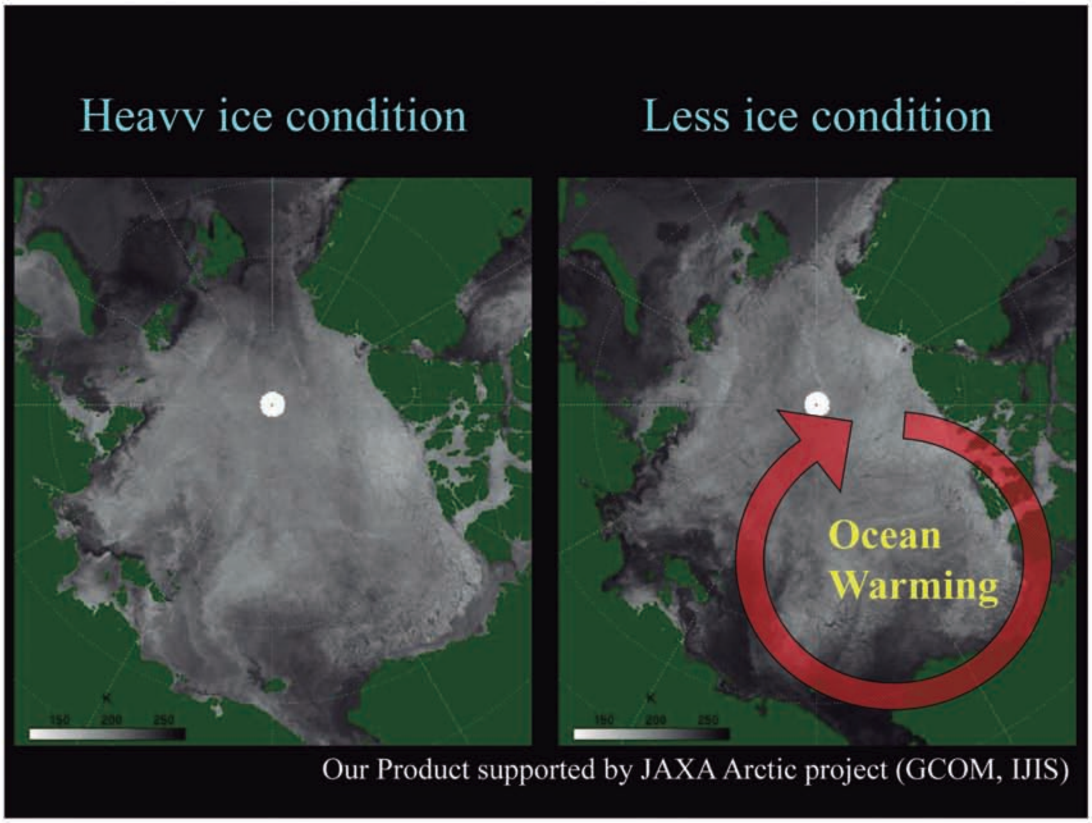


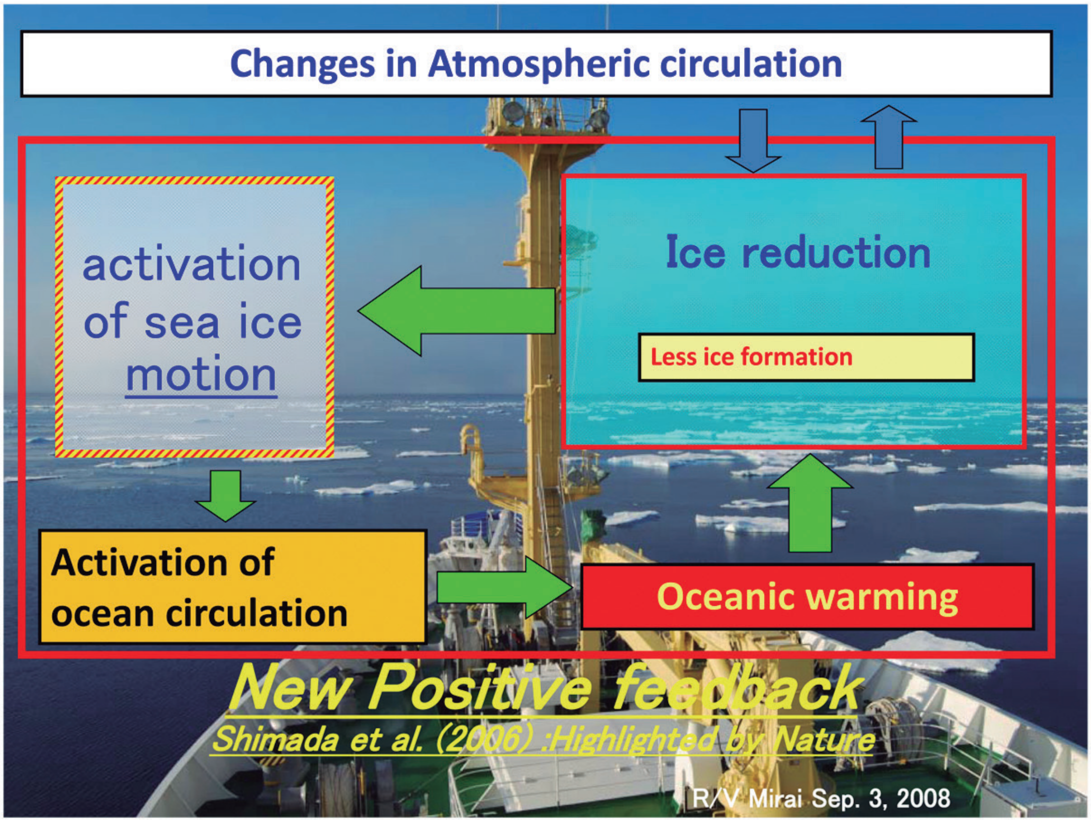


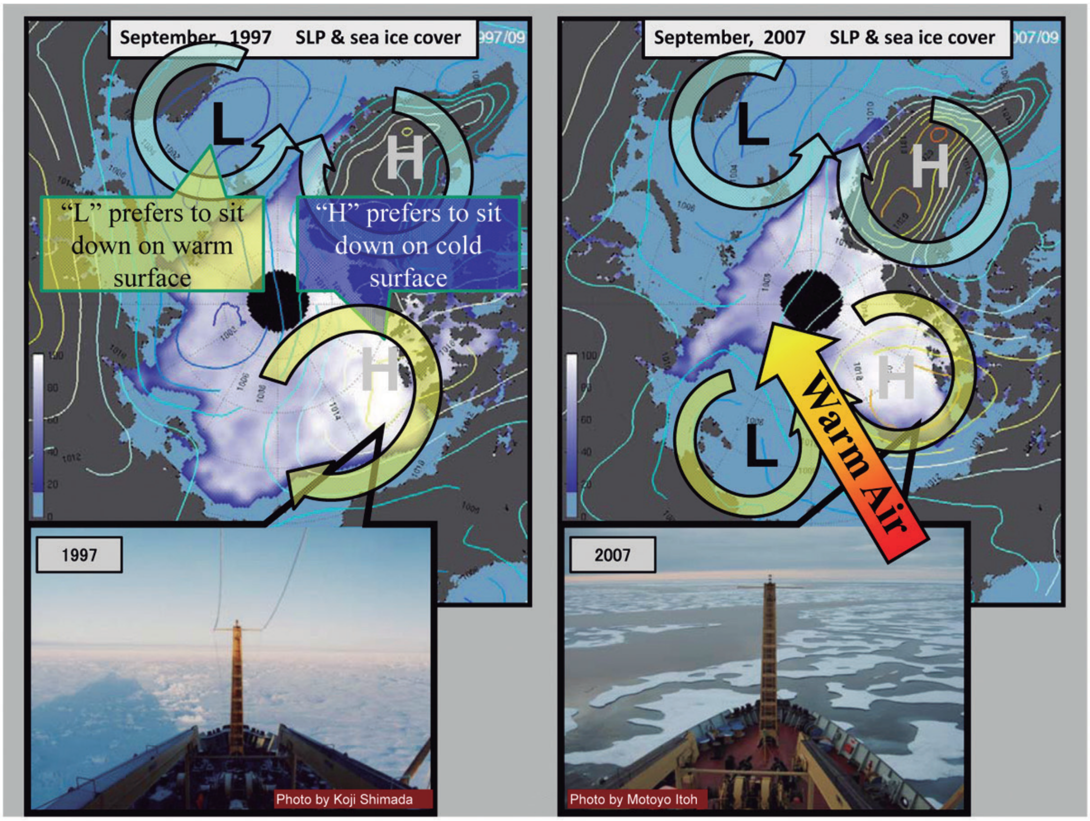

Ocean-Ice feedback mechanism
Ocean circulation is driven by sea ice motion
Barents Sea
Kara Sea
Laptev Sea
East Siberian Sea
Chukchi Sea
Baffin Bay
Nansen Basin
Amundsen Basin
Makarov Basin
Canada Basin
Ocean circulation
90°
135°
180°

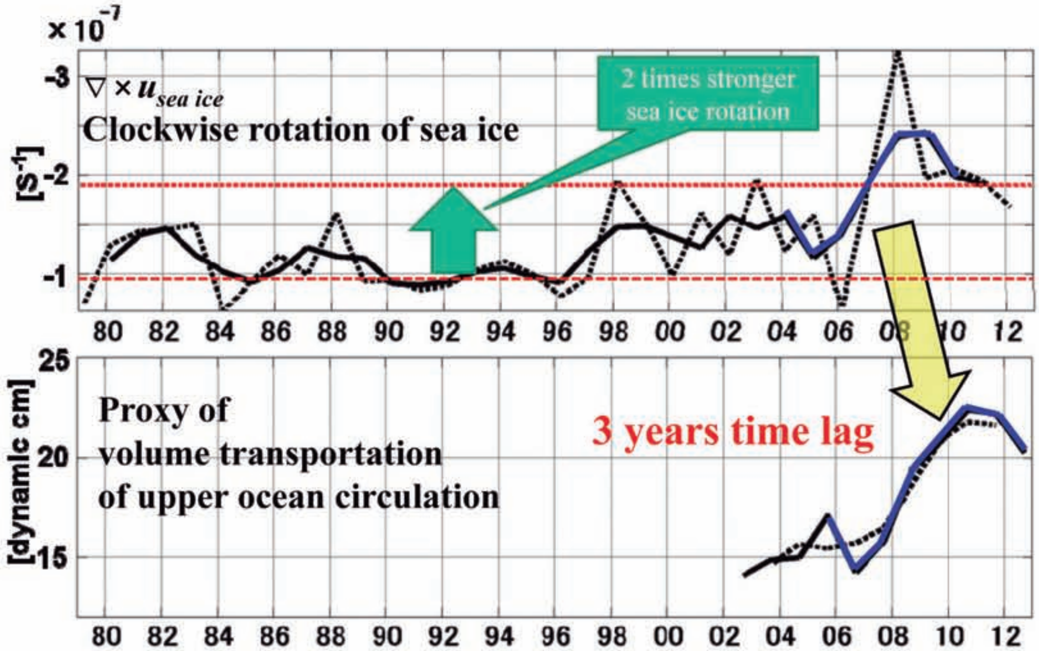

Ice cream, just picked out from the refrigerator, is difficult to be rotated.
Arctic Coast
No slip condition
Häagen-Dazs
季節限定
Muscat


10 minutes later,
it is easy to rotate!
Arctic Ocean
Arctic Coast
slip condition
Häagen-Dazs
季節限定
Muscat

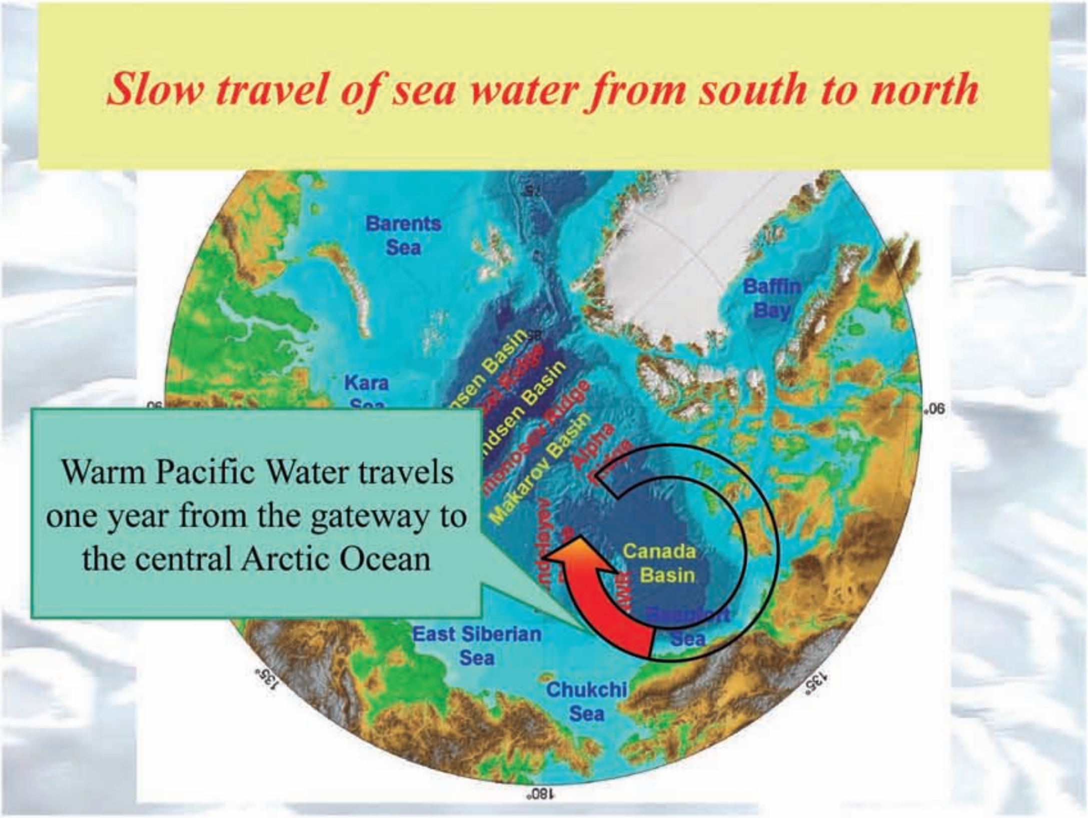

Heavv ice condition
Less ice condition
Ocean
Warming
Our Product supported by JAXA Arctic project (GCOM, IJIS)

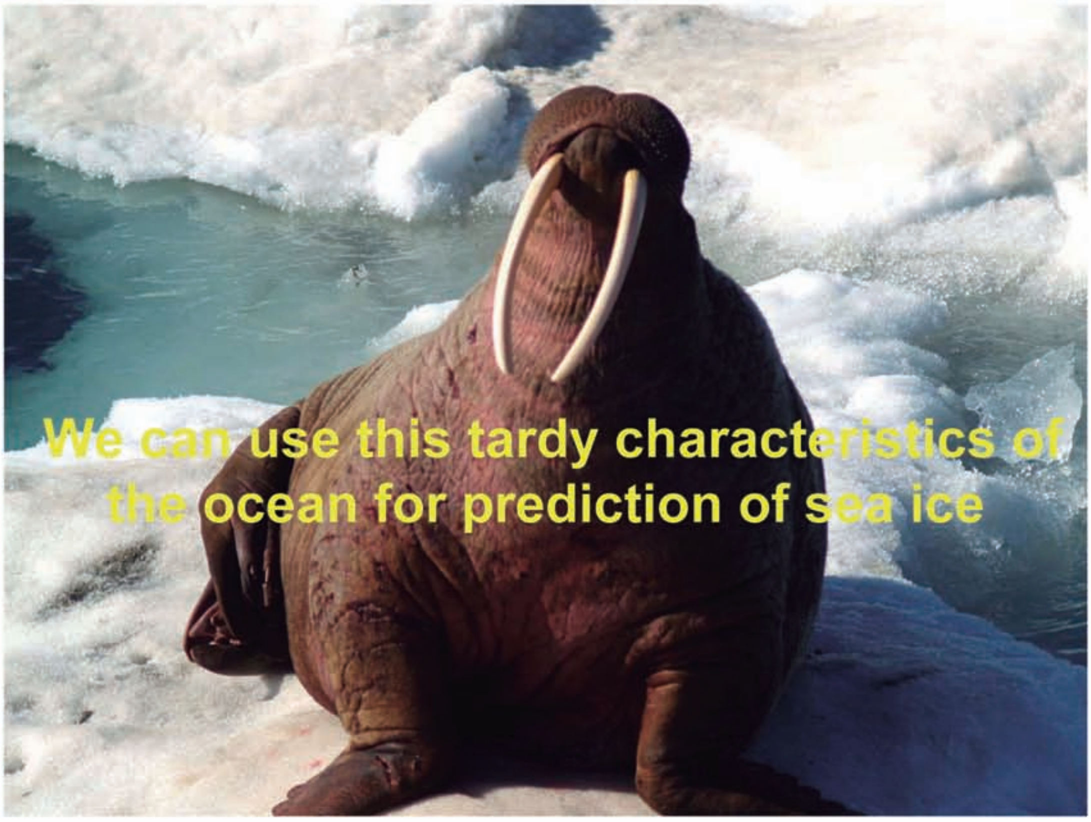

Changes in Atmospheric circulation
activation of sea ice motion
Ice reduction
Less ice formation
Activation of ocean circulation
Oceanic warming
New Positive feedback
Shimada et al. (2006) :Highlighted by Nature
R/V Mirai Sep. 3, 2008

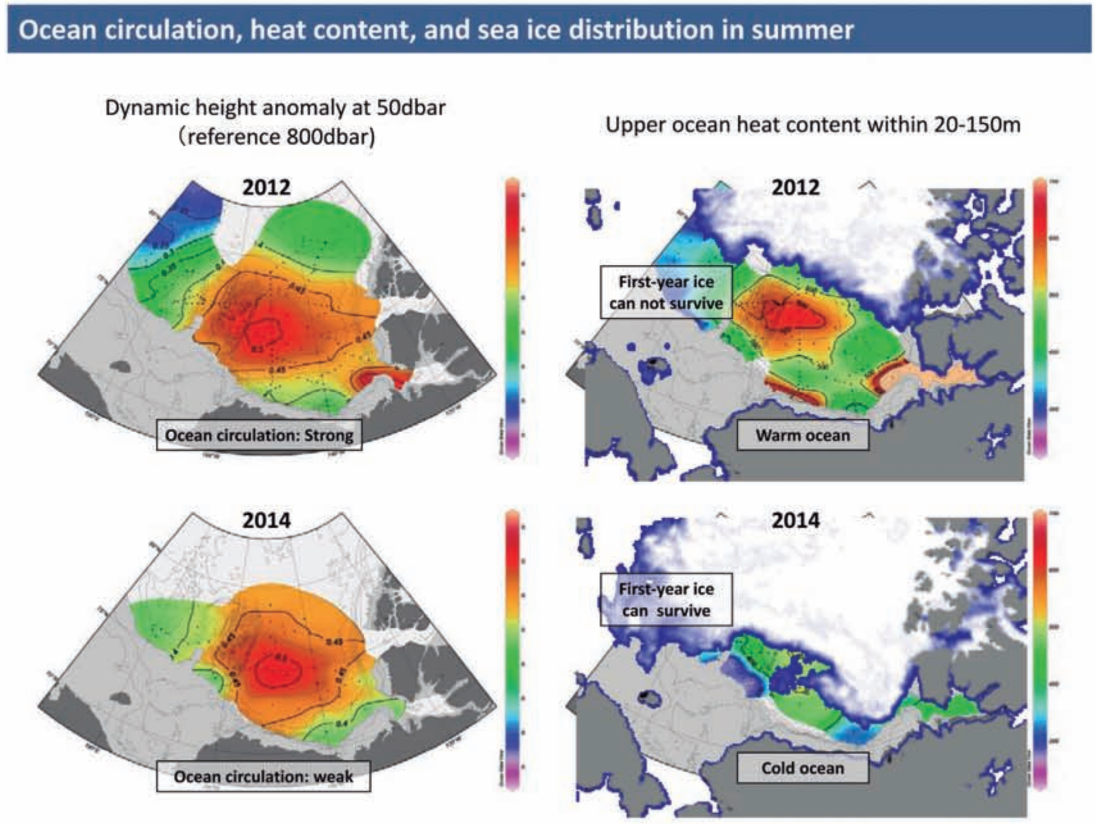

September, 1997 SLP & sea ice cover
September, 2007 SLP & sea ice cover
L
H
H
"L" prefers to sit down on warm surface
"H" prefers to sit down on cold surface
L
H
H
L
Warm Air
1997
Photo by Koji Shimada
2007
Photo by Motoyo Itoh



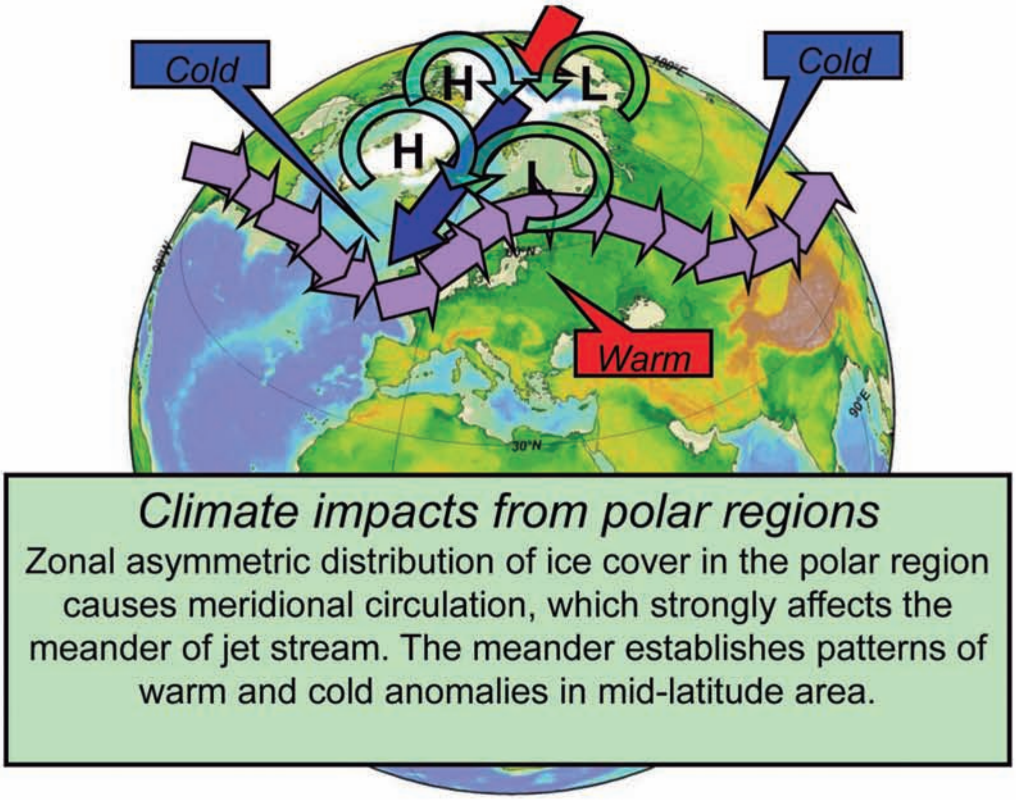
Yoshizawa, E., K. Shimada, H. K. Ha, T. W. Kim, S. H. Kang, K. H. Chung (2015): Delayed response of the oceanic Beaufort Gyre to wind sea ice motion: Influences on recent sea ice reduction in the Pacific sector of the Arctic Ocean. *Best poster award in Arctic Science Summit Week 2015 (25th anniversary of International Arctic Science Commision)*


Slow travel of sea water from south to north
Warm Pacific Water travels one year from the gateway to the central Arctic Ocean
Barents Sea
Baffin Bay
Kara Sea
Makarov Basin
Canada Basin
East Siberian Sea
Chukchi Sea
Beaufort Sea
90°
135°
180°

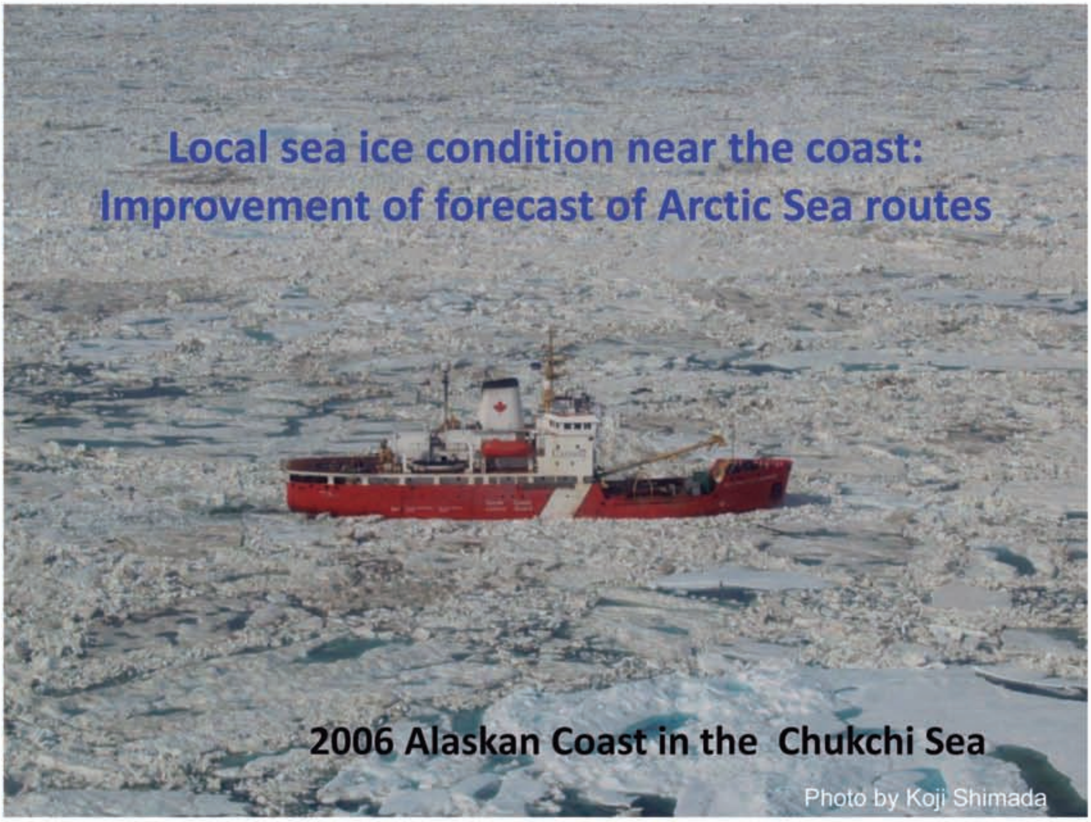

We can use this tardy characteristics of the ocean for prediction of sea ice

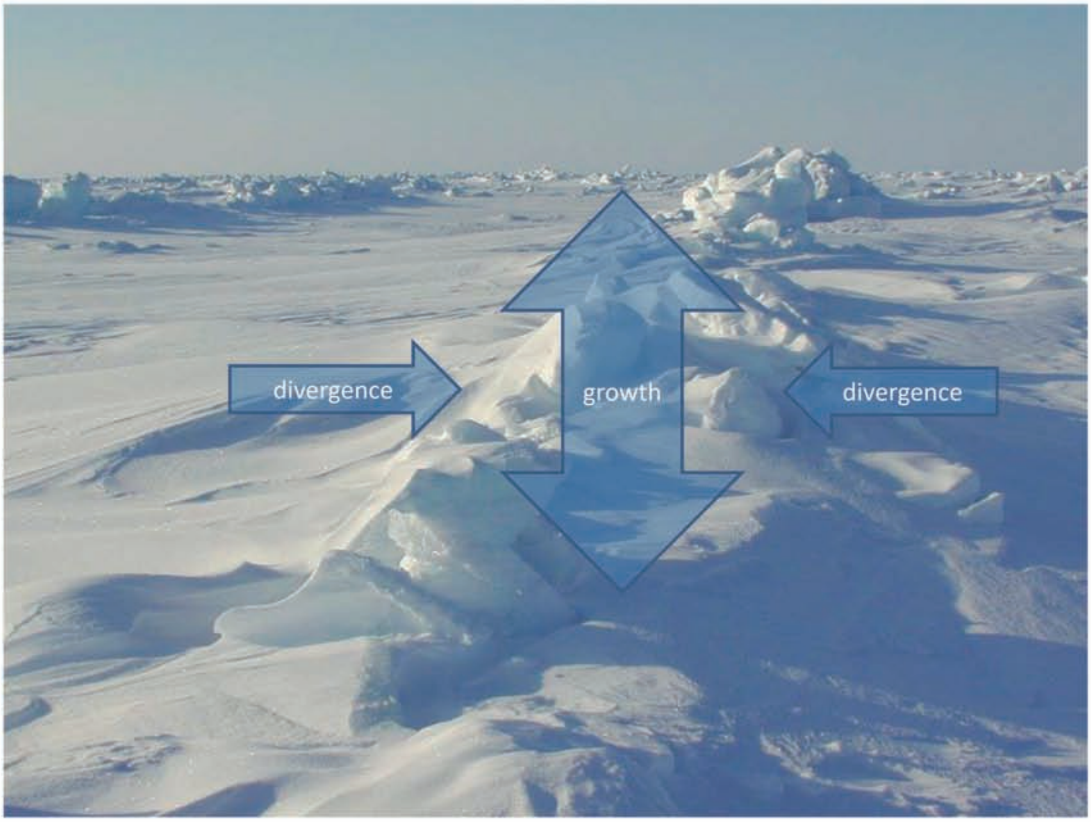


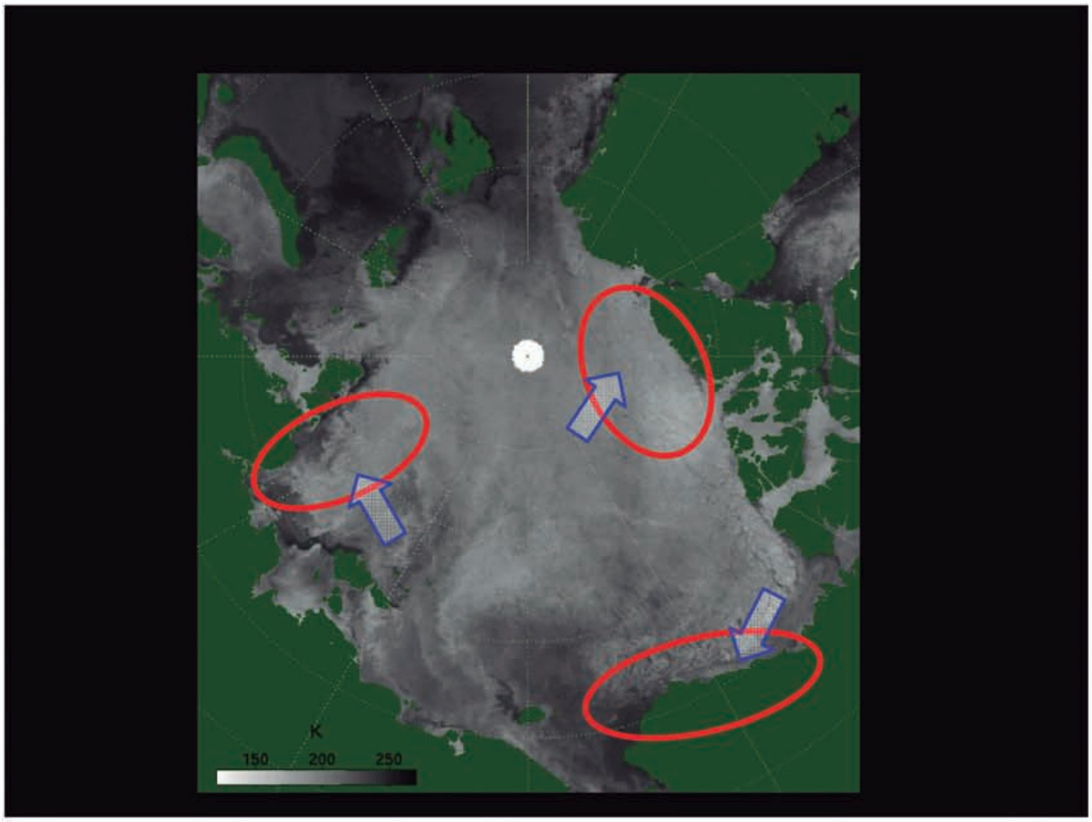
Ocean circulation, heat content, and sea ice distribution in summer
Dynamic height anomaly at 50dbar
(reference 800dbar)
Upper ocean heat content within 20-150m
2012
Ocean circulation: Strong
2012
First-year ice
can not survive
Warm ocean
2014
Ocean circulation: weak
2014
First-year ice
can survive
Cold ocean

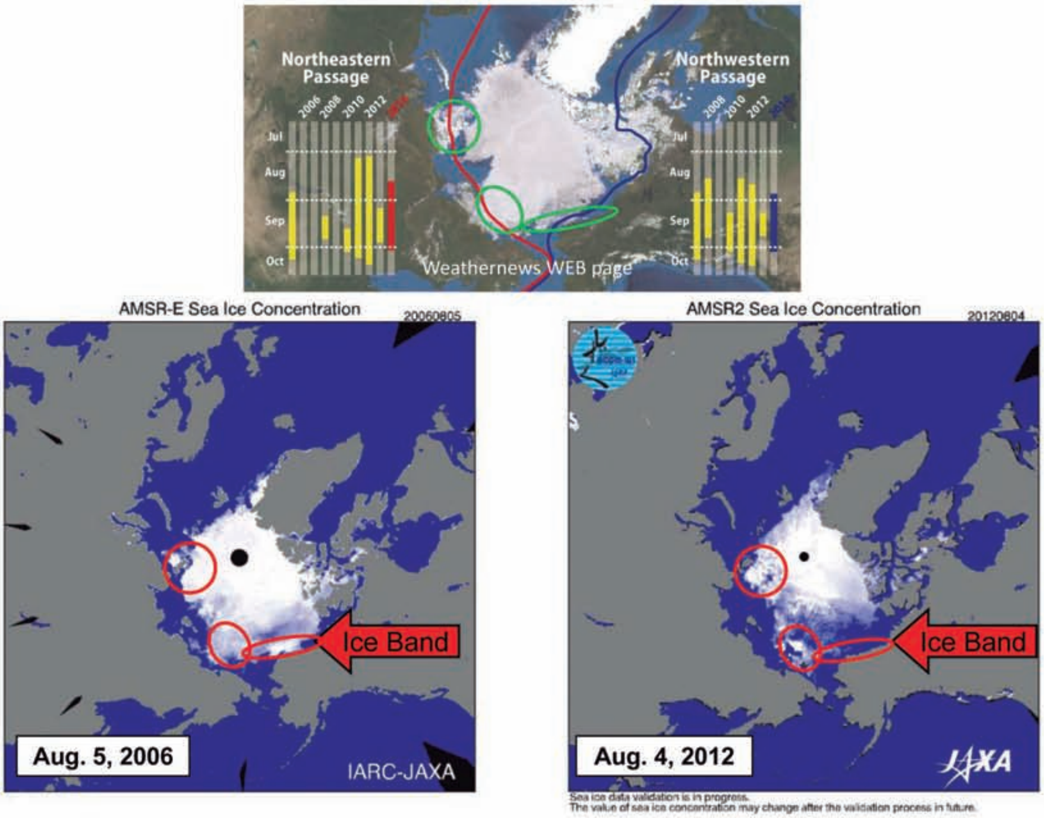


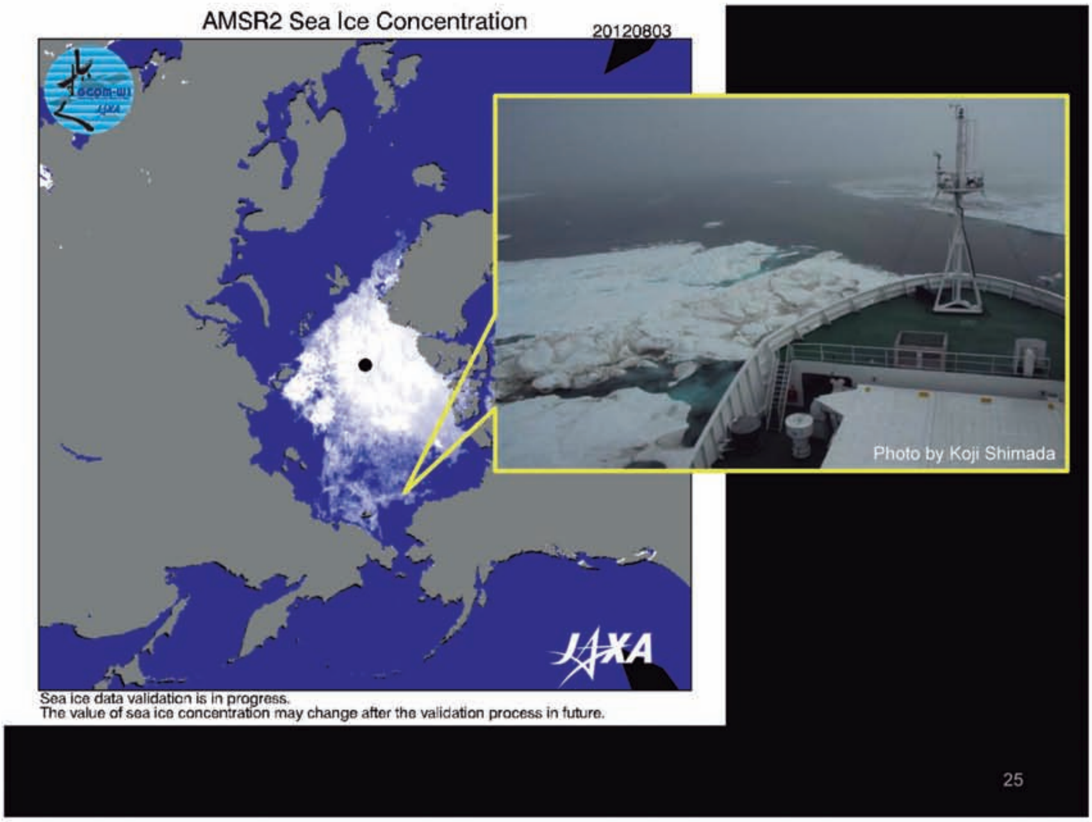
Cold
Cold
H
L
H
L
Warm
Climate impacts from polar regions
Zonal asymmetric distribution of ice cover in the polar region causes meridional circulation, which strongly affects the meander of jet stream. The meander establishes patterns of warm and cold anomalies in mid-latitude area.

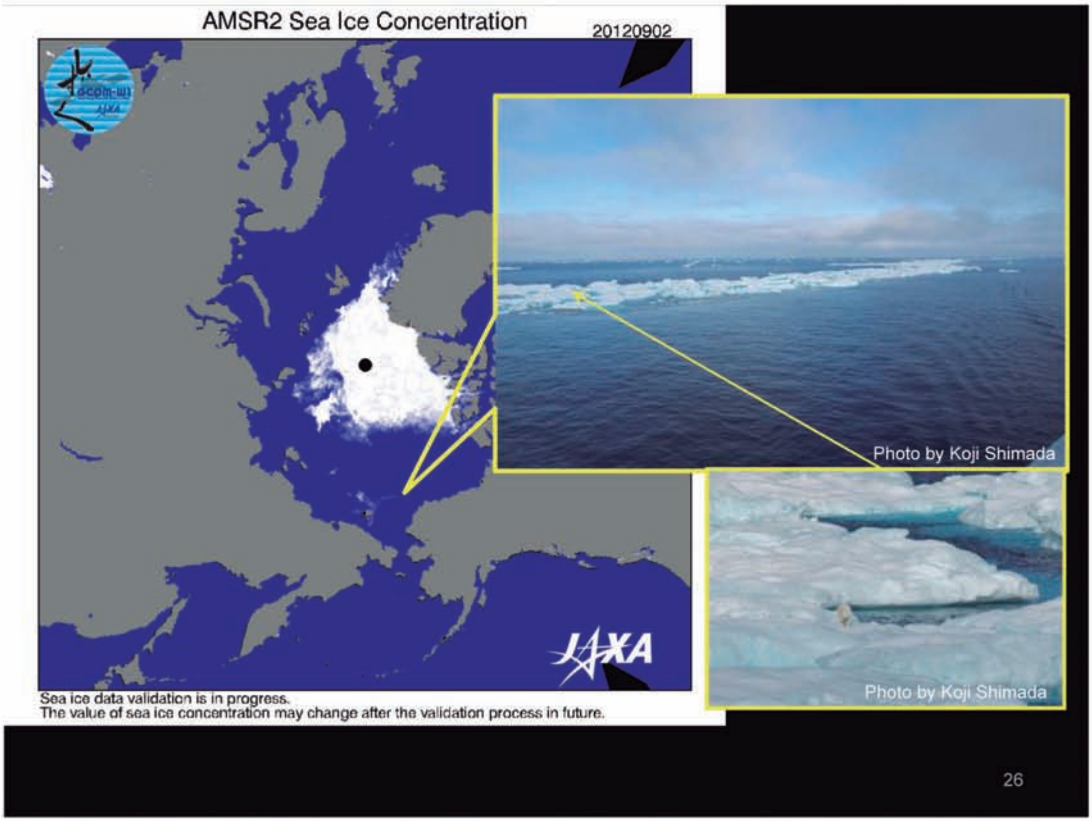

Local sea ice condition near the coast:
Improvement of forecast of Arctic Sea routes
2006 Alaskan Coast in the Chukchi Sea
Photo by Koji Shimada

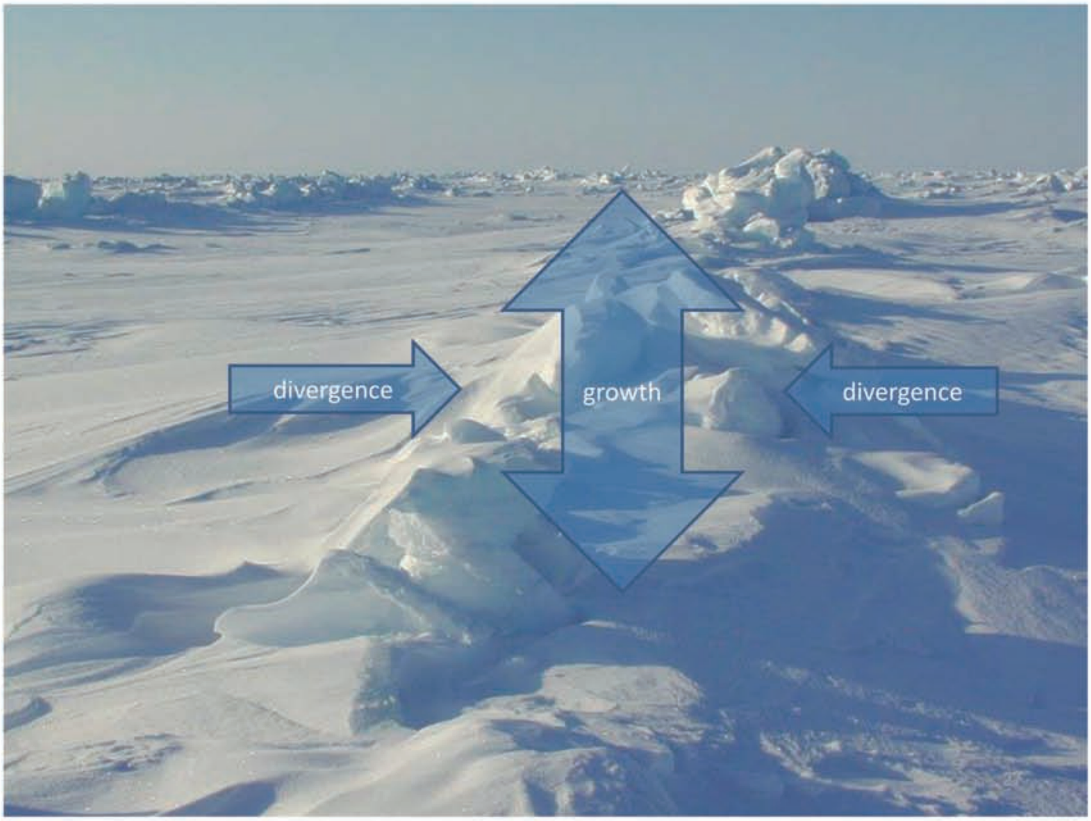

divergence
growth
divergence

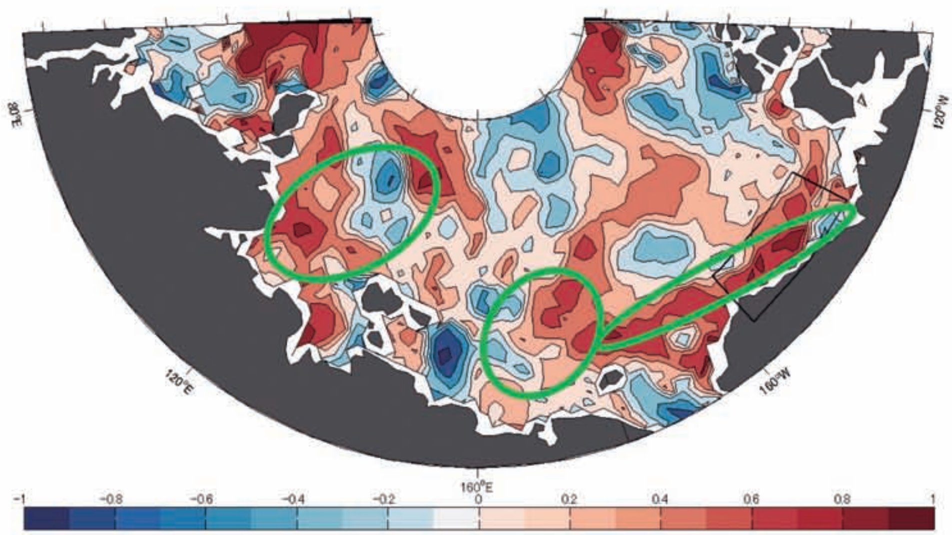

K
150 200 250


Northeastern Passage
2006 2008 2010 2012
Jul
Aug
Sep
Oct
Northwestern Passage
2008 2010 2012
Weathernews WEB page
AMSR-E Sea Ice Concentration
20060805
Ice Band
Aug. 5, 2006
IARC-JAXA
AMSR2 Sea Ice Concentration
20120804
Ice Band
Aug. 4, 2012
JAXA
Sea ice data validation is in progress.
The value of sea ice concentration may change after the validation process in future.

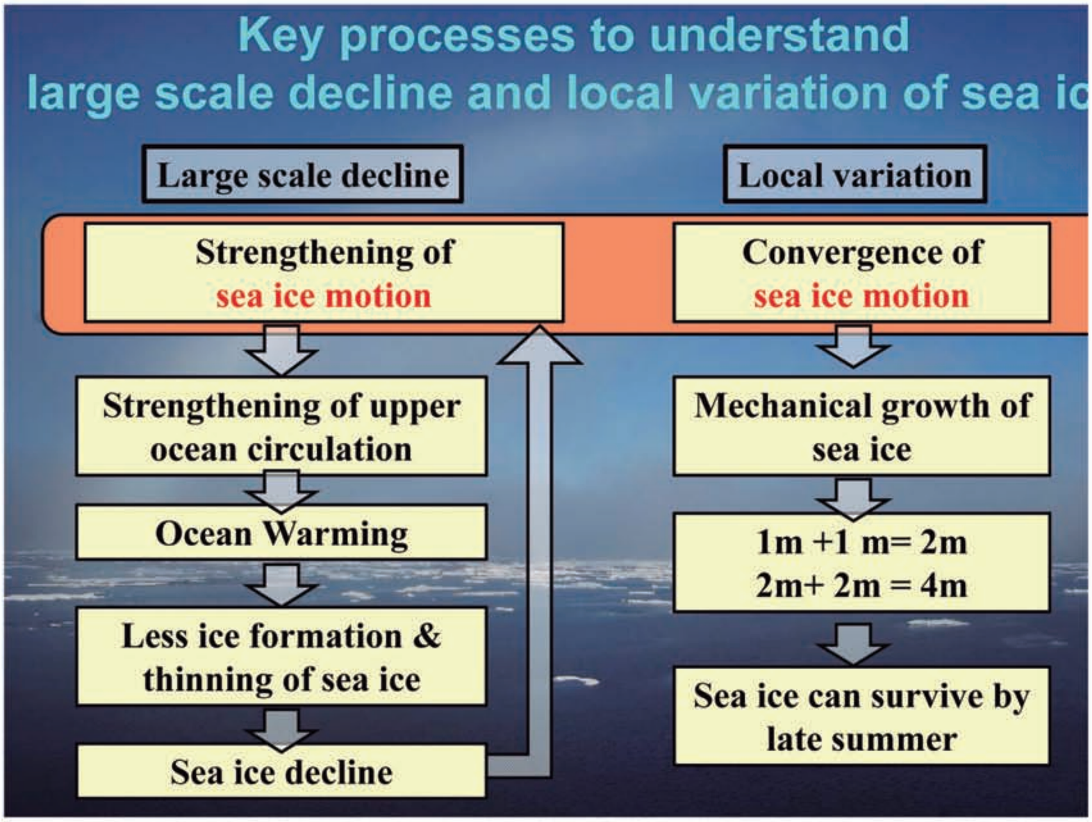

AMSR2 Sea Ice Concentration
20120803
Photo by Koji Shimada
JAXA
Sea ice data validation is in progress.
The value of sea ice concentration may change after the validation process in future.
25


AMSR2 Sea Ice Concentration
20120902
Photo by Koji Shimada
Photo by Koji Shimada
JAXA
Sea ice data validation is in progress.
The value of sea ice concentration may change after the validation process in future.
26





We found high correlation between rafting in winter and sea ice concentration in summer.
We can predict local heavy ice condition in spring.


Key processes to understand
large scale decline and local variation of sea ic
Large scale decline
Local variation
Strengthening of
sea ice motion
Convergence of
sea ice motion
Strengthening of upper
ocean circulation
Mechanical growth of
sea ice
Ocean Warming
1m +1 m= 2m
2m+ 2m = 4m
Less ice formation &
thinning of sea ice
Sea ice can survive by
late summer
Sea ice decline

4-2. IMPLICATIONS FOR GLOBAL TRADE AND DISTRIBUTION SYSTEM

DR. NATSUHIKO OTSUKA
MANAGER, NORTH JAPAN PORT CONSULTATIONS CO. LTD.

The Fifth Assessment Report (AR5) of Intergovernmental Panel on Climate Change (IPCC) pointed out that the Arctic is warming twice as fast as the rest of the world. In spite of scientific uncertainty involved, the current scientific consensus indicates that the Arctic Ocean may experience ice free summers in the 2050's. According to the satellite sea ice monitoring since the 1970s, the Arctic sea ice extent has shown long-term decreasing trend especially in summer.

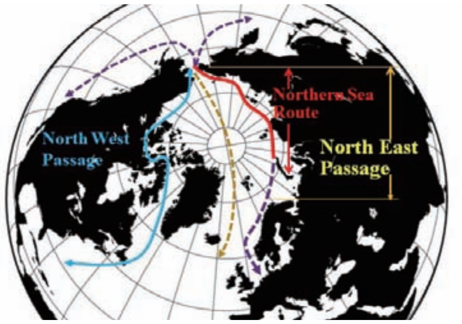


Figure-1 Arctic Sea Route

In recent years, commercial shipping route through the Arctic attracts attention due to the sea ice retreat in summer. In general, there are three Arctic shipping routes known as the North East Passage (NEP), the North West Passage (NWP) and the Trans Arctic Route. Russia defines the part of the NEP between Novaya-Zemlya island and the Bering strait as the Northern Sea Route, widely known as the NSR (Figure-1).

In 2010, under the cooperation between Norwegian shipping companies and the Russian companies, pilot commercial shipping via the NEP between Norway and China by a non-Russian flag cargo ship had been carried out. Following this historical voyage, shipping across the Arctic via the NEP rapidly increased and iron ore, coal, gas-condensate, naphtha, jet fuel and LNG were transported(Figure-2).

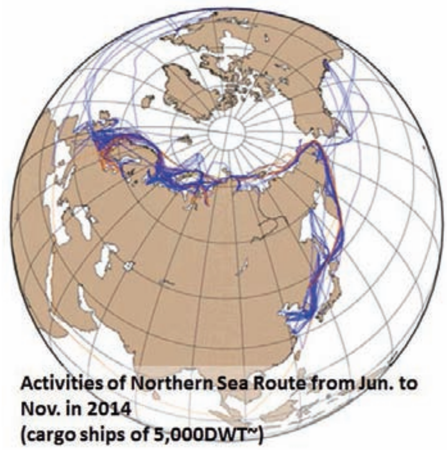


Figure-2 Activities of the Arctic shipping

It is widely known that the NEP can shorten shipping distance between northern Europe and East Asia by about 30~40% compare to the conventional shipping route via the Suez Canal. It is gradually demonstrated not only that ship can sail through the NEP as might has been expected, but also the NEP can reduce fuel consumption and fuel cost, shorten sailing time, and thereby reduce the total shipping cost. At the same time, it is pointed out that it's not easy to predict sea ice conditions, search and rescue system is underdeveloped, the state of preparedness against accidents is still low, and the sailing season is limited for about 5 months.

With the background of the Arctic sea ice retreat and growing demand of natural resources, hydrocarbon development in the Arctic is becoming a reality. Russia has already producing crude oil in the eastern part of the Barents Sea. The Yamal LNG Project in the Ob Bay coast is expected to start production from 2017. All these projects heavily rely on the transportation through the NEP. And the Yamal LNG shipping will become the first international regular shipping activity through the NEP. Thus, a small but brand-new card, which provides hydrocarbon to Asia and Europe from the Arctic, will be placed on the table of the world energy market. Furthermore, it is interesting that the shale-LNG from U.S. Gulf coast will also appear into the market at the same year.

As is widely known, Asia has become the center of world maritime transport in terms of both cargo origin and destination today. Asia will also become a major actor in the Arctic shipping via the NEP. The NEP will attract Asian users by reduction of shipping cost and sailing time, supplying energy resources from the Arctic, and providing new shipping lane free from pirates. At the first stage, the NEP will be regarded as a niche shipping market or an alternative shipping route. However, it could provide new relationship between Europe and East Asia, while these two have been the farthest territories each other.

The Arctic is becoming more accessible due to climate change and technological advance, and is gaining international importance. Asian region could be important stake holders of the Arctic shipping. At the same time, close attention should be paid for sustainability in the use of the Arctic. Regarding feasibility and environmental sustainability of the maritime transport via the NEP, we will face some key factors shown in the Figure-3.

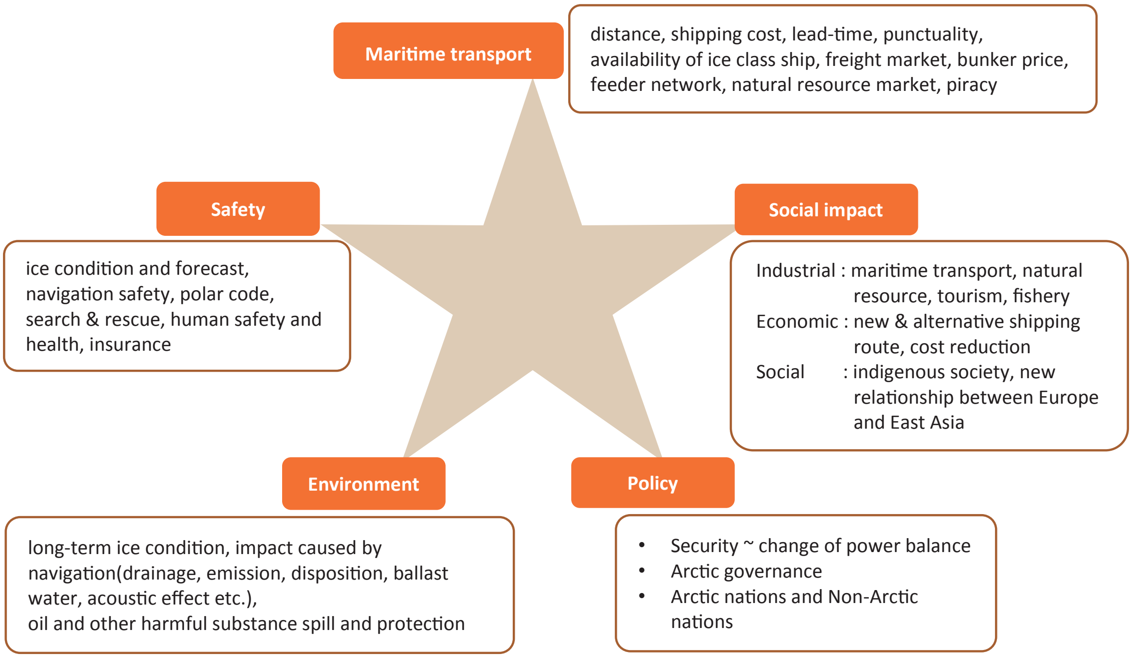
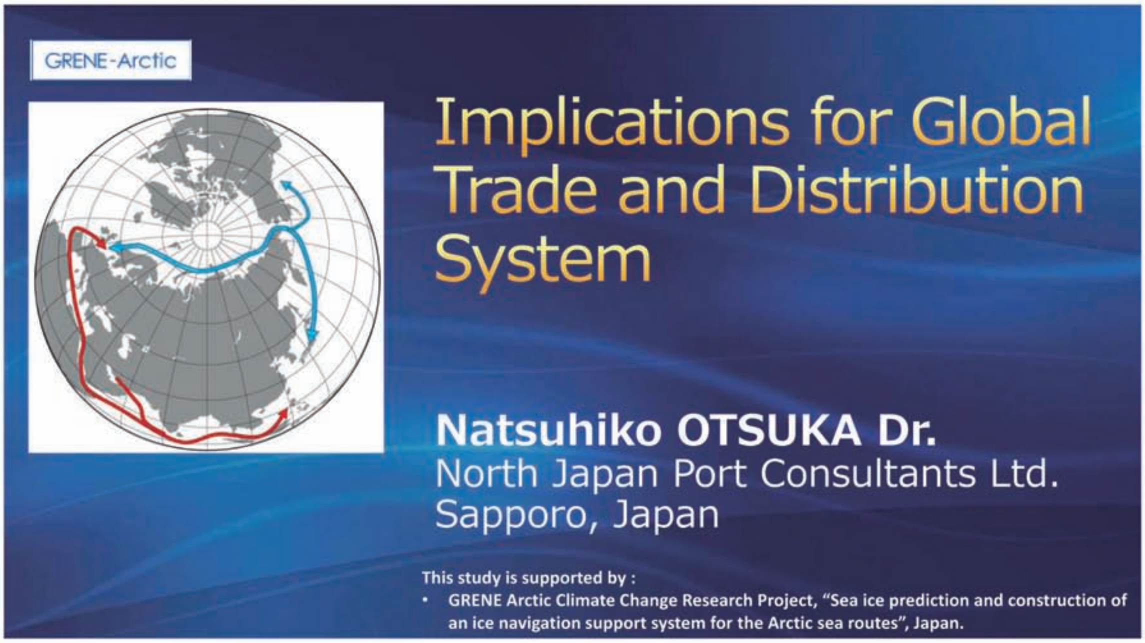
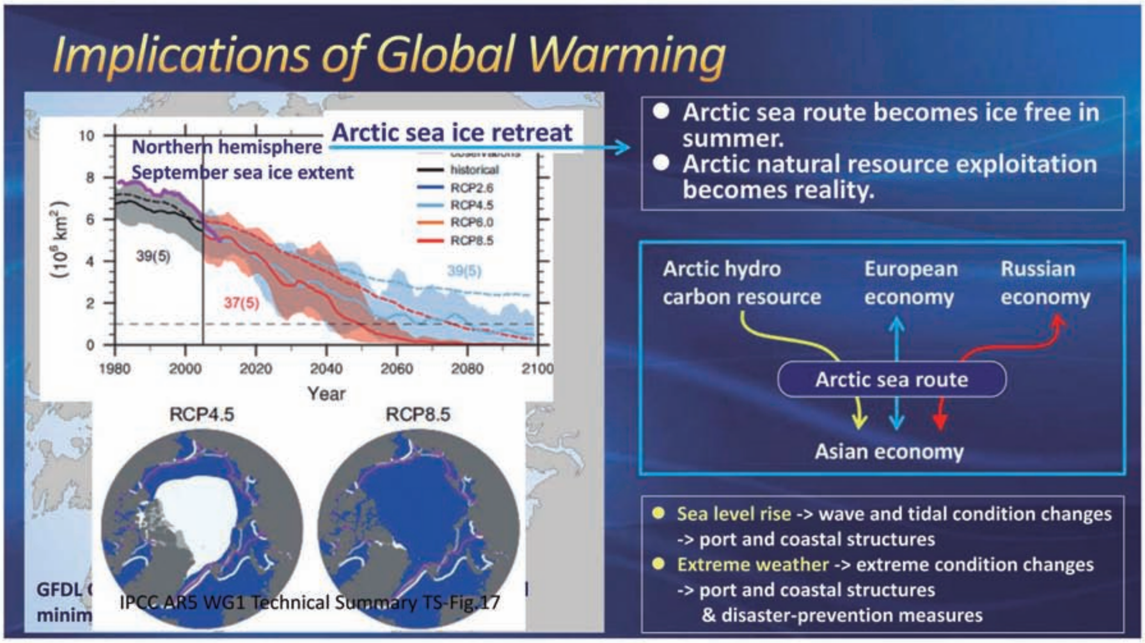
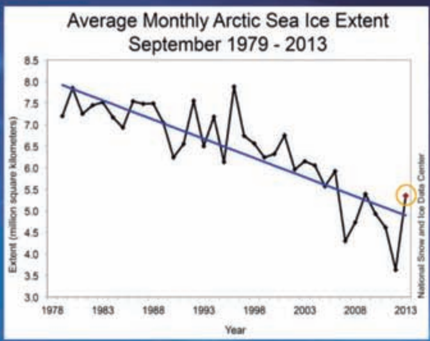


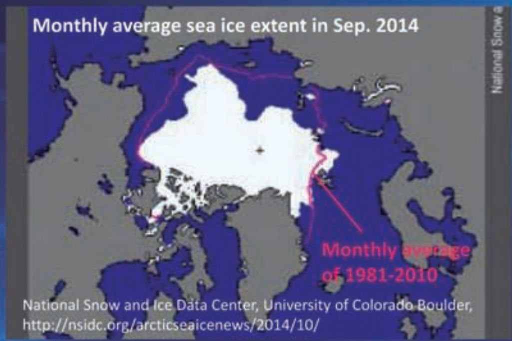
Figure-3 Key Factors on Sustainability and Feasibility of the Arctic Shipping


GRENE-Arctic
Implications for Global Trade and Distribution System
Natsuhiko OTSUKA Dr.
North Japan Port Consultants Ltd.
Sapporo, Japan
This study is supported by :
• GRENE Arctic Climate Change Research Project, "Sea ice prediction and construction of an ice navigation support system for the Arctic sea routes", Japan.


Implications of Global Warming
Arctic sea ice retreat
Northern hemisphere
September sea ice extent
historical
RCP2.6
RCP4.5
RCP6.0
RCP8.5
39(5)
37(5)
39(5)
$(10^6\ km^2)$
Year
RCP4.5
RCP8.5
IPCC AR5 WG1 Technical Summary TS-Fig.17
• Arctic sea route becomes ice free in summer.
• Arctic natural resource exploitation becomes reality.
Arctic hydro carbon resource
European economy
Russian economy
Arctic sea route
Asian economy
• Sea level rise -> wave and tidal condition changes -> port and coastal structures
• Extreme weather -> extreme condition changes -> port and coastal structures & disaster-prevention measures

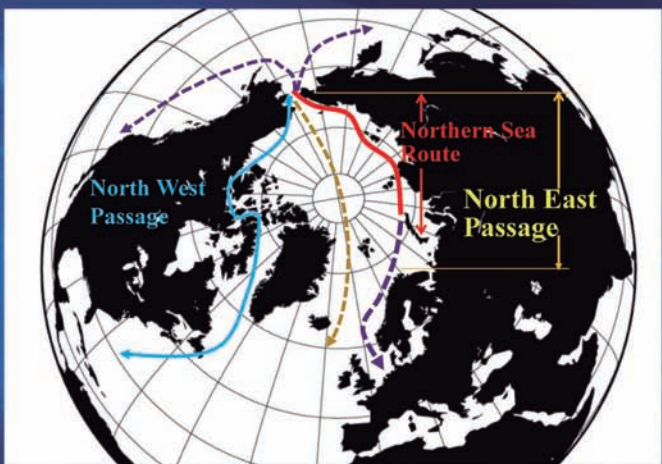
Opening Arctic





- According to the satellite sea ice monitoring since the 1970s, the Arctic sea ice extent has shown a long-term decreasing trend especially in summer.
- The Northern Sea Route (NSR) becomes almost ice free in summer in recent years.
- NSR is navigable from late June to late November for 1A ice class ships.

Arctic Sea Route

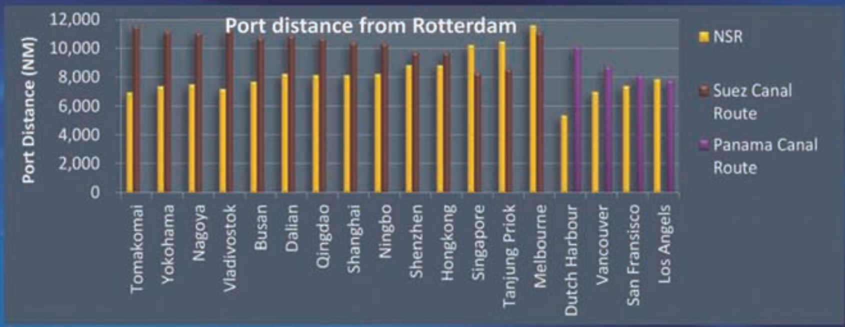


North East Passage(NEP) connects between the Atlantic Ocean and the Pacific ocean along the Eurasian coast. **Northern Sea Route (NSR):** Russian definition between the Novaya-zemlya and the Bering strait.

North West Passage(NWP) connects between the Atlantic Ocean and the Pacific ocean along the North American Arctic coast.

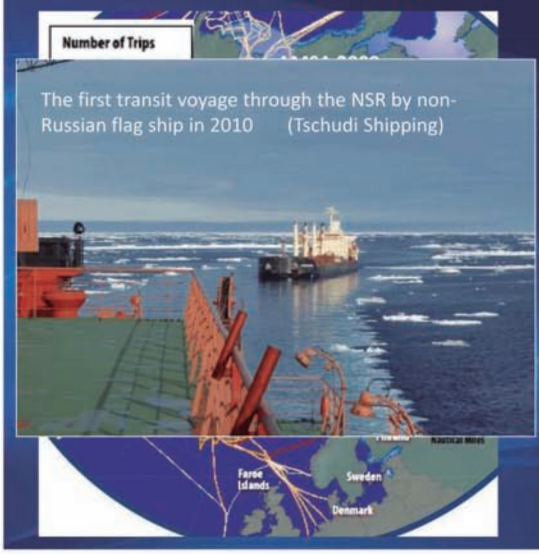
Trans Arctic route which passes through the central part of the Arctic Ocean.

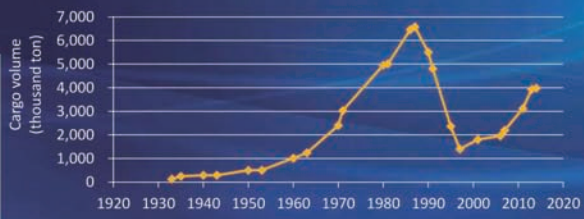
Advantages of the Northern Sea Route



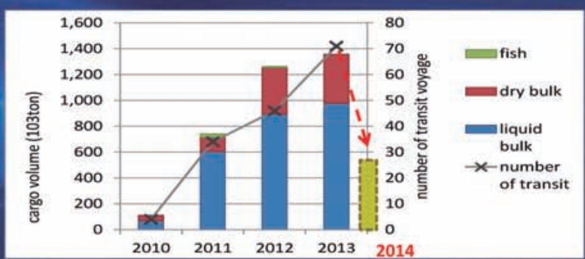
- Ports locating at middle to high latitude can shorten the distance between the Pacific Ocean and the Atlantic Ocean(about 30~40%).
- The NSR can shorten the sailing period, reduce fuel cost and other expenses that are related to sailing time.
- Enable to transport the Arctic natural resources to the world market.
- Shipping route free from the piracy and other choke point issues.

Accelerating Shipping Activities in the Arctic

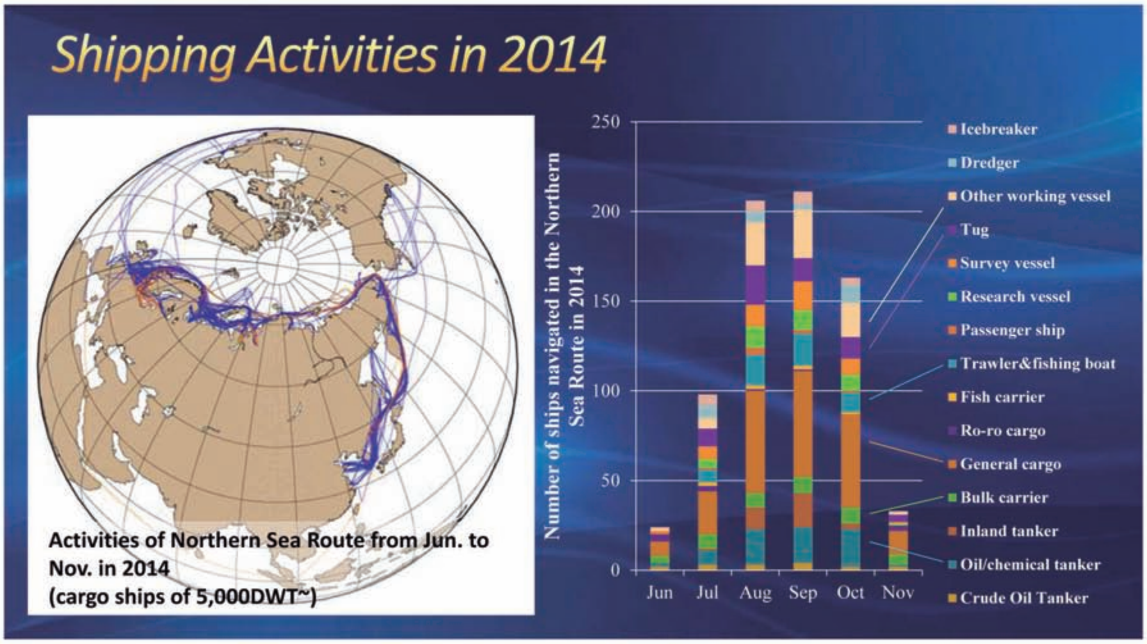




Historical total cargo volume of the NSR



Transit cargo volume 2010-2013

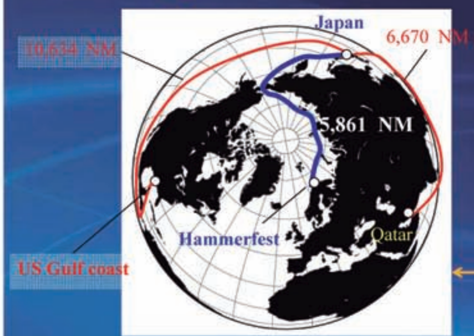

Shipping Activities in 2014
Activities of Northern Sea Route from Jun. to Nov. in 2014
(cargo ships of 5,000DWT~)
Number of ships navigated in the Northern Sea Route in 2014
250
200
150
100
50
0
Jun
Jul
Aug
Sep
Oct
Nov
Icebreaker
Dredger
Other working vessel
Tug
Survey vessel
Research vessel
Passenger ship
Trawler&fishing boat
Fish carrier
Ro-ro cargo
General cargo
Bulk carrier
Inland tanker
Oil/chemical tanker
Crude Oil Tanker


Asia Becomes a Key Player of Arctic Shipping
(×1000ton)
Cargo volume
1000
800
600
400
200
0
2010~2013
Japan
China
Korea
Russia
Finland
Holland
Thai
Denmark
Singapore
Germany
France
Taiwan
Malaysia
DPRK
Poland
General cargo
fish
coal
iron ore
LNG
diesel fuel
gas fuel
jet fuel
naphtha
gascondensate
China:
imported iron ore and gas-condensate
Korea:
imported gas-condensate and Naphtha,
Exported jet fuel
Japan:
imported LNG and Naphtha

Sailing Through the Arctic

- Russia requires advance registration to sail the NSR.
- Russian nuclear icebreaker escort is required based on ice condition and ice class of ship.
- Icebreaker escort fee is decided by the contract with Russian state owned company Rosatomflot.
- Generally, 1A ice class ship is used to sail the NSR. Ice breaker escort is required if sea ice exists.

Cost Effectiveness



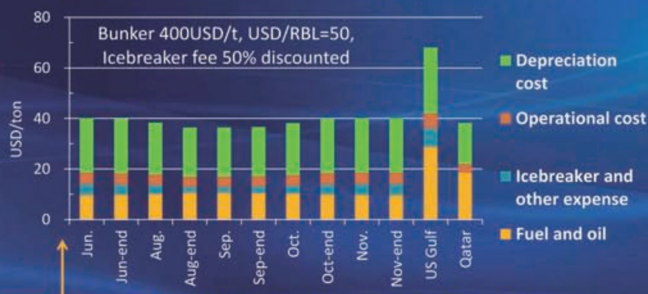
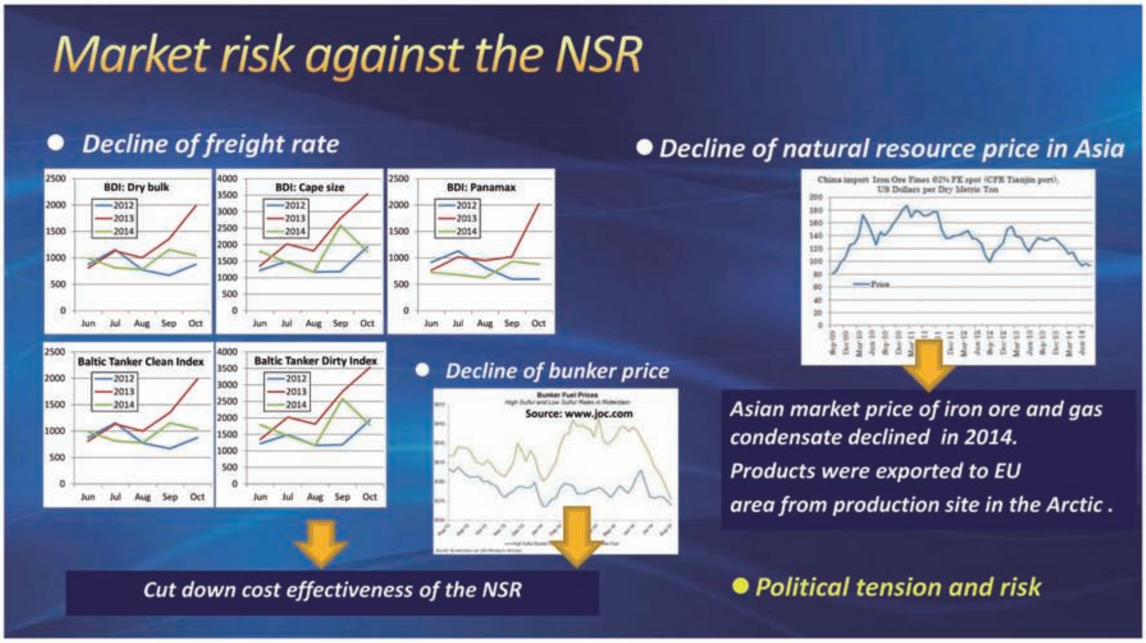
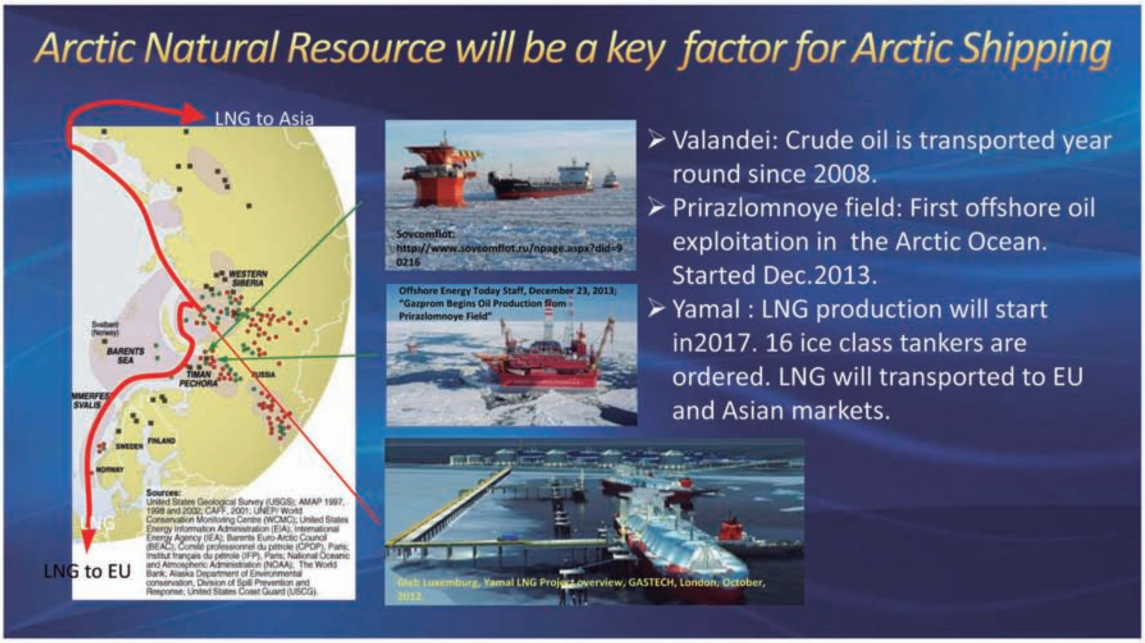


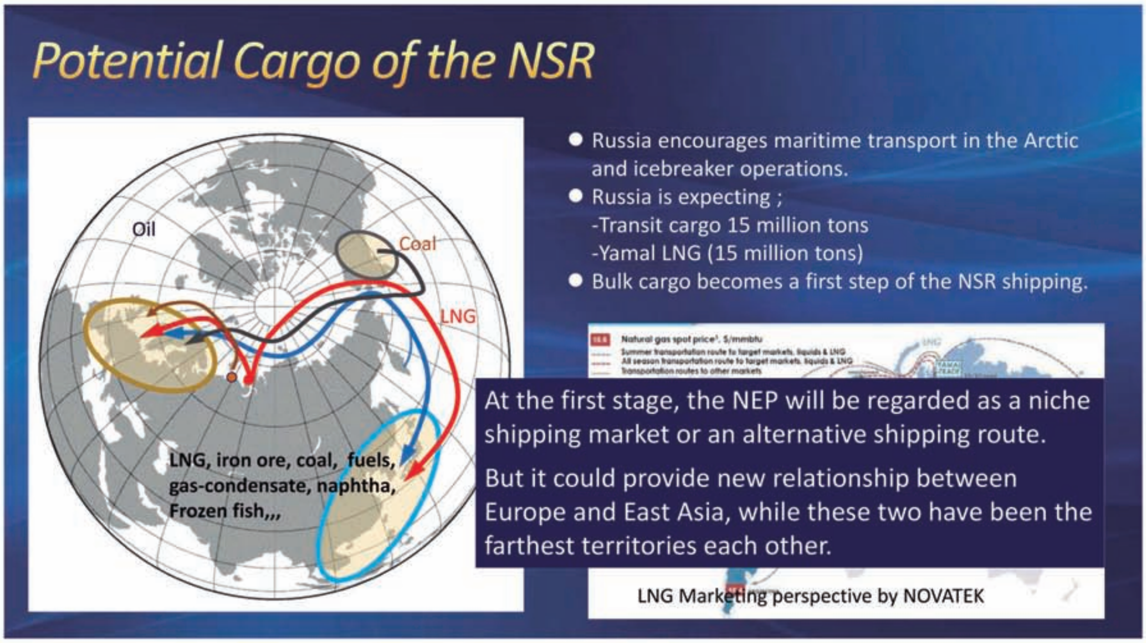
Fig. LNG shipping scenario from Hammerfest to Japan

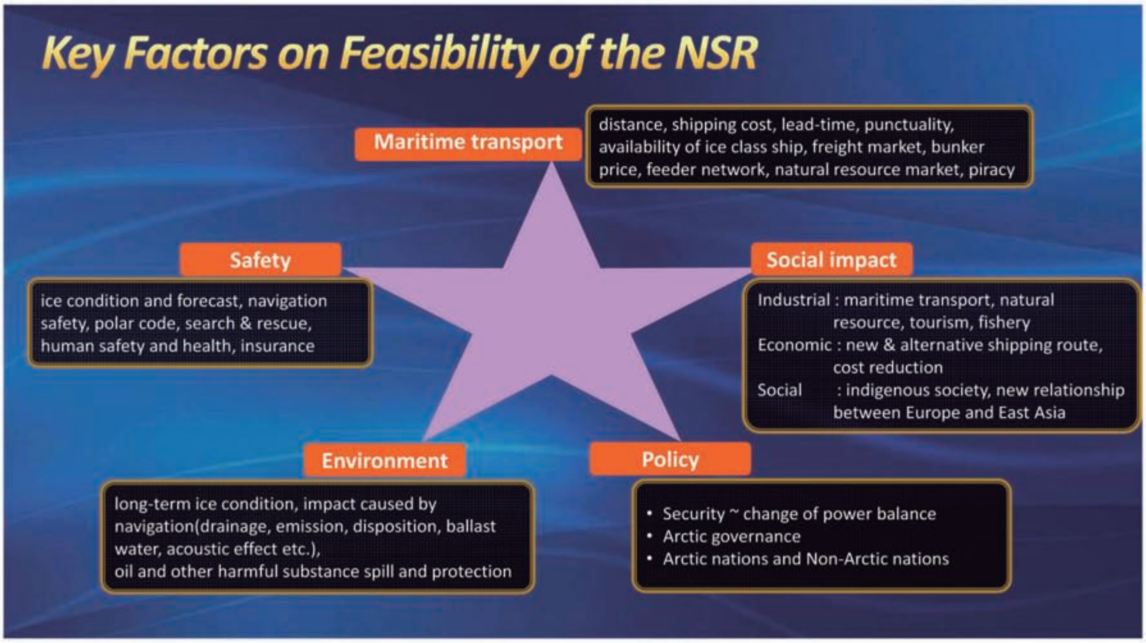
- Shipping distance can be shortened by 20~40%.
- Fuel cost could be reduced more than shortened distance(because of slower sailing speed).
- Depreciation cost and ship operating cost will be reduced due to the shortened sailing time.

- Building cost of ice class ship exceeds abbot 20% from normal ships.
- Icebreaker escort fee is used to set almost equal to the Suez Canal fee since 2010.
- Ice pilot fee is about 2,400USD/day.
- Extra charge will be required for insurance.
- Russian regulations to sail through the NSR.


Market risk against the NSR
Decline of freight rate
BDI: Dry bulk
BDI: Cape size
BDI: Panamax
Baltic Tanker Clean Index
Baltic Tanker Dirty Index
2012
2013
2014
Jun Jul Aug Sep Oct
Decline of bunker price
Source: www.joc.com
Cut down cost effectiveness of the NSR
Decline of natural resource price in Asia
Asian market price of iron ore and gas condensate declined in 2014.
Products were exported to EU area from production site in the Arctic .
Political tension and risk


Arctic Natural Resource will be a key factor for Arctic Shipping
LNG to Asia
LNG to EU
WESTERN SIBERIA
BARENTS SEA
TIMAN PECHORA
RUSSIA
SWEDEN
FINLAND
NORWAY
Sovcomflot:
Offshore Energy Today Staff, December 23, 2013; "Gazprom Begins Oil Production from Prirazlomnoye Field"
Gleb Luxemburg, Yamal LNG Project overview, GASTECH, London, October, 2012
Valandei: Crude oil is transported year round since 2008.
Prirazlomnoye field: First offshore oil exploitation in the Arctic Ocean. Started Dec.2013.
Yamal : LNG production will start in2017. 16 ice class tankers are ordered. LNG will transported to EU and Asian markets.

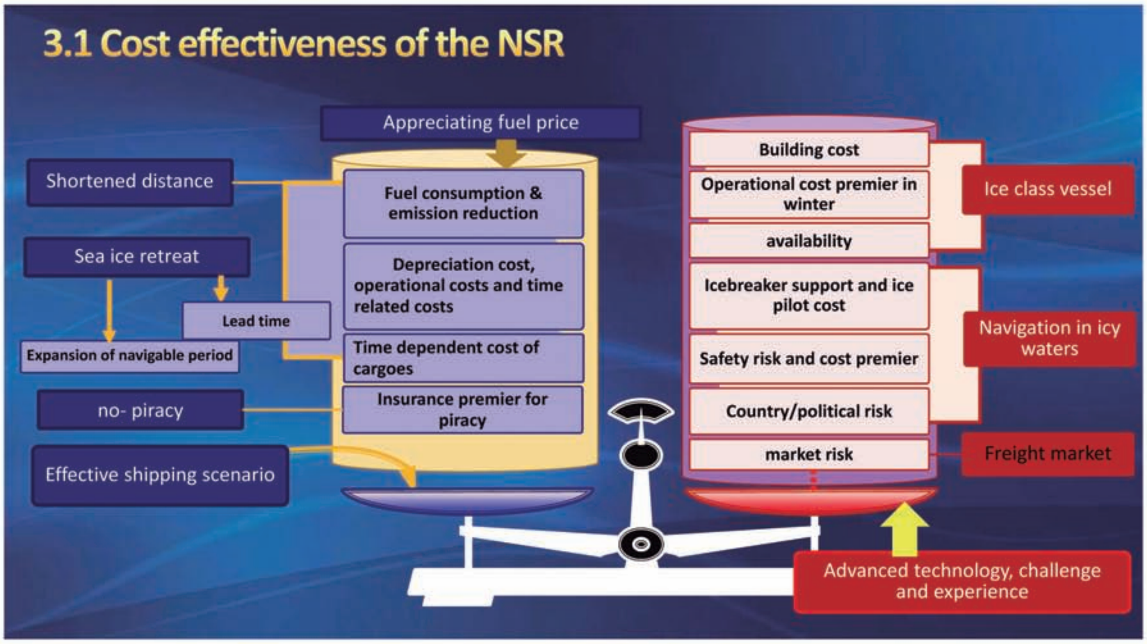

Potential Cargo of the NSR
Oil
Coal
LNG
LNG, iron ore, coal, fuels, gas-condensate, naphtha, Frozen fish,,,
● Russia encourages maritime transport in the Arctic and icebreaker operations.
● Russia is expecting ;
-Transit cargo 15 million tons
-Yamal LNG (15 million tons)
● Bulk cargo becomes a first step of the NSR shipping.
At the first stage, the NEP will be regarded as a niche shipping market or an alternative shipping route.
But it could provide new relationship between Europe and East Asia, while these two have been the farthest territories each other.
LNG Marketing perspective by NOVATEK


Key Factors on Feasibility of the NSR
Maritime transport
distance, shipping cost, lead-time, punctuality, availability of ice class ship, freight market, bunker price, feeder network, natural resource market, piracy
Safety
ice condition and forecast, navigation safety, polar code, search & rescue, human safety and health, insurance
Social impact
Industrial : maritime transport, natural resource, tourism, fishery
Economic : new & alternative shipping route, cost reduction
Social : indigenous society, new relationship between Europe and East Asia
Environment
long-term ice condition, impact caused by navigation(drainage, emission, disposition, ballast water, acoustic effect etc.),
oil and other harmful substance spill and protection
Policy
• Security ~ change of power balance
• Arctic governance
• Arctic nations and Non-Arctic nations

Conclusion and Perspectives

- **The Arctic is becoming more accessible due to climate change and technological advance, and is gaining international importance. Asian region could be important stake holders of the Arctic shipping. At the same time, close attention should be paid for sustainability in the use of the Arctic.**
- **It is too early to file and forget the NSR in response to decline in 2014. Economic feasibility could be changed by various factors . Users would take up a chance to use the NSR in response.**
- Yamal-LNG and related cargoes will become a dominant cargo of the NSR. Demand of cargo for offshore and onshore project will increase further.
- International cargo transit will be strongly affected by fuel, freight and natural resource market.
- Iron ore, coal from North America, naphtha, gas-condensate and frozen fish will be potential transit cargoes for the time being. ~so called "destination shipping"
- West-bound cargo, development of rational commercial shipping scenario, international cooperation for utilization of the NSR will be key issues.

- Large shipping companies that run container liner service emphasize predictability and regularity. SCM system requires just in time services.
- Climatic and bureaucratic uncertainty is also the major obstacles.
- Does NSR provide year round service in future?
- Shipping market is under volatile condition and users think much of economical efficiency. So smaller shipping companies that run tramp liner will have interest in the NSR first. In this regard, bulk shipping fit well with the NSR as is witnessed by the fact.
- For a long time, large shipping companies have been watching and examining how viable the NSR is. And they are waiting the opportunities to join the NSR, when their clients would make a bid in future. It could be any time soon or a long way off.


3.1 Cost effectiveness of the NSR
Appreciating fuel price
Shortened distance
Sea ice retreat
Lead time
Expansion of navigable period
no- piracy
Effective shipping scenario
Fuel consumption & emission reduction
Depreciation cost, operational costs and time related costs
Time dependent cost of cargoes
Insurance premier for piracy
Building cost
Operational cost premier in winter
availability
Icebreaker support and ice pilot cost
Safety risk and cost premier
Country/political risk
market risk
Ice class vessel
Navigation in icy waters
Freight market
Advanced technology, challenge and experience


Via the Arctic Sea Route Toward Asia
アイスランド
ナルビク
キルケネス
イギリス
ムルマンスク
北極開発サイト
アダク
イエテボリ
カムチャツカ
サンクトペテルブルグ
ウスチルガ、タリン
北極開発サイト
ウラジオストク
韓国
中国
• 中国：いずれ航路を開設。しかし単独ではリスクに懸念。
• 韓国：単独で航路開設には躊躇。
• 中国・韓国・日本で航路を開設すれば、貨物量確保、リスク分散、対ロシア・対保険などで発言力向上。
• 北海道からの貨物がないと、日本の貨物の集積にも至らない。
• 時間軸に応じた展望が必要。
• コンテナはまだかなり先。
• バルクから開拓。鉱石や資源系以外でも、可能性を探る必要。欧州側も同様に考えている。

4-3. Discussions

1. Dr. Koji Shimada of Japan's Tokyo University of Marine Science and Technology angled his presentation from the viewpoint of an Arctic climate change oceanographer. At the onset, he pointed out the qualitative difference of ice in Arctic and Antarctic such as in terms of thickness. Arctic is an ocean of sea ice whereas the Antarctic is a continent of ice sheet. While there was a slow change in sea ice decline during summer in the Arctic Ocean from 1979 to 1997, there was a rapid decline observed from 1997 to 2012 which is said to be associated with warmer ocean temperature.

2. Also discussed were the changes in atmospheric circulation, the slow response of the ocean circulation to the sea ice movement, slow travel of sea water from south to north, climate impacts from Polar Regions, as well as the key processes to understand large scale decline and local variation of sea ice.

3. Dr. Natsuhiko Otsuka, Manager of North Japan Port Consultants Ltd. presented the Implications for Global Trade and Distribution System considering that the Northern Sea Route (NSR) is almost ice free in summer in recent years. He informed the workshop that in 2010, a pilot commercial shipping between Europe and East Asia had been carried out under the cooperation between Norwegian Shipping companies and Russian companies.

4. He shared that shipping activities has increased since the route has been opened, though there had been a decline at the end part of 2014, which is due to sanctions and political risks along those time. He presented that Asia becomes a key player of arctic shipping, considering that it has lower shipping cost and free from pirates. In further added that growing demands, natural resource exploitation has been increasing in the Arctic. With a shorter shipping distance, Dr. Otsuka presented the advantages of Northern Sea Route such as: reduce fuel consumption and fuel cost, shorten sailing time thereby reduce total shipping cost. On the other hand, he also presented negative effects and risks in opening the route which include decline of rates and political risks.

5. Finally, he discussed that economic feasibility could be changed by various factors which include safety, social impact, environment and policy. He also suggest that close attention should be paid for sustainability in the use of the Arctic.

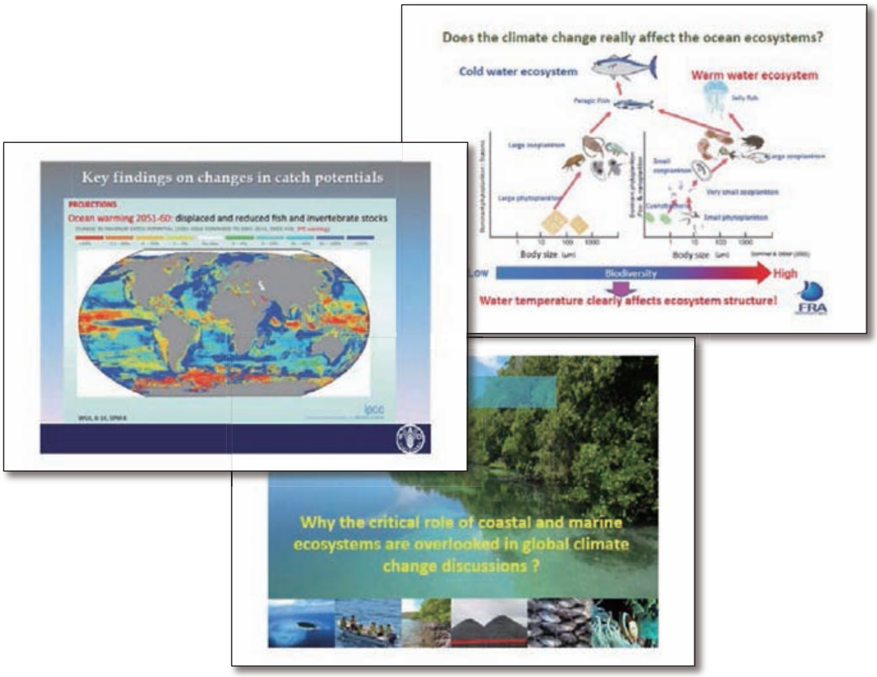
6. An inquiry on the comparison of expenses (ice breaker fee, bunker) or fees, and ice conditions in the NSR was raised. Dr. Otsuka stated that expenses were estimated to reach 2400 dollars per day, and that ice conditions are almost the same. He added that fuel price is not much of an issue.

7. On the imposition of various fees, Dr. Otsuka that such fees (Ice breaker, ice pilot fees) are required by insurance companies for insurance coverage.

8. Finally, there was also an inquiry which states that if the current climate trend continues, will the ice sheets in the Arctic Ocean completely disappear.

Chapter V

Vulnerability of Fisheries



5-1. Climate Change Effects on Fisheries[1]

Árni M. Mathiesen
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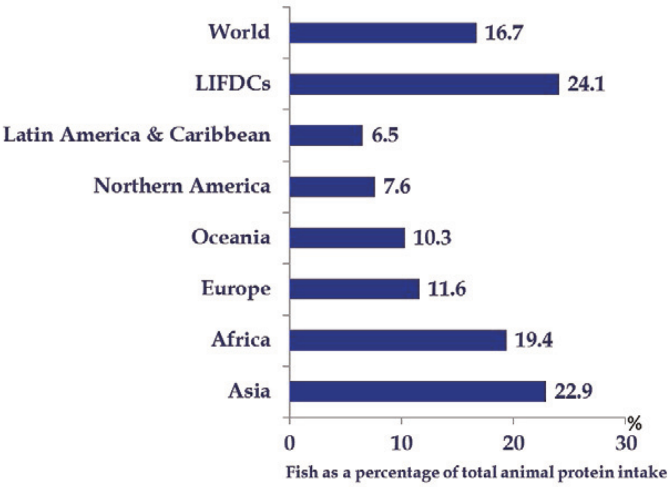
Fisheries and Aquaculture Department
Food and Agriculture Organization of the United Nations

Fish and Food, Nutrition and Livelihood Security and Economic Growth

The latest FAO estimates indicate that global hunger reduction continues: about 795 million people are estimated to be chronically undernourished in 2014–16, down more than 100 million over the last decade, and 216 million lower than in 1990–92. In the same period, the prevalence of undernourishment has fallen from 18.6 to 10.9 percent globally and from 23.3 to 12.9 percent for the developing areas (FAO, IFAD and WFP, 2015). Despite this progress, about one in eight people remain chronically undernourished in the developing areas, millions of children suffer from nutrition deficiency and billions of people are obese or overweight (WHO, 2015).

It is often overlooked that over 800 million people depend, directly or indirectly, on fisheries and aquaculture for their livelihoods and the fish and seafood value chain contributes over US$800 billion annually to economic growth. In addition, fish provides essential nutrition for over 4 billion people and at least 50 percent of animal protein and essential minerals to 400 million people in the poorest areas. Trade is also an important characteristic of fisheries and aquaculture: fish products are among the most widely-traded foods, with more than 37 percent by volume of world production traded internationally (FAO SOFIA, 2014).

Figure 1. Protein contributions of fish



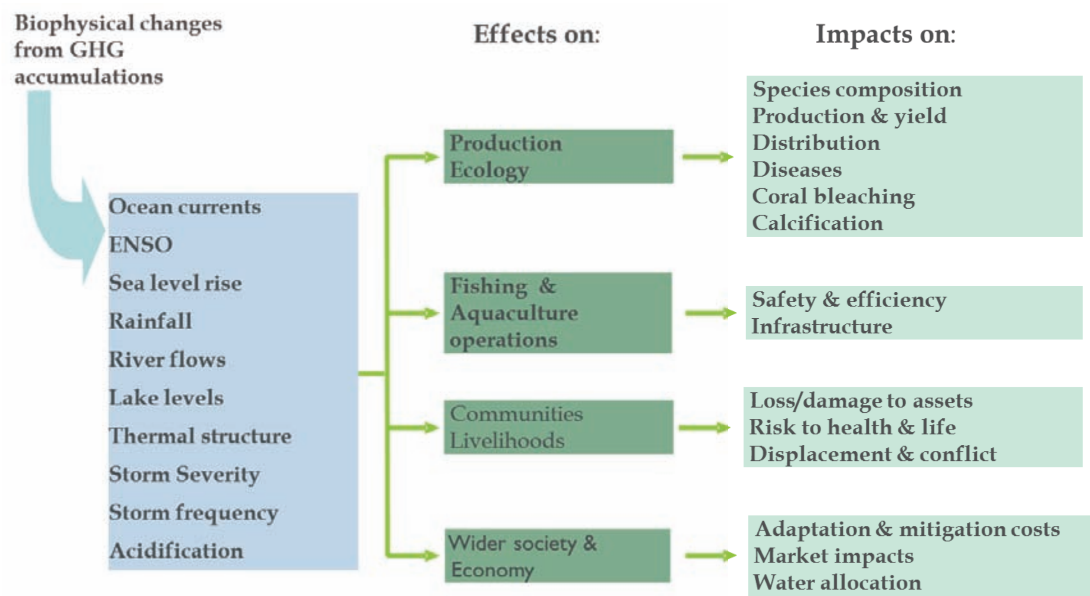
Source: FAO SOFIA, 2014

[1] Primarily extracted from De Young *et al*, 2013.

At the same time, climate change and ocean acidification are bringing an ocean of change to the world's fisheries and the communities and economies that depend on them. Climate change has the potential to compound existing pressures on fisheries and aquaculture, but can also provide opportunities (Cochrane *et al*, 2009). For example, the projected increasing water temperatures stemming from greenhouse gas (GHG) accumulation will also likely result in changes in distributions of species, with many marine species ranges being driven toward the poles, expanding the range of warmer-water species and contracting that of colder-water species whereas migration possibilities for freshwater fish is limited to the catchment area and hence endemic species and species in fragmented habitats will be at risk. Whether positive or negative, these changes will have social and economic impacts on the fisheries and aquaculture industries and communities - possibly causing mismatches between where the fishing happens and where it is landed or processed, changes in fish farm profitability either through inputs needed or productivity of individual farms, or through the disappearance of traditional sources of local food and livelihood security. At the macro scale, there will likely be implications for international fisheries management due to changes in the distributions of transboundary fish stocks. CO_2 accumulation is also increasing the acidification of aquatic systems, with potentially severe consequences for shellfish and squid, mangroves, tropical coral reefs and cold water corals. In addition, changes in frequency or intensity of extreme climatic events can affect fish habitat, productivity, and species distributions. Changes in precipitation will have both direct and indirect impacts on freshwater fisheries and aquaculture, most notably through the need for increased irrigation and drinking water and the desire to increase GHG mitigation through hydrological engineering. The question of how to meet increasing demand for fish in the face of climate change poses a great challenge to fisheries and aquaculture management.

Fisheries- and aquaculture-dependent economies, as well as coastal and riparian communities, are likely to experience a range of effects of climate change (De Young *et al*., 2013). Impacts will include those that are associated with changes in the resource base, such as shifts away from traditional fishing grounds or changes in available fish species. There will also be direct risks to fishers, farmers and coastal communities due to sea level rise, stronger sea surges and changes in the frequency, distribution or intensity of tropical storms. Surrounding the changes in the aquatic food production system will also be a range of other impacts, such as increased risks of human diseases related to increased air and water temperatures. Climate change will also have an impact on food security, social services, social cohesion, and human displacement and migration. Many fishing and coastal communities already subsist in precarious and vulnerable conditions due to poverty and rural underdevelopment. The well-being of these communities is often undermined by poor access to capital, limited skills, the overexploitation of fish stocks, other natural resources and degraded ecosystems. The vulnerability of fisheries, aquaculture and fishing communities depends not only on their exposure and sensitivity to such change, but also on the uncertain ability of individuals or systems to anticipate these changes and adapt.

Figure 2. Pathways of climate impacts in fisheries and aquaculture



Source: Badjeck et al, 2010

Understanding and reducing vulnerability

Vulnerability to climate change in the sector is experienced across a range of productive, social and political dimensions and will also depend on timing and locations of changes. For example, climate risks may be felt at a very specific location and in a targeted manner (e.g. through increased storm events in a small fishing location), or at a broader scale, as in the impacts of a shift in temperature and freshwater balances across a major river delta and its associated coastal system, or as a range of risks impacting on a range of people and communities with different capacities to cope with and adapt to the potential impacts. As with other sectors, vulnerability is also highly connected with other factors, such as the availability of human, social and political capital, access to services and other resources, and options for alternative livelihoods. Options for reducing vulnerability are commonly defined by the nature and severity of the risks involved; the comparative costs of physical and other responses required to reduce impacts by definable amounts; and the capacity of individuals, communities and organizations to analyse, prioritize and implement the appropriate actions.

Tools and best practices for reducing vulnerability in specific conditions are still being developed and validated within the fisheries and aquaculture sector (see Brugere & De Young, in preparation). However, in addition to the general resilience-building actions described in the following section, a number of practical options can be identified. These are outlined in Table 1. Additional examples of adaptation options are provided in De Young *et al (*2013) and Shelton (2014).

Table 1. Overview of practical options for reducing vulnerability in fisheries and aquaculture

Impact area	Potential responses
Capture fisheries	
Reduced yield	Access higher value markets; shift/widen targeted species; increase fishing capacity/effort; reduce costs/increase efficiency; diversify livelihoods, exit fishery
Increased yield variability	Diversify livelihoods; implement insurance schemes; promote adaptive management frameworks
Change in distribution	Migrate fishing effort/strategies and processing/distribution facilities; implement flexible allocation and access schemes
Sea level change, flooding, and surges	New/improved physical defences; managed retreat/accommodation; rehabilitation and disaster response Integrated coastal management; early warning systems and education
Increased dangers of fishing	Weather warning systems; improved vessel stability/safety/communications
Social disruptions/ new fisher influx	Support existing/develop new local management institutions; diversify livelihoods.
Aquaculture	
Extreme weather events	Improve farm siting and design; individual/cluster insurance; use indigenous or non-reproducing stocks to minimize biodiversity impacts;
Temperature rise	Better water management, feeds, handling; selective breeding/genetic improvements; adjust harvest and market schedules
Water stress and drought conditions	Improve efficacy of water usage; shift to coastal aquaculture, culture based fisheries; select for short-cycle production; improve water sharing; improve seed quality, efficiency,
Sea level rise and other circulation changes	Shift sensitive species upstream; introduce marine or euryhaline species (wide salinity tolerance); use hatchery seed, protect broodstock and nursery habitats,
Eutrophication/upwelling, harmful algal blooms	Better planning; farm siting; regular monitoring; emergency procedures
Increased virulence of pathogens, new diseases	Better management to reduce stress; biosecurity measures; monitoring; appropriate farm siting; improved treatments and management strategies; genetic improvement for higher resistance.
Acidification impact on shell formation	Adapt production and handling techniques; move production zones, species selection
Limits on fish and other meal and oil supplies/price	Fish meal/oil replacement; better feed management; genetic improvement for alternative feeds; shift away from carnivorous species; culture of bivalves and seaweeds
Post-harvest, value addition	
Extreme event effects on infrastructure/ communities	Early warning systems and education; new or improved physical defences; accommodation to change; rehabilitation and disaster response
Reduced/ more variable yields, supply timing	Wider sourcing of products, change species, add value, reduce losses, costs; more flexible location strategies to access materials; improve communications and distribution systems; diversify livelihoods
Temperature, precipitation, other effects on processing	Better forecasting, information; change or improve processes and technologies
Trade and market shocks	Better information services; diversify markets and products

Source: adapted from Daw *et al.*, 2009; De Silva and Soto, 2009.
Note: Some adaptations to declining and variable yields may directly risk exacerbating overexploitation of fisheries by increasing fishing pressure or impacting habitats.

Decisions as to which options to select will depend on the location and scale of change; the impacts and the perception of their effects; and the cost, complexity and time required to implement countermeasures. Priorities may be given to small and inexpensive changes in systems or practices that can bring about additional risk reduction. However, if larger climate change risks emerge, these actions may quickly become redundant, or more dangerously, offer a false sense of security. In these circumstances, when time may be required to develop new techniques and/or gain access to investments required, a more strategic approach may be needed. However, early over-investment in expensive forms of protection may pose dangers in that they may deprive communities of important financial resources and protect only some sectors of the population. In some cases, tradeoffs may be required to support decisions to protect and strengthen one area, community or activity, while leaving others relatively unprotected. Over longer periods, infrastructure development and the relocation of people towards safer or more attractive areas may be required.

Reducing and removing GHGs

As for the terrestrial food systems, fisheries and aquaculture GHG emissions, mainly carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), are associated with various aspects of production and distribution; while management of the aquatic ecosystem itself has important potential for reducing net GHG flux to the atmosphere through the natural sequestration of carbon. There are also possible options for aquatic biofuel production, which could be linked with the fisheries and aquaculture sector. In addition, there may be interactions with GHG mitigation efforts in the energy sector in areas such as hydropower and coastal and offshore renewable energy generation. Three areas of interaction can be articulated: the sector's own contribution to GHGs and the potential for reducing these emissions; the sector's potential role in supporting the natural system's removal of emissions; and the sector's role in providing alternative energy sources.

The role of the sector in reducing its emissions

Although there are still substantial areas that need to be addressed, information on GHG emissions and their potential reductions from aquatic food production and distribution systems is becoming more clearly understood (Poseidon, 2011; Muir, 2012). For capture fisheries emissions are primarily related to fuel use. The nature and levels of emissions depend not only on technical aspects, such as types of vessels and gear used (e.g. active/passive gear, trawl, dredge, seine, gillnet, longline, light-attraction fishing, traps) (Muir, 2013) but also on driving market forces and management of fishing capacity – too many vessels chasing after fewer and fewer fish tends to increase fuel use. Emissions of particulate 'black' carbon could add significantly to current estimates, but this issue needs further investigation. For aquaculture, feed is considered to be the primary determining factor for emission levels and fertilizers are a secondary factor. Therefore, GHG emissions tend to increase as an aquaculture system moves from being extensive (untreated or partially fertilised), to semi-intensive (fertilised and/or partially fed) to intensive (completely fed and fertilized). Fuel and energy use for water exchange and treatment, service vessels and vehicles, and husbandry equipment also add to CO_2 emissions, but is usually much less significant. The relatively undetermined effects of CH_4 in sediments and N_2O in sediments and the water column are also potentially important and need to be further defined.

Processing fish and aquatic animals ranges from simple artisanal drying and smoking to highly controlled seafood preparation using high-specification packaging and labelling. In this regard, energy use is the primary determining factor for GHG output. There are wide variations in emissions depending on local practices, input variations (species, sourcing, quantity and quality) and operating efficiency. Water used in food processing and its links to GHG emissions may also be important. As the most widely traded global food product, aquatic foods may travel considerable distances in a range of forms and in various states of perishability. In this regard, GHG outputs are usually directly related to fuel use and to energy use in handling and cold and freezer storage. The specific choice of refrigerants is also important. Leakage from old or poorly maintained equipment can be critical, as many low ozone depletion gases have significant global warming potential. The most perishable fresh products require transport methods (e.g. local trucks, live fish vessels and air transport) that emit higher levels of GHG. Cooled and frozen products require less time-critical transport methods (e.g. ship-borne reefer and freezer containers) that emit fewer GHGs. More stable products (dried, smoked and salted products), particularly those processed in artisanal supply chains, require methods for transport that are not time-sensitive and produce low levels of GHGs.

Overall, the ratios of GHG output per tonne of fish and aquatic foods at the production, distribution and retail stages are similar to those for other foods. GHG levels at first sale accounts for typically 25-40 percent of total outputs. However, these figures vary widely. Limited numbers of comparative assessments of CO2 equivalents per kilo across the different food production systems suggest that high fuel-use fisheries (e.g. poorly catching trawl or dredge fisheries) together with high-energy use post-harvest systems can be among the most GHG-intensive global food systems. Passive fishing gear systems or low-trophic level aquaculture (e.g. bivalves, seaweeds) can produce foods at lower GHG levels than most forms of meat or related animal protein production.2 Such systems have the potential to contribute to strategic shifts in consumption and to reductions in global GHG emissions.

The primary potential for GHG reduction in the fisheries and aquaculture sector has been associated with reducing fuel and energy use, either in direct actions (managing fishing methods and fishing effort, aquaculture intensity and energy use in processing), or indirectly through a variety of actions, including the choice of supply and value chain and strategic waste reduction. To date, the primary drivers for making changes in this area have been fuel prices, which have already made some forms of fishing and distribution unprofitable. As pressure increases to reduce fuel subsidies in primary production, the motivation to reduce fuel use is likely to increase. Actions to reform fisheries management in ways that lead to improved stocks and better more sustainable levels of fishing effort is paramount to improving performance. In aquaculture, dependence on fishmeal and oil is becoming slightly less of a resource constraint; however, further work is required on feed sources and their GHG implications. Across the sector, incentives to invest in more energy-efficient technologies or operations have not yet been adopted, although incentive mechanisms associated with carbon markets have shown some potential.

The role of the sector in supporting the natural removal of emissions

The highly significant role of the oceans and coastal margins in capturing and sequestering carbon is becoming increasingly understood and recognized. Around 93 percent of global carbon is estimated to be stored in aquatic systems and around 30 percent of annual emissions are estimated to be sequestrated in aquatic environments, primarily in mangroves, seagrasses, floodplain forests and coastal sediments (Nellemann *et al.*, 2008). To improve the sector's role in removing emissions, it is of primary importance to halt the disruption of carbon sequestration caused by habitat destruction and inadequate management of fisheries and aquaculture. Secondly, there may be valuable prospects for enhancing sequestration through expanding planted areas of mangroves and floodplain forests. Development of carbon funds to support GHG sequestration in the aquatic systems needs to ensure fisheries and aquaculture communities are properly represented and able to benefit from such funds.

There is also wider potential for exploring the role of aquaculture in carbon sequestration. Primary options include integrated multitrophic aquaculture (IMTA), where molluscs and seaweeds are grown as byproducts using waste inputs from more intensive aquaculture and systems where aquaculture cage or pond sediments are managed to enhance sequestration. These offer potentially valuable means of storing carbon. However, removing the carbon in longer-term conditions would require more secure means of disposal. This would involve either a biochar-type system or the disposal of carbon-

[2] See De Silva and Soto, 2009 for a comparative description of energy use in aquaculture systems.

enriched materials below oceanic thermoclines and into deep sediments. The physical and economic practicalities of this are yet to be demonstrated.

The role of the sector in providing alternative energy sources

There are major technical and environmental interests in developing the potential of renewable aquatic energy. This includes aquatic substrate biofuels and creating links to other aquatic-based energy systems that exploit the energy potential of tides, currents, waves, wind and hydropower. There are also options for physical integration of aquatic-based energy systems with newly developing infrastructure such as offshore wind and wave installations. Currently, there is particular interest in algal biofuels, which are based on either microalgae that are typically cultivated in coastal ponds or intensive stirred tank systems or macroalgae (seaweeds) that is grown in conventional culture systems. Using microbial enzymes to produce fuels such as bioethanols and biodiesels is an already established practice, which is increasing in efficiency and yield. This is particularly the case with genetically engineered (GE) bacterial enzyme systems capable of digesting celluloses and in some cases providing direct conversion to biofuel. GE algae are also a possibility, but they would require more expensive containment and biosecurity systems. The costs of producing and harvesting algal raw materials are currently too high to make production viable for any of the proposed systems and fuel routes. However as oil prices rise and production efficiencies improve, this procedure may become more viable. It should be noted that, as is the case for terrestrial biofuels, algal biofuels will provide an emission displacement function only and they will not lead to a net sequestration of carbon.

Conclusions

Developing rapid and effective responses to climate change in the fisheries and aquaculture sector, and mainstreaming climate-responsive approaches within wider development goals represents a significant strategic and operational challenge. Conventional approaches for building and validating evidence within traditional disciplines and contexts may not always be feasible. Experience will need to be built up through an adaptive management process based on action learning with broad participation and information sharing among stakeholders. In addition, the nature of climate change vulnerability will need to be further explored. Practical means need to be developed to ensure that the most vulnerable states, production systems, communities and people have the potential to develop and apply sound climate smart and resilient approaches.

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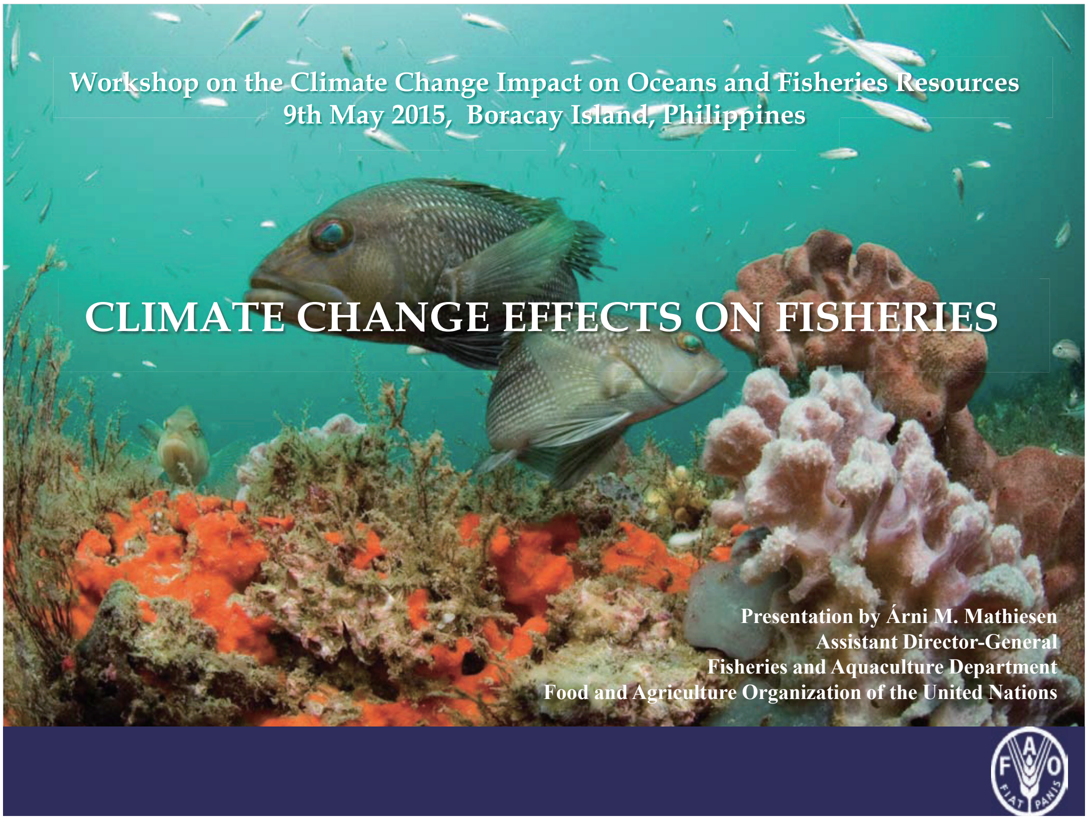
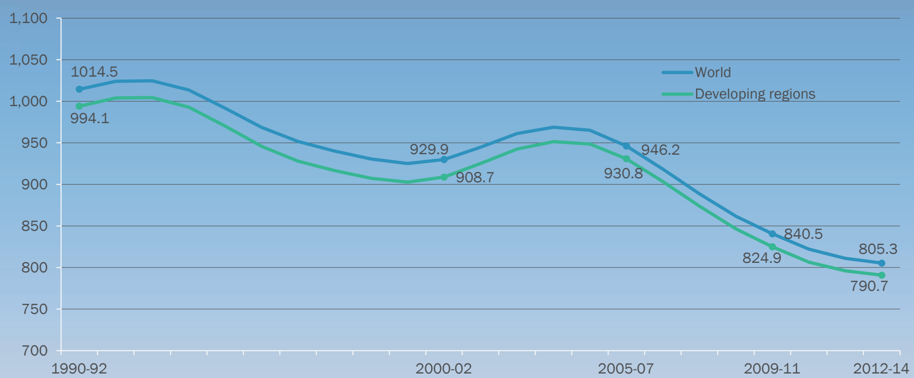


Hunger

- 805 million people estimated to be suffering from chronic hunger in 2012–14, down 100 million in the last decade.
- The vast majority, 791 million, live in developing areas.

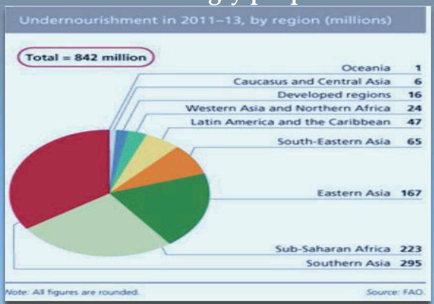


Number of undernourished *(millions)* and prevalence *(%)* of undernourishment

	1990–92		2000–02		2005–07		2008–10		2012–14*	
	No.	%	No.	%	No.	%	No.	%	No.	%
WORLD	1 014.5	18.7	929.9	14.9	946.2	14.3	840.5	12.1	805.3	11.3

Food security and nutrition status

805 million hungry people



Millions of children suffering nutrition deficiency

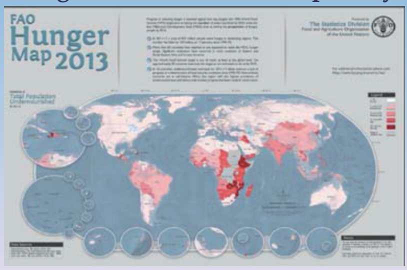
Vitamin A deficiency
- Causing blindness
- 250 million preschool children affected

Iron deficiency
- Anaemia contributes to 20% of all maternal deaths.
- 40% of preschool children anaemic in developing areas.

Iodine deficiency
- Impairing cognitive development in children
- 54 countries still iodine-deficient

Source: WHO

Hunger hand-in-hand with poverty



Billions of obesity or overweight people

Trend
- Worldwide **obesity** has nearly doubled since 1980.

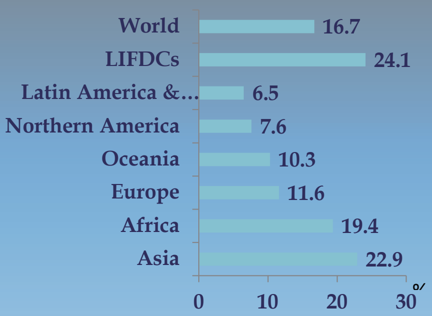
Adults (aged 20 or older)
- More than 1.4 billion (35% of total) **overweight** in 2008
- Over 200 million men and nearly 300 million women (11 % of total) **obese** in 2008.

Children (under the age of 5)
- More than 40 million children **overweight** or **obese** in 2012.

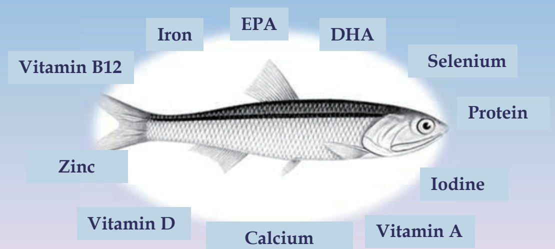
Source: WHO

Contribution of fish to human nutrition

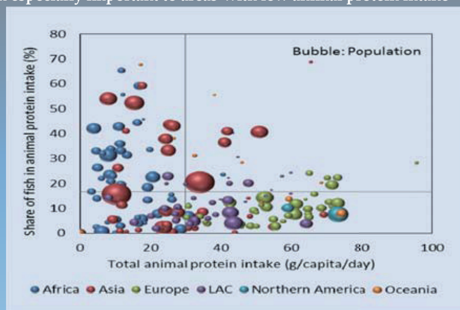
Fish provides high quality animal protein



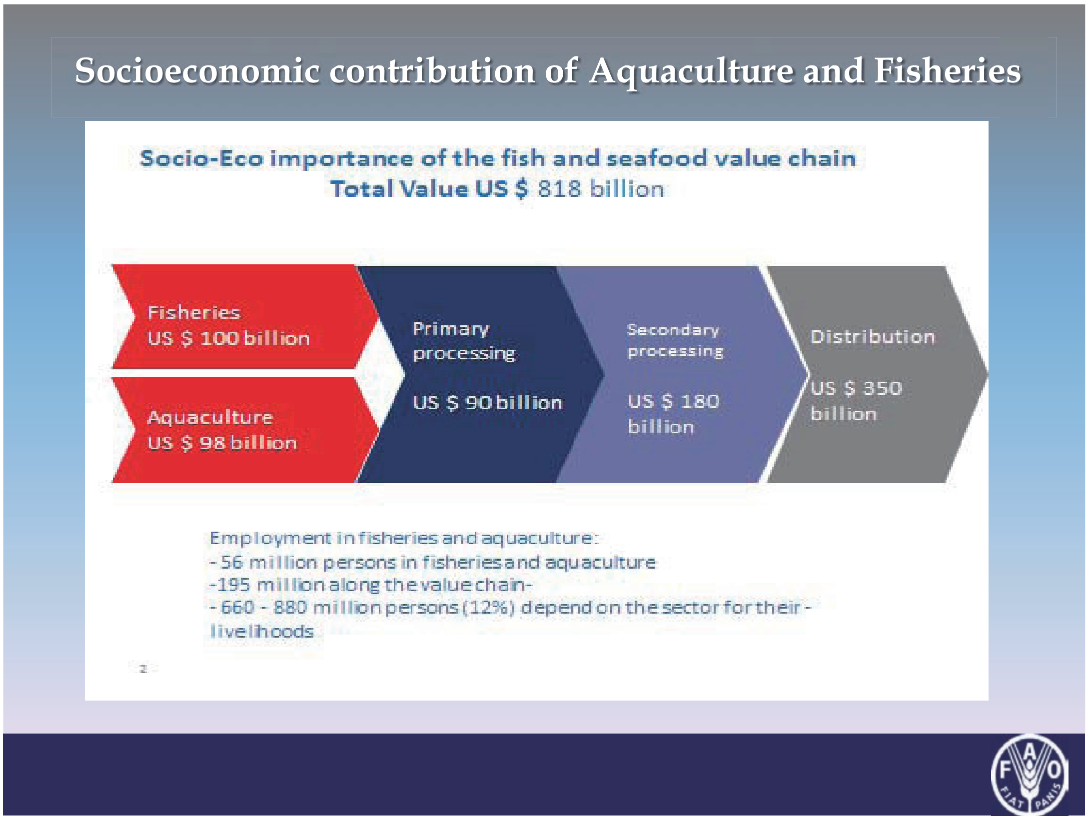
Fish as a percentage of total animal protein intake



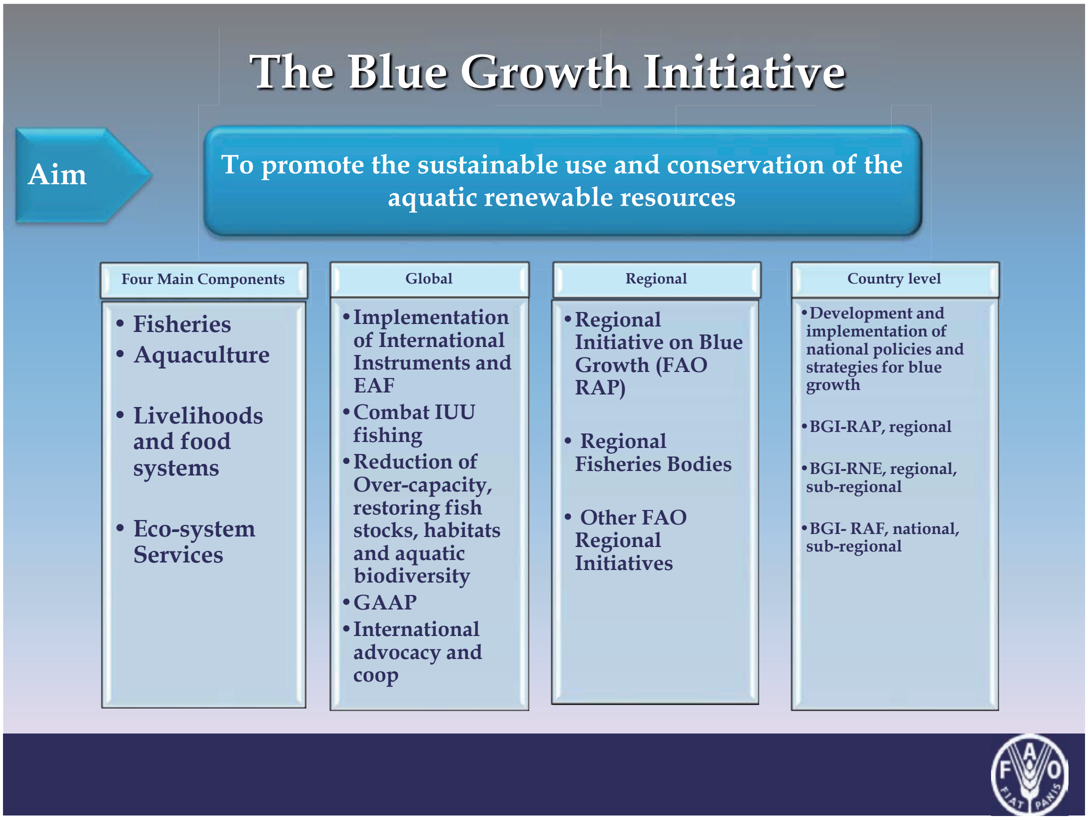
Fish especially important to areas with low animal protein intake

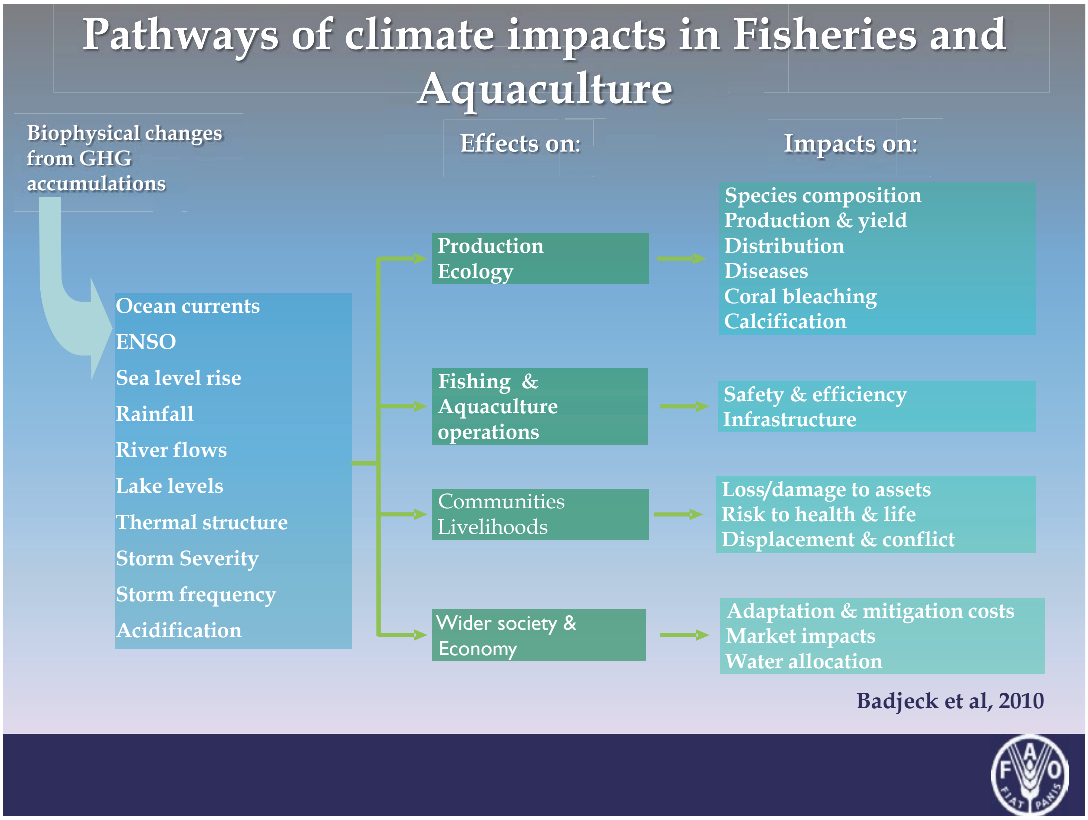


Fish, a source of nutrients	Daily need (RDI) for children:
DHA+EPA (Ω-3); seafood main source	150 (250) µg
Vitamin A; **250 million** preschool children deficient	150 (250) mg
Iron; **1.6 billion** people deficient	8.9 mg (at 10% bioavailability)
Iodine; seafood natural source, **2 billion** people deficient	120 µg
Zinc; **800 000** child deaths per year	5.6 mg (at moderate bioavailability)

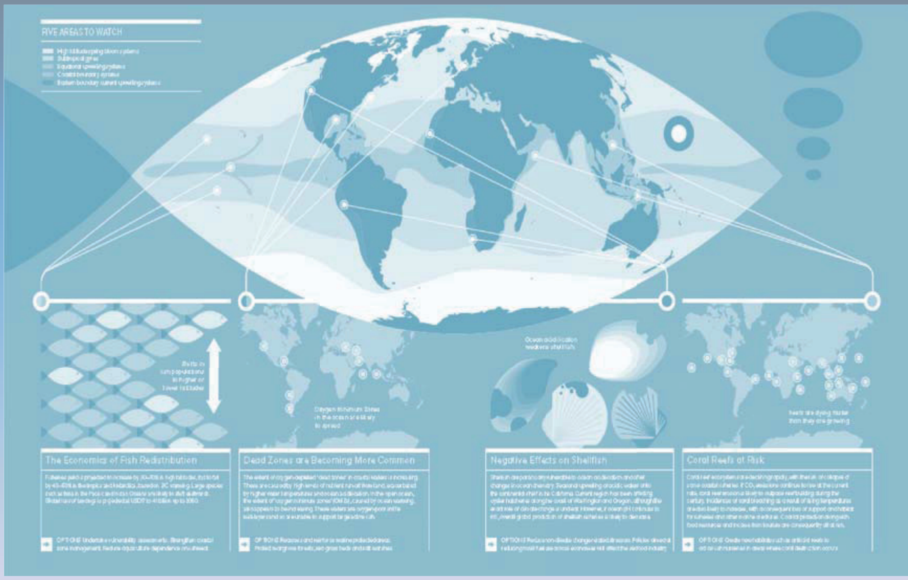

Socioeconomic contribution of Aquaculture and Fisheries
Socio-Eco importance of the fish and seafood value chain
Total Value US $ 818 billion
Fisheries
US $ 100 billion
Aquaculture
US $ 98 billion
Primary processing
US $ 90 billion
Secondary processing
US $ 180 billion
Distribution
US $ 350 billion
Employment in fisheries and aquaculture:
- 56 million persons in fisheries and aquaculture
-195 million along the value chain-
- 660 - 880 million persons (12%) depend on the sector for their -
livelihoods


FAO's strategic goals
ERADICATE HUNGER, FOOD
insecurity and MALNUTRITION
ELIMINATE RURAL POVERTY
THROUGH SOCIO-ECONOMIC
SUSTAINABLE MANAGEMENT
AND UTILIZATION OF NATURAL
SOURCES


The Blue Growth Initiative
Aim
To promote the sustainable use and conservation of the aquatic renewable resources
Four Main Components
• Fisheries
• Aquaculture
• Livelihoods and food systems
• Eco-system Services
Global
• Implementation of International Instruments and EAF
• Combat IUU fishing
• Reduction of Over-capacity, restoring fish stocks, habitats and aquatic biodiversity
• GAAP
• International advocacy and coop
Regional
• Regional Initiative on Blue Growth (FAO RAP)
• Regional Fisheries Bodies
• Other FAO Regional Initiatives
Country level
• Development and implementation of national policies and strategies for blue growth
• BGI-RAP, regional
• BGI-RNE, regional, sub-regional
• BGI- RAF, national, sub-regional


Pathways of climate impacts in Fisheries and Aquaculture
Biophysical changes from GHG accumulations
Effects on:
Impacts on:
Ocean currents
ENSO
Sea level rise
Rainfall
River flows
Lake levels
Thermal structure
Storm Severity
Storm frequency
Acidification
Production Ecology
Species composition
Production & yield
Distribution
Diseases
Coral bleaching
Calcification
Fishing & Aquaculture operations
Safety & efficiency
Infrastructure
Communities Livelihoods
Loss/damage to assets
Risk to health & life
Displacement & conflict
Wider society & Economy
Adaptation & mitigation costs
Market impacts
Water allocation
Badjeck et al, 2010

Key findings on species from IPCC AR 5

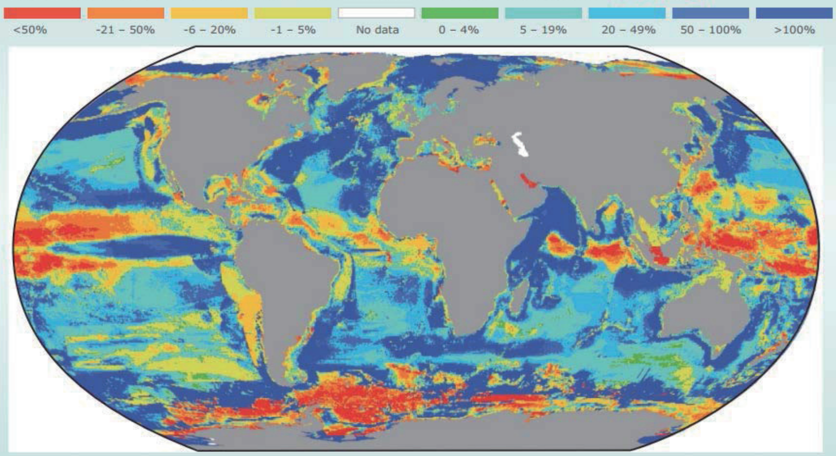


Key findings on changes in catch potentials

PROJECTIONS

Ocean warming 2051-60: displaced and reduced fish and invertebrate stocks

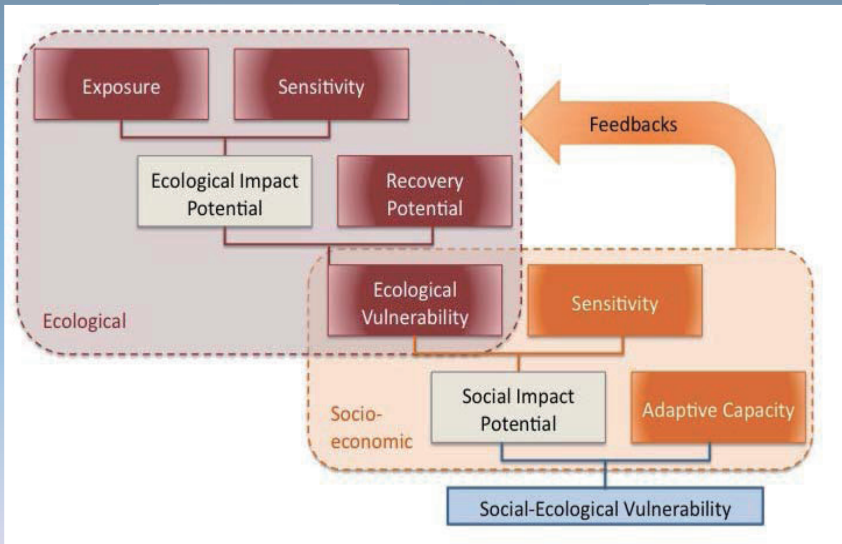
CHANGE IN MAXIMUM CATCH POTENTIAL (2051-2060 COMPARED TO 2001-2010, SRES A1B, 2°C warming)



WGII, 6-14, SPM.6

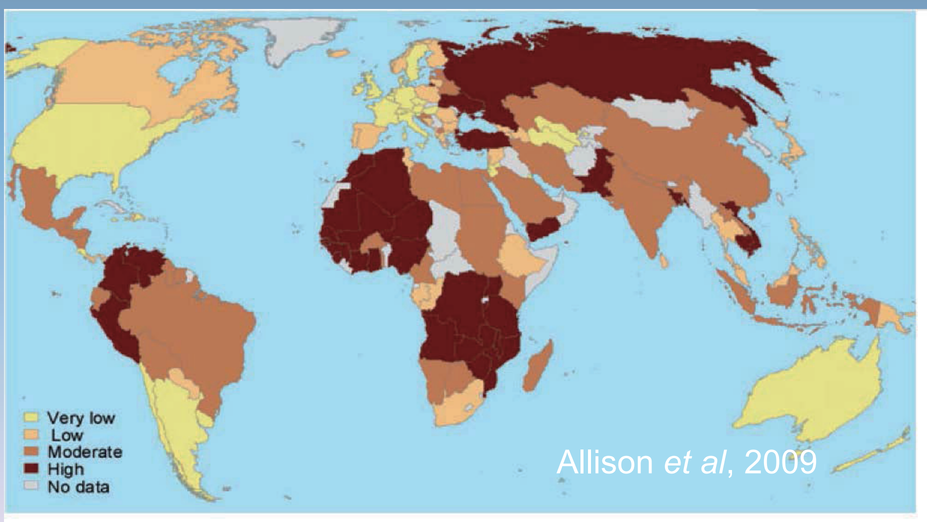
ipcc INTERGOVERNMENTAL PANEL ON climate change

Understanding Vulnerabilities: Evolving the IPCC model

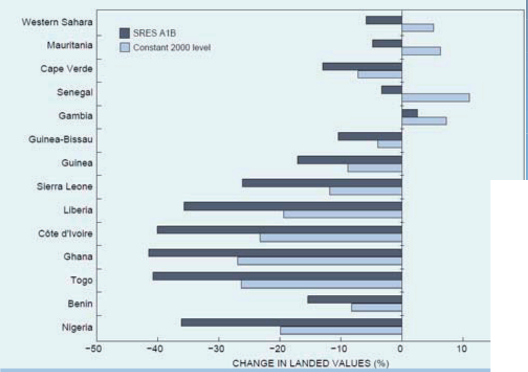


Understanding vulnerabilities: the first applied fisheries example

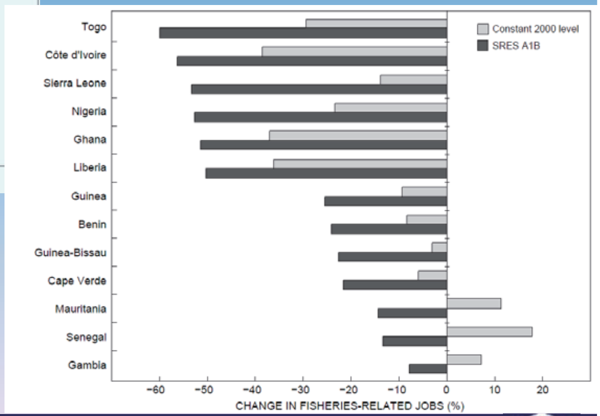
Global mapping of national economies' vulnerability to climate change impacts on fisheries



Potential Impacts in the Atlantic – A West African example of social and economic impacts

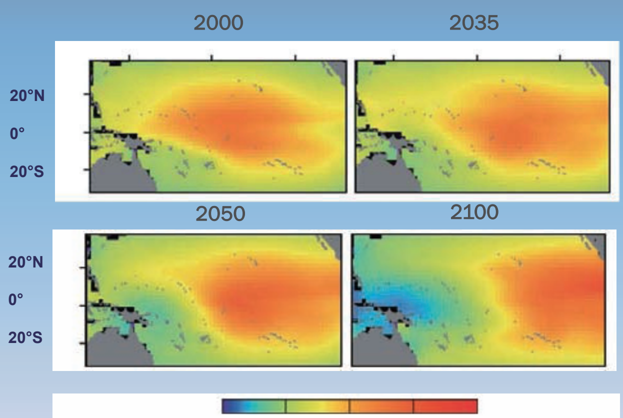


2050 versus 2000 Lam et al 2012



Potential Impacts in Pacific– A Tuna example of range shifting

Projected estimates of total biomass of skipjack tuna based on average (1980–2000) fishing effort, (source: Lehodey et al. 2011).



Relative vulnerability or benefit for PICT economics to changes in tuna fisheries

PICT	Surface fishery			Longline fishery		
	B1/A2 2035	B1 2100	A2 2100	B1/A2 2035	B1 2100	A2 2100
Melanesia						
Fiji*				- Very low	- Very low	- Very low
New Caledonia*				+ Very low	+ Very low	+ Very low
PNG	+ Very low	- Very low	- Very low	- Very low	- Very low	- Very low
Solomon Islands	+ Very low	- Very low	- Low	- Very low	- Very low	- Very low
Vanuatu	+ Very low	+ Very low	+ Very low	- Very low	- Very low	- Very low
Micronesia						
FSM	+ Low	+ Very low	- Low	- Moderate	- High	- Moderate
Kiribati	+ Very high	+ Very high	+ Very high	- Moderate	- Very high	- Very high
Marshall Islands	+ Low	+ Low	+ Low	- High	- Very high	- Very high
Nauru**	+ Moderate	+ Moderate	- Very low			
Palau	+ Very low	+ Very low	- Very low	- High	- Very high	- Very high
Polynesia						
American Samoa*				- Low	- Low	- Very low
Cook Islands	+ Very low	+ Very low	+ Very low	- Low	- Moderate	- Very low
French Polynesia				- Very low	- Very low	- Very low
Niue*				- Very high	- High	- Moderate
Samoa	+ Very low	+ Very low	+ Very low	- Very low	- Very low	- Very low
Tokelau**	+ High	+ High	+ Very high			
Tonga	+ Very low	+ Very low	+ Very low	- Very low	- Very low	- Very low
Tuvalu	+ Moderate	+ Moderate	+ Moderate	- Low	- Low	- Very low

---

Reaching demand in the face of CC - Zooming in on global models in Asia

China

- Population expected to fall to 1.29 Billion by 2050
- Climate change is expected to decrease marine capture fisheries production (and fish meal) in China by approximately 3%
- For fish consumption to increase from between 26.5 to 44 kg/person:
  - Chinese aquaculture will need to produce an additional 27 to 50 Mt of fish
  - China's current overall 0.37 FIFO will need to be reduced by over 70% to 0.1 to meet a 30 kg/cap/yr objective using 80% of its national fishmeal production
  - However, China is the world's largest market, with total fishmeal imports of 1 Mt in 2005. If these imports were maintained, a 44 kg per capita production objective could be met if FIFO rates decrease to just ca. 0.15.

Bangladesh

- Population expected to grow to 194.3 M by 2050
- Direct impacts of climate change not significant but marine fish production (currently 20% of national fish supply by volume) may be reduced by 5%, leaving aquaculture to produce between 0.3 and 3.8 Mt of fish to achieve national fish consumption targets of 13–31 kg fish/cap
- If consumption were increased to 21 kg/cap/yr, the FIFO ratio would need to be reduced to0.025 (Fig. 3D), almost 90% lower than current rates

Source: Merino et al 2012

Potential Impacts of Climate Change on Fisheries in the Arctic

Major fisheries (cod, haddock, saithe, redfish, Greenland halibut, and capelin stocks in Barents Sea and Norwegian Sea) may change its abundance and distribution (e.g. Arctic cod larval survival may increase).

Some sub-Arctic species are expanding northwards into the Arctic (known northward-movement: snow crab in the Bering and Chukchi seas, several crab and mollusk species in the Chukchi Sea, blue mussel in Svalbard, sand eel in the North Sea, etc).

Some Arctic-adapted species are losing habitat along the southern edges of their ranges (Pacific walrus in Bering Sea).

Warming ocean temperatures, migrating fish stocks and shifting sea ice conditions from a changing climate may potentially favor the development of new commercial fisheries.

Fisheries governance and management

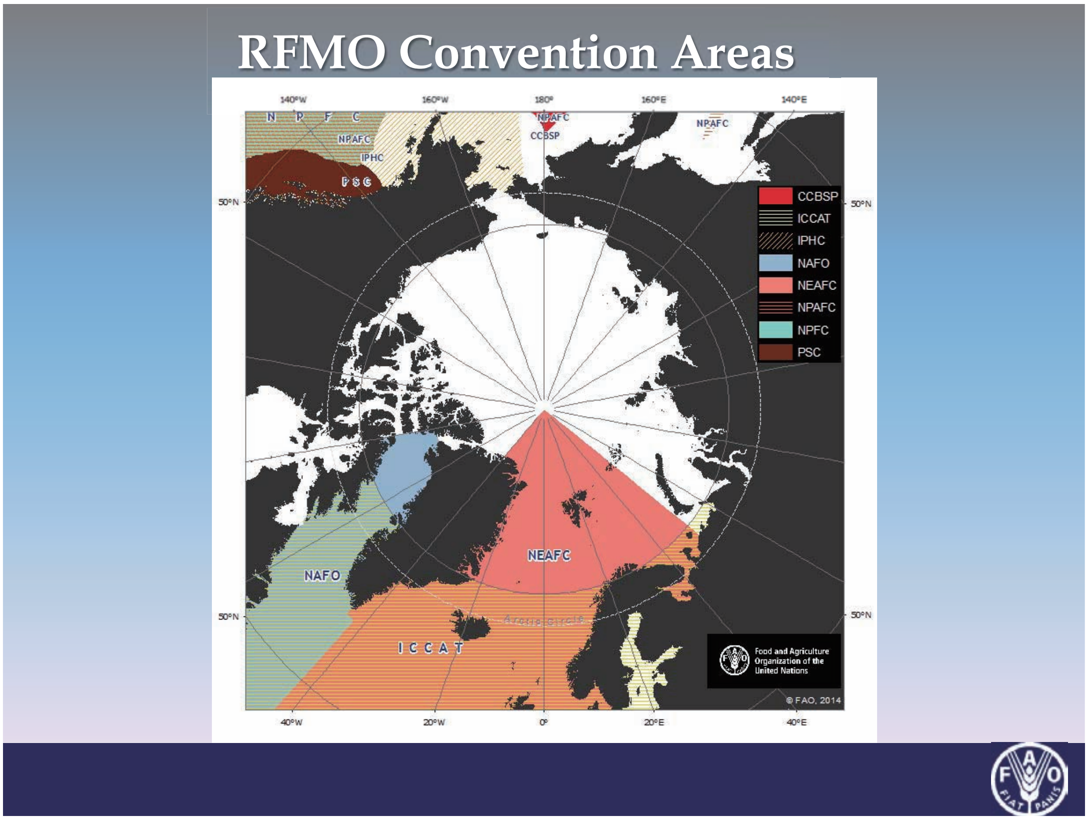
The global policy and legislative framework for the conservation and management of living marine resources is laid down principally in UNCLOS, the UN Fish Stocks Agreement, and the FAO Code of Conduct for Responsible Fisheries and related instruments. UNGA, FAO-COFI.

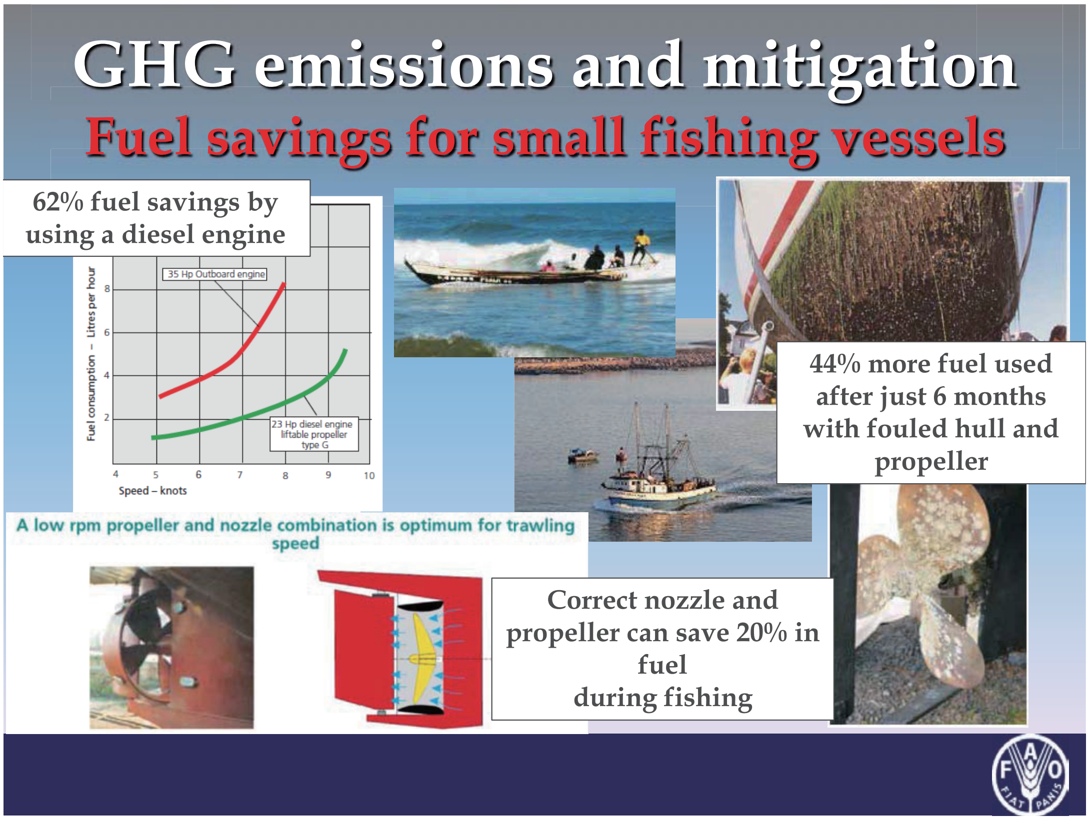
States have sovereign responsibility with in EEZs.

RFMOs play a key role in fostering cooperation among States to ensure the long-term sustainability of fisheries, through the adoption and implementation of regionally-agreed management and conservation measures, based on the best scientific evidence.

Two long-established RFMOs in the northern hemisphere are NEAFC and NAFO, which enjoy a strong cooperative relationship, including in the joint management of the pelagic redfish – *Sebastes mentella.*

NEAFC also has a special agreement with ICES, an intergovernmental scientific organization, which provides scientific information and advice, on the basis of which NEAFC adopts fisheries management measures.


RFMO Convention Areas
140°W
160°W
180°
160°E
140°E
50°N
40°W
20°W
0°
20°E
40°E
N P F C
NPAFC
IPHC
PSC
CCBSP
NAFO
NEAFC
ICCAT
Arctic circle
CCBSP
ICCAT
IPHC
NAFO
NEAFC
NPAFC
NPFC
PSC
Food and Agriculture Organization of the United Nations
© FAO, 2014


GHG emissions and mitigation
Fuel savings for small fishing vessels
62% fuel savings by using a diesel engine
35 Hp Outboard engine
23 Hp diesel engine liftable propeller type G
Fuel consumption – Litres per hour
Speed – knots
44% more fuel used after just 6 months with fouled hull and propeller
A low rpm propeller and nozzle combination is optimum for trawling speed
Correct nozzle and propeller can save 20% in fuel during fishing

GHG emissions and mitigation

Ecological footprint of aquaculture

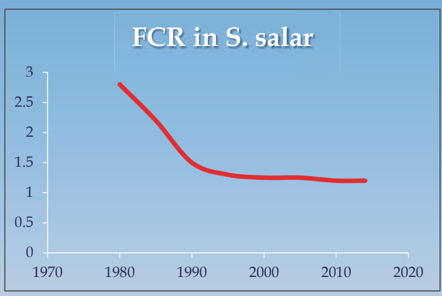
Table 4 | Social, Economic, and Environmental Performance of Aquaculture (~2010) (continued)

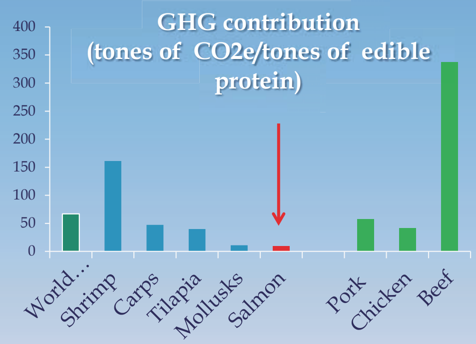
SPECIES GROUP	ECOSYSTEMS			WATER			CLIMATE
	HABITAT[a]	LAND USE (ha / t EDIBLE PROTEIN)[b]	USE OF WILD FISH IN FEED (FISH-IN / FISH-OUT RATIO)	FRESHWATER CONSUMPTION (m^3 / kg EDIBLE PROTEIN)	WATER POLLUTION (kg P / t EDIBLE PROTEIN)	WATER POLLUTION (kg N / t EDIBLE PROTEIN)	GREENHOUSE GAS INTENSITY (t CO2e / t EDIBLE PROTEIN)
Carps	F	12.0	0.2	61.4	97	329	47.2
Mollusks	M	0.0	0.0	0.0	-148	-136	11.1
Shrimps	B, F, M	16.4	0.8	4.4	104	422	161.7
Tilapias	F, B	7.5	0.7	15.9	82	349	40.7
Catfish	F	9.5	0.4	52.2	97	234	134.8
Salmonids	M, F	2.4	1.9	0.0	48	182	9.8
All six species groups							
World aquaculture	**F, M, B**	**9.1**	**0.3**	**40.4**	**76**	**273**	**66.8**
TERRESTRIAL LIVESTOCK							
Pork	T	2.0	N/A[c]	56.5	120	800	57.6
Chicken	T	3.0	N/A[c]	34.3	40	300	42.3
Beef	T	50.0–145.0	N/A[c]	112.5	180	1200	337.2

GHG emissions and mitigation

Reducing feed in aquaculture

Technological improvements in salmon farming have reduced environmental impacts including through reduction of the Feed Conversion Rate (FCR) and reduced fish meal and fish-oil use in feeds. This has led to a low GHG contribution





Technology and know how can be transferred to other aquaculture systems in less developed areas and regions. This could have multiple benefits including reduction in GHG emissions

Technology transfer from salmon farming to other aquaculture systems to improve FCRs

What to do?

- Better feeding technologies
- Better feeds and searching for new marine originated ingredients
- Feed management
- Genetic improvements
- Better access to quality feeds
- Better management of aquaculture management areas

How?

- Export training, bring farmers from less developed areas to learn
- Establish cooperation programmes with other farming sectors (e.g. tilapia, catfish, grouper)
- Share technological advances through public-private cooperation

---

Adapting to Climate Change
Examples from the Field

- **Food security in Palau**: New varieties of salt-tolerant taro and traditional management techniques are being tested, monitoring programs in aquaculture are being developed and improved clam and crab farming techniques will be implemented.

Aquaculture in Palau
SOURCE: PACC Palau

- **Innovative insurance scheme in Peru**: Farmers in the coastal region are able to purchase an insurance that uses index-based instruments based on the occurrence of previously established climate data parameters proven to predict damaging events rather than measurement of actual damage (e.g. rise is sea surface temperatures near Peru, which are correlated with El Nino onset).

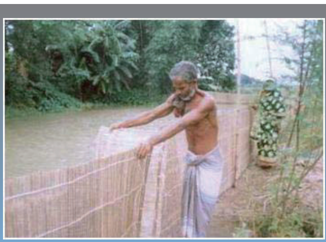
▪ Ecosystem based climate change adaptation in Seychelles:

To address coastal flooding from an ecosystem approach, coastal erosion is being addressed via mangrove management and restoration, sand dune rehabilitation using native species, wetland restoration and alien species removal and agricultural land reclamation, and construction and rehabilitation of fringing coral reefs. These habitats will provide important coastal habitats, reduce erosion and maintain other ecosystem services important to the Seychelles.

Smoking kilns at Lake Malawi. *SOURCE: Jamu 2011*.

▪ Reducing post-harvest losses in Lake Malawi:

Improved smoking kilns to dry fish have been introduced to address post-harvest loss. As climate change reduces the quantity and quality of fish harvested from the lake, reducing post-harvest loss increases in importance. In addition to reducing these losses, the smoking kilns also reduce deforestation and improve water quality, improving habitat quality for aquatic species and removing an additional stressor for fish.



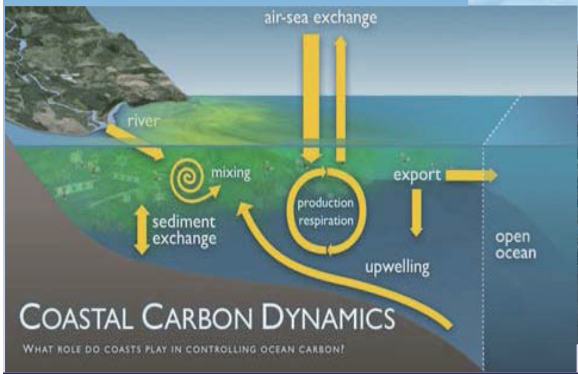
Fencing a pond for flood management in Bangladesh. Source: ITDG-B

▪ Creating opportunities for flood-friendly fisheries in coastal Bangladesh that are flooded up to 4-5 months of the year.

Small scale homestead pens. Bamboo pens with trap doors were built next to homes. These were stocked with some fish, and then when seasonal floods came the fish were not washed away, and new fish were introduced via floodwater. Households ate the larger fish, and smaller fish washed restocked the pens.

Trap pond management. On seasonally flooded land, bushes and branches are used to build traps for flood periods and traditional bamboo traps are modified to reduce catch per unit effort. The traps also provide habitat for young native species. As this cultivated land is unavailable for several months of the year this increased catch provides additional food and income sources.

- **Early warning system for US Pacific shellfish hatcheries:** In 2012, scientists in Oregon found evidence that higher levels of carbon dioxide in the Pacific Ocean were responsible for the failure of oyster larvae to survive in 2005. Investments in monitoring of coastal seawater have helped to provide shellfish hatchery managers with real-time data on the seawater coming into their hatcheries. The data provide an early warning system, signalling the approach of cold, acidified seawater one to two days before it arrives in the sensitive coastal waters where shellfish larvae are cultivated. The data help hatchery managers schedule production when water quality is good, anticipate the need to buffer or adjust the chemistry of the water coming into their hatcheries, and avoid wasting valuable energy and other resources it water quality is poor.



5-2. Adaptations to Ecosystem Affects and Marine Environmental Shifts

-Marine Environmental shifts caused by the Global Climate Change and Adaptations to Ecosystem change in Japanese Fisheries-

Masanori Miyahara
President, Fisheries Research Agency, Japan

The dominant fish species alternation among the economically important species in fisheries such as sardine, anchovy, mackerel, Pollock etc occurred from ancient periods along with the climate regime shifts. The global warming trend in the ocean clearly observed in the recent decades was added to the decadal climate regime shifts as a major affecting factor. Long term monitoring research conducted by Fisheries Research Agency, Japan has detected the effects of the climate change on the status of phenology of fishery grounds. The research identified changes of the survival rate, growth rate, and distribution area of Japanese sardine (*Sardinops melanostictus*) and anchovy *(Engraulis japonicas)* in relation to the variability of water temperature and their food conditions of their habitat. Rearing experiments also showed the warming effects on the hatching success of Pacific herring (*Clupea pallasii*). These results suggest that there is a suitable temperature range for each fish species and even with the excess of a few degrees Celsius of the range has large impact on the fish. In particular, the water temperature change will affect on the recruitment of the stock in case where the change is occurred near the spawning ground during early life stages with poor swimming ability. Adversely, it will affect on the distribution / migration pattern in case where occurred during fish stages with swimming ability. Thus the climate change in multiple life stages is clearly emerging as impact on fisheries and related industry. The change of the flora of seaweed beds according to the recent warming trend is also clearly observed. The change has caused to decrease coastal important species in fisheries such as abalone and spiny lobster. Transplantation of seaweed in the seaweed bed in summer is a potential countermeasure of adaptation against the altered flora by supporting settlements of larval lobster. Using the models of physical oceanography and ecosystem structure with the monitoring data, it became possible to predict the distribution pattern of the important species in fisheries, e.g. Japanese sardine or Pacific saury (*Cololabis saira*) while significant uncertainties are associated. According to the prediction on Pacific saury, warming condition will cause the delay of southward migration, consequently it raise the fishing season shift. The prediction is useful for preparation to meet the infrastructure of fish markets, fish processing industries, etc. However, the important point here is the uncertainties associated with available data and knowledge on the impacts on fishery resources by the global warming and ocean acidification, as for which the research has yet to be developed. Monitoring activities as well as researches on impacts on marine life should be strengthened as a matter of priority in an internationally well-coordinated and cooperative manner. Otherwise, it would be extremely difficult to formulate appropriate and effective future actions to adapt to or take remedial measures against the global warming and ocean acidification.

Marine Environmental shifts caused by the Global Climate Change and Adaptations to Ecosystem change in Japanese Fisheries

Masanori Miyahara
(Fisheries Research Agency)

Questions

- **Does the climate change really affect the ocean ecosystems?**
- **Does global warming trend affect the fisheries?**
- **Can we adapt fisheries to climate change to sustain the status of fishery resources?**

Does the climate change really affect the ocean ecosystems?

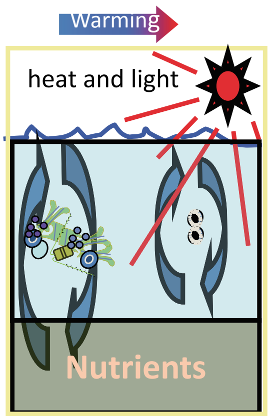
➡ **YES !**

Change of the temperature of environment affects

(1) Physiology of each marine organism
i.e. Metabolic rate, growth rate, feeding rate, hatching success, mortality,

and

(2) Nutrient supply to the euphotic layers, and thereby the structure of marine ecosystem.



⬅ Strong thermocline prevents the vertical nutrient mixing under high surface temperature condition

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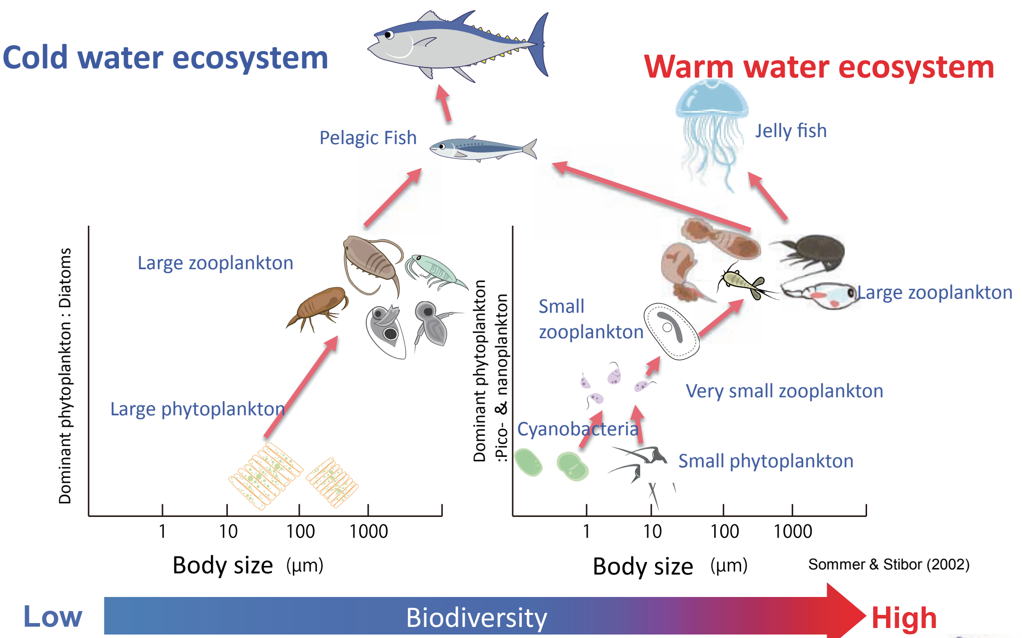
Does the climate change really affect the ocean ecosystems?



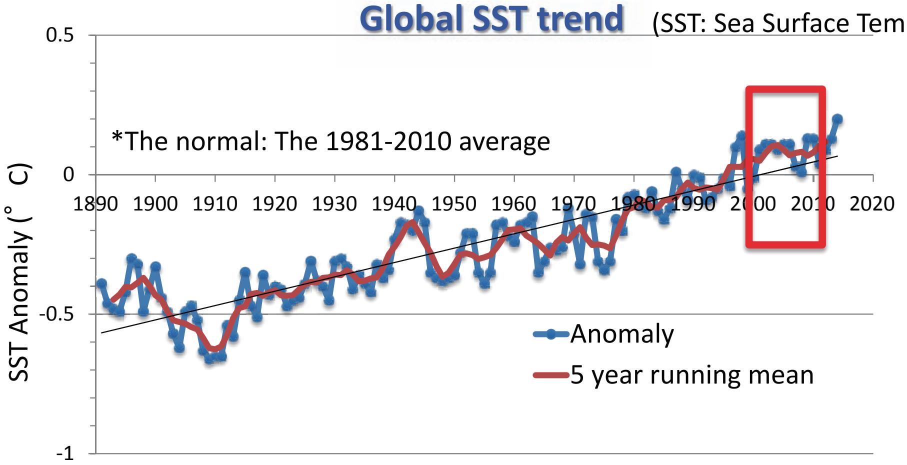
Water temperature clearly affects ecosystem structure!

Has the climate changed globally?

➡ **YES !**

- **1900～2010 : SST has risen at speed of 0.051℃/10 years**
- **2001～2010 : Climate hiatus (Delay in global warming)**

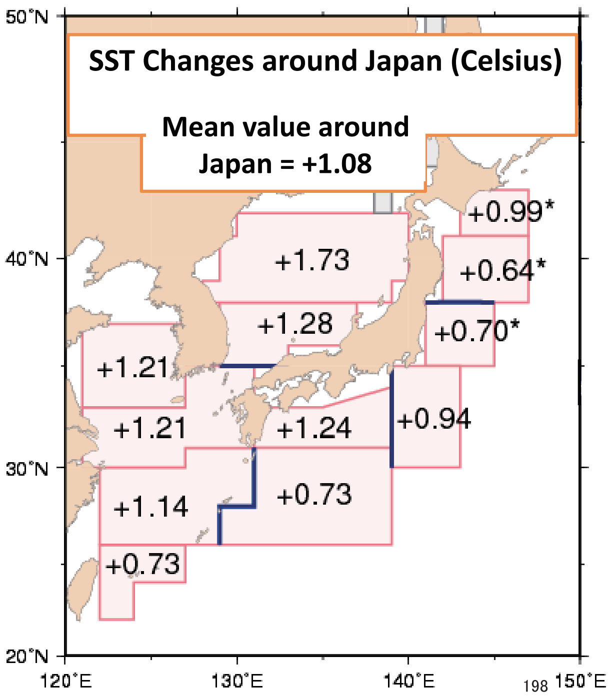
Global SST trend (SST: Sea Surface Temperature)



(Japan Meteorological Agency)
http://www.data.jma.go.jp/gmd/kaiyou/data/shindan/a_1/glb_warm/glb_warm.html

FRA Fisheries Research Agency

The effect of the climate change in the sea areas around Japan

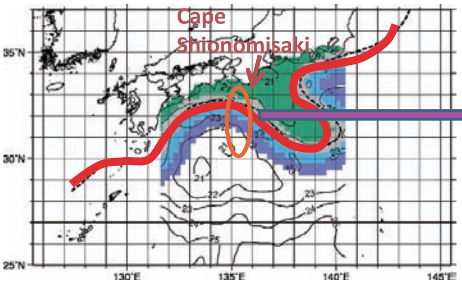


SST Changes around Japan during the past 100 years

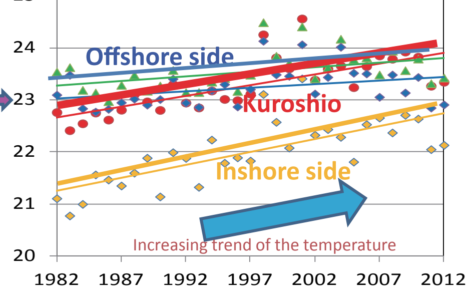
Global mean＝0.51° C/100years

FRA Fisheries Research Agency

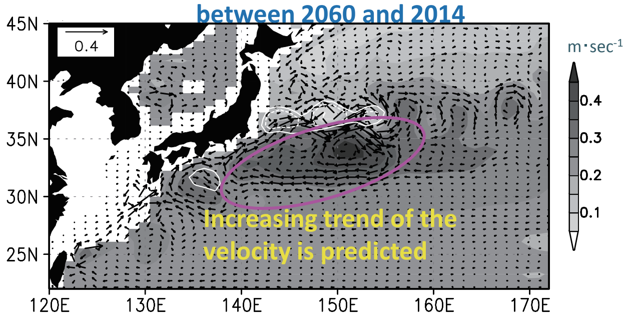
Increasing trend of the temperature and velocity of the Kuroshio warm current



Sea Surface Temperature observed from satellite image off Cape Shionomisaki



Predicted difference of the velocity between 2060 and 2014

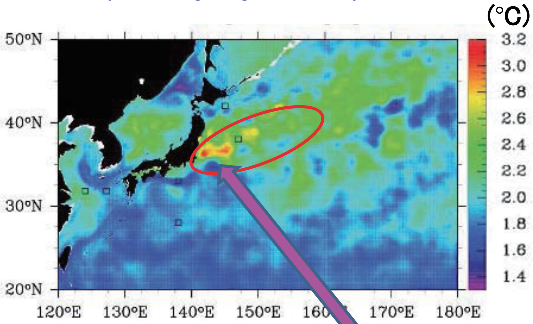


The velocity of the Kuroshio current has increased 0.016m/sec in 10years since 2002.

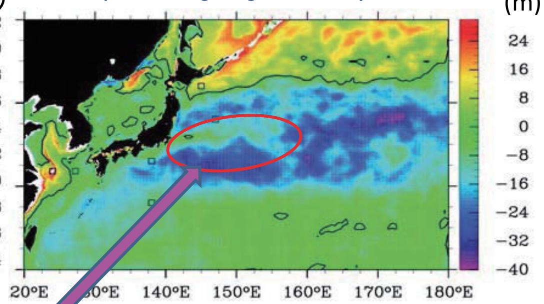
This velocity change makes 40km distance in 1 month.

Projection of SST and the MLD（Mixed layer depth) around Japan

Elevation of SST (°C) in the 21st century:
Temp. at the end of the century（2090-2100）minus
Temp. at the Beginning of the century（2000-2010）



Changes of MLD (m) in the 21st century :
Depth at the end of the century（2090-2100）minus
Depth at the Beginning of the century（2000-2010）



（CHOPE+MIROC 3.2, A1B scenario）

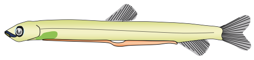
The effect of warming trend is estimated to be high in Kuroshio extension area

Kuroshio extension area is known to be important spawning and nursery grounds for pelagic fish species (e.g. Japanese sardine, Pacific saury etc.)

Response to temperature change is different at developmental stages

◎ **Larvae with poor swimming ability (Planktonic stage) :**

Climate change ➡ survival, stock size
（Temperature affects the spawning region in the spawning season）

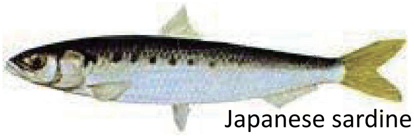


Larval sardine

Vs.

◎ **Fish with fully developed swimming ability :**

Climate change ➡ migration, distribution,
（Temperature affects the food availability in the feeding area : main fishing ground)

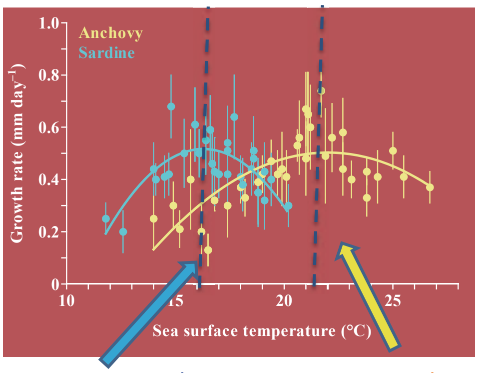


Japanese sardine (*Sardinops melanostictus*)

Change of water temperature has a large influence on larval fish ecology

Relationships between SST and growth rate of sardine and anchovy larvae

Takasuka et al., 2007

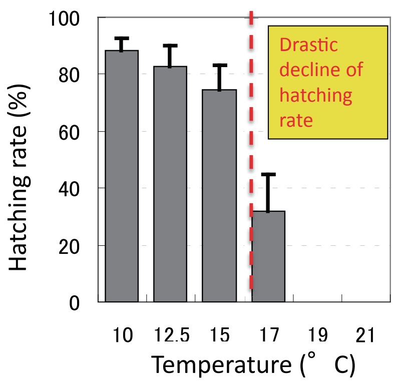


Japanese sardine　　Japanese anchovy

➡ **Warming condition is favorable for anchovy's growth rather than sardine's**

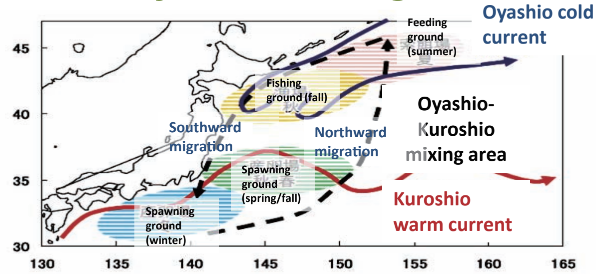
Effects of water temperature on hatching success of Pacific herring

〔Ministry of Agriculture, Forestry and Fishery, 2007〕

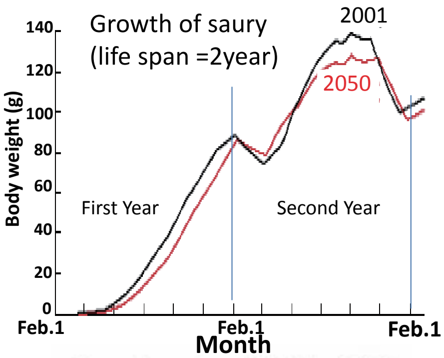


➡ **Warming condition is NOT favorable for herring's hatching**

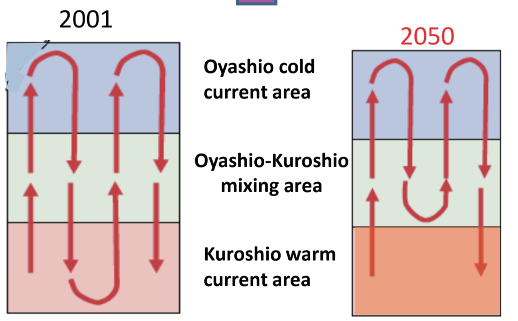
Prediction on the migration pattern of Pacific saury under the global warming condition



Warming condition will cause the delay of southward migration and season of fishing



Growth rate will fall in 2050

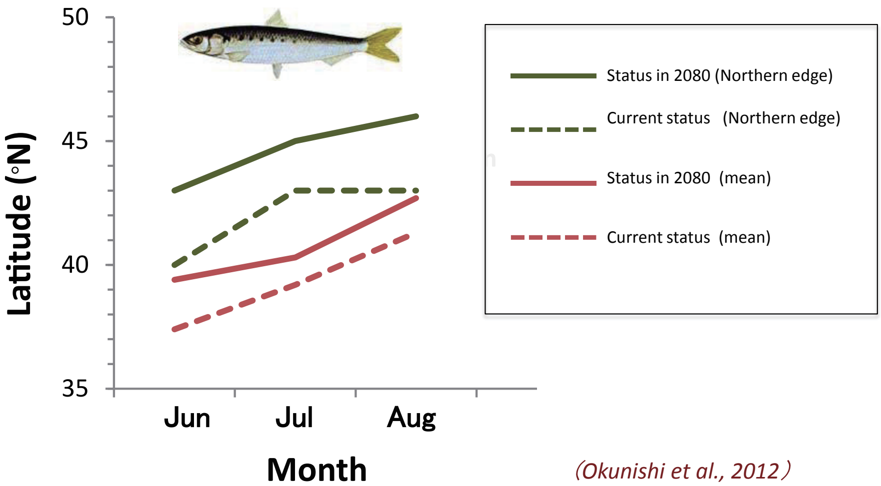


Migration pattern will change in 2050

(Ito et al., 2007 ; Ito, 2009)

FRA

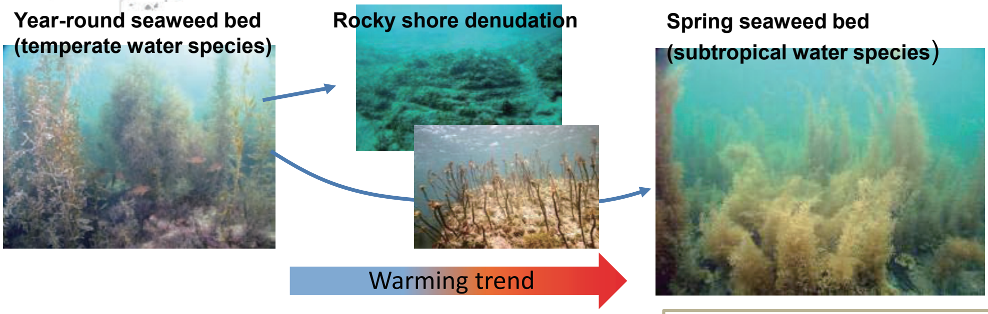
Prediction on the distribution of feeding area of Japanese sardine during summer in 2080 using ecosystem model

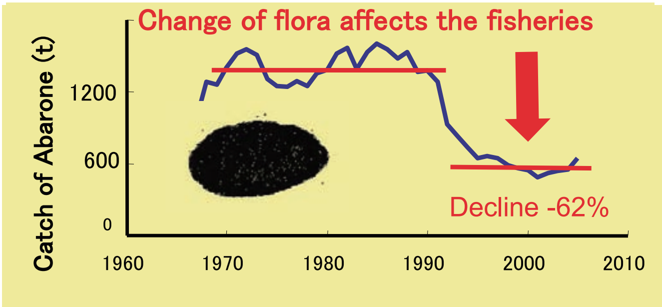


(Okunishi et al., 2012)

The distribution area of 1st year sardine will move to 120-220km northward, and their spawning area is also predicted to move northward.

Recent problems for coastal ecosystem and fisheries in Kyushu, southern Japan in relation to warming condition

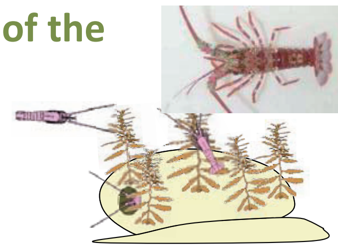




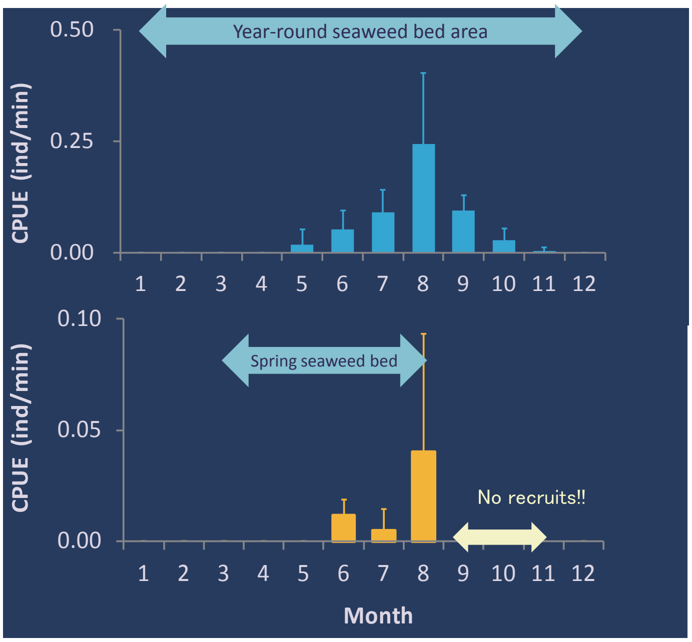
According to warming trend

- •Rocky shore denudation
- •Flora of seaweed change
- •Change of the status of coastal important species

Adaptation of fisheries to the change of the flora of seaweeds



Seaweed bed is very important for post-larval lobster as feeding ground and shelter

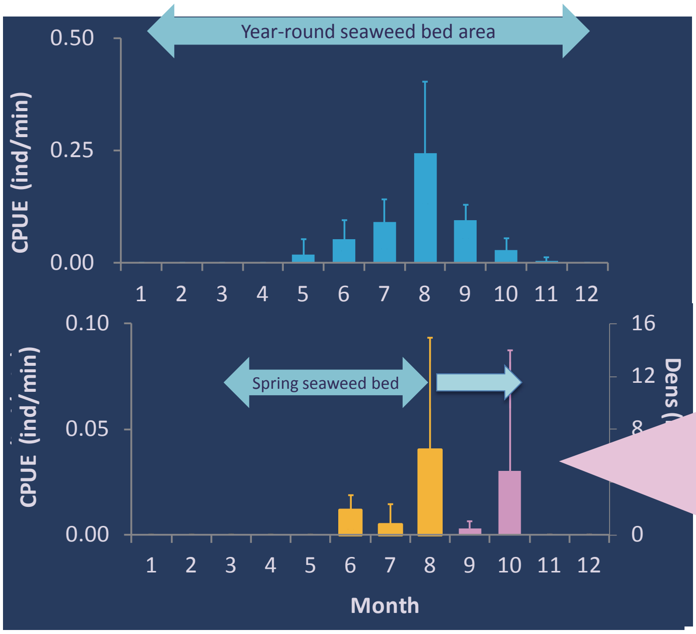


Post-larval lobster recruits in May to November

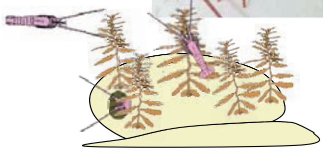
Post-larval lobster recruits in June to August

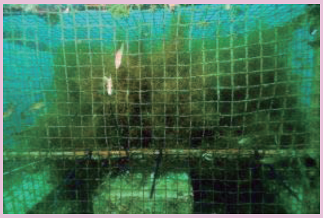
Density of post-larval stage of Japanese spiny lobster

Adaptation of fisheries to the change of the flora of seaweeds



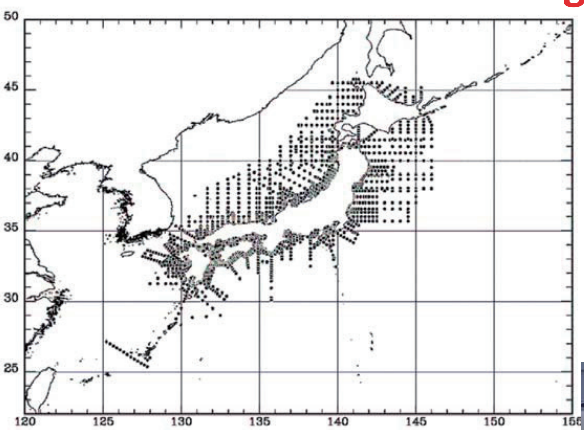
Density of post-larval stage of Japanese spiny lobster



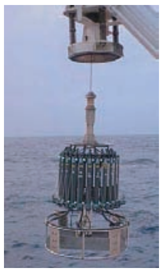


By transplantation of seaweed in the spring seaweed bed in summer restores the introduction of post-larval lobster after September.

In order to cope with the climate change in fisheries, intensive and extensive field research is necessary to comprehend the mechanisms of the climate change



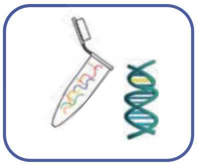
Map of the ocean monitoring stations conducted by Fisheries Research Agency and local fisheries institutes of prefectures since 1950's



Approach in the Future

Plant breeding technology using genomic methods

Research on
Nori seaweed (*Pyropia yezoensis*)



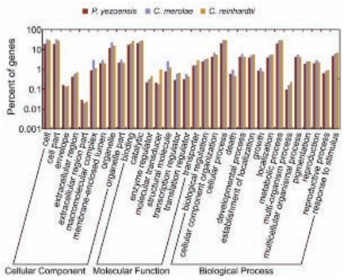
DNA extraction

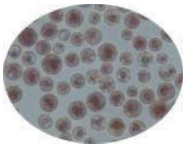
next-generation sequencing technology

Bio-informatics method

To collect genomic information

Genome wide linkage analysis





Select cultured cells of Nori seaweed

Nori seaweed

Using genomic technics, isogenic strain of high tolerance for warm condition are selected and cultured.

It is expected to produce the warm tolerant Nori !

FRA
Fisheries Research Agency

5-3. Blue Carbon
From Research To Policy And Its Implementation

Achmad Poernomo[1] & Widodo Pranowo[2]
[1] Director General and Senior Research Scientist; [2] Research Scientist
Agency For Marine & Fisheries Research & Development
Ministry of Marine Affairs & Fisheries, The Republic of Indonesia
email: achpoer@yahoo.com

Having the second longest coastal line in the world, Indonesia is rich of vegetation and other marine organisms in its coastal ecosystem. The ecosystem which mainly consists of mangroves, seagrasses and salt marshes has been claimed to be able to store atmospheric carbon five times the amount stored by tropical rainforests per square kilometer. These carbon are known as blue carbon and having almost 23% of the world's mangrove and the largest area of seagrass system (up tp 300,000 $km^{2)}$, Indonesia can potentially sequester $39x10^8$ ton carbon from these two ecosystems alone and thus plays a siginficant role in global climate change and initiatives to mitigate the effects.

Coastal ecosystem is facing anthropogenic stresses in many parts of the world including Indonesia. Inappropriate coastal management has added to the factors causing the losses. The annual rate degradation and destruction has been reported to be 0.7-2.1% for mangrove forests, 1-2% for saltwater marshes and 1.2-2% for seagrass meadows[1]. At such a rate, it is predicted that all mangrove forests will diminish within 100 years. This destruction of the ecosystem will damage its ability to sequester carbon, and even more will significantly contribute to climate change, especially through CO^2 emissions. This will in turn threaten the life of coastal communities.

These critical roles of coastal and marine ecosystems are often overlooked in global climate change discussions. Even in Indonesia, these ecosystems are not included in the effort to reduce Green House Gases, where Indonesia is targeted to reduce the emission by 41%, none of which is designed from coastal ecosystem. There are many reasons why the roles of coastal ecosystem are overlooked, these include:

1. Lack of scientific basis (knowledge gaps) due to complexity of coastal-marine ecosystems.
2. Status of the ecosystems as common property resources
3. Limited national-international attentions and available funding.

There are a lot of information needed in order to foster better understanding about blue carbon. The following five scopes of work should further be conducted[2] in a

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[1] AGEDI. 2014. **Building Blue Carbon Projects - An Introductory Guide**. AGEDI/EAD. Published by AGEDI. Produced by GRID-Arendal, A Centre Collaborating with UNEP, Norway.

[2] Howard, J., Hoyt, S., Isensee, K., Telszewski, M., Pidgeon, E. (eds.) (2014). Coastal Blue Carbon: Methods for Assessing Carbon Stocks and Emission Factors in Mangroves, Tidal Salt Marshes, and seagrasses. Conservation International, Intergovernmental Oceanographic Commission of UNESCO, International Union for Conservation f Nature, Arlington, Virginia. USA.

concerted effort: Geographical extent, Sequestration and storage, Emissions and removals, Human drivers and Coastal erosion.

Studies in blue carbon has been initiated since 2010, and getting wider attention in the country. From a series of meetings, workshops and field study (10 study cites in CTI area of Indonesia) , it became necessary that there are affirmative actions should be taken such as defining adequate measures and most appropriate process to address current and long-term impacts in coastal areas, including vulnerability of coastal ecosystems, degradation of water quality, changes in hydrological cycles, depletion of coastal resources and adaptation to sea level rise and other impacts of global climate change. Ministry of Marine Affairs and Fisheries, through its Research and Development Agency has also putting actions including the establishment of Blue Carbon Center to implement further policies.

The said international symposium or workshop which has been conducted since 2012 has attracted some interest from country partners or even funding agencies. Following these fora, collaborative research projects or activities has and will be developed. These include:

- **IUCN/UNEP** → Since 2011 (Supporting in International Blue Carbon Scientific & Policy Workshop)
- **USAID** → Supporting training on Cabon stock "*Carbon Stock Assessment and Emissions Inventory in Asian Mangroves: Field Training for Scientists and Agency Staff*", 29 April – 08 Mei 2013 in Trang, Thailand.
- **Tokyo Inst. Of Technology Japan** → Since 2011 in TROMEC Research project
- **First Inst. Of Oceanography China** → Since 2011 for Cruise, Lab Analysis, & Expert Exchange
- **Xiamen University China** → MoU in progress
- **The World Bank** → Preliminary stage (Drafting a joint concept note & held a workshop)
- **The Food & Agriculture Organization of UN** → Initiation stage (PIF submission)
- **The Japan International Cooperation Agency** → Initiation Stage (Proposal submission)
- **Remote Sensing Technology Center of Japan (RESTEC)** → In discussion

The participation of community in maintaining the health of coastal ecosystem is very critical. Together with government's facilitation, coupled with external funding from donors, a local community organisation in North Sumatera has taken steps to promote the sustainability of mangrove through carbon trade scheme. This organisation, called Yagasu, litterally means Yayasan Gajah Sumatera or Sumatran Elephant Fondation, has initiated a program which was named Coastal Carbon Corridor. It is a community based mangrove restoration & protection for climate change mitigation, natural disaster risk reductions and green-livelihoods. It was claimed that this activity has increased the income of the community and at the same time mangrove health was maintained which also contributed to fishery production by more than 27%.

Way Forward

There is still a lot of efforts to be taken to promote the important role of blue (coastal) carbon in Indonesia before a sound management practice can be implemented. In the near future, some activities are planned, ie:

- To continue research & monitoring of coastal carbon ecosystem (mangrove, seagrass, coral reef)
- To restore coastal ecosystem from its coastal degradation
- To advancing (marine) biotechnology (product) to supporting seafood security
- To Build & strenghten capacity of (local) government on integrated marine & coastal resources management
- To advance sustainable coastal fisheries activities
- Restocking coastal fisheries resources

For doing the above, a collaborative action with international community might became necessary, especially in sharing the experience and expertise.

Agency for Marine & Fisheries Research & Development
Ministry of Marine Affairs & Fisheries of the Republic of Indonesia
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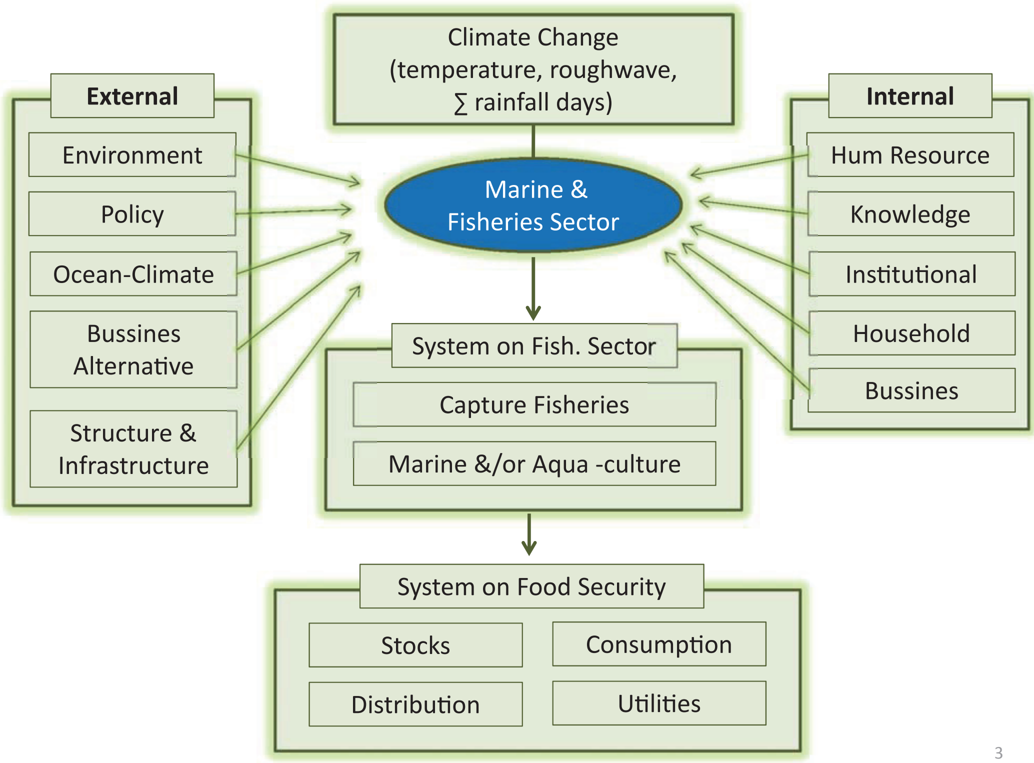
Coastal (Blue) Carbon In Indonesia: From Research To Policy And Its Implementation

Achmad Poernomo[1] & Widodo Pranowo[2]
[1] Director General and Senior Research Scientist; [2] Research Scientist

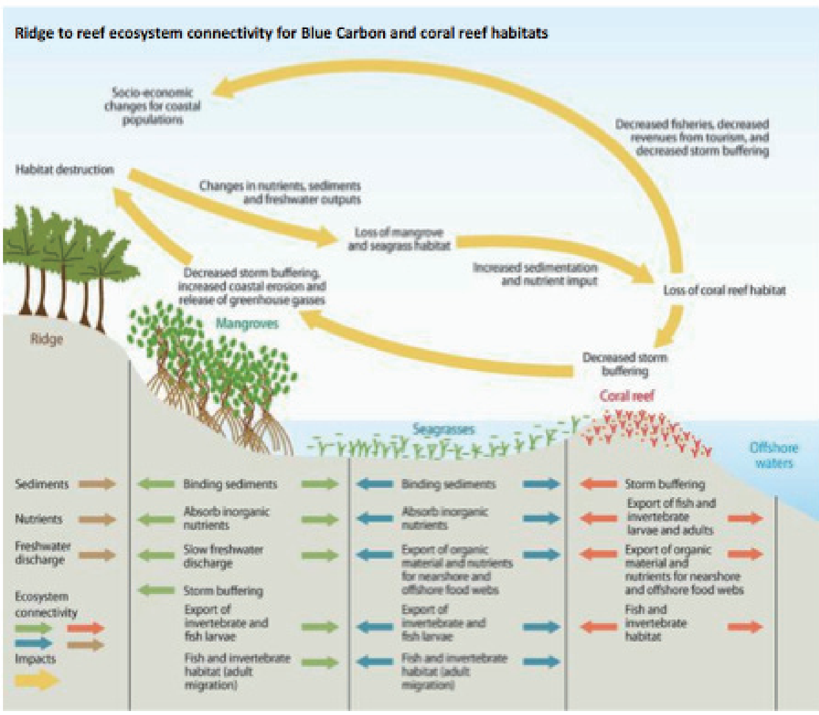
TERRITORIAL OF INDONESIA

Sea territorial : 6.3 Million Km^2
ZEE Indonesia : 2.9 Million Km^2
Land territorial : 1.9 Million Km^2
Continental Shelf : 2.7 Million Km^2

Coastline : 95,093 km
Number of Islands : 13,466 islands
Coastal Cities : 297 Regencies/Cities of 440 Regencies/Cities



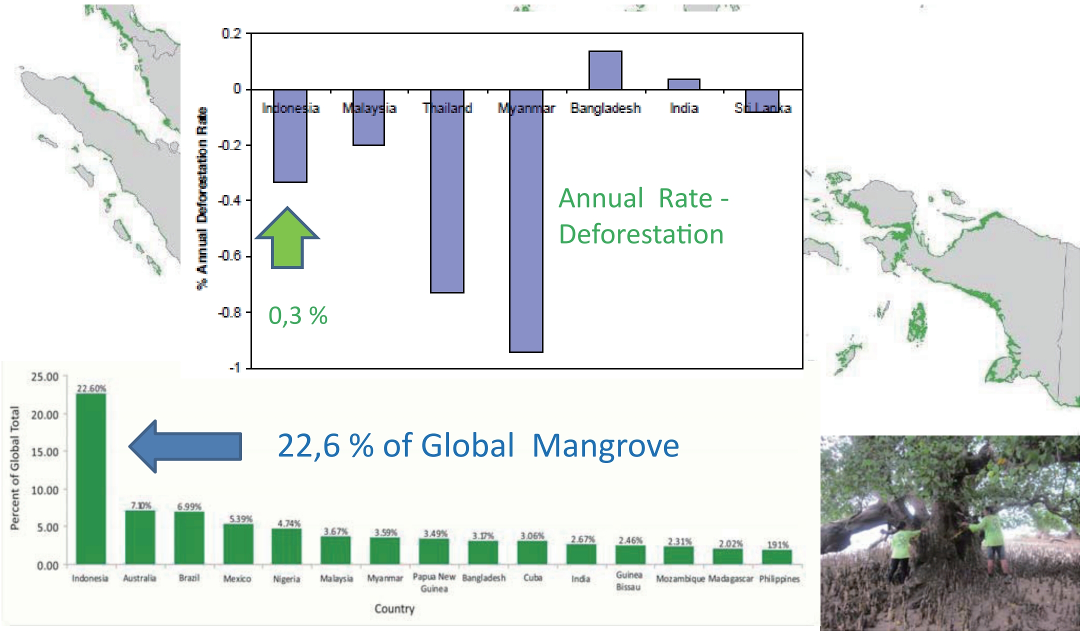
3

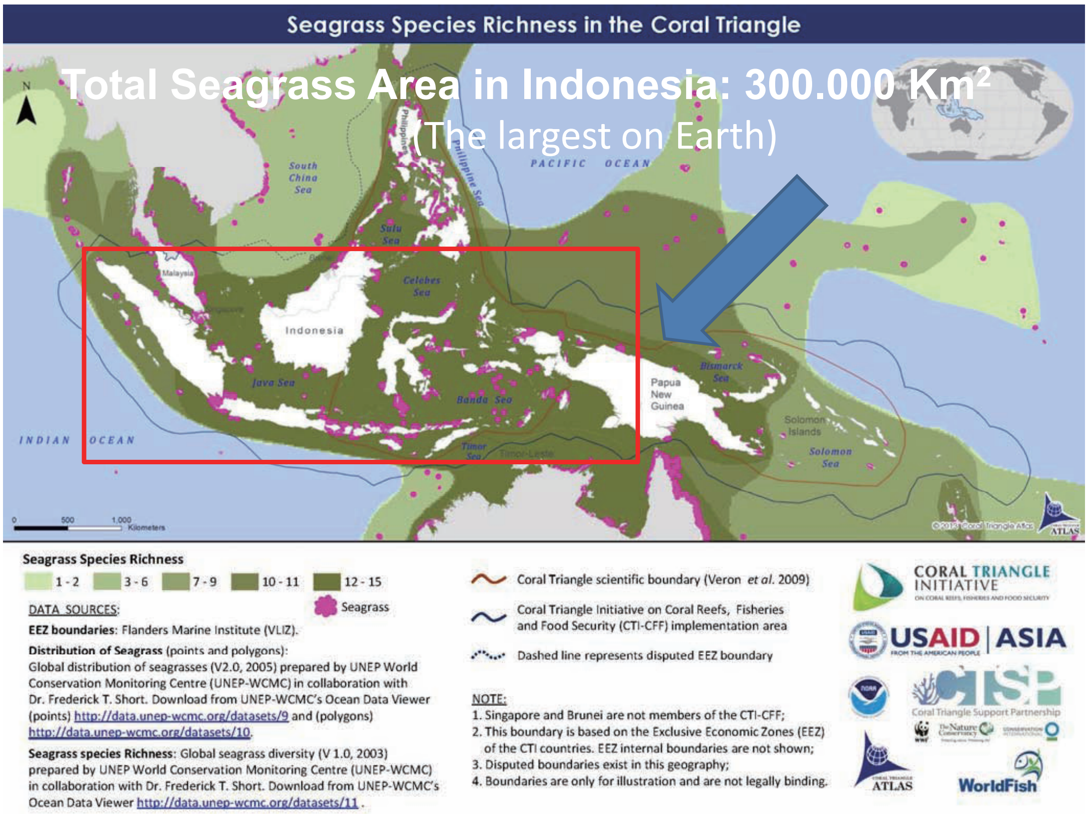


❖ AGEDI. 2014. **Building Blue Carbon Projects - An Introductory Guide**. AGEDI/EAD. Published by AGEDI. Produced by GRID-Arendal, A Centre Collaborating with UNEP, Norway.

Mangrove Distribution in Indonesia

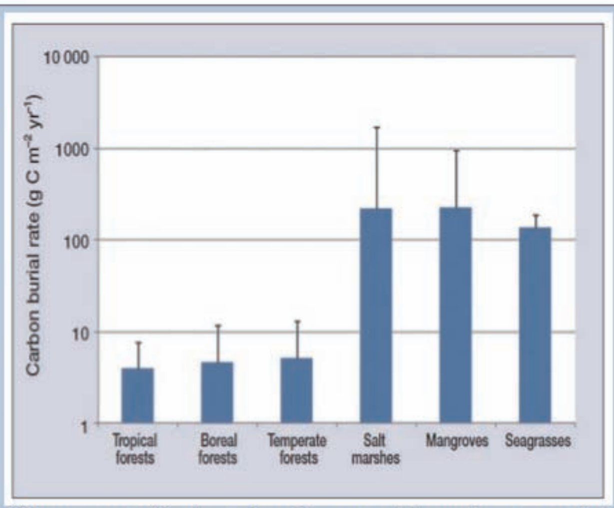
Total Area: 3.11 million Ha (The largest on Earth)
(Giri *et al*, 2011)





Box 1
Blue Carbon

"Blue carbon" refers to carbon that is sequestered in coastal vegetation systems (e.g. mangrove forests, seagrass beds, salt marshes). These systems are better at removing and keeping carbon from the atmosphere than their terrestrial counterparts (e.g. rainforests) due to their high productivity and how well they trap sediments (and therefore carbon). These areas may even increase their potential as carbon sinks over time, unlike many terrestrial soils. The exact amount of carbon and how long it remains in these systems is uncertain, although this is currently being researched. Unfortunately these areas are being lost at a critical rate all over the globe due to rapid coastal development and mismanagement of coastal areas. (*from McLeod et al. 2011*)

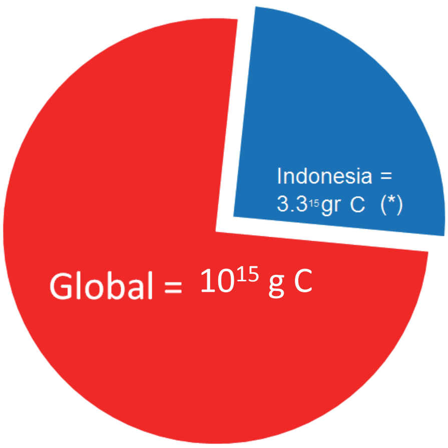


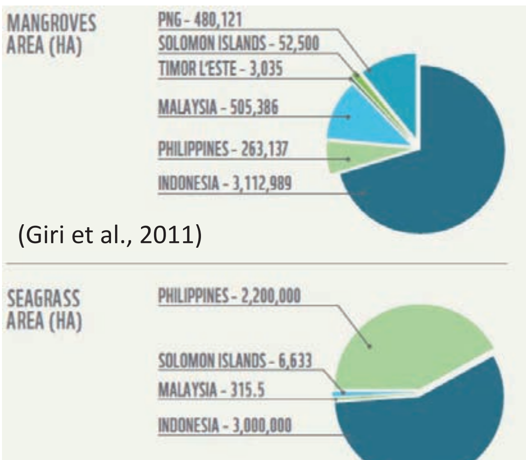
The amount of estimated carbon stored in major terrestrial forest systems and areas of "blue carbon" storage. Although there is uncertainty in the total amounts, "blue carbon" in salt marshes, mangroves and seagrass has much great storage potential than forests. Source: McLeod et al. 2011

Mcleod, E., Chmura, G.L., Bouillon, S., Salm, R., Björk, M., Duarte, C.M., Lovelock, C., Schlesinger, W. & Silliman, B. 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. *Frontiers in Ecology and the Environment*, 9: 552–560.

(Eco)-Marine Services

Carbon Storage





From : Alongi, et al (2014 *in Prep*)

(Kiswara, 1994)

10^{15}gr = 1 PetaGram = 1 GigaTon = 1 billion Ton

Global Blue Carbon ecosystem services are quickly disappearing*

Annual rate degradation and destruction:

- 0.7-2.1% mangrove forests
- 1-2% saltwater marshes
- 1.2-2% seagrass meadows

100 years

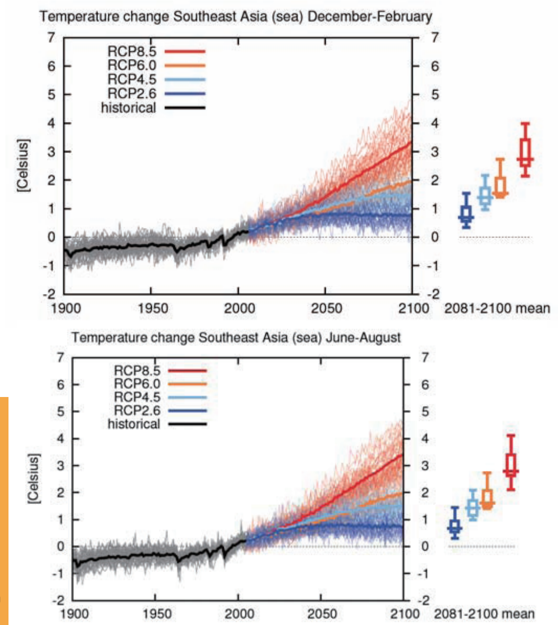
Gone:

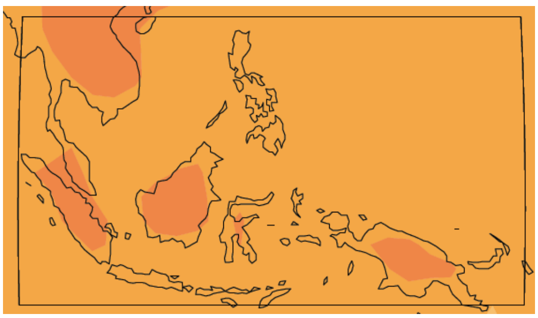
- 100% mangrove forests
- 30-40% saltwater marshes and seagrass meadows

❖ AGEDI. 2014. **Building Blue Carbon Projects - An Introductory Guide**. AGEDI/EAD. Published by AGEDI. Produced by GRID-Arendal, A Centre Collaborating with UNEP, Norway.

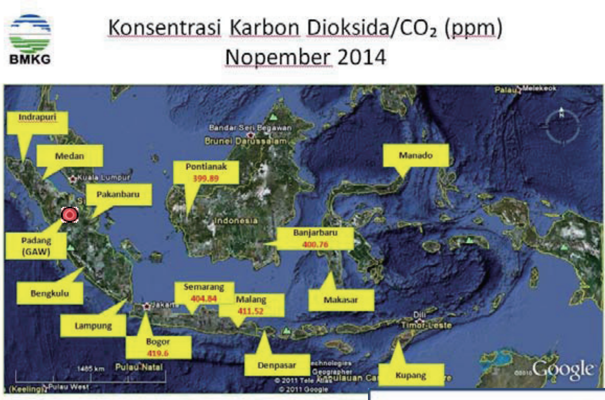
Regional Sea Surface Temperature Warming

- Global warming phenomenon impact Asia region including Indonesia
- Sea surface temperature predicted 1 – 3 °C warmer for year of 2081-2100.





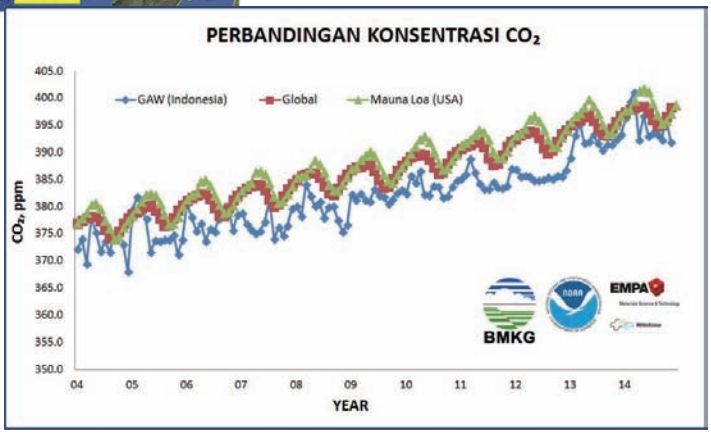
(IPCC, 2014)



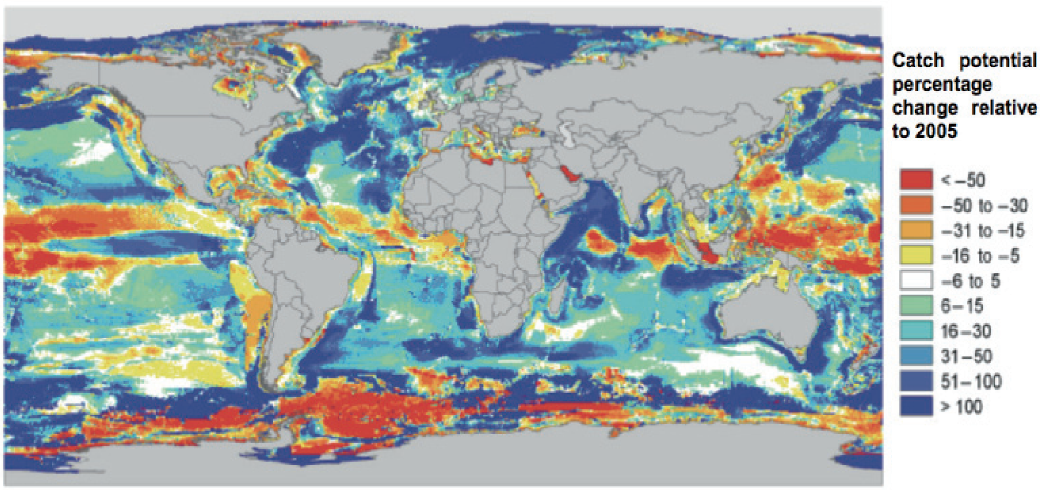
Ambient CO_2 Measurement

Global Atmospheric Watch (GAW) Stations

CO_2 Concentration in Atmosphere of GAW BMKG Station in Padang Indonesia is <u>LOWER THAN</u> in GAW Mauna Loa Station in Hawaii (USA) & the Global Concentration.



Changes in catch potential in 2055 with a doubling of greenhouse gases in the atmosphere by 2100



Notes: Model predictions of catch potentials indicate that tropical countries are likely to experience large decreases in catch potential within their exclusive economic zones in 45 years, while some countries (e.g. Norway and Iceland) will see an increase. This is due to fish moving away from warmer waters and ice melt opening up new areas. Temperate countries do not see as extreme a decline in catch potential as, although species are moving away, new species are moving into those areas.

Cheung, W.W.L., Lam, V.W.Y., Sarmiento, J.L., Kearney, K., Watson, R., Zeller, D. & Pauly, D. 2010. Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. *Global Change Biology*, 16: 24–35.

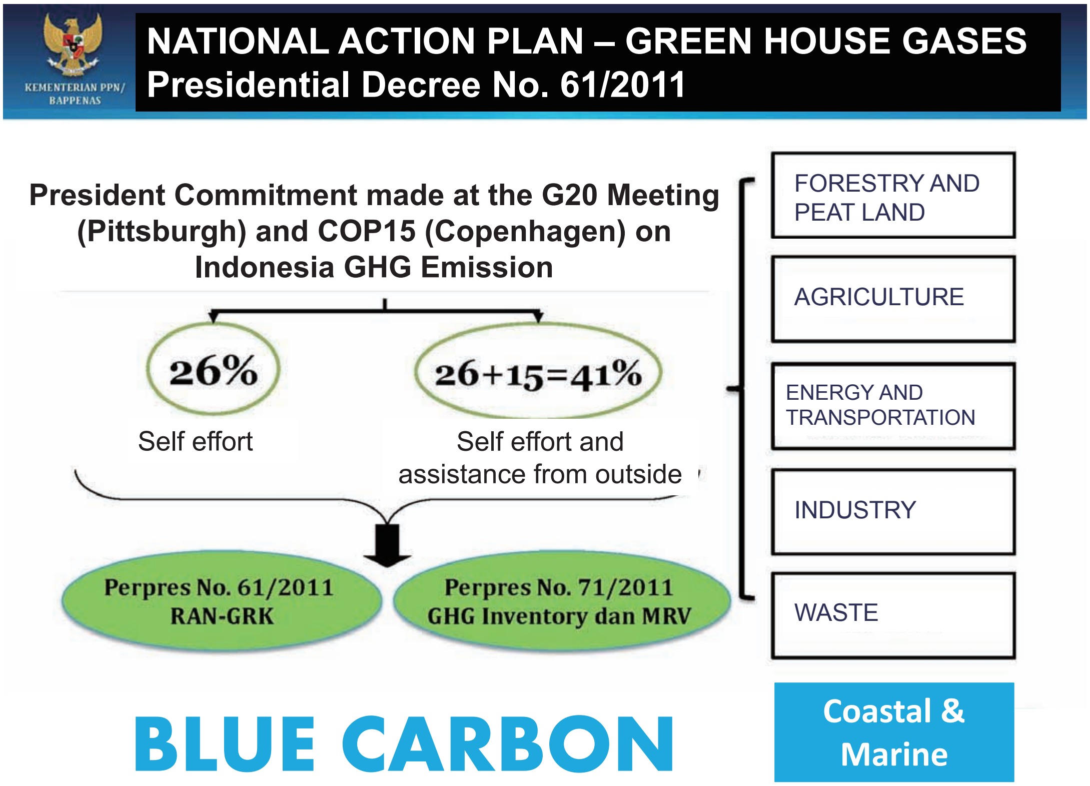
IMPACTS of CC on FOOD SECURITY*

- *availability* of aquatic foods will vary through changes in habitats, stocks and species distribution;
- *stability* of supply will be impacted by changes in seasonality, increased variance in ecosystem productivity and increased supply variability and risks;
- *access* to aquatic foods will be affected by changes in livelihoods and catching or farming opportunities; and
- *utilization* of aquatic products will also be impacted and, for example, some societies and communities will need to adjust to species not traditionally consumed.

* Cochrane, K.; De Young, C.; Soto, D.; Bahri, T. (eds). Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper. No. 530. Rome, FAO. 2009. 212p.

13


The Reasons :
1. Lack of scientific basis due to complexity of coastal-marine ecosystems.
2. Status oft he ecosystems as common property resources
3. Limited national-international attentions and available funding.


KEMENTERIAN PPN/ BAPPENAS
NATIONAL ACTION PLAN – GREEN HOUSE GASES
Presidential Decree No. 61/2011
President Commitment made at the G20 Meeting (Pittsburgh) and COP15 (Copenhagen) on Indonesia GHG Emission
26%
Self effort
26+15=41%
Self effort and assistance from outside
Perpres No. 61/2011
RAN-GRK
Perpres No. 71/2011
GHG Inventory dan MRV
FORESTRY AND PEAT LAND
AGRICULTURE
ENERGY AND TRANSPORTATION
INDUSTRY
WASTE
BLUE CARBON
Coastal & Marine

Selasa, 23/09/2014 22:07 WIB

Report from New York

SBY Study of Blue Carbon Ecosystem To Prevent 2 °C Temperature Rise

Arifin Asydhad - detikNews

Rep. Indonesia President in the UN-Climate Summit 2014, New York-USA.

To Explore **Blue Carbon Ecosystem** for Climate Change Mitigation

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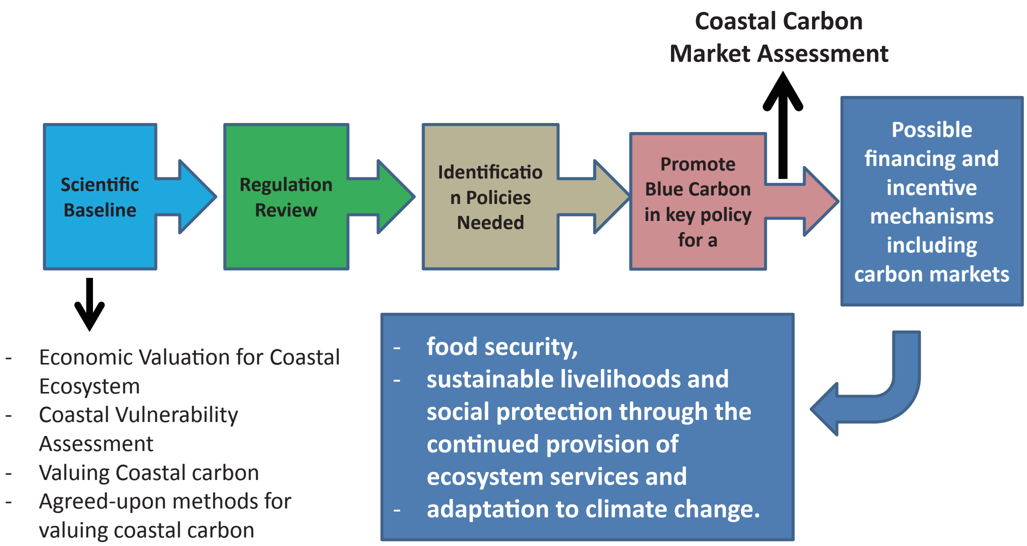
Framework for Coastal Carbon



(Eco)-Marine Services

Livelihood Management Carbon Base

No.	Ecosystem	Area (Ha)	Potential Carbon Absorption (Ton C / Ha)	Total Pot. Carbon Absorption (Ton C / Ha)
1.	Seagrass **)	$30{,}00 \times 10^6$	100	$30{,}00 \times 10^8$
2.	Mangrove **)	$03{,}11 \times 10^6$	291	$09{,}05 \times 10^8$
			TOTAL	$39{,}05 \times 10^8$

Shrimp Pond (Ha)	Emission Potential (Ton C / Ha)	Total Emission Potential (Ton C / Ha)
657.346	160 – 437 *)	$10{,}52 \times 10^8$ – $28{,}73 \times 10^8$

Shrimp Pond Emission < Potential Carbon Absorption

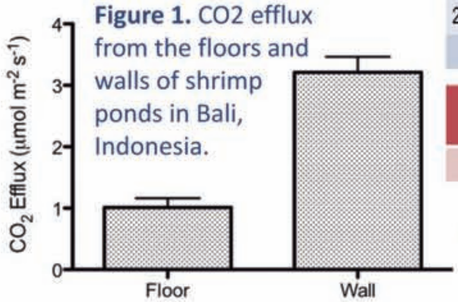


Figure 1. CO2 efflux from the floors and walls of shrimp ponds in Bali, Indonesia.

*) Sidik F, Lovelock CE (2013) CO2 Efflux from Shrimp Ponds in Indonesia. PLoS ONE 8(6): e66329. doi:10.1371/journal.pone.0066329
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0066329
**) Blue Carbon Center, AMFRD, MoMAF Republic of Indonesia

PLOS | ONE

National Action Plan for the GHG's reduction (RAN-GRK)

8 Programme of the Ministry of Marine Affairs & Fisheries are dedicated to support Climate Change Mitigation

Presidential Decree No. 61/2011 for RAN GRK

Signed on 20 September 2011

No.	Action Plan	Activity/Target	Period	Location
1	Marine Research Carbon in Indonesia	5 Research Packages	2010 - 2014	Indonesian coastal zone & Coral Triangle Iniative area
2	Study Marine Hazard Response to Climate Change in Southeast Asia Region	2 Research Packages	2010 - 2014	South China sea & Karimata strait
3	Implementation of the Indonesia Global Ocean Observing System (INAGOOS)	2 Research Packages	2010 - 2014	Jakarta, Bali & Indonesian seas
4	Implementation of the Indo-China Ocean & Climate Research Centre	3 Research Packages	2010 - 2014	Sunda strait, Indian Ocean, & Karimata strait

KEMENTERIAN

20

National Action Plan for the GHG's reduction (RAN-GRK)

8 Programme of the Ministry of Marine Affairs & Fisheries are dedicated to support Climate Change Mitigation

Presidential Decree No. 61/2011 for RAN GRK

Signed on 20 September 2011

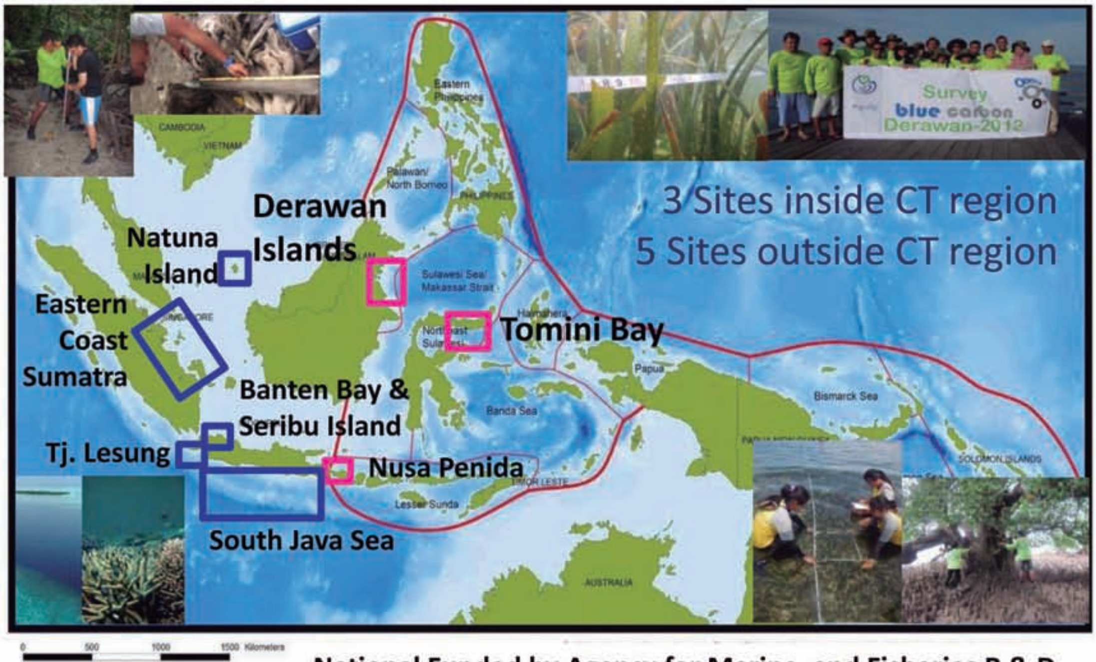
No.	Action Plan	Activity/Target	Period	Location
5	Development of Masterplan for Central Fisheries Acitivites in Province/Regency/City	100 – 300 Masterplan	2010 - 2020	Province/Regency/ City
6	Coastal Ecosystem Rehabilitation	300 Ha Coastal Area to be rehabs	2010 - 2020	Province/Regency/ City
7	Coastal Conservation Management	9 Mio Ha Coastal Conservation Area to be managed	2010 - 2020	Province/Regency/ City
8	Coastal Conservation Area Rehabilitation	9 Mio Ha Coastal Conservation Area to be rehabs	2010 - 2020	Province/Regency/ City

21

The National Program of Marine & Coastal Carbon

- Research & Monitoring since 2008
- Development of the National Policy since 2010
- Expert Forum since 2011
- Blue Carbon Center since 2012

Reseach & Monitoring on Marine & Coastal Carbon Sites



National Funded by Agency for Marine and Fisheries R & D

Blue Carbon (Center) Indonesia *since 2012*

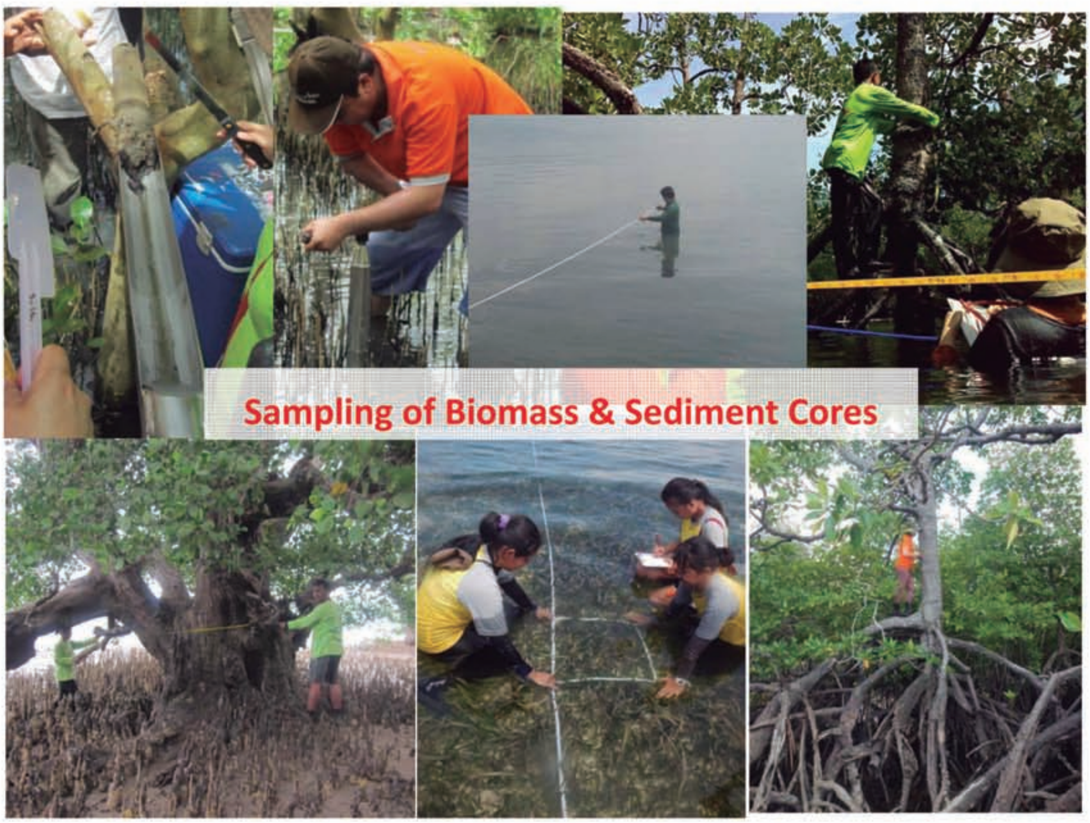
www.p3sdlp.litbang.kkp.go.id

Study sites:

- Banten Bay
- Tanjung Lesung
- Derawan Islands
- Raja Ampat
- Nusa Penida
- Tomini Bay
- Western Sumatra
- Eastern Sumatra
- South Java
- Java Sea

Indonesia – German SPICE III (2012 -2015)

Carbon Sequestration in the Indonesian Seas and Its Global Significance: Generation of Scientific Knowledge for Formulating Strategies For Adaptation to Climate Change



(Eco)-Marine Services

Translation Book into BAHASA INDONESIA: BLUE CARBON Launched by Minister of Marine Affairs & Fisheries 11 May 2011

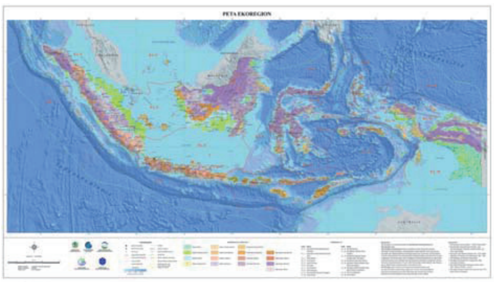
Indonesian translation of the UNEP Book "Blue Carbon: The Role of Healthy Oceans in Binding carbon"

Strategic Plan on Marine Carbon Research in Indonesia Seas (ISBN 978-602-9086-18-8)

National Science Plan on Blue Carbon 2014-2019 (Updated 15-16 April 2015)

(Eco)-Marine Services

One Map Policy



1. Fisheries Management Area Map - 2009
2. Marine Ecoregion Map – 2013
3. Seawater Characteristic Map – 2014
4. Seagrass Distribution - 2014
5. Mangrove Distribution – 2014

(Eco)-Marine Services

Expert Forum

1. Consultation Forum for Blue Carbon - 2012
2. International Workshop on Blue Carbon - 2013
3. International Blue Carbon Symposium - 2014
4. Coastal Carbon Technical Workshop - 2015

Ministry of Marine Affairs & Fisheries
The Republic of Indonesia

THE WORLD BANK

Coastal Carbon Technical Workshop, Jakarta, 15 – 16 April 2015

Ministry of Marine Affairs & Fisheries
The Republic of Indonesia

THE WORLD BANK

The workshop recommends the following :

1. Increase the important value of Blue Carbon in coastal ecosystem management through **finalization of National Scientific Plan or Strategic Plan on Blue Carbon**., which will cover: improving research capacity, strengthening policy , strengthening data sharing capacity and community outreach.

2. **Development of Project Concept on Blue Carbon by involving all stakeholders** to improve the understanding on Blue Carbon needs through national & international supports

Coastal Carbon Technical Workshop, Jakarta, 15 – 16 April 2015

Cooperation in Coastal Carbon Within APEC Region, International Organization And Its Status

- **IUCN/UNEP** → Since2011 (Supporting in International Blue Carbon Scientific & Policy Workshop)
- **USAID** → Supporting training on Cabon stock *"Carbon Stock Assessment and Emissions Inventory in Asian Mangroves: Field Training for Scientists and Agency Staff"*, 29 April – 08 Mei 2013 in Trang, Thailand.
- **Tokyo Inst. Of Technology Japan** → Since 2011 in TROMEC Research project
- **First Inst. Of Oceanography China** → Since 2011 for Cruise, Lab Analysis, & Expert Exchange
- **Xiamen University China** → MoU in progress
- **The World Bank** → Preliminary stage (Drafting a joint concept note & held a workshop)
- **The Food & Agriculture Organization of UN** → Initiation stage (PIF submission)
- **The Japan International Cooperation Agency** → Initiation Stage (Proposal submission)
- **Remote Sensing Technology Center of Japan (RESTEC)** → In discussion

Blue Carbon Projects Worldwide*

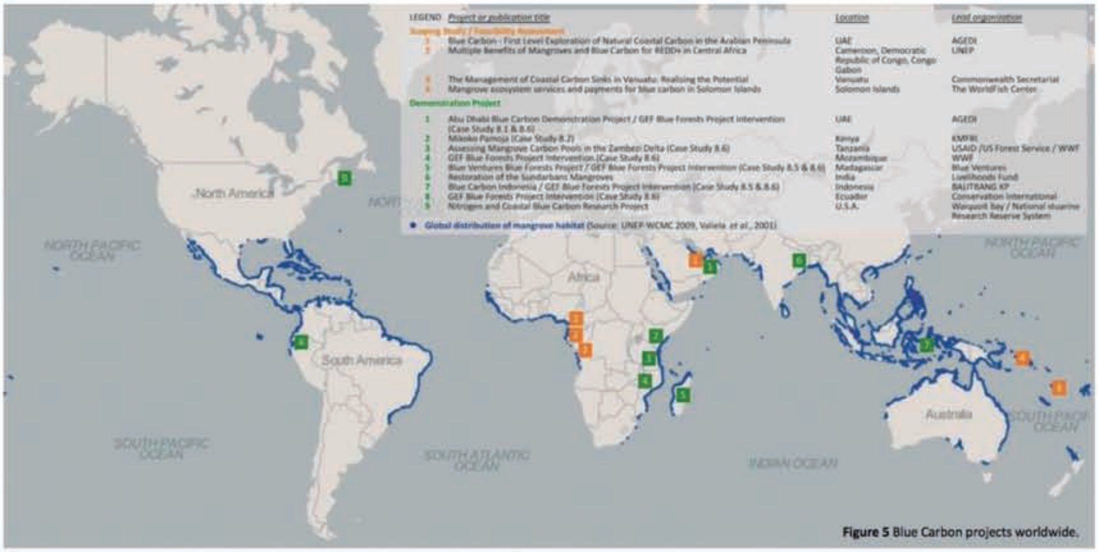


Figure 5 Blue Carbon projects worldwide.

❖ AGEDI. 2014. **Building Blue Carbon Projects - An Introductory Guide**. AGEDI/EAD. Published by AGEDI. Produced by GRID-Arendal, A Centre Collaborating with UNEP, Norway.

(Eco)-Marine Services

YAGASU

USAID

LIVELIHOODS

Carbon Credit implemented by Coastal Community

The uses of mangroves in Aceh and North Sumatra

Component	Economic value for local people
Ecosystem	collecting fish, crab, shrimp, mussel, oyster, mollusk and honey collection
	organic silvo-fishery, eco-tourism and fishing recreation
Stems, branches and barks	water gate pond construction, fences, fishing poles, tanbark for tanning leather, fibers for ropes, dyeing fish-nets and natural "batik" inks.
Roots	handicrafts, medicines and natural "batik" inks
Leaves and flowers	herbal tea and nypa roof shingles, young leaves as forage to cows & goats, and natural "batik" inks.

Coastal Carbon Corridor: community based mangrove restoration & protection for climate change mitigation, natural disaster risk reductions and green-livelihoods.

7 – 12 ton crabs per day collected from Aceh & North Sumatra exported to Singapore, Taiwan, Malaysia, etc

Yagasu is the Indonesian NGO working for climate change mitigation and adaptation

(Eco)-Marine Services

YAGASU

USAID FROM THE AMERICAN PEOPLE

LIVELIHOODS

Carbon Credit implemented by Coastal Community

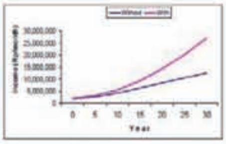
NET POSITIVE COMMUNITY IMPACTS

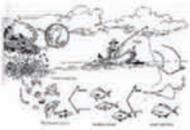
Community net-income using the formula below:

$$TPB = \sum_{i=1}^{n} Y_i P_i - Ci$$

TPB : Total net-income (Rp)
Y_i : Production of community land **i** (kg)
P_i : commodity price **i** (Rp)
C_i : Expenses of product commodity **i** (Rp)

Our CCB study: average income of local communities was Rp 1.850.000 or 148 USD per family per month and increased 57% to Rp 3.071.000 or 246 USD per family per month after 3 years of project implementation.





Positive correlation: mangrove ecosystem and fishery production: $h_t = 0.6883E_t + 5.23623\ E_t^2$, in which mangrove ecosystem contribute 27.21% to fishery resource production.

Coastal Carbon Corridor: community based mangrove restoration & protection for climate change mitigation, natural disaster risk reductions and green-livelihoods.

Yagasu is the Indonesian NGO working for climate change mitigation and adaptation

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Bounty (and also beauty) from Mangrove

Outlook Activities

- To continue research & monitoring of coastal carbon ecosystem (mangrove, seagrass, coral reef)
- To restore coastal ecosystem from its coastal degradation
- To advancing (marine) biotechnology (product) to supporting seafood security
- To Build & strenghten capacity of (local) government on integrated marine & coastal resources management
- To advance sustainable coastal fisheries activities
- Restocking coastal fisheries resources

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blue carbon CENTER

We welcome all economy member of APEC and International Organization to work together to promote Blue/Coastal Carbon in Indonesia and the region in:

- Human Resources Capacity Building
- Research & Monitoring Capacity
- Public Outreach

THANK YOU

Agency For Marine & Fisheries Research & Development
Ministry of Marine Affairs & Fisheries
The Republic of Indonesia
Jl. Pasir Putih I, Ancol Timur, Jakarta, INDONESIA – 14430
www.balitbangkp.kkp.go.id
www.p3sdlp.litbang.kkp.go.id

5-4. Discussions

1. On his presentation H.E. Mr. Arni Mathiesen emphasized the high dependence of people on fisheries and aquaculture for their livelihood. He explained the goals of the Food and Agriculture Organization which are to: (1) eradicate hunger, eradicate poverty, and promote sustainable use of resources and presented some of the initiatives of the FAO in promoting conservation of renewable aquatic resources.

2. He explained that climate change and ocean acidification has direct impact on fisheries as it has the potential to compound existing pressures on fisheries and aquaculture. He also explained that climate change also provide opportunities as changes in distributions of species, with many marine species ranges being driven to the poles, will likely be its result. Climate change also imposes risks in fisheries as migration of species in fragmented habitats limits the fish catch production.

3. Mr. Mathiesen emphasized the need to learn from global models to reach the demand of climate change in fisheries. He enumerated practical ways on how the AMS can reduce carbon emissions and how technological improvements contribute to climate change mitigation. Several examples from the field of adaptation measures were also provided during the presentation. He stressed the importance of reacting and the need to address the challenges by working together recognizing that fisheries and aquaculture will help the region ward off food deficiency.

4. Mr. Masanori Miyahara, President of the Fisheries Research Agency in Japan presented the Marine Environmental Shifts caused by the Global Climate Change and Adaptations to Ecosystem Change in Japanese Fisheries.

5. He confirmed that change in environmental temperature affects ocean ecosystem specifically the physiology of each marine organism, and the availability of nutrients for food. He highlighted that the effects of high temperature vary at different developmental stages of fish species, and has large influence in the larval fish ecology.

6. Likewise, he discussed the effects of the changing global warming trend on selected demersal species in Japan. He showed the changes in sea surface temperature (SST) in the past 100 years, the velocity of Kuroshio current, and projections of SST and mixed layer depth (MLD) in the 21st century. Moreover, he showed the predictions on migration patterns of Pacific saucy, and distribution of feeding area for Japanese sardine. Also, he enumerated the recent problems for coastal ecosystem and fisheries caused by warming conditions specifically in Kyushu, Japan. Further, he cited the study on the adaptation of Japanese spiny lobster along with the changes in the abundance of seaweeds. Moreover, he shared that there is an ongoing research on warm tolerant Nori seaweed (*Pyropiayezoensis*) using genomic technology.

7. He concluded that in order to cope with the climate change in fisheries, intensive and extensive field research is necessary to be able to understand the mechanisms of climate change.

8. Dr. Achmad Poernomo, Director General of the Agency for Marine and Fisheries Research and Development, Ministry of Marine Affairs and Fisheries in Indonesia, shared to the group the development of research and policy for coastal carbon, otherwise known as blue carbon, in Indonesia.

9. He started his presentation with a background on the territory of Indonesia; internal and external factors affecting Indonesia's marine and fisheries sector; and, Indonesia's mangrove and sea grass area and distribution. Dr. Poernomo then introduced the concept of blue carbon and the global blue carbon ecosystem services, including its eco-marine services, storage and livelihood management. Gaps related to blue carbon management were likewise presented which principally revolves around the lack/insufficient scientific studies as well as related institutional weaknesses/discrepancies.

10. Other highlights of his presentation include: the 2014 Climate Summit during which the President of the Republic of Indonesia presented to the floor the important role of blue carbon; status and updates from its Cooperation in Coastal Carbon within APEC Region and other International Organizations, Indonesia's National Action Plan on Green House Gasses: 2015-2019, key results and recommendations from the Coastal Carbon Technical Workshop held on 15 – 16 April 2015 in Jakarta, Framework for Coastal Carbon, Indonesia's

National Program of Marine & Coastal Carbon, and Research & Monitoring on Marine & Coastal Carbon Sites. An experience working with local community organization in preserving mangroves and obtaining external funding (which could be considered as "Carbon Credit" in certain aspects) was also presented, describing the social and economic benefits gained by the community.

11. In closing, Dr. Poernomo shared Indonesia's outlook activities along Blue Carbon Initiative; and enjoined all APEC member economies and all other International Organizations to work together in promoting Blue/Coastal Carbon in Indonesia specifically in the areas of human resources capacity building, research & monitoring capacity and public outreach.

12. On the inquiry on artificial reef, Dr. Miyahara, responded that they have existing studies but has not achieved substantive evidence yet in the effectiveness of the method. Mr. Mathiesen concurs with the potential of artificial reef.

13. Indonesia shared the Coral Triangle Initiative for Fisheries and Food Security and the commitment of six members to maintain healthy environment for corals.

14. Another participant informed that there have been several trials on the use of artificial reef whose purpose is to enhance vertical mixing of waters, where current is so strong, thus more nutrient in the surface.

15. On the assumption that fish size will decrease due to restraint environment, Dr. Miyahara stated that fishes might stay in mixing area where they will produce more fish, and added that there is still a need to ascertain the findings and intensify research activities on the matter.

16. On the implementation of blue carbon initiative, an inquiry on the difficulties encountered on its implementation. In response, Dr. Poernomo stated that not all areas are zoned. He further recognized the importance of non government organizations (NGOs) to put pressure to aquaculture stakeholders so that coastal vegetation is not disturbed in the aquaculture development.

17. On the other hand, Mr. Mathiesen added that sea grass beds in good condition are 3 to 5 times more effective than forest areas in terms of carbon sequestration.

However, for food security, he stated that mitigation and adaptation must be considered in aquaculture.

18. Mr. Miyahara pointed out the need to intensify oceanographic studies and migration pattern study, but would require sufficient funding support.

19. On the inquiry on regional component of the blue growth initiative and the operationalization of network, Mr. Mathiesen informed the workshop that there are regional components in four regions, with one regional component based in Bangkok. He emphasized that in improving capacity of aquaculture for food security, the need to consider sustainability, and welcomed cooperation with APEC on the matter. Along this line, Indonesia updated that they have an ongoing project on the blue economy assisted by FAO.

20. A query if there is a limit to aquaculture production was raised. Mr. Mathiesen shared that the industry has shown adaptability to reduce protein and fish oil inclusion. Although 2030 will be the measuring date for the economies in protein consumption, he emphasized that there is a need to find other sources of protein and fish oil aside from species from the wild and that actions can be initially taken at this period.

21. In order to improve cooperation and transfer of technology, Mr. Mathiesen suggested the need to continue collaboration and sharing of scientific knowledge on a steady phase.

22. Indonesia raised that fish diseases poses another challenge for aquaculture which was concurred by Mr. Mathiesen. He further acknowledged the venue to discuss climate change studies, and stressed out that there is a need to move towards a larger picture, where other related sectors can participate and respond actively.

Chapter VI

General Discussion and Conclusions

6. General Discussion and Conclusions

Akima Umezawa

The Workshop highlighted, as its key message, the importance of the synergetic integration between science and policymaking, which strengthens the policy coherence in the approach on the social and economic adaptation to the impact of climate change on oceans and fisheries resources. The Workshop penetrated the impact of climate change, which increases uncertainty in every sustainable use of marine resources, consequently not only endangering fisheries and aquaculture industry, but also posing serious risk on human life. It shared a lots of serious changes, impacts and degradations caused by the climate change, while the scientific mechanism of such impacts has not been properly revealed yet. However, such uncertainty of scientific mechanism should never use for an excuse of leaving the policymaking until later stage. Conventional approaches for building and validating evidence on the traditional disciplines may not achieve the effective outcomes within the successful time line.

Today, the global community faces multiple and interlinked challenges of greater climate change vulnerabilities. The vital contributions from fisheries and aquaculture to global food security and economic growth would seriously suffer from the impact of the climate change. The oceans and the benefits derived from oceans are being threatened by climate change through temperature increases, distribution shifts of living marine resources, sea level rise and ocean acidification. If we would fail to address it properly, it could seriously threaten the sustainability of fishing community and the integrity of marine ecosystems.

The Workshop revealed the future projection of the climate change impacts, including many striking features. While carbon dioxide greenhouse gas has increased and affected the global warming of the earth's surface, the global mean surface temperature is proceed to increase by 1 - 4 degrees Celsius by 2200, and there have been also discerned the changes in precipitations. The Workshop pointed out a large scale precipitation change showed a global scale model, "wet gets wetter, and dry gets drier", resulting in a higher rate of increase in extreme weather. The intensity of extreme weather conditions will continue to increase in the feature. Ocean is continuously affected by the global warming and change in precipitation pattern. In the last hundred years, the planetary-induced extreme high productivity in some coastal waters might have absorbed a certain degree of marine environmental changes. However, such higher marine biomass productivity has no longer withstand an over exploitation in recent decades under the damaged ocean environment impacted by the climate change. The Workshop pointed out that coupling effects of human activities and climate change has further increased the vulnerabilities of the coastal ecosystem. Marine coastal areas have to be used in a scientific and rational way. It also needs to strengthen the international coordination and communication.

The Workshop emphasized that Asia-Pacific is extremely vulnerable to a changing climate in the coming decades. As one of the most serious impacts of climate change, ocean acidification is the ongoing decrease in the pH of the Earth's oceans, caused by the uptake of carbon dioxide (CO_2) from the atmosphere. Ocean acidification has already affected reproduction, behavior and physiological functions of marine organisms. It may cause negative impacts in economically important marine species including corals, molluscs, crustaceans, echinoderms and fish. If the climate change impact on oceans continues at the pace of business as usual, the growth of reef-building coral will disappear around 2060, and all the seashell will not survive around 2100. More than quarter of marine species will be threaten with extinction by 2050. It results in serious damage on the marine ecosystem in terms of biodiversity, consequently making less resilient environment in marine and coastal areas. Collaboration among scientists is indispensable for strengthening economic cooperation, and may need to discuss on how to incorporate climate change and sustainability concerns on the policymaking level.

In addition, as the climate change implications on marine ecosystem, there are observed many other striking features such as ocean stratification, large scale floods, geographical distribution change of marine species, Isoyake phenomenon and coral bleaching, especially caused by the increasing in carbon dioxide. There might also be losers and winners amidst global warming and ocean acidification. Biologically, it may occur the changes in sensory ability and behavior of marine species, resulting in many marine species in danger of extinction. For addressing this serious challenge of earth's environmental system, the Workshop emphasized the need for continuous dialogue between science and policy to address the various uncertainties and gaps. In addition, it needs to invest in science for better predictions, and maintain their credibility for policymaker. It's also inevitable to motivate scientist to be involved in policy advisory bodies and other related endeavors.

The Workshop focused on the Arctic issue, as polar regions are more quickly affected by climate change impact more than the rest of oceans. There was a rapid sea ice decline in the Arctic observed in last two decades, being associated with warmer ocean temperature. Sea ice decline in the Arctic has accelerated the Arctic Ocean circulation, which resulting in further sea ice melting. It predicts large scale decline of Arctic sea ice. In a meantime, ice free in summer Arctic in recent years has opened the commercial shipping between Europe and East Asia, due to about 30% - 40% shorten distance comparing to the conventional shipping route via the Suez Canal. Shipping activities in the Northern Sea Route has increased since 2010, though there had been a decline in 2014 because of still uncertainty of business environments, including the pilotage, ice-breaker escort service, ice condition, navigation risk management, special premier insurance, etc. There are substantial advantages such as reducing fuel consumption and fuel, shortening sailing time thereby reducing total shipping cost. However, it may involve not only the economic feasibility, but also factors of safety and business predictability. Biggest attention also has to be paid for sustainability of Arctic, the most vulnerable oceans with less resilient.

The climate change and ocean acidification has direct impact on fisheries as it has the potential to compound existing pressures on fisheries and aquaculture. The climate change has also caused the changes in distributions of species, and many marine species will likely to be driven to migrate from the conventional fishing grounds. It has also imposed risks in fisheries as the migration of species in fragmented habitats limits the fish catch production. The Workshop stressed how technological improvements contribute to climate change mitigation. Change in environmental temperature affects ocean ecosystem specifically the physiology of each marine organism, and the availability of nutrients for food. Even the excess of a degree Celsius in sea water temperature has large impact on fish life cycle. The effects of high temperature also vary at different developmental stages of fish species, and has large influence in the larval fish ecology. In order to cope with the climate change in fisheries, intensive and extensive field research is necessary to be able to understand the mechanisms of climate change. Intensive study on the oceanography and fish migration pattern affected by the climate change impact is necessary for sustainable fisheries, while the mitigation and adaptation must be considered first in aquaculture. The Workshop observed the marine and fisheries policy; "Blue Carbon". A typical example of the concept of blue carbon is to create a huge scale of mangrove and sea grass area for catching and storage of the carbon in sea water, which eventually provides not only the protection of coastal vulnerable shore lines but also the vast nursery areas for many species. This is more than ecologically friendly. Sea grass beds in good condition are 3 to 5 times more effective than forest areas in terms of carbon sequestration. This is the synergetic outcome between the robust scientific evidences and the innovative policy idea.

The Workshop recognized the increasing uncertainty arisen by climate change impact in terms of sustainable use of fisheries resources. In order to properly address such increasing uncertainty, an interrelated dialogue between science and policymaking in more coordinative and cooperative way on a good platform may accomplish the strategic development toward policy coherence in the approach on social and economic adaptations to the climate change impact. Every lecturer stated the Workshop is the first of this kind, demonstrated eventually by this opportunity in which the prominent scientists and international and national stakeholders including policy making people came together and discussed the issue of the climate change impact on an equal footing. The Workshop concluded to demand more dialogue, coordination and integration of policies with the robust science, so that coherent strategies to the sustainable ocean use can achieve such successful synergies. This kind of platform composed of multi-stakeholders should be continued vigorously, consequently it will achieve the social and economic adaptations in successful manner to the impact of climate change.

Chapter VII

Impressions by Lecturers (Panel Discussions)

7. Impressions by Lecturers

(Panel Discussions)

The lecturers / speakers shared their impressions on the day's workshop as follows:

1. Dr. Chen was pleased to share his experiences on the topic and expressed that learned from the participants as well. He found the workshop very informative and look forward to forge more cooperation. He likewise expressed his thanks and congratulations to organizers.

2. Prof. Gallardo shared his opinion on the need to complement the discipline of chemistry and sensibility to social problems. While pure research has to be emphasized he has also put his self into the task of concretizing the idea such research ideas. He reiterated that Chile has one of the best oceanography and has the biological advantage since it has species with infinite demand and high economic value. There are still opportunities, however, for more production by improving the hard bottoms. Thus, collective support is need in terms of maximizing the benefits of using artificial reefs. Finally, he offered to hold a seminar in Chile on the application of artificial reefs technology which are environmentally friendly (not made of tires).

3. Dr. Leung expressed her gladness to be invited and mentioned that she learned as well from the impressive speakers from a wide range of topics. She underscored that people have to think of the earth system as an interconnected system so to understand the impacts of climate change on marine ecosystem and fishery, one needs to be able to understand and predict changes in other connected systems such as climate change impacts on precipitation and streamflow that influence the coastal environment. She also hoped to continue this kind of discussion to come up and provide with better information and how such can be translated into policies.

4. Mr. Miyahara put emphasis on the need to invest for the future right now. And that the job has to be done in a more coordinative and cooperative way. Strategies to intensify research have to be put forward as well and that APEC is a good platform for efforts like this.

5. Prof. Okamoto hoped that the participants were able to understand and comprehend well the presentations and soon become either part of the world leading experts on the topic of climate change and/or contribute meaningfully to their respective policy making.

6. Dr. Otsuka pointed out that while some industry players are now starting the Northern Sea Route in the Arctic, stakeholders should likewise pay attention on the safety nets for sustainability.

7. Dr. Poernomo stated that he learned a lot from the day's discussions and presentations. The topics maybe broad but they are all interrelated. He then emphasized on the need for a concerted effort to address the impacts of climate change to the fisheries sector especially among the developing areas in Asia and the Pacific where food security and livelihood of the people are at stake.

8. Dr. Sabine shared to the group that the term ocean acidification didn't exist 10 years ago and expressed his happiness that incidentally he was part of the group of chemists and biologists who even before postulated the impact of elevated CO_2/lower Ph values to marine organisms. And that such undertaking lead to the birth of a whole new field of study on ocean acidification. He confided that he felt the same excitement in this workshop where experts converged and share their knowledge. Finally, he conveyed his high hopes that if this group will move forward to the right direction after this workshop, a real paradigm shift can be achieved.

9. Dr. Shimada conveyed his gratefulness to be invited and look forward to more information sharing like this.

10. Dr. Shirayama shared few highlights of the recently concluded Arctic Forum where different stakeholders view differently as to who are the main stakeholders of the Arctic. Furthermore, he revealed that stakeholders' view on the credibility

of science is decreasing. He is optimistic thought that this form and related undertakings will regain the confidence of stakeholders.

11. Dr. Vergara realized that biodiversity issues are not in isolation with other fields including that of earth sciences. Along this line, she thought that there should be a different skills set that will translate and bridge between scientists and policy makers to come up with well-informed policies. She likewise mentioned that she was able to appreciate the sequence of the topics in this workshop as they feed into each other.

12. Dr. Umezawa, extending his deepest appreciations to all the speakers and lecturers for their outstanding performances, shared all the views and impressions expressed as above, especially of the urgent needs to do paradigm shift for outreaching from science to policymaking with regard to the impact on oceans. Serious threats caused by the climate change impact have not occurred in the different planet. It has acceleratory damaged on our earth environments. He also emphasized the importance of better awareness of the impact of climate change on oceans and of sharing all the related experiences, knowledge and successes among not only the scientists but also every stakeholder especially by the policymaking people. As the Workshop demonstrated a first of this kind bridging between scientists and policy makers, he strongly hoped this kind of platform composed of multi-stakeholders be continued, consequently it will achieve the social and economic adaptations in successful manner to the impact of climate change.

Appendix

I. List of Lectures and Speakers (including CVs)

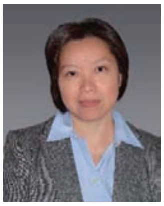
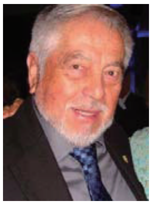
II. List of Participants

III. Abstracts of Presentations

IV. Remarks

V. Project Proposal

I. Workshop on the Climate Change Impact on Oceans and Fisheries Resources List of Lecturers and Speakers

	Atty. Asis G. Perez Director, Bureau of Fisheries and Aquatic Resources
	Prof. Nobuaki Okamoto *President, Tokyo University of Marine Science and Technology, Japan*
	Dr. Ruby Leung *Pacific Northwest National Laboratory, United States*
	Prof. Victor Ariel Gallardo *Professor of the Department of Oceanography, Universidad de Conception, Chile*
	Dr. Shaobo Chen *Professor, Zhejiang Mariculture Research Institute, China*
	Dr. Christopher Sabine *Director, Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration (NOAA), United States*
	Dr. Sheila G. Vergara *Director of Biodiversity Information Management of ASEAN Centre for Biodiversity*

	Dr. Yoshihisa Shirayama *Executive Director, Japan Agency for Marine Earth Science and Technology (JAMSTEC), Japan*
	Dr. Koji Shimada *Associate Professor, Department of Ocean Science, Tokyo University of Marine Science and Technology, Japan*
	Dr. Natsuhiko Otsuka *Manager, North Japan Port Consultations Co. Ltd.*
	H.E. Mr. Arni Mathiesen *Assistant Director General, Food and Agriculture Organization of the United Nations (FAO), Fisheries and Aquaculture Department*
	Mr. Masanori Miyahara *President, Fisheries Research Agency, Japan*
	Dr. Achmad Poernomo *Director General, Ministry of marine Affairs and Fisheries, Indonesia*
	Moderator (APEC Project Overseer) Dr. Akima Umezawa *Cabinet Counsellor, Government of Japan*

Atty. Asis G. Perez

Director
BUREAU OF FISHERIES AND AQUATIC RESOURCES
2011-present

Atty. Asis G. Perez was born on October 4, 1963 to parents Pedro Ticson Perez and Elena Laraya Generoso of Tiaong, Quezon. He finished his education in Veterinary Medicine at Francisco Balagtas College in 1987 and his Juris Doctor degree at the Ateneo De Manila University in 1991.

Between the years 1995 to 1998, he was a lecturer of Environmental Laws at the UP Law Center and served as Director of Alternative Environment Dispute Resolution Program of the DENR. He also became a Director of Law Enforcement at Tanggol Kalikasan, a non-governmental organization advocating environmental protection and conservation.

Because of his wide exposure in handling cases with relation to the environment and the actual implementation of environmental laws, he became a member of the Special Committee On The Rules Of Procedures For Environmental Cases of the Supreme Court from 2009 to 2010.

From time to time, Atty. Perez lectures on Environmental Law at the Philippine Judicial Academy.

An awardee of Quezon Medalya ng Karangalan in 2008, Atty. Perez is also a recipient of the First Gawad Sagip Dagat Award and the 2010 Clark R. Bavin Law Enforcement Award which was given during the 15th Conference of the Parties of CITES in Doha, Qatar.

Some of his published works are “Essentials of Protected Area Management in the Philippines (2000)”; “Improving the Governance of the Philippine Coastal and Marine Areas: A Guide For Local Government Units”; “A Study On Community-Based Law Enforcement in Tayabas Bay”; “Philippine Adaptation of the Code of Conduct for Responsible Fisheries”; and a primer on “Appropriate Dispute Resolution Processes.”

Nobuaki Okamoto

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Position: President

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Degree: PhD (Hokkaido University, Japan)

Hobbies: traveling, cycling tour, golf, keeping goldfish

Recent research topic: Study on genetic improvement program for grouper

Resent publications:

1. Akiyuki Ozaki, Hiroyuki Okamoto, Toshiyuki Yamada, Tomomasa Matuyama, Takamitsu Sakai, Kanako Fuji, Takashi Sakamoto, **Nobuaki Okamoto**, Kazunori Yoshida, Keita Hatori, Kazuo Araki, Masanori Okauchi. 2010. Linkage analysis of resistance to *Streptococcus iniae* infection in Japanese flounder (*Paralichthys olivaceus*). Aquaculture 308, S62-S67.

2. C. Castaño-Sánchez, K. Fuji, A. Ozaki, O. Hasegawa, T. Sakamoto, K. Morishima, I. Nakayama, A. Fujiwara, T. Masaoka, H. Okamoto, K. Hayashida, M. Tagami, J. Kawai, Y. Hayashizaki , **N. Okamoto**. 2010. A second generation genetic linkage map of Japanese flounder (*Paralichthys olivaceus*). BMC Genomics, 11:554.

L. Ruby Leung

Laboratory Fellow
Pacific Northwest National Laboratory, Richland, WA
Atmospheric Sciences and Global Change Division
Phone: (509) 372 - 6182, Email: Ruby.Leung@pnnl.gov

Education and Training

Chinese University of Hong Kong, Hong Kong, B.S., Physics & Statistics, 1984
Texas A&M University, College Station, TX, M.S. Atmospheric Science, 1988
Texas A&M University, College Station, TX, Ph.D. Atmospheric Science, 1991

Research and Professional Experience

2004-Present Laboratory Fellow, PNNL, Richland, WA. Current research efforts include: 1) leading a U.S. Department of Energy (DOE) funded project on "Water Cycle and Climate Extremes Modeling" to evaluate a hierarchy of high resolution climate models on their fidelity in simulating water cycle processes and understanding the role of various climate feedbacks; 2) leading the PNNL land modeling team on modeling subgrid heterogeneity, soil hydrology, riverine processes, and water management in a DOE funded project to develop an Earth System Model; and, 3) led the DOE ARM Cloud-Aerosol-Precipitation Experiment (ACAPEX) to investigate the role of atmospheric rivers and aerosols on precipitation in California.

1992-2004 Senior Scientist, PNNL, Richland, WA. Developed a subgrid parameterization of orographic precipitation for regional and global climate models. Led the regional climate modeling task of the DOE Accelerated Climate Prediction Initiative. Task lead of US DOE – China Ministry of Science and Technology bilateral agreement on climate research.

2004-Present Affiliate Scientist, National Center for Atmospheric Research (NCAR), Boulder, CO. Led the development of regional climate modeling capability in the Weather Research and Forecasting (WRF) model as part of the NCAR Regional Climate Modeling Initiative. Co-organized a workshop on "Research Needs and Directions of Regional Climate Modeling Using WRF and CCSM" in 2005.

Awards and Honors

Member, Washington State Academy of Sciences, elected 2013
Fellow, American Geophysical Union (AGU), elected 2013
Fellow, American Meteorological Society (AMS), elected 2011
Fellow, American Association for the Advancement of Science (AAAS), elected 2009

Synergistic Activities (selected)

Co-organizer, U.S. Department of Energy Biological and Environmental Research Advisory Committee Workshop on Integrated Field Laboratory (IFL) with a Focus on Incorporating Urban Systems as Part of Human – Earth System Interactions, 2015
AGU Atmospheric Science Fellows Committee, 2015
Senior Editor, Oxford Handbooks Online in Climate Science, since 2015
Editor, AGU Journal of Geophysical Research – Atmospheres, since 2014
Editor, AMS Journal of Hydrometeorology, since 2012
Steering Committee, World Climate Research Program High Resolution Model Intercomparison Project (HighResMIP)
Chair, Organizing Committee, U.S. Department of Energy Workshop on Community Modeling for Long-Term Predictions of the Integrated Water Cycle, September 24 – 26, Washington DC, 2012
Member, U.S. Climate Variability (CLIVAR) Working Group Committee on Large Scale Circulation Patterns Associated with Extremes, since 2012
Member, National Research Council study committee on "A National Strategy for Advancing Climate Modeling", 2011 – 2012

Member, Department of Energy's Office of Biological and Environmental Research Advisory Committee (BERAC), since 2009

Organizer, Workshop on Research Needs and Directions of Regional Climate Modeling Using WRF and CCSM, sponsored by NCAR, March 22-23, 2005, Boulder, CO

Organizer and Program Committee Chair, Workshop on "Regional Climate Research: Needs and Opportunities", co-sponsored by the National Science Foundation and Department of Energy, April 2001, Boulder, CO

Selected Publications (of 175 peer-reviewed publications)

Mei, R., M. Ashfaq, D. Rastogi, L.R. **Leung**, and F. Dominguez. 2015. "Dominating Controls for Wetter South Asian Summer Monsoon in the 21st Century." J. Clim., doi: 10.1175/JCLI-D-14-00355.1.

Gao, Y., L.R. **Leung**, and J. Lu. 2015. "Persistent Cold Air Outbreaks Over North America in a Warming Climate." Environ. Res. Lett., in press.

Gao, Y., X. Li, L.R. **Leung**, D. Chen, and J. Xu. 2015. "Aridity Changes in the Tibetan Plateau in a Warming Climate." Environ. Res. Lett., 10(3), doi:10.1088/1748-9326/10/3/034013.

Foltz, G.R., K. Balaguru, and L.R. **Leung**. 2015. "A Reassessment of the Integrated Impact of Tropical Cyclones on Surface Chlorophyll in the Western Subtropical North Atlantic." Geophys. Res. Lett., doi: 10.1002/2015GL063222.

Taraphdar, S., L.R. **Leung**, and S. Hagos. 2015. "Linkages of Remote Sea Surface Temperatures and Atlantic Tropical Cyclone Activity Mediated by the African Monsoon." Geophys. Res. Lett., 42, 572-578, doi: 10.1002/2014GL062600.

Balaguru, K., S. Taraphdar, L.R. **Leung**, G.R. Foltz, and J.A. Knaff. 2014. "Cyclone-Cyclone Interactions Through the Ocean Pathway." Geophys. Res. Lett., 41, doi: 10.1002/2014GL061489.2/2015GL063222.

Balaguru, K., S. Taraphdar, L.R. **Leung**, and G.R. Foltz. 2014. "Increase in the Intensity of Postmonsoon Bay of Bengal Tropical Cyclones." Geophys. Res. Lett., 41(10), 3594–3601, doi: 10.1002/2014GL060197.

Lu, J., L.R. **Leung**, Q. Yang, G. Chen, W.D. Collins, F. Li, Z. Hou, and X. Feng. 2014. "The Robust Dynamical Contribution to Precipitation Extremes in Idealized Warming Simulations Across Model Resolutions." Geophys. Res. Lett., 41, 2971–2978, doi: 10.1002/2014GL059532.

Leung, L.R., T. Ringler, W.D. Collins, M. Taylor, M. Ashfaq. 2013. "A Hierarchical Evaluation of Regional Climate Simulations." Eos Transactions, 297-298, doi: 10.1002/2013EO340001.

Balaguru, K., P. Chang, R. Saravanan, L.R. **Leung**, X. Zhao, M. Li, and J. Hsieh. 2012. "Effects of Ocean Barrier Layers on Tropical Cyclone Intensification." Proc. Nat. Acad. Sci, doi/10.1073/pnas.1201364109.

Leung, L.R., M. Huang, Y. Qian, X. Liang. 2011. "Climate-Soil-Vegetation Control on Groundwater Table Dynamics and its Feedbacks in a Climate Model." Clim. Dyn., 36, 57-81, doi:10.1007/s00382-010-0746-x.

Leung, L.R., and Y. Qian. 2009. "Atmospheric Rivers Induced Heavy Precipitation and Flooding in the Western U.S. Simulated by the WRF Regional Climate Model." Geophys. Res. Lett., 36, L03820, doi:10.1029/2008GL036445.

Leung, L.R., Y.-H. Kuo, and J. Tribbia. 2006. "Research Needs and Directions of Regional Climate Modeling Using WRF and CCSM." Bull. Amer. Meteorol. Soc.,87(12), 1747-1751.

Leung, L.R., Y. Qian, X. Bian, W.M. Washington, J. Han, and J.O. Roads. 2004. "Mid-Century Ensemble Regional Climate Change Scenarios For the Western United States." Climatic Change, 62(1-3):75-113.

Leung, L.R., and W.I. Gustafson, Jr. 2005. "Potential Regional Climate Change and Implications to U.S. Air Quality." Geophys. Res. Lett., 32, L16711, doi:10.1029/2005GL022911.

Leung, L.R. 2005. "Effects of Climate Variability and Change on Mountain Water Resources in the Western U.S." In Global Change and Mountain Regions: A State of Knowledge Overview, U.M. Huber, H.K.M. Bugmann, and M.A. Reasoner, (eds.), Springer, Dordrecht, pp355-366.

Leung, L.R., and S.J. Ghan. 1998. "Parameterizing Subgrid Orographic Precipitation and Surface Cover in Climate Models." Mon. Wea. Rev., 126(12), 3271-3291.

Victor Ariel Gallardo

Present Position:
Professor, Department of Oceanography, Faculty of Natural Resources and Oceanography, University of Concepcion, Concepcion, Chile.

Studies:
1948-53 State Rural Primary School Teacher Diploma, Normal School "Juan Madrid", Chillan, Chile.
1954-61 State Secondary School Teacher Diploma (Biology and Chemistry), University of Chile (U. of Concepción).
1967 Ph.D. (Biology), University of Southern California, Los Angeles, California, U.S.A.
1974 Master of Marine Affairs, University of Rhode Island, Kingston, Rhode Island, U.S.A.

Administrative experience:
1971-73 Founder Director of the Department of Marine Biology and Oceanography, University of Concepción, Concepción, Chile.
1978-82 Director of the Department Marine Biology and Marine Biological Station, University of Concepcion, Dichato, Chile.
2002-03 Founder Director of the Center for Oceanographic Research in the Eastern South Pacific (COPAS).
2003-05 Member of the International Scientific Steering Committee of the global program Census of Marine Life.
2006-10 Vice-Chair of the International Scientific Steering Committee of the global program Census of Marine Life.

Other international academic experience:
1975-76 Post-doctoral, Department of Biology and Marine Policy and Ocean Management Program, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, U.S.A.
1987 Visiting Scientist, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany.
1995 Courtesy Professor, COAS, Oregon State University, Corvallis, Oregon, U.S.A.
2005 Visiting Scientist, Smithsonian Institution, Washington D.C., U.S.A.
2005 Visiting Scholar, Consortium for Oceanographic Research and Education (CORE), Washington, D.C., U.S.A.
2005 Visiting Scientist, J. C. Venter Institute, Rockville, Maryland, U.S.A.
2008 Visiting Scientist, Synthetic Genomics Institute, Del Mar, La Jolla, California, U.S.A.

Other associations:
2003-10 Vice-Chair of the Scientific Steering Committee of the Global Program, Census of Marine Life, Ocean Leadership Consortium, Washington D.C., U.S.A.

Fields of Interest: Biological oceanography, marine benthic ecology, marine microbial ecology, marine biodiversity, marine farming, marine conservation.

Honors:
1960 Life Membership of the Marine Biological Association of the UK.
1992 Pure Science Prize, Municipality of the City of Concepción, Concepcion, Chile.
2011 Co-participated of the COSMOS Prize awarded to the International Scientific Steering Committee of the Census of Marine Life global marine biodiversity program by the Expo-90 Foundation, Osaka, Japan.

Speciality honors: Twelve new species of marine invertebrates have been dedicated to VAG.

Expeditions:
Many marine biology and oceanographic expeditions around the world: the North Atlantic Ocean, the North Sea, the Andaman Sea (West Thailand), the South China Sea (Viet Nam), Benguela Current (Namibia), Eastern South Pacific Ocean (Panamá, Galapagos Archipelago, Perú and Chile), and the Southern Ocean (West Antarctica).

Publications:
More than 70 publications in English language journals, several book chapters, and many marine policy and envirment-related contributions in Spanish.

Main achievements:

a. **Scientific:**
   - Discovery and description of 37 new species of marine invertebrates.
   - Discovery of the first marine non-photosynthetic mat-building megabacteria ecosystem (*Thioploc*a) and description of the Humboldt Sulfuretum (1962-2013).
   - Discovery and description of a new assemblage of macrobacteria in the Humboldt Sulfuretum (2007).

b. **Academic:**
   - Laid the bases of the financing and building of University of Concepcion first oceanographic research vessel (1971).
   - Laid the bases for the creation of University of Concepcion´s first Department of Marine Biology and Oceanography (1971).
   - Laid the bases for the creation at the University of Concepción of the Marine Biology Professional Diploma program (1973). More than 600 professionals have graduated since.
   - Laid the bases for the first Graduate Program (M. Sc.) in Oceanography at the University of Concepcion (1986).
   - Helped the establishment of several international cooperation agreements with Universities and Institutions with research and education programs in Marine Sciences.
   - Directed several major pioneer research programs on the Oceanography of the Eastern South Pacific (1997-2002).

Shaobo Chen

Present Position: Professor, Deputy Director, Zhejiang Mariculture Research Institute

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Research Interests: Marine ecology and management

Education:

2010	PhD	Xiamen University, Marine Biology

Professional History:

2004-2013	Director, Zhejiang Society of Zoology
2012	Vice President, Wenzhou Society of Biochemistry and Molecular Biology
2012	Standing Director, Wenzhou Friendship Association of Non-party Personages
2012	Leader, Joint Laboratory of Marine Ecological Rehabilitation, Zhejiang Mariculture Research Institute and College of Environmental Science and Engineering, Shanghai Jiaotong University
2013	Leader, Joint Laboratory of Simulation of Coastal Climate Change, Zhejiang Mariculture Research Institute and College of Ocean and Earth, Xiamen University
2013-2014	Vice Chairman, Mangrove Branch, China Society of Ecology
2013	Director, Zhejiang Society of Botany
2014	Vice Chairman, Wenzhou Society of TCM Culture

Publications:

Books

Yongyue Yu, Chang Chen, Qilang Xie, **Shaobo Chen**, et al,2011, Practices and Lessons from Island-based Conservation of Biodiversity in Nanji Islands, China *Marine Press*

Shaobo Chen, Changyi Lu, et al, 2012, Ecology of Northward Transplantation of Mangrove Adapting to Climate Change, China *Marine Press*

Wen Quan, **Shaobo Chen,** et al, Practice on Coastal Ecosystem Adapting to Climate Change, in press.

Papers

Shaobo Chen, Peng X and Qiu J B, *et al*, 2006, Status Analysis and Development Prospect of Mangrove in Southern Zhejiang, China. Book of Abstract, 2nd international symposium on cage aquaculture in Asia, 109~110

Shaobo Chen, Ding W Y, Qiu J B, et al, 2010 ，The Genetic Diversity of the Mangrove Kandelia Obovata in China Revealed by ISSR Analysis , *Pakistan Journal of Botan*， 42(6)：3755-3764

Wei Chi, Jianbiao Qiu, **Shaobo Chen,** et al. 2010. Application of Several Kinds of Fertilizer in Growth and Development Process of Kandelia candel Hypocotyl. *Journal of Anhui Agricultural Sciences*. 38(2)679-680.

Xin Peng, Qilang Xie, **Shaobo Chen,** et al., 2011. The community distribution pattern of intertidal macrozoobenthos and the responses to human activities in Yueqing Bay. *Acta Ecologica Sinica*. 31(4): 954-963.

Chunfang Zheng, Dewei Ji, Weicheng Liu, Jianbiao Qiu, Jingo Wu, **Shaobo Chen**, et al.2011. Physiological and ecological effects of high altitude transplanted Aegiceras corniculatum seedling under NaCl stress. *Chinese Journal of Applied Ecology*. 22(9).

Feng Yu, Chunfang Zheng, Mengjia Shi, Weicheng Liu, Jianbiao Qiu, Dewei Ji, Li Huang, **Shaobo Chen**(corresponding author)**,**. 2011. Establishment and Optimization of 2-DE Technique System in Leaf Proteome of Kandelia candel. *Journal of Tropical and Subtropical Botany*. 19(6):519-523.

Jianbiao Qiu, Wenyong Ding, **Shaobo Chen,**.Comparison of the Efficiency of Different DNA Extraction Methods on the Leave of Mangrove Kandelia obovataComparison of the Efficiency of Different DNA Extraction Methods on the Leave of Mangrove Kandelia obovata[J].*Journal of Zhejiang Ocean University(Natural Science Edition)*,2012, 31(5).

Xin Peng,Xiaolin Huang,Haihan Nan,**Shaobo Chen,** *et al*, 2011, Zhejiang intertidal respectively with large benthic algae and medicinalvalue. *Zhejiang Journal of Agricultural Sciences*, 23（4）：818-824

Chunfang Zheng, Jianbiao Qiu, Weicheng Liu, **Shaobo Chen**, *et al.* Physiological and ecological characteristics of the strong tide region of high latitudetransplantation of kandeliacandel. *Chinese Journal of Ecology*, 2012, 32(14).

Weicheng Liu, Chunfang Zheng, Zhen Chen, **Shaobo Chen** , *et al*.The florescence of Salicornia bigelovii Torr of physiological response to salt stress. *Chinese Journal of Ecology*, 2013, (17).

Li Huang, **Shaobo Chen**, Jianbiao Qiu.*et al*.Ximen Island artificial Kandelia candel forest recovery effects on benthicorganisms. *Chinese Journal of Ecology*, 2013, 33(10).

Chunfang Zheng,Weicheng Liu, **Shaobo Chen** , *et al*. The short night effect of low temperature stress on carbon and nitrogen metabolism and related enzyme activity of Kandelia candel seedlings *Chinese Journal of Ecology*, 2013, (21).

Xiao Chen, Weiming Ai, Dan Xiang, **Shaobo Chen,**. 2014. Complete mitochondrial genome of the red stingray Dasyatis akajei (Myliobatiformes: Dasyatidae).Mitochondrial DNA. 25(1):37-8.

Dan Xiang, Weiming Ai, Xin Peng, Jianbiao Qiu, **Shaobo Chen,**. 2014. Complete mitogenome of Hemiculter leucisculus (Cyprinidae: Cultrinae)." Mitochondrial DNA.

Xiao Chen, Weiming Ai, Dan Xiang, Yunyun Chen, **Shaobo Chen,**. 2013. Complete mitogenome of the pale-edged stingray Dasyatis zugei (Myliobatiformes: Dasyatidae). Mitochondrial DNA. 24(3):196-8.

Weiming Ai, Xiao Chen, Dan Xiang, **Shaobo Chen,**, Yunyun Chen. 2013. Complete mitochondrial genome of Acrossocheilus wenchowensis (Cyprinidae, Barbinae).Mitochondrial DNA. 24(3):249-51.

Weiming Ai, Xiao Chen, Dan Xiang, Yunyun Chen, **Shaobo Chen,**. 2013. Complete mitochondrial genome of the Sinibrama macrops (Cyprinidae: Cultrinae).Mitochondrial DNA. 24(3):231-3.

Christopher Lee Sabine

Present Position: Director, NOAA Pacific Marine Environmental Laboratory

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7600 Sand Point Way, NE
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FAX: [206] 526-4576
email: chris.sabine@noaa.gov

Research Interests

My research addresses the role of the ocean in the global carbon cycle. In particular, my work centers on interpreting ocean inorganic carbon measurements and understanding ocean acidification. This includes understanding the air-sea exchange of CO_2 at the ocean surface, examining the basin-scale distributions of both natural and anthropogenic carbon in the ocean's interior, understanding multiple tracer relationships (e.g. anthropogenic CO_2 and dissolved oxygen), evaluating ocean carbon cycle GCMs with data-based global carbon distributions, and examining carbonate and organic matter re-mineralization within the open ocean and in coastal environments.

Education

1992 Ph.D. in Oceanography, University of Hawaii at Manoa, Honolulu, HI 96822 (Fred T. Mackenzie, Advisor).

Professional History

2011-Present Director, NOAA Pacific Marine Environmental Laboratory
2007-Present Affiliate Full Professor, Department of Oceanography, University of Washington
2004-Present Senior Fellow, University of Washington Joint Institute for the Study of the Atmosphere and Ocean
2008-2011 Supervisory Oceanographer, NOAA Pacific Marine Environmental Laboratory

Professional Societies

American Geophysical Union
The Oceanography Society

Synergistic Activities

2013-present member of NOAA Libraries Advisory Committee

2013-present member of Joint Institute for the Study of the Atmosphere and the Ocean (JISAO) Executive Board

2013-present member of Joint Institute for Marine and Atmospheric Research (JIMAR) Executive Board

2011-present member of Cooperative Institute for Alaska Research (CIFAR) Executive Board

2011-present member of Cooperative Institute for Marine Resources Studies (CIMRS) Executive Board

2011-present member of NOAA Senior Research Council

2010-present member of Interagency Working Group on Ocean Acidification chartered under JSOST

Recent Significant Abstracts, Presentations and Workshop Activities

Fassbender, A. J.; **Sabine, C. L.**; Meinig, C.; Lawrence-Slavas, N. (2014) Autonomous Ocean Carbon Monitoring With A Moored DIC Sensor, *2014 Ocean Sciences Meeting*, poster.

Rhein, M.; Feely, R. A.; Masson-Delmotte, V.; **Sabine, C.**; Rintoul, S. (2014) Understanding The IPCC WG1 Fifth Assessment Report: Ocean And Carbon In Past, Present, And Future, *2014 Ocean Sciences Meeting*, talk given by Rhein.

Sutton, A. J.; Feely, R. A.; **Sabine, C. L.**; McPhaden, M. J.; Takahashi, T. (2014) Natural And Anthropogenic Change Since 1997: A Synthesis Of Equatorial Pacific Surface Ocean PCO_2 Observations On The TAO Array, *2014 Ocean Sciences Meeting*, talk given by Sutton.

Noh, J. H.; Sutton , A.; Lee, C. M.; **Sabine, C.**; Lee, K. (2014) Ocean Acidification Monitoring In Tropical Lagoon Waters Of Chuuk, FSM, *2014 Ocean Sciences Meeting*, poster.

Salisbury, J.; Vandemark, D.; Hunt, C. W.; **Sabine, C.** (2014) Musielewicz, S. (2014) Factors Contributing To Variability In PCO_2 And Calcite Mineral Saturation State In A Sensitive Coastal Ecosystem, *2014 Ocean Sciences Meeting*, talk given by Salisbury.

Williams, N. L.; Feely, R. A.; **Sabine, C. L.** (2014) Quantifying Anthropogenic Carbon Inventory Changes In The Southern Ocean, *2014 Ocean Sciences Meeting*, talk given by Williams.

Diggs, S. C.; Sloyan, B.; Sabine, C.; Swift, J.; Kramp, M. (2014) Go-Ship: Building A Global Time Series Of A Suite Of Ocean Properties, *2014 Ocean Sciences Meeting*, poster.

Ciais, P, and **Sabine, C** (2013) Carbon cycle and climate change, a tale of increasing emissions and uncertain future sinks, *AGU Fall Meeting 2013*, invited talk.

Sabine, C, Bakker, D C E, Hankin, S, Olsen, A, Pfeil, B, Smith, K, Alin, S R, Cosca, C, Hales, B, Harasawa, S, Kozyr, A, Nojiri, Y, O'Brien, K, Schuster, U, Telszewski, M, Tilbrook, B, Wada, C, and all other SOCAT contributors (2013) An update to the Surface Ocean CO_2 Atlas (SOCAT), *AGU Fall Meeting 2013*, poster.

Sheila G. Vergara

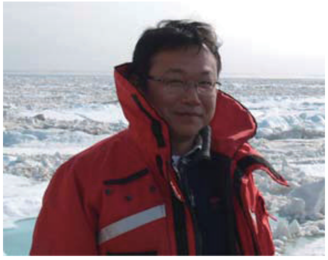
Sheila G. Vergara, PhD is a marine ecologist by training and has managed projects on coastal zone management, marine biodiversity conservation, coastal zone management training and database management. She has worked with both Philippine Government agencies and International Organizations based in the Philippines. She served the Department of Environment and Natural Resources as Head Executive Assistant and National Coordinator of the then Coastal Environment Program, as Team Leader of ReefBase and the Coastal Management Training Program at the WorldFish Center, and Marine Biodiversity Program Director at Conservation International – Philippines. At current she leads the ASEAN Centre for Biodiversity's (ACB's) Biodiversity Information Management team. Their combined efforts have produced the ASEAN Clearing House Mechanism for Biodiversity (http://chm.aseanbiodiversity.org) a platform for sharing biodiversity related information in the region.

Yoshihisa Shirayama

Name	Yoshihisa Shirayama
official position	Executive Director, JAMSTEC
academic degree	Ph.D.

Term	Career
1982	Post-Doctoral Fellow. The University of Tokyo
1991-1997	Associate Professor, Ocean Research Institute, The University of Tokyo
1997-1998	Professor, Seto Marine Biological Laboratory, Kyoto University
1998-2007	Director, Seto Marine Biological Laboratory, Kyoto University
2007-2011	Director, Field Science Education and Research Center, Kyoto University
2011-	Present Executive Director, JAMSTEC (reappointed on April 1, 2014)

Koji Shimada



Koji Shimada is a physical oceanographer of Department of Ocean Sciences at Tokyo University of Marine Science and Technology. His research is focused on climate dynamics including the recent changes in the Arctic. He is also a member of Marine working group under International Arctic Science Comittee). Prior to his teaching position at Tokyo University of Marine Science and Technology, he worked as a leader of Arctic research project in the Japan Agency for Marine and Science Technology (JAMSTEC) where he conducted extensive field researches in the Arctic Ocean since 1996. He earned his Ph.D. in geophysical fluid dynamics from Kyushu University, and B.A. and M.S. from Tohoku University.

1990: BS, Tohoku Univ, Physical Oceanography
1992: MS, Tohoku Univ, Physical Oceanography
1995: Doctor of Science, Kyushu Univ, Physical Oceanography
1995-2005: JAMSTEC research scientist, Arctic Ocean Research Group
2000-2001: Visiting scientist, Institute of Ocean Sciences, Fishery and Ocean Canada
2005-2006: JAMSTEC sub-leader, Arctic Ocean Research Group
2007-2008: JAMSTEC group-leader, Arctic Ocean Research Group
2008-present: Associated professor, Tokyo University of Marine Science and Technology

Publications: http://www2.kaiyodai.ac.jp/~koji/papers.html
Services: http://www2.kaiyodai.ac.jp/~koji/activity.html
Award:
*Horiuchi Prize from Meteorological Society of Japan (2011)
(Contribution to studies on ocean-ice-atmosphere interactions)
*Best paper in Journal of Oceanography (2007-2008) from Oceanographic Society of Japan (2009): Sumata, H, and K. Shimada (2007), On northward transport of Pacific Summer Water along the Northwind Ridge in the western Arctic Ocean, J. Oceanogr., Vol. 63, 363-378.

* International Arctic Science Committee (IASC), Marine-AOSB Working Group member (2011～)
http://www.iasc.info/home/groups/working-groups/marineaosb/member
* International Arctic Science Committee(IASC), International Study of Arctic Change (ISAC), SSG member (2008～)
http://www.arcticchange.org/isac-science-steering-group/
*Working group I contribution to the IPCC fifth assessment report (AR5), Climate change 2013: The physical science basis. Chapter 3 – Observations: Ocean. [LINK]

Natsuhiko Otsuka

Dr. Natsuhiko Otsuka is a Manager of "R&D, Management Planning Department" of North Japan Port Consultants Ltd. and adjunct lecturer of Department of Systems Innovation at The University of Tokyo, Japan. He is also a researcher of Slavic-Eurasian Research Center at Hokkaido University. He graduated from Civil Engineering Course of the Faculty of Engineering at Hokkaido University in 1981. And after he studied at the Graduate School of Engineering at Hokkaido University from 1998, he received a Phd. in 2001. His research fields include seismic design of port facilities, ice engineering in the ocean, maritime transport and engineering in the Arctic. Since 1990's, he has been studying about development of the Arctic including maritime transport via the Northern Sea Route. His recent articles include "Cost Analysis of the Northern Sea Route and the Conventional Route Shipping" (International Association of Maritime Economists 2013), "Study on feasibility of the Northern Sea Route from recent voyages"(Port and Ocean Engineering under Arctic Conditions 2013), and "Study on navigability and ice condition of the Northern Sea Route from the 2014 Sailing record"(International Symposium on Okhotsk Sea&Sea Ice, 2015.).

Árni M. Mathiesen

Born on 2 October 1958
National of Iceland
Married to Steinunn Kristin Fridjonsdottir
3 daughters

Mr Árni M. Mathiesen, Assistant Director-General of the Fisheries and Aquaculture Department at the Food and Agriculture Organization (FAO), holds a Bachelor of Veterinary Medicine and Surgery degree from the University of Edinburgh, U.K. and an MSc in Aquatic Veterinary Science from the University of Stirling, U.K. After completing his studies, he worked as a veterinarian, specializing in fish diseases for ten years and was also the Managing Director of an aquaculture firm. Mr Mathiesen was a member of the Board of the Icelandic Veterinary Association from 1986 to 1987 as well as the Chairman of the Council for the Prevention of Cruelty to Animals from 1994 to 1999. From 1990 to 1994, he was a member of the Board of the Guarantee Division of Aquaculture Loans and, from 1994 to 1998, a member of the Board of the Agricultural Bank of Iceland and of the Agricultural Loan Fund. In 1991, Mr Mathiesen was elected to the Icelandic Parliament and served as Minister for Fisheries from May 1999 to September 2005 and, subsequently, as Minister for Finance until February 2009. Before joining FAO in 2010, was a consultant for the Confederation of Icelandic Employers as well as working in a general veterinary practice in Iceland.

Masanori Miyahara

President, Fisheries Research Agency, JAPAN

Personal Information

Name : Masanori MIYAHARA

Age : 59

Birth Place: Tokyo, Japan

Education

1978 BS Faculty of Fisheries Science, University of Tokyo

1985 MA Department of Political Science, Duke University

Employment History

1978 Technical Officer, Fisheries Agency of Japan

1986-90 First Secretary, Embassy of Japan in United State

1994-97 Director of Fishery Division, Ishikawa Prefecture, Japan

2005-08 Director, Fisheries Coordination Division, Fisheries Agency

2008-11 Senior Counselor, Resources Management Department, Fisheries Agency

2011-14 Deputy Director-General, Fisheries Agency

2014-present

President, Fisheries Research Agency

And Special Adviser to Minister of Agriculture, Forestry and Fisheries

Other:

2002-05 Chairman of International Commission for Conservation of Atlantic Tunas (ICCAT)

2011-13 Chairman of ICCAT

2013-present

Visiting Professor, Nagoya University, Japan

Achmad Poernomo

Present Position: Director General of Agency for Marine and Fisheries Research and Development

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Phone: (+6221) 7340679; +628111660200
Email: achpoer@yahoo.com

Education:

1997 **Post Graduate (PhD),** Dept. of Food Science and Technology, University of New South Wales, Australia

Professional History:

2008 – 2012	SEAFDEC National Coordinator for Indonesia
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Fields of interest:

Food Processing, especially seafood
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Publication:

Has published about 100 articles on fisheries (processing, safety, marketing, industry) in local and international journals, proceedings, and has presented papers in national and international fora.

Membership:

1. Indonesian Food Technologist Association
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4. Association of Indonesian Fisheries Scientist (ISPIKANI)
5. Indonesia Cold Chain Association

Others:

- Part time lecturer (Fisheries University, Swiss German University, Pelita Harapan University, and Al Azhar Indonesia University).
- Editorial Board Journal of Fisheries Post Harvest Technology Anggota (1988 – 1991), in Indonesian
- Editorial Board Agricultural Biotechnology Journal (1997 - 2001), in Indonesian
- Editorial Board, Indonesian Fisheries Research Journal (2000 - 2001), in English
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- Editorial Board, Journal of Fisheries Post Harvest and Biotechnology (2009 -), in Indonesia
- Has reviewed some articles for publication, in international journals (by request).

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- Officer, Ministry of Foreign Affairs (MOFA) 1991-present
- 2nd Secretary, Embassy of Japan in Canada 1996-1999
- Assistant Director, First North America Division, MOFA 1999-2002
- Principal Deputy Director, Ocean Division, MOFA 2002-2005
- Principal Deputy Director, 2nd Southeast Asian Division, MOFA 2005-2007
- Principal Deputy Director, European Policy Division, MOFA 2007-2009
- Head of Chancery, Embassy of Japan in Singapore 2009-2011
- Director, Fisheries Division, MOFA 2011-2013
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- Ph.D. in Ocean Resource Management, University of Tokyo, Ocean Research Institute, 1991
- MA in International Relations, University of Leeds, Institute of International Relations, 1995
- MSc diploma in Management of Information System, University of Leeds, Faculty of Engineering, 1996

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- APEC Project Overseer (Project title: Workshop on the Climate Impact on the Oceans and Fisheries Resources), 2014-2015
- Visiting Scholar, Yokohama National University, Center for Oceanic Studies and Integrated Education, 2014-2015
- Advisor, Representative of the Government of Japan, International Court of Justice (ICJ), the case concerning Whaling in the Antarctic (Australia v. Japan), June - July 2013
- Chair, Commission for the Conservation of Southern Bluefin Tuna (CCSBT), 2012
- Representative of the Government of Japan to the International Convention for the Conservation of Atlantic Tunas (ICCAT), 2011-2013
- Representative of the Government of Japan to the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC), 2011-2013
- Special Advisor in Charge of Promoting the Overseas Infrastructural Projects, 2010-2011
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Publications (related to Professional Experience)

- UMEZAWA Akima, 2003, Prevention of crimes: by whom and how?, Proceedings of the 2003 international symposium : Unity in Diversity : Asian perspectives on international law in the 21st century, Oct. 11-12, 2003, Nagoya University, Japan, Japanese Society of International Law and Nagoya University's Research Project on the "Legal Technical Assistance in Asia"; co-editors of the proceedings: Saburi Haruo, Obata Kaoru, Kuong Teilee
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- UMEZAWA Akima, 2005, International prospects over preparation of submission to the Commission on the Limits of the Continental Shelf, Trends in the Science (Japan Science Support Foundation), p26-31.

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III. Abstracts of Presentations

Meteorological Views about Climate Change

Dr. L. Ruby Leung,

Pacific Northwest National Laboratory, Richland, WA, USA

Human activities have significantly perturbed the climate system since the pre-industrial era. While the surface temperature response to the radiative forcing of greenhouse gases is dominated by broad meridional gradients and imprints of land-sea contrast at continental scale, the precipitation response is much more varied, both spatially and temporally. Changes in regional precipitation have serious implications for human society and ecosystems. Improving understanding and projections of changes in water cycle processes is important to inform decisions on climate mitigation and adaptation. In this presentation, I will first provide a brief overview of the evidences of climate change. I will review research findings on projected changes in precipitation and extreme events, and their association with large-scale atmospheric circulation, with the goal of understanding the robust changes projected by climate models. Specific examples related to the Asian monsoon will be highlighted.

Impact of Marine Environment
-The Case of the Climatically Variable Humboldt Eastern Boundary Upwelling Ecosystem-

Prof. Víctor A. Gallardo
Department of Oceanography
University of Concepcion, Concepcion, Chile

As a result of plate tectonics present Earth exhibits four well defined Eastern Boundary Upwelling Ecosystems (EBUEs). These marine ecosystems owe most of their ecological characteristics to Earth´s rotation that raise nutrient-rich deeper waters (upwelling) to the lit surface, which together with local winds, sustain a very productive photosynthetic system. The same dynamics that produce, both an oxygen-poor intermediate water mass (the Subsurface Sub Equatorial Water) and a sulfide-rich sea-bottom (the latter, the so-called Humboldt Sulfuretum), foster the existence of a sulfur-based, highly diversified, prokaryotic (bacteria) dominated chemosynthetic system. Along the geological history of Earth, ecosystems such as those of the HEBUE must have evolved in different geographic locations following plate tectonic. Later, in the geological time scale, this system was joined by the more modern eukaryotic biota.

The HEBUE, located in the most ocean-dominated Hemisphere of Earth, and facing the largest ocean, is subjected, at different space and time scales, to extreme climatic variability, v. gr., at weekly (upwelling events), intra-annual (seasons), inter-annual (ENSO cycle: El Niños and La Niñas), and inter-decadal (Pacific Interdecadal Oscillation) cycles, and probably from even larger time-space scales variability, that alter in greater or lesser degree all major ecosystem parameters.

Moreover, several major extinctions also molded the HEBUE where deoxygenation, acidification and warming have been mentioned as related causes. The end result of all these forces determines the structure and function of present-day marine communities where a very strong contrast between the number of species (species richness) and the information diversity of the prokaryotic versus de eukaryotic communities are observed. While the first exhibit extremely high numbers of species and nearly the maximum theoretical diversity, the eukaryotic communities are poor in both counts, although, instead, abundances and biomasses are high.

As a conclusion, it is posited that the HEBUE, an Eon-old ecosystem, well tested along the geological history, should withstand any “climate change” process, maintaining or perhaps even increasing its primary productivity. It should be emphasized that until now this basic ocean production has not been utilized in our economies beyond basic resource recollection and continues to offer an opportunity for the introduction and application of technologies of long history in the Asian Pacific basin economies such as artificial reef-based ocean farming.

Impact of Climate Change on Coastal Ecosystem and Practice for Adapting

Dr. Shaobo Chen

Professor, Zhejiang Mariculture Research Institute, China

Climate change has caused various negative effects on coastal ecosystems including the increase of sea surface temperature and CO_2 concentration, sea level rise, as well as the changes of precipitation and hydrologic dynamics. The coupling effects of human activities and climate change has further increased the vulnerabilities of the coastal ecosystem. Formulating scientific adapting strategies and adopting efficient adapting measures to improve the coastal ecosystem's resilience therefore become an urgent need globally. In the past few years, Zhejiang Mariculture Research Institute has been very active in studying the coastal ecosystem's adaptation to climate change, as well as in putting proper adapting strategies in practice. These studies and practices mainly include: (1) holding a climate change themed forum – "Marine Eco-civilization Forum"; (2) carrying out two major projects of "Northward Transplantation of Mangrove Adapting to Climate Change", and "Reconstruction of Macro-algal Field"; (3) construction of a "Long-term Ecological Research Site" and establishment of joint laboratories studying climate change simulation and eco-rehabilitation; (4) conducting a Sino-Italian climate change cooperation program- "Ecosystem Adaptation to Climate Change in Coastal Areas of China".

Ocean Acidification

-Potential Economic Implications of Ocean Acidification-

Dr. Christopher Sabine

NOAA's Pacific Marine Environmental Laboratory, Seattle, WA USA

Understanding of the Earth's carbon cycle is an urgent societal need as well as a challenging intellectual problem because of its intimate connection with the Earth's climate system. The ocean plays a major role in the global carbon cycle through the uptake and redistribution of atmospheric carbon dioxide (CO_2). Over the last two centuries the ocean has absorbed over 550 billion metric tons of CO_2 produced from human activities. This absorption has resulted in measurable ocean chemical changes, including a decline in seawater pH, termed ocean acidification. Increasing acidity and related changes in seawater chemistry can affect reproduction, behavior, and general physiological functions of many marine organisms and lead to significant shifts in marine ecosystems. Impacts in some species are already being observed today.

A wide range of economically important marine species including corals, mollusks, crustaceans, echinoderms, and fish will likely be negatively affected by ocean acidification over the coming decades. Scientific understanding of the ocean chemical changes is very high. The effect of those changes on ecosystem services is less well known. Very little work has been done to assess the impact of ocean acidification on the global economy, but some initial estimates suggest it could cost over one trillion US dollars per year by the end of this century. The latest reports from the Intergovernmental Panel on Climate Change begin to assess the societal risk of climate change and ocean acidification. They conclude that the tropical and polar oceans have among the highest risk and the lowest potential for adaptation to reduce risk, but more research needs to be done in these areas.

The international research community is coordinating its efforts to understand the global impact of ocean acidification through organizations like the Global Ocean Acidification Observing Network (http://goa-on.org). In the Western Pacific we are working with groups like the IOC sub-commission for the Western Pacific (http://iocwestpac.org/) and the Secretariat for the Regional Environment Program (http://www.sprep.org/) to expand the observing system and build ocean acidification research capacity. However, more should be done to relate this work to the local and regional economies so we can better understand the economic implications of ocean acidification in the Asia Pacific region.

Stresses on Marine Biodiversity

Dr. Sheila G. Vergara
Director of Biodiversity Information Management of
ASEAN Centre for Biodiversity

Marine biodiversity generally refers to the richness of species and habitats that reside in the world's oceans. In the ASEAN Region, marine and coastal ecosystems are considered as one of the most valuable natural assets. Based on the ASEAN Biodiversity Outlook (2011), nine of the ten ASEAN Member States in Southeast Asia are endowed with extensive coastlines, providing an aggregate total of some 173,000 kilometers of shoreline. The region hosts 28 percent of the world's coral reefs, 35 percent of mangroves and at least 33 percent of all seagrass environs on earth. These ecosystems support the highest biodiversity of coastal and marine fauna and flora in the planet. An estimated 600 million people depend directly on these resources for food and income that also form the economic base for the fishing and tourism industries of the region.

In addition to providing food and livelihood, coastal and marine ecosystems provide functional services including: protection of water resources, nutrient storage and cycling, pollution breakdown and absorption, contribute to climatic stability, recovery from unpredictable events (e.g., typhoons and hurricanes), medicinal resources and recreation. Unfortunately these rich natural resources are faced with pressures that may diminish their ability to supply food, functional buffer zones for natural weather disturbances, and livelihood for communities.

The key drivers of biodiversity loss in Southeast Asia include ecosystems and habitat change, climate change, invasive alien species, over-exploitation (as a result of deforestation and land-use and water-use change, as well as wildlife hunting and trade for food), pollution and poverty. The ASEAN marine environment is particularly threatened with a) habitat change through the use of destructive fishing implements and deforestation, b) climate change through temperature increase, sea level rise and variability in precipitation, c) invasive alien species through introductions intended to improve food production and support for the aquarium industry, d) overfishing e) pollution from industrial, domestic and agriculture-associated wastes and f) a general increase in populations and consumption – related requirements.

There is thus an urgent need to develop appropriate management measures such as establishing marine protected areas (MPAs) and MPA networks, as well as promulgate policies that allow marshes, mangroves and other coastal ecosystems to persist and make these ecosystems more resilient to the impact of sea level rise, and thus protect the vital services they provide.

Implications for Marine Ecosystem

Dr. Yoshihisa Shirayama
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In the end of this century, the atmospheric concentration of carbon dioxide (CO_2) may become twice as large as the level before industrial revolution. In such high CO_2 world, the marine environment will change dramatically due to climate change and ocean acidification. For example, the area favorable for the growth of reef-building coral probably will disappear around 2060, because high sea-water temperature causes coral bleaching, whereas in lower temperature area, ocean acidification will be more serious. To overcome the problem, several mitigation options have been proposed, such as carbon capture and sequestration (CCS). In addition, many projects to utilize marine resources such as manganese nodules, methane hydrate, and deep-sea fishes are under planning. These human action however may damage the marine ecosystem seriously, and various sectors are arguing about implementation of these plans. For the continuous development of human society, sustainable use of marine resources and conservation of the health of the ocean are both essential, and to realize both these two issues, it is the most important that the uncertainty of the prediction regarding the future of marine environment should be minimal and well reliable based on holistic scientific knowledge.

Sea Ice Decline
- Catastrophic reduction of sea ice in the Arctic Ocean and global influences -

Dr. Koji Shimada
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The rate of recent sea ice reduction in the Arctic Ocean is beyond that of global warming. This evidence has been recognized as a polar amplification. To understand mechanisms of the recent rapid changes in the Arctic, order of sequential changes to accelerate sea ice reduction are significant. Here we introduce fundamental mechanism affecting the recent catastrophic reduction of sea ice associated ice-ocean coupled dynamics.

The first domino of the sequential changes is the strengthening of upper ocean circulation caused by the effective momentum penetration from atmosphere into the ocean via sea ice. The less sea ice condition reduced the momentum dissipation inside the sea ice as an internal stresses. Then the surface stress at the top of the ocean is increased and the upper ocean circulation is strengthened even under the same wind stresses. The activated upper ocean circulation delivered huge amount of heat within the Pacific Water into the Arctic basin. The warming of the upper ocean resulted in less sea ice formation in winter there. An imbalance between sea ice growth in winter and melt in summer caused total sea ice reduction and less ice condition. These sequential changes form a positive feedback loop with “no-rebound” reduction of sea ice in the Arctic Ocean. This is not variation, but is catastrophic change. The rapid sea ice decline promotes global warming, and leads regional extreme climate events far from the Arctic region since earth climate system is driven by energy balance between tropical region and polar region.

Implications for Global Trade and Distribution System

Dr. Natsuhiko Otsuka

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The Fifth Assessment Report (AR5) of Intergovernmental Panel on Climate Change (IPCC) pointed out that the Arctic is warming twice as fast as the rest of the world. In spite of scientific uncertainty involved, the current scientific consensus indicates that the Arctic Ocean may experience ice free summers in the 2030's. According to the satellite sea ice monitoring since the 1970s, the Arctic sea ice extent has shown a long-term decreasing trend especially in summer.

In recent years, commercial shipping route through the Arctic attracts attention due to the sea ice retreat in summer. In general, there are three Arctic shipping routes known as the North East Passage (NEP), the North West Passage (NWP) and the Trans Arctic Route. In 2010, under the cooperation between Norwegian shipping companies and the Russian companies, pilot commercial shipping via the NEP between Europe and East Asia by a non-Russian flag cargo ship had been carried out. Following this historical voyage, shipping across the Arctic via the NEP rapidly increased transporting cargoes such as iron ore, coal, gas-condensate, naphtha, jet fuel and LNG.

It is widely known that the NEP can shorten shipping distance between northern Europe and East Asia by about 30~40% compare to the conventional shipping route via the Suez Canal. It is gradually demonstrated not only that ship can sail through the NEP as planned, but also the NEP can reduce fuel consumption and fuel cost, shorten sailing time, and thereby reduce the total shipping cost. At the same time, it has been pointed out that it is not easy to predict sea ice conditions, search and rescue system is underdeveloped, the state of preparedness against accidents is still low, and the sailing season is limited for about 5 months.

With the background of the Arctic sea ice retreat and growing demand of natural resources, hydrocarbon development in the Arctic is becoming a reality. Russia has already producing crude oil in the eastern part of the Barents Sea. The Yamal LNG Project in the Ob Bay coast is expected to start production from 2017. All these projects heavily rely on the transportation through the NEP. The Yamal LNG shipping will become the first international regular shipping activity through the NEP. Thus, a small but brand-new card, which provides hydrocarbon to Asia and Europe from the Arctic, will be placed on the table of the world energy market. Furthermore, it is interesting that the shale-LNG will also appear into the market at the same year.

As is widely known Asia has become the center of world maritime transport in terms of both cargo origin and destination today. Asia will also become a major actor in the Arctic shipping via the NEP. The NEP will attract Asian users by reduction of shipping cost and sailing time, supplying energy resources from the Arctic, and providing new shipping lane free from pirates. At the first stage, the NEP will be regarded as a niche shipping market or an alternative shipping route. However, it could provide new relationship between Europe and East Asia, while these two have been the farthest territories each other.

The Arctic is becoming more accessible due to climate change and technological advance, and is gaining international importance. Asian areas could be important stake holders of the Arctic shipping. At the same time, close attention should be paid for sustainability in the use of the Arctic.

Climate Change Effects on Fisheries

Mr. Árni M. Mathiesen
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It is often overlooked that over 800 million people depend, directly or indirectly, on fisheries and aquaculture for their livelihoods. In addition, fish provides essential nutrition for over 4 billion people and at least 50 percent of animal protein and essential minerals to 400 million people in the poorest areas. Trade is also an important characteristic of fisheries and aquaculture: fish products are among the most widely-traded foods, with more than 37 percent by volume of world production traded internationally. At the same time, climate change and ocean acidification are bringing an ocean of change to the world's fisheries and the communities and economies that depend on them. Climate change has the potential to compound existing pressures on fisheries and aquaculture, but can also provide opportunities. For example, the projected increasing water temperatures stemming from greenhouse gas (GHG) accumulation will also likely result in changes in distributions of species, with many marine species ranges being driven toward the poles, expanding the range of warmer-water species and contracting that of colder-water species whereas migration possibilities for freshwater fish is limited to the catchment area and hence endemic species and species in fragmented habitats will be at risk. Whether positive or negative, these changes will have social and economic impacts on the fisheries and aquaculture industries and communities - possibly causing mismatches between where the fishing happens and where it is landed or processed, changes in fish farm profitability either through inputs needed or productivity of individual farms, or through the disappearance of traditional sources of local food and livelihood security. At the macro scale, there will likely be implications for international fisheries management due to changes in the distributions of trans boundary fish stocks. CO_2 accumulation is also increasing the acidification of aquatic systems, with potentially severe consequences for shellfish and squid, mangroves, tropical coral reefs and cold water corals. In addition, changes in frequency or intensity of extreme climatic events can affect fish habitat, productivity, and species distributions. These same events can also have direct impacts on fishing operations and the physical infrastructure of coastal communities. Storm and severe weather events, can destroy or severely damage assets such as boats, landing sites, post-harvesting facilities and roads. This loss of infrastructure often leads to a decrease in harvesting capacity and access to markets, affecting both local livelihoods and the overall economy of the coastal communities. The question of how to meet increasing demand for fish in the face of climate change poses a great challenge to fisheries and aquaculture management. This presentation will discuss the contributions of fisheries and aquaculture to growth, food, nutrition and livelihood security, the climate change implications for the sector – from vulnerability to adaptation, as well as win-win GHG mitigation from within the sector, to help ensure the economic growth, food, nutrition and livelihood objectives for the sector.

Adaptations to Ecosystem Affects and Marine Environmental Shifts -Marine Environmental shifts caused by the Global Climate Change and Adaptations to Ecosystem change in Japanese Fisheries-

Mr. Masanori Miyahara
President, Fisheries Research Agency, Japan

The dominant fish species alternation among the economically important species in fisheries such as sardine, anchovy, mackerel, Pollock etc. occurred from ancient periods along with the climate regime shifts. The global warming trend in the ocean clearly observed in the recent decades was added to the decadal climate regime shifts as a major affecting factor. Long term monitoring research conducted by Fisheries Research Agency, Japan has detected the effects of the climate change on the status of phenology of fishery grounds. The research identified changes of the survival rate, growth rate, and distribution area of Japanese sardine (Sardinops melanostictus) in relation to the variability of water temperature and their food conditions of their habitat. The change of the flora of seaweed beds according to the recent warming trend is also clearly observed. Using the models of physical oceanography and ecosystem structure with the monitoring data, it became possible to predict the distribution pattern of the important species in fisheries, e.g. Japanese sardine or Pacific saury (Cololabis saira) while significant uncertainties are associated. The prediction is useful for preparation to meet the infrastructure of fish markets, fish processing industries, etc. In this presentation, the recent results of the studies in fisheries oceanography in relation to the ecosystem change, and the attempt to adapt the fisheries to climate change are shown.

Blue Carbon
Coastal Carbon in Indonesia: From Research to Policy and its Implementation

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[1] Director General and Senior Research Scientist; [2] Research Scientist

Agency For Marine & Fisheries Research & Development

Ministry of Marine Affairs & Fisheries, The Republic of Indonesia

Having the second longest coastal line in the world, Indonesia is rich of vegetation and other marine organisms in its coastal ecosystem. The ecosystem which mainly consists of mangroves, seagrasses and salt marshes has been claimed to be able to store carbon five times the amount stored by tropical rainforests per square kilometer. These carbon are known as blue carbon and having almost 23% of the world's mangrove and the largest area of seagrass system, Indonesia plays a significant role in global climate change and initiatives to mitigate the effects. Coastal ecosystem is facing anthropogenic stresses in many parts of the world including Indonesia. This has resulted in ecosystem degradation inhibiting its ability to sequester carbon, and even more will significantly contribute to climate change, especially through CO_2 emissions. This will in turn threaten the life of coastal communities. To minimize these adverse impacts, studies in blue carbon has been initiated since 2011, and getting wider attention in the country. From a series of meetings, workshops and field study, it became necessary that there are affirmative actions should be taken such as defining adequate measures and most appropriate process to address current and long-term impacts issues in coastal areas, including vulnerability of coastal ecosystems, degradation of water quality, changes in hydrological cycles, depletion of coastal resources and adaptation to sea level rise and other impacts of global climate change. Ministry of Marine Affairs and Fisheries has also putting actions including the establishment of Blue Carbon Center to implement further policies. This paper describes the initiatives taken, from research down to implementation within the last years.

Keywords: coastal carbon, Indonesia, research, policy, implementation, blue carbon

IV. Remarks

APEC
Asia-Pacific Economic Cooperation
APEC
Workshop
Ocea
DR. AKIMA UMEZAWA
ATTY. ASIS G. PEREZ

Welcome Remarks

1. The OFWG Lead Shepherd, Atty. Asis Perez, welcomed the participating economies to the Philippines. He gave a brief overview of Boracay, which is known for its sprawling white sand beaches and unique lifestyle and culture, but is faced with challenges and is vulnerable to effects of changing global climate patterns.

2. He shared that Philippines has raised to UN-World Tourism Organization, ASEAN International Conference on Tourism and Climate Change the concern on possible loss of Philippine beaches due to effects of climate change.

3. He noted the importance of the workshop which aims at addressing the effects of climate change on marine ecosystems and sustainable use of fisheries resources, and is considered as one of the highlights of the Oceans and Fisheries Working Group (OFWG) for 2015, which is held in time with the Month of the Ocean.

4. He then recognized the Government of Japan for initiating the project and organizing the workshop, and acknowledged Mr. Miyahara's presence, whom he considers as one of his mentors. He also expressed gratitude to the co-sponsors such Peru, Viet Nam and the Philippines, and thanked the speakers, delegates and the APEC Secretariat and wished everyone a productive workshop.

Opening Key Remarks

1. Prof. Nobuaki Okamoto, President of Tokyo University of Marine Science and Technology in Japan expressed his pleasure to give the opening remarks for the workshop and thanked Philippines for the hospitality accorded to the participants in Boracay Island. He also congratulated Japan for successful preparation of the workshop.

2. He informed the workshop of that though Japan greatly benefits from the ocean in developing their economy, it has also suffered various natural disasters, which caused them to continuously work towards creating a robust and resilient nation. He shared the key features of Japan's 5 Year Plan of Oceans Policy which was adopted in 2013, that calls upon Japan to promote and disseminate disaster prevention technologies to other members.

3. He then emphasized the big role of fisheries and aquaculture to the global food security and economic growth in the APEC and outlined the agenda items that will be discussed during the day.

4. Finally, he recognized that climate change has now been mainstreamed as priority issue in APEC and enjoined the scientific based policy making in the future.

V. APEC Project Proposal

APEC Project Proposal

Project title and number:	**OFWG 02 2014 – Workshop on the Climate Change Impact on the Oceans and Fisheries Resources: Ensuring Adaptation, Food Security and Sustainability, and Mitigation on Fisheries including Aquaculture**
Source of funds *(Select one)*: ☒ Operational Account ☐ TILF Special Account ☐ APEC Support Fund	
Committee / WG / Sub-fora / Task-force:	Ocean and Fisheries Working Group (OFWG)
Proposing APEC economy:	Japan
Co-sponsoring economies:	Peru, the Philippines and Viet Nam
Expected start date:	July 2014
Expected completion date:	December 2015
Project summary: **Describe the project in under 150 words. Your summary should include the project topic, planned activities, timing and location:** *(Summary must be no longer than the box provided. Cover sheet must fit on one page)*	This project is aimed at providing better awareness to the ineluctable impact of the climate change on the oceans and fisheries resources and at widely sharing good adaptation practices with regard to ocean and fisheries related activities including the aquaculture. APEC economies account for 70 percent of global consumption of fish products, and these fisheries' products are among the most traded food commodities. As the impact of the climate change will bring increasing uncertainty in ocean and fisheries related activities around the world, the project will focus on the following objectives through the two-day workshop: - Sharing experiences and knowledge accumulated through scientific research as well as success stories of innovative measures to adapt to the impacts of climate change on ocean and fisheries related activities especially for ocean-dependent communities' activities and products for their livelihoods, and establishing a coordinated framework for this sharing; and - Strengthening policy coherence and development of comprehensive preparedness on ocean and fisheries related activities in the approach to climate change adaptations, especially in vulnerable small-scale and artisanal communities.

Summary of Proposed Budget: (USD)	**APEC funding**	**Self-funding**	**Total**
	117,820	**Nil**	**117,820**

Project Overseer Information and Declaration:

Name: Akima Umezawa, Ph.D.

Title: Cabinet Counsellor

Organization: Cabinet Secretariat (Oceans Policy), Government of Japan

Postal address: 3-7-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-0013, Japan

Tel: +81 3 6257 1763 ***E-mail:*** akima.umezawa@cas.go.jp

As Project Overseer and on behalf of the above said Organization, I declare that this submission was prepared in accordance with the **Guidebook on APEC Projects** and any ensuing project will comply with said Guidebook. Failure to do so may result in the BMC denying or revoking funding and/or project approval. I understand that any funds approved are granted on the basis of the information in the document's budget table, in the case of any inconsistencies within the document.

Akima Umezawa
Date: 22 May 2015

Project Details

SECTION A: Relevance to APEC

1. **<u>Relevance:</u> Why should APEC undertake this project? What problem or opportunity will the project address and why is it important?** *[½ page]*

APEC economies account for 70 percent of global consumption of fish products and 90 percent of global aquaculture production. As fisheries and aquaculture make crucial contributions to the world's well-being and prosperity, fish and fishery products are among the most traded food commodities worldwide. In the next decade, total production from both fisheries and aquaculture will exceed that of beef, pork or poultry, according to the FAO.

Today, the global community faces multiple and interlinked challenges of greater climate change vulnerabilities. The vital contributions from fisheries and aquaculture to global food security and economic growth would seriously suffer from the impact of the climate change. The oceans and the benefits derived from oceans are being threatened by climate change through temperature increases, changing distribution of living marine resources, sea level rise and ocean acidification. If we would fail to properly address it, it could seriously threaten the sustainability of fishing community and the integrity of marine ecosystems. Adaptations and mitigation to the impact of climate change are also required in educational, social or economic systems.

Securing the source of animal protein is indispensable contribution to the food security, which is provided through the free and open trade and investment. This requires widely acceptable and flexible approach enabled by APEC Non-Binding Principles and consensus-based procedure. APEC is the best platform for sustainable-compatible approach with a view to maximize the harmonization between inclusive economic growth and global environment conservation.

The project responds to such requirements, in terms of the mandate under the OFWG which facilitates cooperation to promote the sustainability of economic resources and vitality of fishing and aquaculture industries and to expand the seafood trade.

2. **<u>Objectives:</u> Describe the 2-3 key objectives of the project. (e.g. to create a framework for…; help participants to...; share experiences in...; enhance understanding of...; etc.)** *[¼ to ½ page]*

The climate change impact is nonreversible to the ocean environmental gradation and will bring increasing uncertainty to fishery and aquaculture. An approach to climate change adaptations will need to be well integrated with the processes of improving fisheries and aquaculture governance. In order to significantly mitigate and reduce the climate change impacts on fishery and aquaculture as well as on ocean ecosystems, the specific objectives are:

- To share APEC economies' experiences and knowledge accumulated through the researches and good practices, and establish a coordinated framework to share them;
- To enhance and integrate understandings of the increasing vulnerability of fisheries, aquaculture and their communities to climate change and develop comprehensive preparedness in these sectors, and contribute to the policy coordination for better management on climate change adaptation and alleviation.
- To strengthen policy coherence and institutional structures to ensure explicit and adequate consideration of fisheries and aquacultures in the approach to climate change adaptations, and produce these policy recommendations and best practice guideline as well as to explore to transfer of innovative technology with anticipation of each economy's situation.
- To share and acknowledge the result in the forthcoming OFWG, and moreover preferably the result will be acknowledged in the high level meeting regarding to Oceans and Fisheries (e.g. AOMM5).

The project may also mention Arctic sea issues. The climate change has caused its impact on the Arctic Sea more quickly than the rest of oceans. Melting the Arctic ice due to the climate change opened and has increased the shipping along the Northern sea route in the Arctic, which has potentially the significant impact on world shipping trade patterns, especially for the economies facing the Pacific Ocean. APEC is the best platform tackling with this environmental and trade impact in this regard.

3. **<u>Alignment:</u> Describe how the project will help achieve APEC's key priorities and meet your forum's work-plan or medium-term plan.** *[less than ½ page]*

The Project delivers the immediate response to the APEC 2013 Leaders' Declaration which stated, being mindful of the grave economic consequences of natural and human-caused disaster, such as the impact of climate change on oceans, the leaders committed to pursue cross-sectorial work under the APEC Initiative on Mainstreaming Ocean-related Issues, that will maintain the health and sustainability of our oceans and coastal resources for the benefit of food security, poverty eradication, preservation of traditional culture and knowledge, conservation of biodiversity and facilitation of trade and investment.

Since the Project strengthens the policy coherence and evolves comprehensive preparedness on sustainable growth of economic and social activities benefitted from oceans in the approach to climate change adaptations, it contributes the development of the Blue Economy, a long-term integrated ocean policy for the sustainable development and the protection of the marine environment, as a priority area of cooperation defined by this year's Chair economy, China. In addition, "ocean-related issues (see below*)" has taken the 2014 Rank 1 Funding Criteria, which specifically and significantly contribute to promoting regional economic integration via free and open trade and investment.

*: "Mainstreaming ocean-related issues for economic growth, including blue economy, conservation and sustainable development of coastal and marine resources"

The Project enhances the area of commitment of the Paracas Declaration and Paracas Action Agenda, adopted by the APEC Ocean-related Ministers (AOMM) in 2010, which manifested the impact of climate change on the oceans as a main area of strengthened implementations for addressing key oceans-related challenges. The project also reaffirms the Bali Plan of Action concluded by the APEC Ocean-related Ministers in 2005, which addressed a better understanding of effects of climate changes. It also supports the effort to achieve the one of the priorities in the "Ocean and Fisheries Working Group Strategic Plan 2013-2015 (page 3, "Climate Change").

This Project follows the APEC endeavors in line with priorities of not only the stream of the outcomes from the vigorous discussions of the AELMs as well as the AOMMs and the OFWG but also this year's priority area of cooperation. As utilizing the result of precedent work as APEC Project (e.g. IST 03 2011A – which was approached science and technology) as much as possible, this project will focus on the prospect for the development of economy and trade through the sharing information and good practice in order to facilitate the multi-layered and comprehensive approach to this issue.

In the meantime, the FAO Committee on Fisheries in 2013, placed emphasis on programme frameworks, mitigating the impacts of climate change on livelihoods especially in small-scale fisheries, gender mainstreaming, technical assistance and capacity building in support of sustainable capture fisheries, and reducing post-harvest losses; and emphasized the need for further work to understand the ecological and social impacts on aquaculture from climate change. This project will also help to achieve one of the priorities in Strategic Plan for 2013-2015 OFWG (3.4) as well as Work Plan for 2014 OFWG (1.4).

4. **For TILF Special Account applications: Briefly describe how the project will contribute to APEC trade and investment liberalization and facilitation with reference to specific parts of the Osaka Action Agenda (Part 1, Section C and, where appropriate, Part 2).**
   For APEC Support Fund applications: Briefly describe how the project will support the capacity building needs of APEC *developing economies*, and how they will be engaged. *[¼ page]*

SECTION B: Project Impact

5. **Outputs and Beneficiaries:**
   - **Describe the outputs (e.g. workshop, tool, research paper, recommendations, etc.)**
   - **Describe the direct project participants and users of the outputs. Explain how the project outputs will benefit them.** *[½ to ¾ page]*

The main part of the project will be implemented through a 2 day workshop to be taken place in the city in Philippines, 2015 APEC Chair economy, in May 2015, or in the margin of the OFWG4. The project will focus on the following objectives through the workshop:

- Sharing experiences and knowledge accumulated through scientific research as well as success stories of innovative measures to adapt the impacts of climate change on fisheries, woman's perspective and possible role models for women involved in the adaptations efforts to this issue, and establishing a coordinated framework for the above information sharing; and
- Strengthening policy coherence and development of comprehensive preparedness on fisheries and aquaculture in the approach to climate change adaptations, especially in vulnerable small-scale and artisanal communities.

The speaker and lecturer will be invited from the relevant multilateral organizations such as FAO to ensure this Workshop is complementary and not duplicative.

Workshop presentations and outcomes for the above objectives will be compiled into a report, allowing lessons learnt to be disseminated via an electronic format more broadly not only within the APEC economies but also for the relevant international communities.

The direct beneficiaries of the project are ocean-dependent communities in APEC economies, especially of their citizens, most specifically those who rely on oceans activities and products for their livelihoods, including women in the communities. The project will also contribute the beneficially of the fishermen association and women groups depending on small-scale fisheries activities, which are most vulnerable to the impact of climate change. Sharing information and good practices (including exploring the possibility to transfer the innovative measures) for adaptation and mitigation according to changes on the Oceans should be concrete profit especially small-scale and artisanal fisheries.

Relevant stakeholders, such as the key decision-makers within governments, academia and the scientific communities and private sector including fisheries and aquaculture communities will be invited to attend the workshop.

6. **Dissemination:** **Describe plans to disseminate results and/or outputs of the project, including:**
   - **The number, form and content of any publications. (Note: APEC will not fund website maintenance or publications that are collections of PowerPoint slides. APEC encourages electronic publication.)**
   - **The target audience.**
   - **Any intention to sell outputs arising from this project.** *[less than ½ page]*

The project will produce fact sheets, booklets, scientific papers for the effective distribution through APEC economies and the relevant APEC fora, including the dissemination by the APEC website. These outcome documents will be also sent to other international and regional organizations such as FAO, CPPS, RFMOs, and NGOs.

The project will also create a platform for exchanging and sharing information with key beneficiaries, stakeholders, decision makers and policy makers. It is planned to enhance the networks building throughout the beneficiaries and stakeholders. The project will also be followed by similar formats of information and knowledge sharing, having alignment with the basis resulted in by this workshop.

The two-day workshop will demonstrate the efficiency and effectiveness to meet sustainable use of oceans and fisheries resources through adapting and mitigating the impact of climate change, and also elaborate practical recommendations aimed to support small-scale fisheries activities in APEC developing economies.

(This project will lead to maintaining webpage on the APEC website for policy maker, scientists, government officers and representatives of the relevant institution. PO has begun already consultation with APEC CPAU Media Manager Mr. Hendrickson about advertising and post awareness of this project.)

7. **Gender:** **What steps will the project take to ensure the participation and engagement of both men and women throughout the project? How do project objectives benefit women?** *[less than ½ page]*

Women in the oceans communities will be actively involved throughout the planning, implementation, and delivery phases, as mentioned in the above section of the beneficiaries. There is an intention to identify and engage female experts to present during the workshop, in order to represent a woman's perspective and serve as possible role models for women involved in the adaptations efforts to the impact of the climate change on the oceans. Each APEC economy is also encouraged to put forward qualified woman participants in the workshop. The project will contribute the beneficially of women groups working in small-scale fisheries communities, which are one of the most vulnerable society to the impact of climate change.

SECTION C: Project Effectiveness

8. **Work plan:** **Provide a timeline of actions you will take to reach your objectives. For each, include:**
   - **How it will be carried out and how member economies, beneficiaries & others will be involved**
   - **Related outputs for that particular step (e.g. contract, agenda, participant list, workshop, report)** *[1-2 pages. Answers may be taken or adapted from the Concept Note]*

The following timeline of preparation, organization and implementation are planned.

July 2014 to April 2015

The project initially develops the program of the workshop, including the arrangement of the concrete direction of the theme and agenda setting, as well as the coordination of the logistic preparation such as the meeting venue. Then, the coordination between each agenda and lecturer follows the theme setting. Dissemination image is also built on through consultations with some key lecturers. The participants from eligible APEC economies are selected by each economy.

May 2015

The project conducts a 2 day workshop on the impact of the climate change on fisheries and aquaculture, which will contribute the sustainable development of fishery and aquaculture especially in small-scale and artisanal fisheries communities. The project contributes the promotion of the Mainstreaming Oceans-related Issues for economic growth, including conservation and sustainable development of ocean resources, especially for the 5th meeting of the OFWG.

June – July 2015

The project produces outcome documents described in the above "Dissemination", and circulate and distribute them, for the outreach effects facilitating an effective capacity building.

By December 2015

PO submits the project completion report.

9. **Risks: What risks may be involved in implementing the project and how will they be managed?** *[⅛ to 1 page, depending on project nature/complexity]*

Risk	Management
Schedule conflicts, lecturers' unavailability	Account will be taken of the meeting dates of relevant international fora, such as FAO, CPPS, and RFMOs, in order to avoid schedule conflicts. Project oversees liaises with 2015 Host Economy, Philippines, and key lecturers on timing of the workshop. The schedule and contents of the workshop will be freely accessible for all APEC economies as well as relevant international communities.
Lack of participants' interests	Co-sponsors will be consulted on agenda and speakers to ensure relevance. Information about the workshop will be provided at the OFWG and circulated to all relevant APEC fora. The schedule and contents of the workshop will be widely distributed to all APEC economies.
Duplication of work of other for a	During the development of the workshop program, necessary consultations will be organized with the relevant international organizations which have worked in the areas of oceans and fisheries, including the related APEC fora.
Inadequate logistics, and lack of resources and supports for lectures and participants	Project overseer will facilitate constant consultation with the host economy as well as co-sponsor economies in order to ensure the adequate logistics with regard to the workshop holding and the effective support for lecturers and participants.

10. **Monitoring and Evaluation: What indicators will you use to know if the project is on track (monitoring) and successful in meeting its objectives (evaluation)? What information will you collect (e.g. stakeholder feedback, website hits, participant stats etc.) and how will you collect it (e.g. meetings, surveys, interviews, peer review, records review)?** *[½ page]*

The project will be monitored and evaluated through extensive reviews and improvements of the relevant theme setting, appropriate agenda and lecturer coordination, effective and constructive consultations with lecturers, reflection on the prior consultations with participants to gather their desires, initial feedback using a questionnaire distributed to both lecturers and participants just after the workshop.

Post-workshop feedback process will be also conduct, in order to accumulate the further opinions with regard to the outcomes of the workshop. Lecturers and participants will gather such opinions from their communities. PO conduct reviews and final project report including monitoring based through the suggestions, criticizes and opinions from the participants and lecturers at 2 months later from the Workshop.

11. **Linkages: Describe the involvement of other APEC fora, and other relevant organizations. Include:**
- ***Engagement:* How are you engaging other relevant fora, within and outside of APEC?**
- ***Previous work:* How does this project build on, yet avoid duplication of, previous or ongoing APEC initiatives, or those of other organizations?**
- ***APEC's comparative advantage:* Why is APEC the best sources of funds for this project?**

[¼ to 1 page. Answers may be taken or adapted from the Concept Note]

Engagement: The OFWG has been informed of Japan's intention to develop this project proposal and has had the opportunity to comment on the project's Concept Note. Japan also has its intention to share information about the project with relevant key economies as well as relevant international organizations such as FAO, CPPS, RFMOs, and NGOs. These preparation processes of the outreach engagement improve well coordination for the up-to-date information sharing.

Previous work: The issue of the climate change adaptation has been addressed in 2011 under the project titled as "Climate Change Adaptation in the Asia-Pacific (IST 03 2011A)" proposed by Japan and USA. However, it was dealt with in the forum of Industrial Science and Technology Working Group (ISTWG) with regard to the topics of Science and Technology, and has never focused on the issue in the context of fisheries and aquaculture as a main theme. This project will address the contribution for the sustainable development of fishery and aquaculture, especially focusing on the adaptation by small-scale and artisanal fishery communities, and follows up the above project (IST 03 2011A) as well.

In the meantime, the FAO has addressed the impact of the climate change on fisheries. The Committee on Fisheries, a subsidiary body under the FAO, placed emphasis on programme mitigating the impacts of climate change on livelihoods at its 30th Session held in June 2013. The project overseer will hold a necessary consultation in order to facilitate better coordination for the synergy effects and outcomes.

APEC's comparative advantage: As APEC economies account for 70 percent of global consumption of fish products and 90 percent of global aquaculture production, the APEC is the best international body to address the economic and social impacts related to the oceans and the benefit from oceans, with a sense of ownership. Securing the source of animal protein is indispensable contribution to the food security, which is provided through the free and open trade and investment. This requires widely acceptable and flexible approach enabled only by APEC Non-Binding Principles and consensus-based procedure.

SECTION D: Project Sustainability

12. **Sustainability: Describe how the project will continue to have impact after the APEC funding is finished.**
- **How will stakeholders and beneficiaries be supported to carry forward the results and lessons from the project?**
- **After project completion, what are the possible next steps to build on its outputs and outcomes? How will you try to ensure these future actions will take place?** *[less than 1 page]*

The workshop presentations and documents will be compiled, enabling workshop participants to disseminate the outcome materials more broadly within their economies. The workshop outcome materials will be also available via the APEC meeting document portal, and will thus remain accessible to not only participants but also everyone in the future.

The project will also create a platform for exchanging and sharing information of know-how and any innovative measure with key beneficiaries, stakeholders, decision makers and policy makers. The project will be followed by the workshop or similar forum with some alignments based on the result of the workshop. It helps the enhancement of the networks building throughout the beneficiaries and stakeholders.

13. **<u>Project Overseers:</u> Who will oversee the project—including any hiring of contractors—and drive it to success? Please include the names and brief biographies of the PO and any other main point(s) of contact responsible for this project.** *[less than ½ page]*

    The project will be overseen by Dr. Akima Umezawa. Dr. Umezawa is a Cabinet Counsellor, the Cabinet Secretariat in charge of the Oceans Policy in the Japanese Government. He joined the Ministry of Foreign Affairs (MOFA) in 1991, and has tackled many oceans issues in his professional carrier in the MOFA, by many assumed positions including Principle Deputy Director of the Ocean Division in 2002 - 2005, and Director of Fisheries in 2011 – 2013. He also has served lots of oceans related roles, as Advisor of the Representative of the Government of Japan, International Court of Justice (ICJ), the case concerning Whaling in the Antarctic (Australia v. Japan) in June - July 2013; Chairman of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) in 2012; Representative of the Government of Japan to the International Convention for the Conservation of Atlantic Tunas (ICCAT) in 2011-2013; Representative of the Government of Japan to the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC) in 2011-2013; Chairman of the Negotiation on the Convention, "Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia (ReCAAP)" in 2003-2005; and Member of Experts, the Global Reporting and Assessment of the State of the Marine Environment, including Socio-Economic Aspects, United Nations, in 2004.

    Mr. Kiyotaka Tanaka is the alternative contact point for this project. Mr. Tanaka is a Cabinet Officer, the Cabinet Secretariat in charge of the Oceans Policy in the Japanese Government.

SECTION E: Project Efficiency

14. **<u>Cost Efficiency:</u> Highlight how the project offers APEC maximum value for money. In what ways will the project maximize the cost-efficient use of resources?** *[¼ to ½ page]*

    It is vital to be supported by experts, institutions and the other international organizations. Participants will be expected to contribute to non-allowable APEC expenses. Participants who are not selected by each APEC economy are also welcome to attend the workshop at their own cost. The workshop outcome documents will be published electronically in the CD format and related websites with open access. Everyone who has interests in the topic of the impact of the climate change on the oceans and fisheries can access as well as download the relevant workshop documents. The Project Overseer will track every financial record for monitoring expenses with the APEC Secretariat to ensure financial austerity. There is a concerted focus to ensure cost-efficient use of resources.

15. **<u>Budget:</u> Complete the budget and budget notes for the project in the template in SECTION F of this form. The budget should include calculation assumptions (e.g., unit costs) and self-funding contributions. Please consult the *Guidebook on APEC Projects* for eligible expenses.**

SECTION F: APEC Project Itemized Budget
Please consult the descriptions of eligible expenses in the *Guidebook on APEC Projects*

All Figures in USD	**# of Units**	**Unit Rate**	**APEC Funding**	**Self-Funding**	**Notes**
Direct Labour					
Speaker's honorarium (*government officials ineligible*)	(6 of speakers)	$1,000	$6,000		
Short-term clerical fees	(# of hours)				
Contractor (including Contractor's Secretarial and Researchers') fees	(4 days, 32 of hours)	$2,400	$9,600		
Travel (Speaker, Experts, Researchers)					
Per diem (incl. accommodation and "75% additional payment")	(6 of persons 5.75 days)	$234	$8,073		Iloilo City, Philippines. Note 3
Airfare	(6 of persons and trips)	N/A	$31,955		Economy Class, Note 4
Travel for Participants (from travel-eligible economies only. Active participants only)					
Per diem (incl. accommodations and "75% additional payment")	(11 of persons 5.75days)	$234	$14,801		(cf. Note 3)
Airfare (*restricted economy class)*	(11 of persons and trips)	N/A	$32,671		Economy Class
Other items					
Publication/distribution of report	(500 of copies)	$5	$2,500		English Version
Specialized equipment or materials (*please describe*)	(type, #, and # of days)	$1,560	$3,120		Rental for 2 days; 2 Projectors, 8 monitors , 24 microphones, speaker
Photocopying	(# of copies)				
Communications (telephone, fax, mail, courier)		$50	$100		Wi-Fi setting for 2 days
Hosting	(units as appropriate)	$4,500	$ 9,000		Note 5
		Total	**$117,820**		

Budget Note 1: Direct Labour: Provide information for APEC-funded positions including general duties, total hours and who will be contracted, if known. (It is not acceptable to contract staff from your own organization or government employees.)

N/A.

Budget Note 2: Waivers: Provide details of any requests for waivers from the normal APEC financial rules, with justifications (e.g. from tendering requirements, for advance payment, simultaneous interpretation payment) in the notes column of the budget table, or below if the waiver requires a detailed explanation.

Budget Note 3: PO's plan: (uncertainty on the venue and unavoidable stopover in Manila for speakers/participants.)

Per diem is calculated for 5.75days for Manila in order to set aside budget in case of changing venue and/or stopover there. The extra per diem will only be accorded to traveler who requires accommodation for an unavoidable overnight transit.

Budget Note 4: PO's plan: speakers will be invited from

Washington D.C.
Moscow
Rome (FAO)
Lima (CPPS Peru)
Montreal (Convention of Biological Diversity)
Qingdao

Budget Note 5:

This is for 2 days Conference room rental with basic instruments, excluding electric devices. The amount budgeted is estimated on the basis of previous project (HWG 03/2013A actual payment to Marriott Hotel, Manila) and consultation with above-mentioned hotel which said that the conference room fee is subject to be raised in 2015 because of APEC year.


APEC
Asia-Pacific
Economic Cooperation
Workshop on Climate Change Impact on Oceans and Fisheries Resources
May 9, 2015, Boracay, Aklan, Philippines
APEC
PHILIPPINES
2015

Implemented by JAPAN

APEC
Asia-Pacific
Economic Cooperation

APEC Project (OFWG 02 2014)

Workshop on the Climate Change Impact on Oceans and Fisheries Resources

May 9. 2015, Boracay Island, the Philippines

APEC 2014 Ministerial Statement, paragraph 52, "We also welcome the APEC Project 'Workshop on the Climate Change Impact on Oceans and Fisheries Resources'".

APEC 2013 Leaders' Declaration "being mindful of the grave economic consequences of natural and human-caused disaster (e.g. Climate Change), the Leaders committed to pursue cross-sectoral work under the APEC Initiative on Mainstreaming Ocean-related Issues,that will maintain the health and sustiainability of oceans and coastal resources for benefit..."

- The impact of climate change has threatened the ocean and its derived benefits.
- Irreversible marine environmental changes have occurred, such as ocean warming, sea level rise, ocean acidification and Arctic sea-ice melting.
- It will bring further increasing uncertainties in sustainable use of the seas, especially of fisheries and aquaculture.

IPCC Report (March 2014) The striking feature of observed impacts (of climate change) is occurring from the tropics to the poles, from small islands to large continents.

- Aiming at better awareness of the impact of climate change on oceans, Project (Workshop) goals are:
  - ✓ To establish a coordinated framework for sharing (1) experiences and scientific knowledge, (2) good practices of the impact mitigation, and (3) success stories of the adaptation with innovative approaches;
  - ✓ To enhance further awareness of the increasing vulnerability of fisheries and aquaculture, and to develop comprehensive preparedness in these sectors; and
  - ✓ To strengthen policy coherence to ensure ocean-related economic activities, in the approach to the economic and social adaptation to the impact of climate change.

IPCC Report (March 2014) Climate change often interacts with other stresses to increase risk. Adaptation can play a key role in decreasing these risks.

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