Mangroves and Coastal Ecosystems Losses and Disaster-Related Damages

The East Asian Seas Congress 2012
Building a Blue Economy: Strategy, Opportunities and Partnerships in the Seas of Eas
Changwon City Republic of Koreat

- Orapan Nabangchang

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Outline of presentation

- Non-market valuation and demonstration of non-use values of marine resources in Asia
- Case studies:
  - Storm Protection Services of Mangrove Ecosystem. Saudamini Das
  - An Economic Analysis of Shrimp Farm Expansion and Mangrove Conversion in Thailand. Suthawan Sathirathai and Edward Barbier
- Challenges

Non-market values of selected marine resources

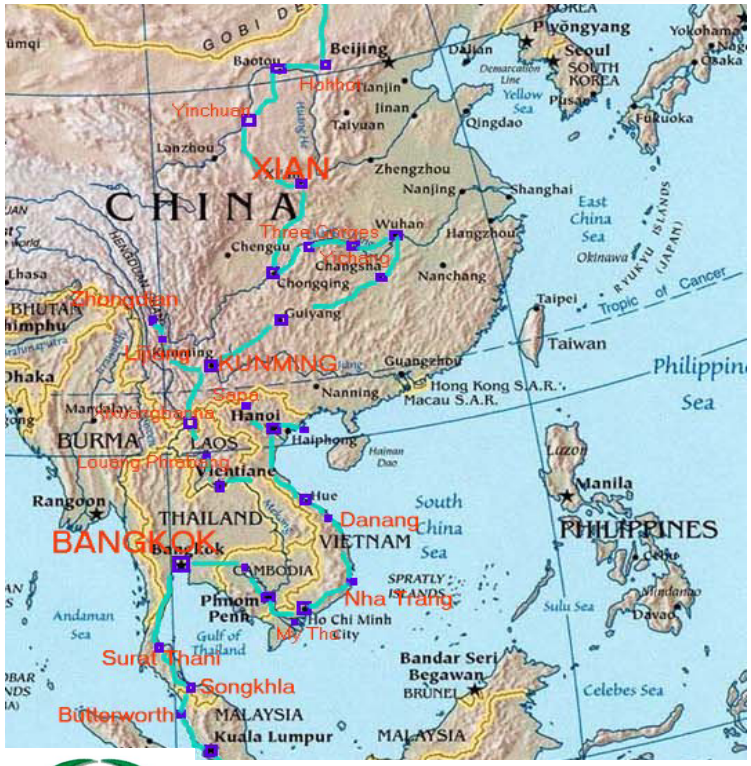
Mobilizing Resources for Marine Turtle Conservation in Asia: A Cross-Country Perspective

USD/month/hh for 5 years

Beijing, China	1.16
Davao City, Philippines	0.17
Bangkok, Thailand	1.41
Ho Chi Minh/ Hanoi, Vietnam	0.83

Policy → Information →
- Potential revenue of the Conservation Program
- Factors that affect people's willingness to support conservation
- Options for management

Methodological/ Academic → Comparative Tests



Economy and Environment Program for Southeast Asia

International tourists

47 USD/person

51 USD/person

Thais

Unit: USD/hh

	Parametric estimates		Non-parametrics	
	Whale sharks	Manta rays	Whale sharks	Manta rays
Bangkok	17	22	14	12
Krabi	3	6	7	8
Pooled	3	12	11	10

Orapan for WWF Thailand 2011

MWTP 39 USD/hh

Majority of people were wiling to pay 16 USD/hh

Orapan for DMCR, MONRE 2009

Conserving Mangroves for Storm Protection Services

October 1999 Super Cyclone

- Cyclone Warning from 27th October in TV, Radio, News papers
- Prediction of super cyclonic nature at 3.30am of 29th and storm entered the state around 7 am
- All villages within 10km of coast were asked to evacuate (logistics provided)
- In Kendrapada only 9 Cyclone shelters for 262 villages, population = 173,450.
- No evacuation of Livestock

Saudamini Das, Institute of Economic Growth & Swami Shradhanand College, University of Delhi, Fellow, SANDEE

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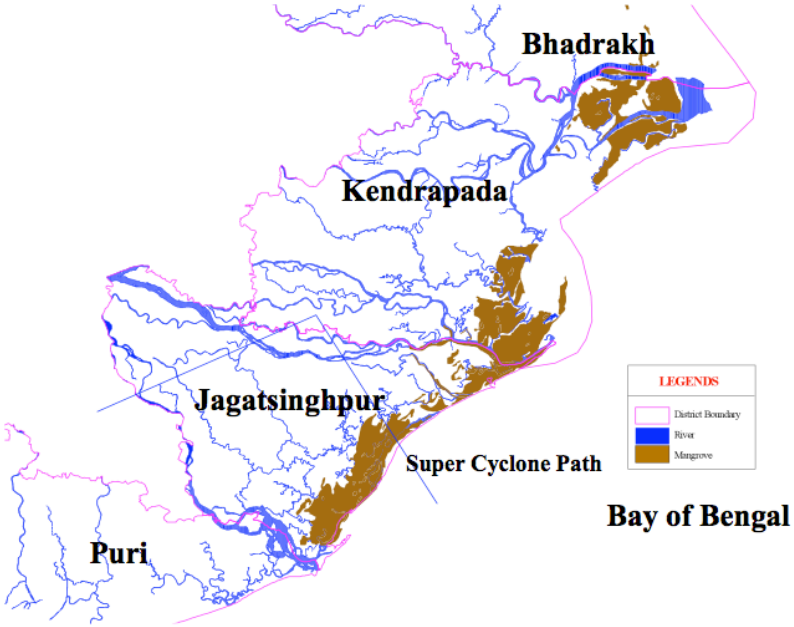
Do mangroves provide storm protection ?

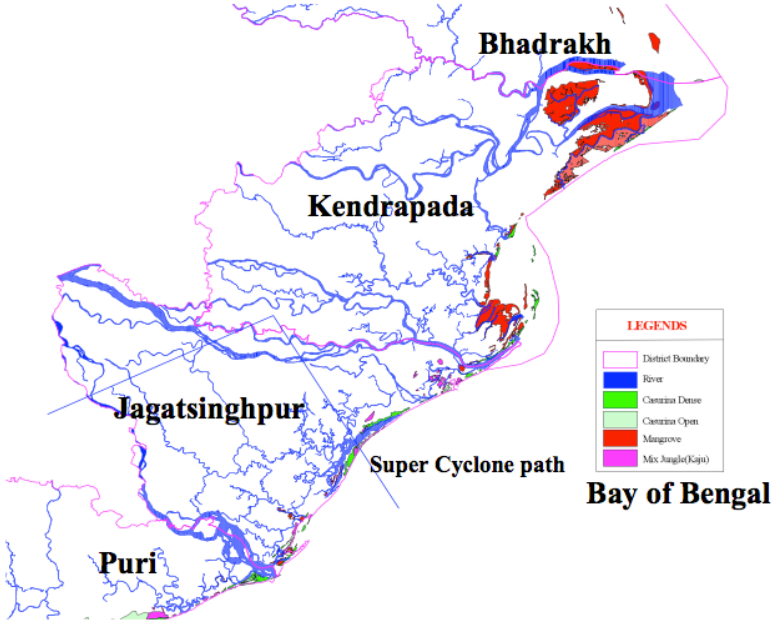
Is mangrove preservation an economically viable adaptation strategy to climate change?

- Debated since the *Bhola Cyclone* (Nov 1970) in East Pakistan *(Bio.Conserv, 1971)*
- Much focus due to prominent natural disasters like *2004 tsunami, Katrina, Sidr, Nargis, Aila* etc.
- Accepted as a prominent ecosystem service *(*Barbier et al*, Science 2008;* Day et al*, Science 2007;* Gedan et al*, Climate Change 2010).*
- Most of the empirical works are questioned.

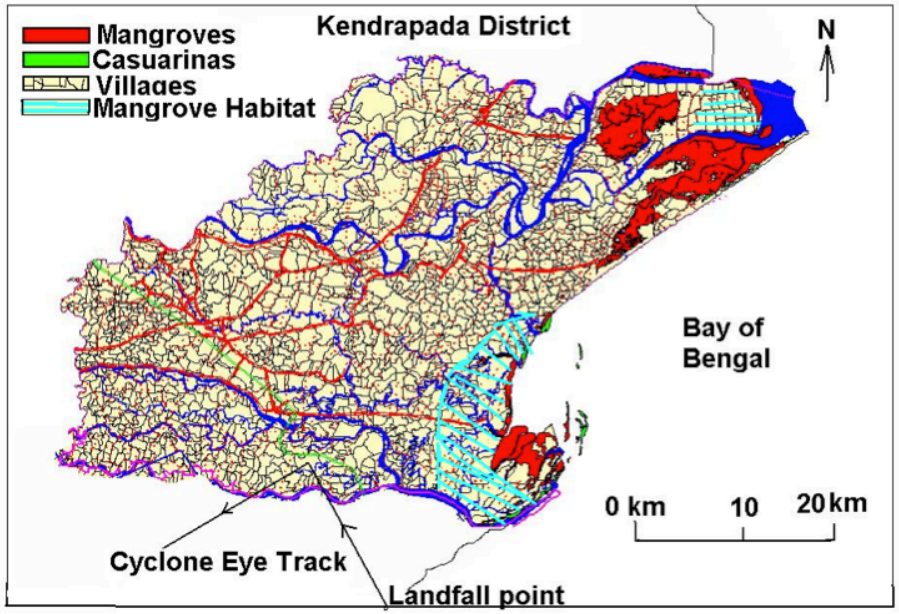
Mangrove Forest Cover in 1950 **(30,766 hectares)** and the Cyclone path



Mangrove Forest Cover in 1999 **(17,900 hectares)** and the Cyclone path



Study Area



Cyclone damage function

Di = f (Pi, Vi, Wi, Si)

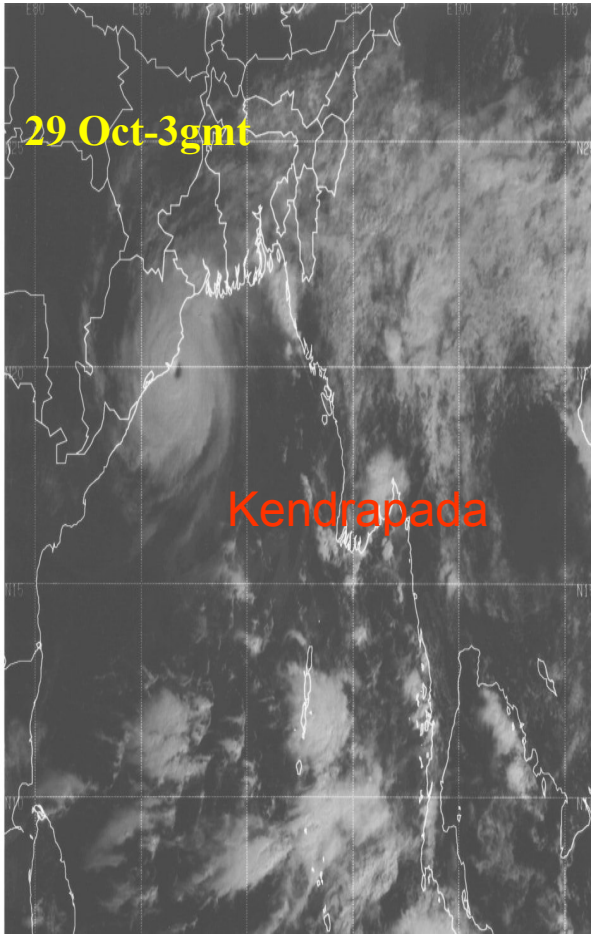
Di is the damage suffered in the ith village (human mortality, house damage and livestock loss)

Pi is property at risk

Vi is the appro measure of wind velocity

Wi is the severity of flooding due to storm surge

Si is the group of socio-economic factors influencing the damage occurences



Storm Protection Value

Area / Mangrove unit	Value of 1km width	Value of 1 hectare
Entire study area	USD 68, 586	USD 4335

Opportunity cost of protecting mangroves	Value/ha/year
Market value of land in coastal Kendrapada:	3,107.06
Annual return from land (8%)	248.55
Annual return from land (12%)	372.84

Benefit for retaining mangroves	Value/ha/year (Rs)
Storm protection value (only for 3 damages)	3,270.7
Annual Probability of VSCS and SC:	0.15 \ yr
Annual Storm Protection Value (3 damages):	490.61

Benefit > Opportunity Cost

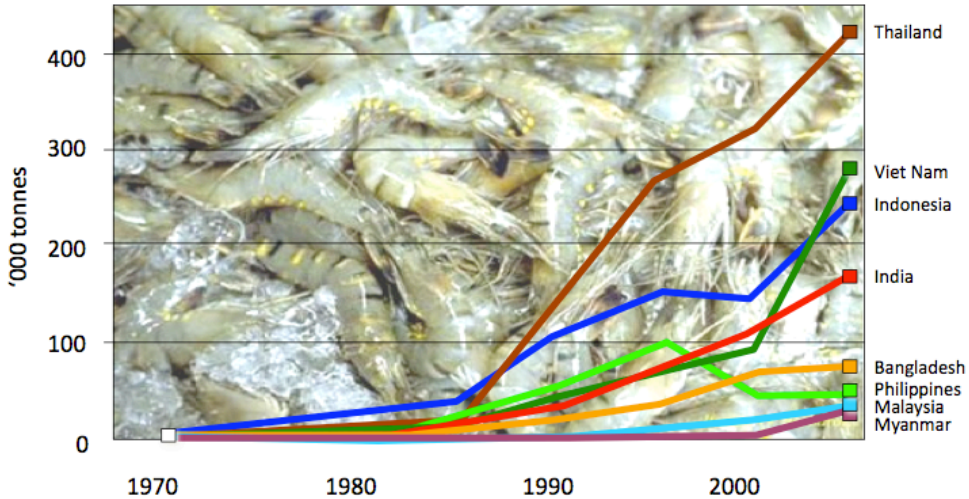
Opportunity cost of saving a life by retaining mangroves= 11.7 million rupees/life saved

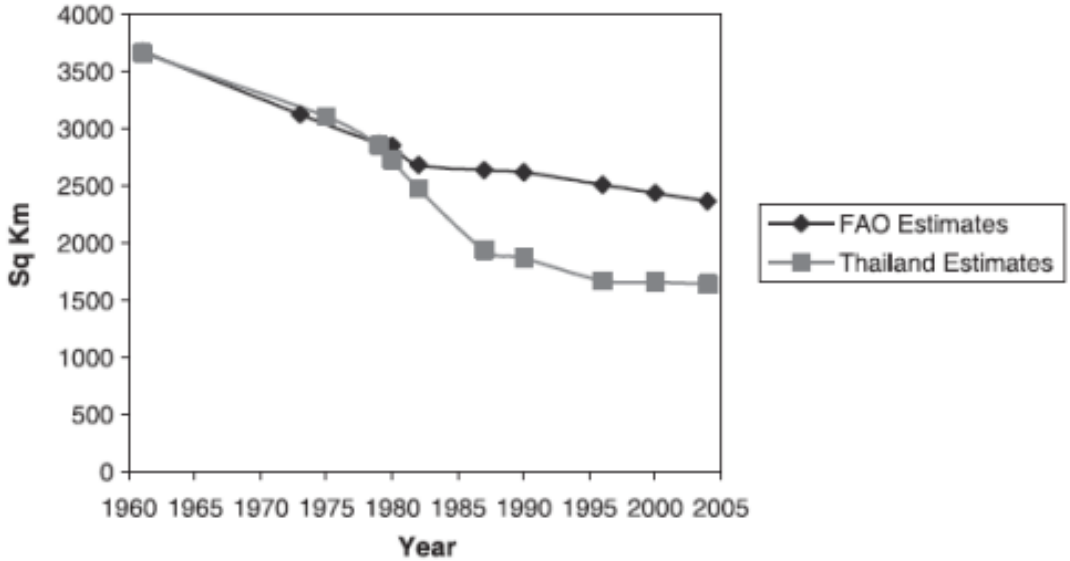
Findings

1. Mangroves reduced human death, livestock loss and house damages during the T-7 Super cyclone of October 1999.
2. Human death toll would have been nearly doubled in absence of mangroves.
3. Annualized storm protection benefit of mangrove for reducing three damages was found higher than annual return from land justifying mangrove conservation as a viable adaptation strategy to climate change.

An Economic Analysis of Shrimp Farm Expansion and Mangrove Conversion in Thailand.

Suthawan Sathirathai
Edward Barbier





Mangrove area (km2) in Thailand, 1961-2004

Source: Barbier. 2007. Valuing ecosystem services. Economic Policy 22: 177-229

Commercial shrimp farms not econoimically viable if taking into account externalities

	USD /hectare
Direct Use Value	87.84
Indirect Use Value	
-off shore fishery	20.82-68.90
-coastline protection	3678.96
Net Present Value of Direct Use Value	822.59
Net Present Value of Direct and Indirect Use Value (10% discount rate)	35,470.72 -35,920.98

NPV calculations are based on 20 years time frame; 10 % discount rate

Gulf of **Thailand shrimp farmss** mangroveactionproject.org

NPV of commercial shrimp farm	USD/ hectare
Financial analysis	8336.47
Economic analysis	
Without forest rehabilitation	209.36
With forest rehabilitation	-5,447.97

Development

Conservation

Understanding of economic values of mangroves and coastal ecosystems

True value of economic losses?

Development

Conservation

Opportunity costs?

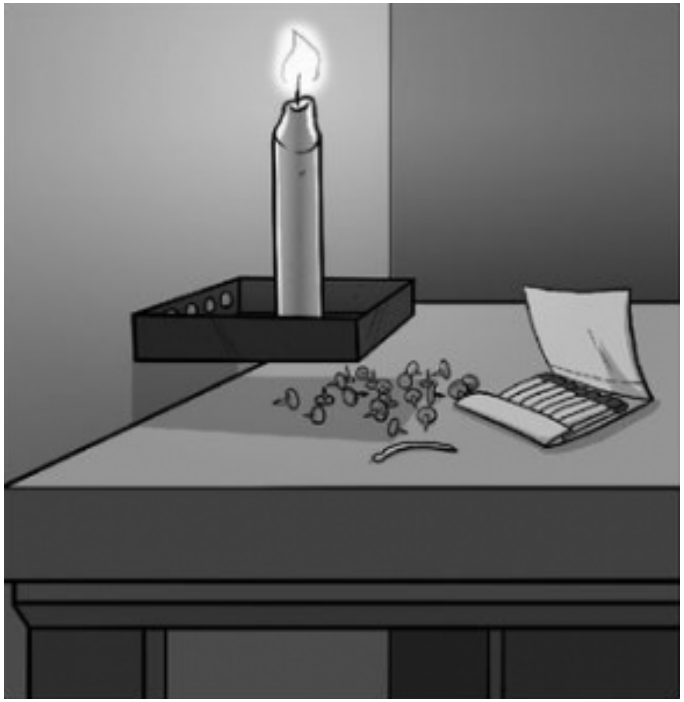
flows of goods and services ?

damage costs avoided?

Challenges

- How to expand the capacity within the region to undertake generate more valuation studies of mangroves and coastal ecosystems in the Region.
- How to use the results of valuation studies to design economic instruments to 'capture' the economic values.

Daniel Pink: A Whole New Mind



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Economic Valuation of Coastal Resources Degradation in Seribu Islands:

Is Blue Economy a Solution for Reversing the Degradation?

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2012

INTRODUCTION

- Seribu Islands is a group of 105 islands in the north of Jakarta
- 80 percent the archipelago managed by the District Administration of Seribu Islands and 20 percent falls within the Seribu Islands Marine National Park
- Ecosystem includes 193 coral species, mangrove and seagrass
- Seribu Island provides at least four major functions to the existence of human well being and economic development, i.e.

1. Life-support services
2. Supply natural resources
3. Recreational services
4. Waste regulating services

PROBLEMS

- The condition of Seribu Islands is fragile
- Coastal ecosystem and natural resources at Seribu Islands has been degraded for years
- Coastal degradation caused by natural factors and human-induced factors, such as:

  1. Pollution
  2. Unsustainable resource exploitation (destructive fishing)
  3. Overfishing

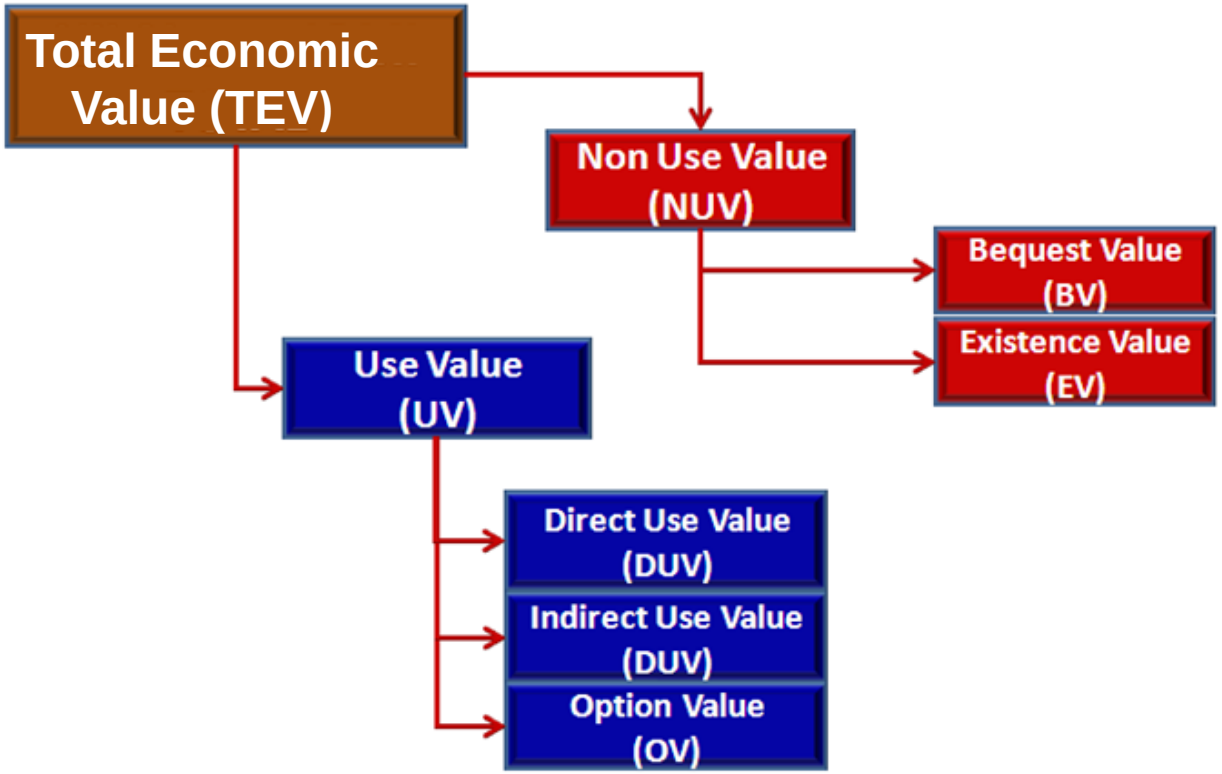
- Both factors will disturb the flow of good and services, and finally will reduce the value of the resources that are impacted

MEASURING COASTAL AND MARINE RESOURCES DEGRADATION

- Damage valuation
- Fisheries resources degradation and depreciation

Total Economic Valuation

Diadopsi dari Barton (1994)



$$TEV = UV + NUV = (DUV + IUV + OV) + (BV + EV)$$

Economic Valuation Techniques

Teknik Valuasi Ekonomi Sumberdaya

easy ↕ difficult

No	Approach	Technique
1	Market Value	*Change-in-productivity Approach/Effect of Production (EOP)*
		Loss-of-Earnings/Human Capital Approach (HC)
		Opportunity Cost Approach (OC)
2	Direct Expenditure Value	*Cost Effectiveness Analysis (CEA)*
		Preventive -Expenditure (PE)
		Compensation Payments (CP)
3	Implicit Market Value *(Surrogate Market)*	*Hedonic Value / Property value approach (PV)*
		Wage-differential Approach (WD)
		Travel-cost Approach (TC)
		Marketed Goods as Environmental Surrogates (ES)
4	Implicit Expenditure Value	*Replacement Cost (Rep. C)* *Relocation Cost (Rel. C)* *Shadow-Project Cost (SPC)*
5	Artificial Market	*Contingent Valuation Method*
6	Non-WTP	*Energy Theory of Value -Energy Analysis (EA)*

MEASURING TOOLS: Fisheries Resource Valuation

$$\frac{\partial x}{\partial t} = f(x) - h$$

$$f(x) = r.x.\ln\left(\frac{K}{x}\right)$$

$$h = q.x.E$$

$$\frac{\partial x}{\partial t} = r.x.\ln\left(\frac{K}{x}\right) - q.x.E$$

$$h_s = q.K.E.e^{\left(-\frac{q}{r}E\right)}$$

Adopted from Clark, 1985

MEASURING TOOLS: Fisheries Resource Economic Valuation

$$\pi = TR - TC$$

$$TR = p.h$$

$$h = q.x.E$$

$$TC = c.E$$

$$\pi = q.x.E - c.E$$

$$\pi_s = p.q.K.E.e^{\left(-\frac{q}{r}E\right)} - c.E$$

$$\frac{\partial \pi}{\partial E} = MR - MC = 0 \rightarrow p.q.K.e^{\left(-\frac{q}{r}E\right)} = c$$

Adopted from Clark, 1985

MEASURING TOOLS: Fisheries Resource Degradation and Depreciation

Adopted from Amman and Duraiappah (2001) in Anna (2003), Fauzi (2004)

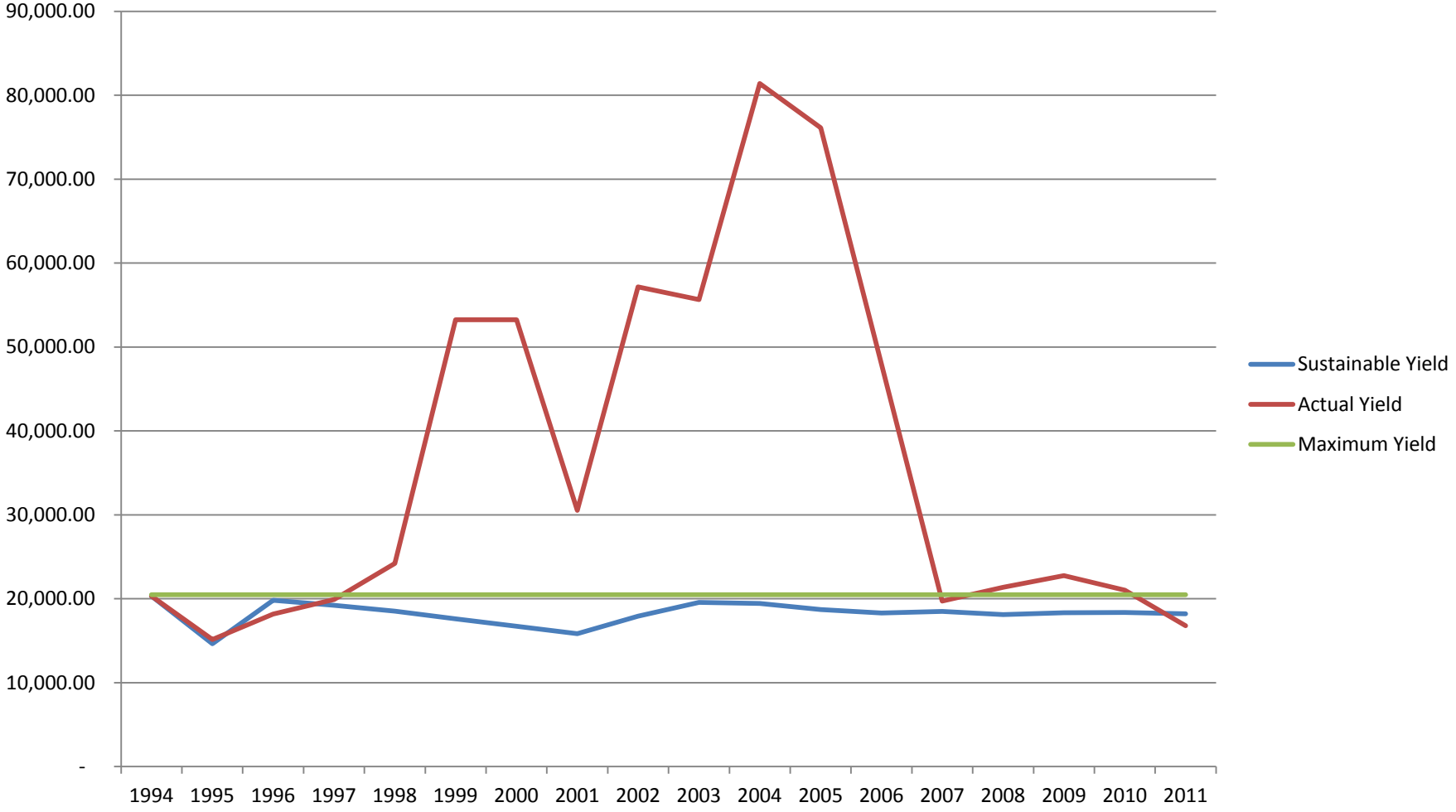
$$D\% = \frac{h_s - h_a}{h_s} * 100\%$$

$$\phi_D = \frac{1}{1 + e^{\frac{h_s}{h_a}}}$$

$$D\% = \frac{\pi_s - \pi_a}{\pi_s} * 100\%$$

$$\phi_D = \frac{1}{1 + e^{\frac{\pi_s}{\pi_a}}}$$

FISHERIES STATUS: Sustainable Yield v.s Actual Yield



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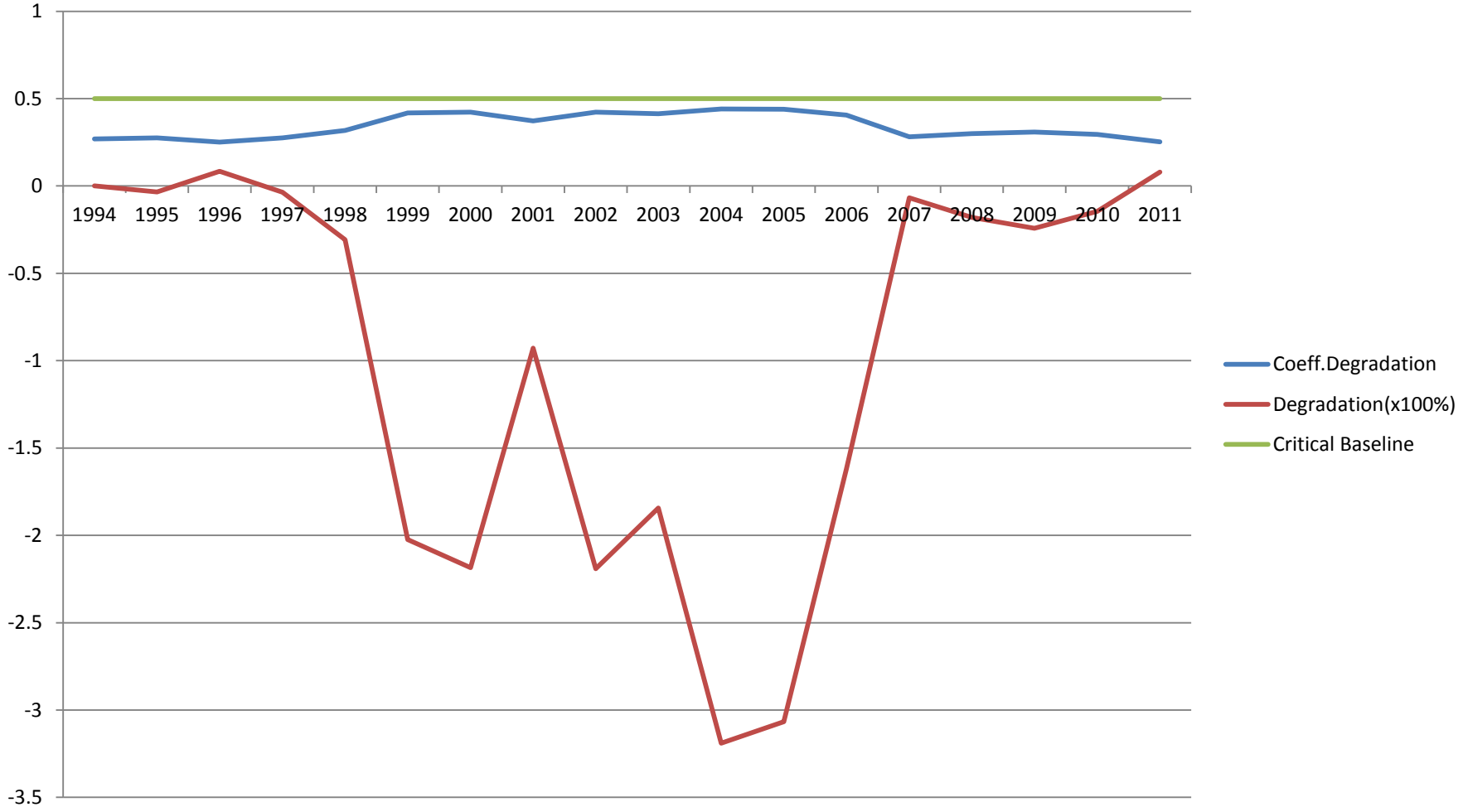
FISHERIES STATUS: Resources Degradation



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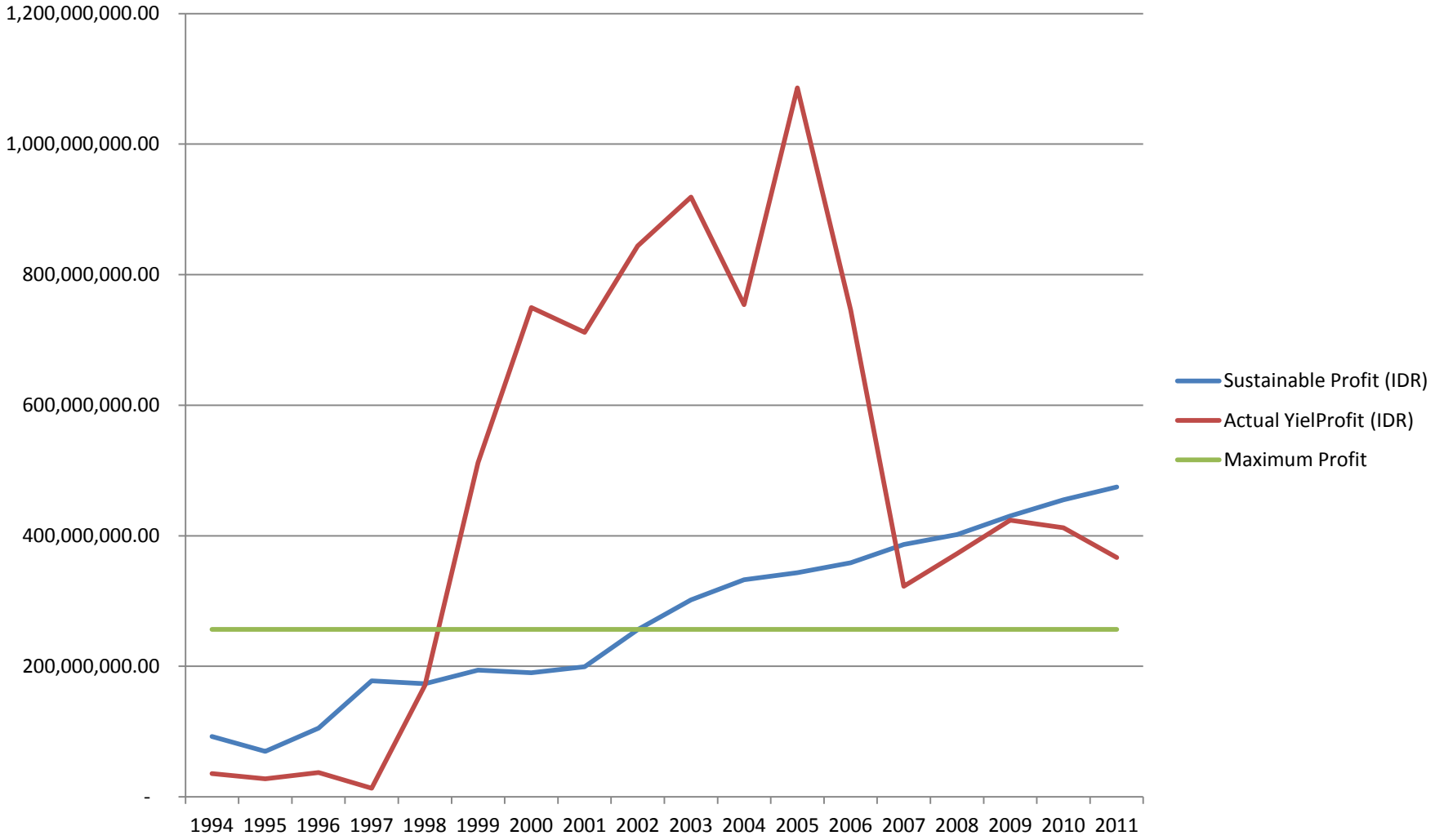
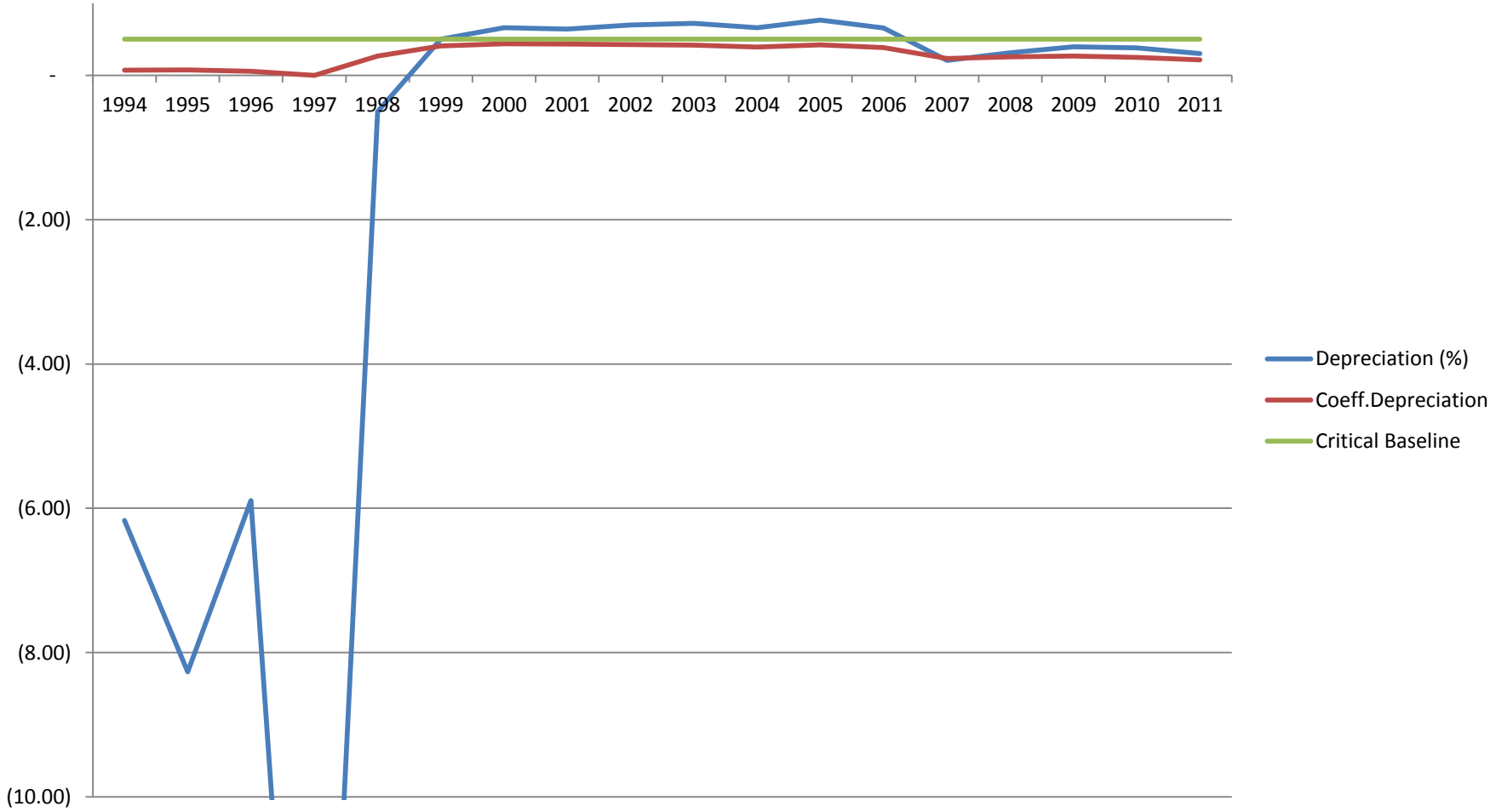
FISHERIES STATUS: Sustainable Profit v.s Actual Profit



FISHERIES STATUS: Resources Economic Depreciation



ECONOMIC VALUE OF RESOURCES AND ENVIRONMENTAL DEGRADATION

- Resources and Environmental Degradation (1999 -2006):

Fisheries	:	IDR 518,241,938.86
Ecosystem	:	IDR 2,936,787,655,641.64
Total	:	IDR 2,937,305,897,580.48

INITIATIVES

- Some activities conducted to reverse the degradation at the local level (Seribu Island:Panggang, Pramuka Islands- Approx 500 ha)

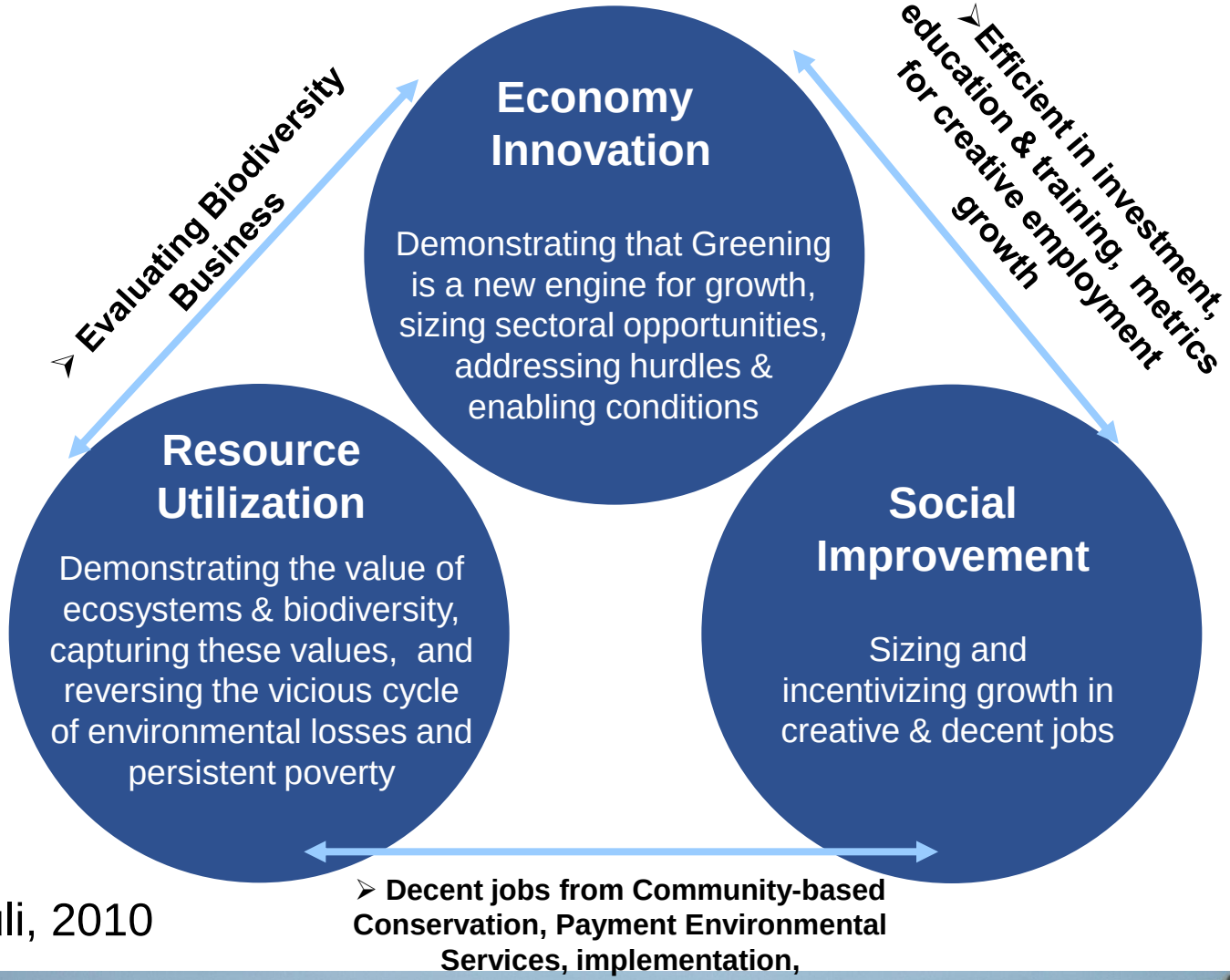
  1. Capacity building of small island communities in managing ecosystem and resources
  2. Ecosystem rehabilitation
  3. Income alternative generation
  4. Integrated Coastal and Small Island Management

- An holistic policy is necessary for achieving sustainable use of resource for socio-economic activities while maintaining environment, reducing the threat of the sustainability of Seribu Islands coastal ecosystem and resources should be established

- The question of the application of the blue economy approach at local level will be a solution for reversing resources degradation?

THE CONCEPTS

Breakthrough Economy Initiative: A family of Initiatives



Source: Pauli, 2010

THE CONCEPTS : Blue Economy as Value System

- The natural world with all its life forms has an intrinsic value, an *existential ethics*
- Fellow humans, now and in the future, should be respected and be given equal opportunities, an *ethics of justice*
- Societies should be governed using democratic methods, with participation, cooperation and rule of law, *Kantian peace*
- Life and society as such should be developed and as good as possible, an *"hedonistic" ethics*

In many ways the practical consequences of the four approaches coincide (Pauli, 2010)

THE CONCEPTS : Triple Threats

Natural Resources Constraint (including energy)

Financial Crisis

Climate Change

Economic Stimulus

Blue Stimulus

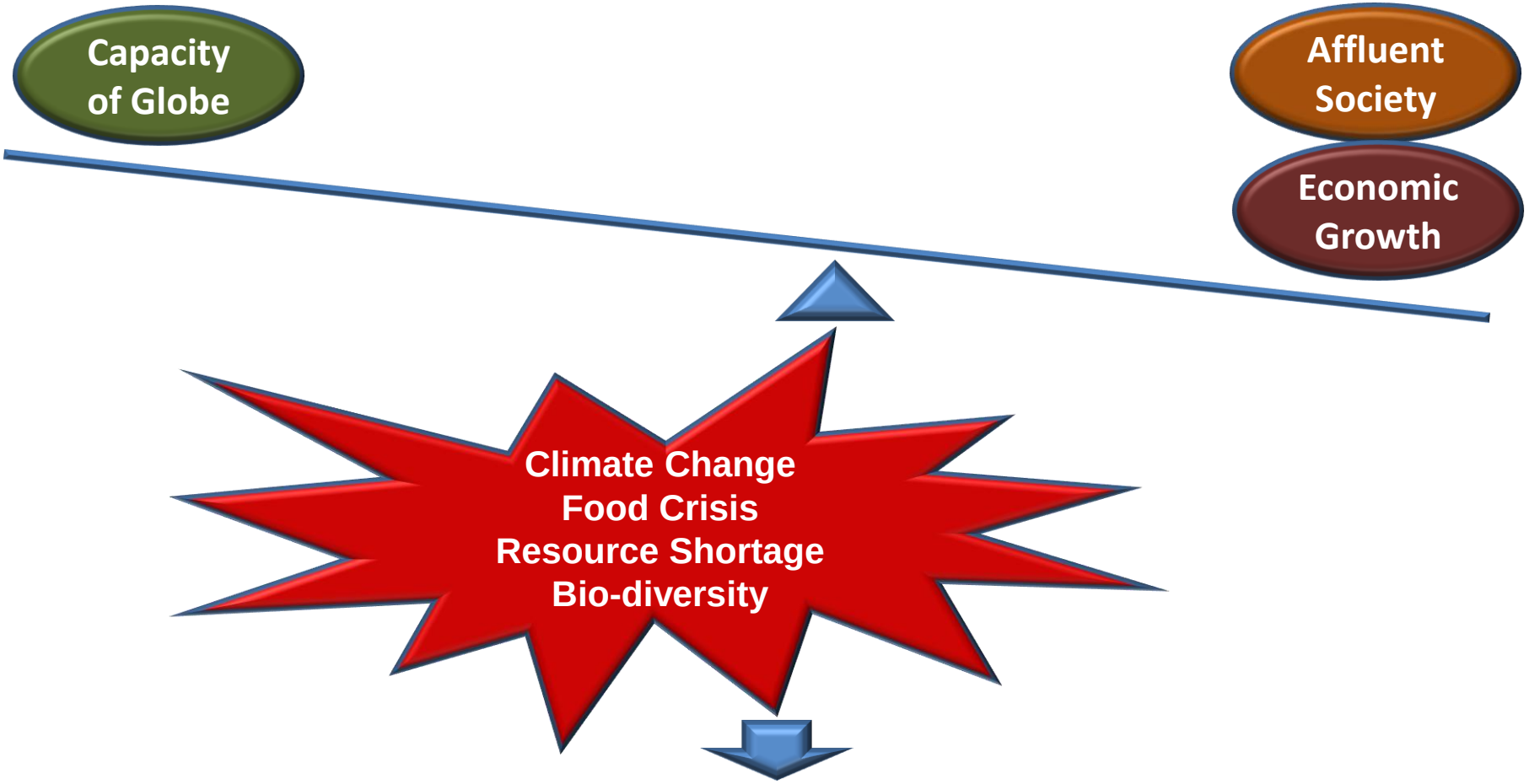
Resources/energy : efficiency

Renewable resources/energy/new energy

Short term and mid-long term strategy

Source: Hongo, 2011

THE CONCEPTS : Where are we now? : Global Constraint



Source: **Hongo, 2011**

TOWARDS A BLUE SOCIETY

- Developing a new ambitious vision in a spirit of well being and equity for mankind in harmony with the world's ocean, its fundamental element
- The "Blue Society" concept is based on the premise that there are two imperatives that society should integrate:

1. Satisfying the growing needs of our planet's inhabitants today
2. Preserving the means of subsistence for the generations to come, especially the resources and services provided by the ocean in preserving the balance of marine ecosystem

TOWARDS A BLUE SOCIETY : Point of Sustainability View

- **A social point of view**: equitable access to resources to ensure the adequate provisioning of resources to the world's populations and to encourage and promote sustainable livelihoods
- **An economic point of view**: the sustainable exploitation of marine resources, taking into account the economic value of biodiversity and ecosystem services
- **An ecological point of view**: ensuring that marine ecosystems are resilient to change and capable of continuing to provide valuable resources and fulfill their major biological, chemical, and physical functions (e.g. oxygen production, climate regulation, nutrient cycling, etc.)
- **A cultural point of view**: presenvation and respect for traditional cultures and knowledge linked to the sea
- **A political point of view**: effective governance of the ocean

TOWARDS A BLUE SOCIETY : Components

Economy
Investing in new opportunities, innovation & sustainable activities

Society
Promoting well-being & equal access to services and resources

Environment
Preserving ecosystems and their potential

Culture
Developing common understanding & an integrated vision

Space equity
Developing geographical balance in access and use of marine resources

Time equity
Managing the means of subsistence for inhabitants of today and generations to come

Policy making
Fostering good ocean governance

BLUE SOCIETY
Oceans of new opportunities for all

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TOWARDS A BLUE SOCIETY

Implementations at local level

Tourism

Development Priority of the District Administration of Seribu Islands

Fisheries

Mari-culture

Sea Farming

Capture Fisheries

Cage Culture

Pen Culture

Hatchery

Seed Production (Hatchery)

Restocking

Sea Ranching

Enclosure

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A BLUE ECONOMY : Three Pillar Sea Farming

SEA FARMING

FISHING RIGHTS (FR)

- Common FR
- Demarcated FR
- Set-net FR (environmental-friendly fishing)

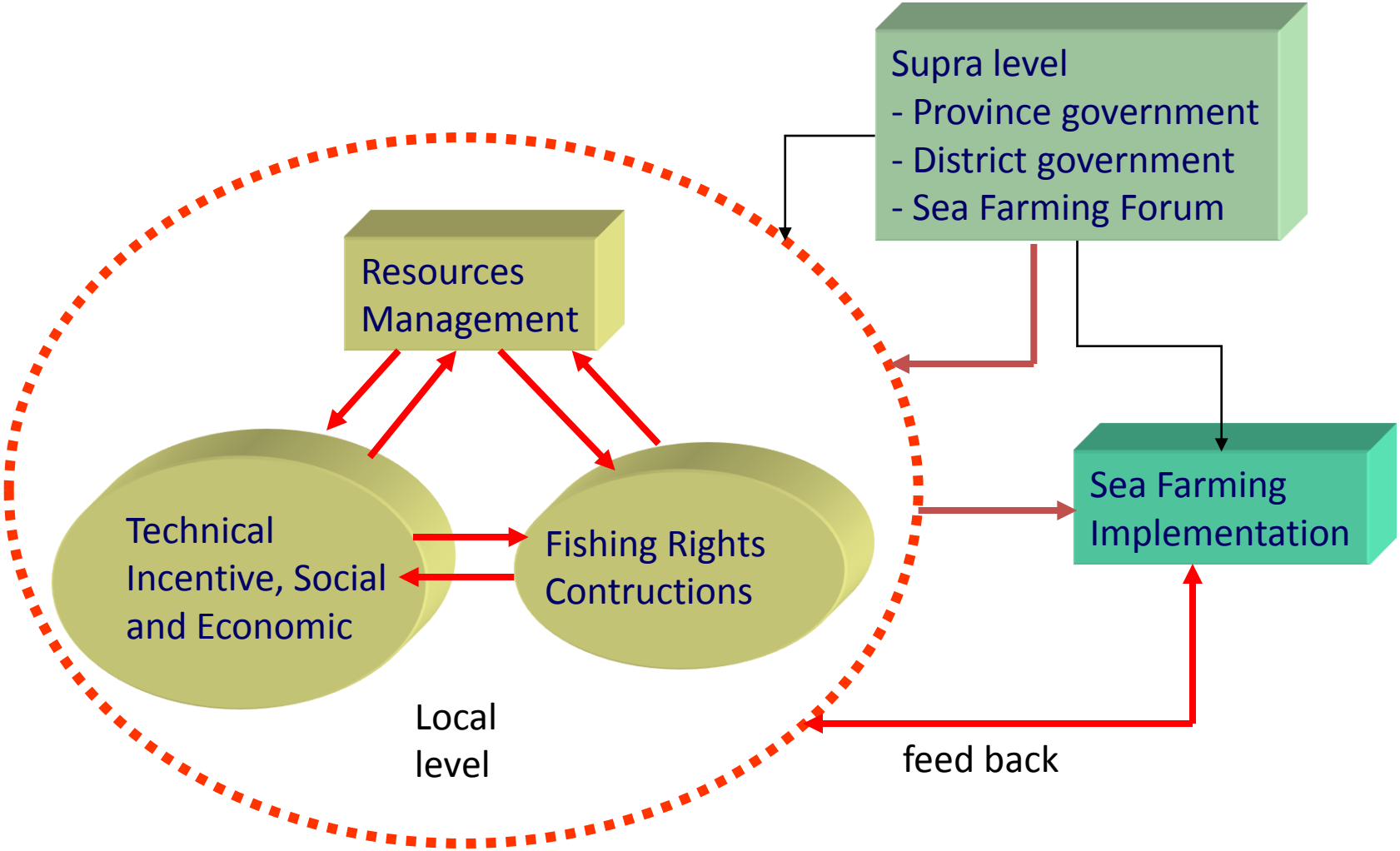
TECHNICAL INCENTIVE, SOCIAL AND ECONOMIC

- Technical Skill
- Business Skill
- Insurance Market
- *Social capitalizing (trust building)*

RESOURCES MANAGEMENT

- Water environment management
- Regulation of resources use
- *Natural capitalizing*

A BLUE ECONOMY : Unity of the Pillar



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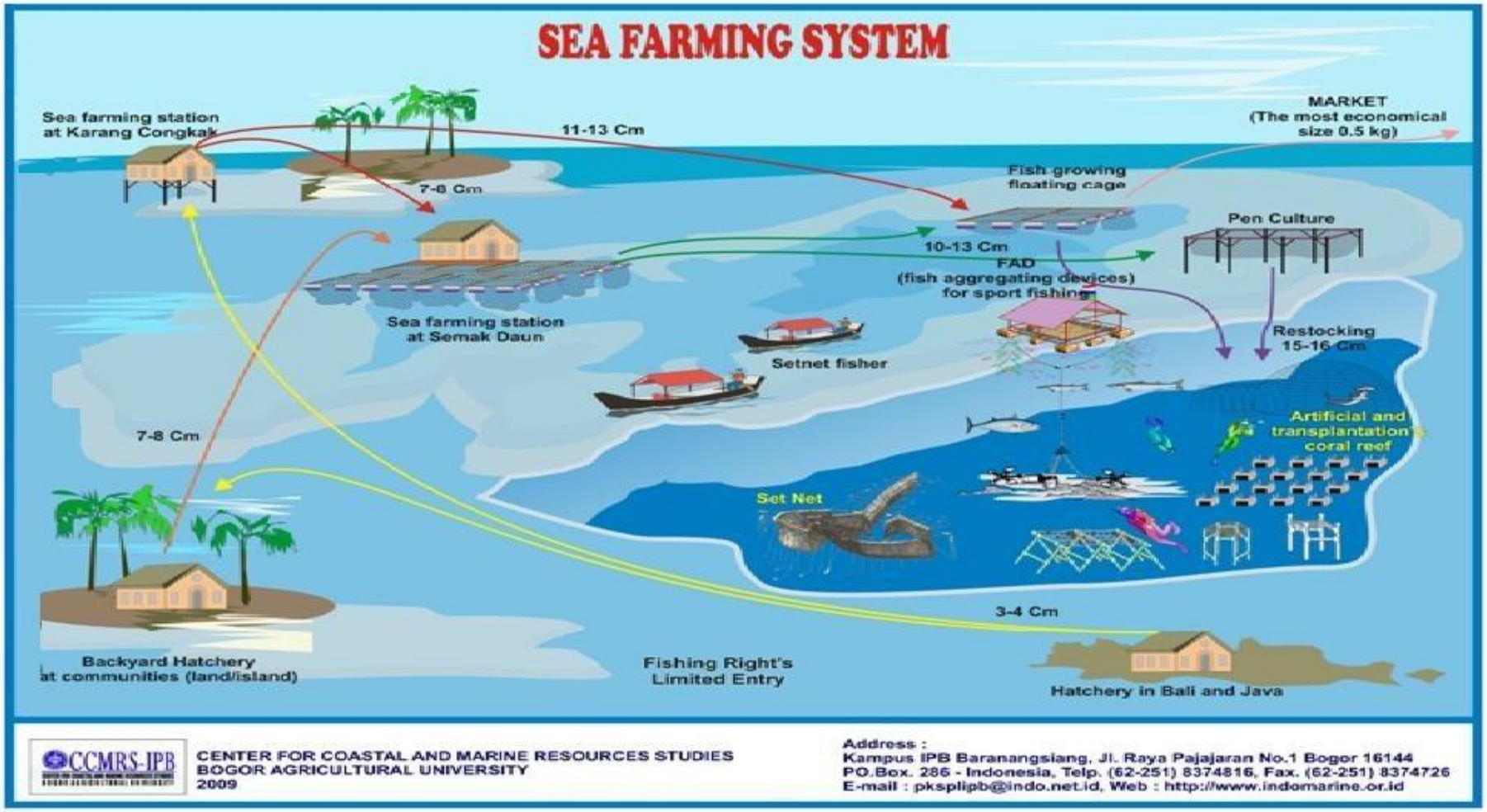
SEA FARMING SYSTEM
Sea farming station at Karang Congkak
11-13 Cm
MARKET (The most economical size 0.5 kg)
7-8 Cm
Fish growing floating cage
Pen Culture
10-13 Cm
FAD (fish aggregating devices) for sport fishing
Sea farming station at Semak Daun
Restocking 15-16 Cm
Setnet fisher
Artificial and transplantation coral reef
7-8 Cm
Set Net
3-4 Cm
Backyard Hatchery at communities (land/island)
Fishing Right's Limited Entry
Hatchery in Bali and Java
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E-mail : pkspliipb@indo.net.id, Web : http://www.indomarine.or.id

A BLUE ECONOMY : Ecosystem Restoration

Mangrove Rehabilitation

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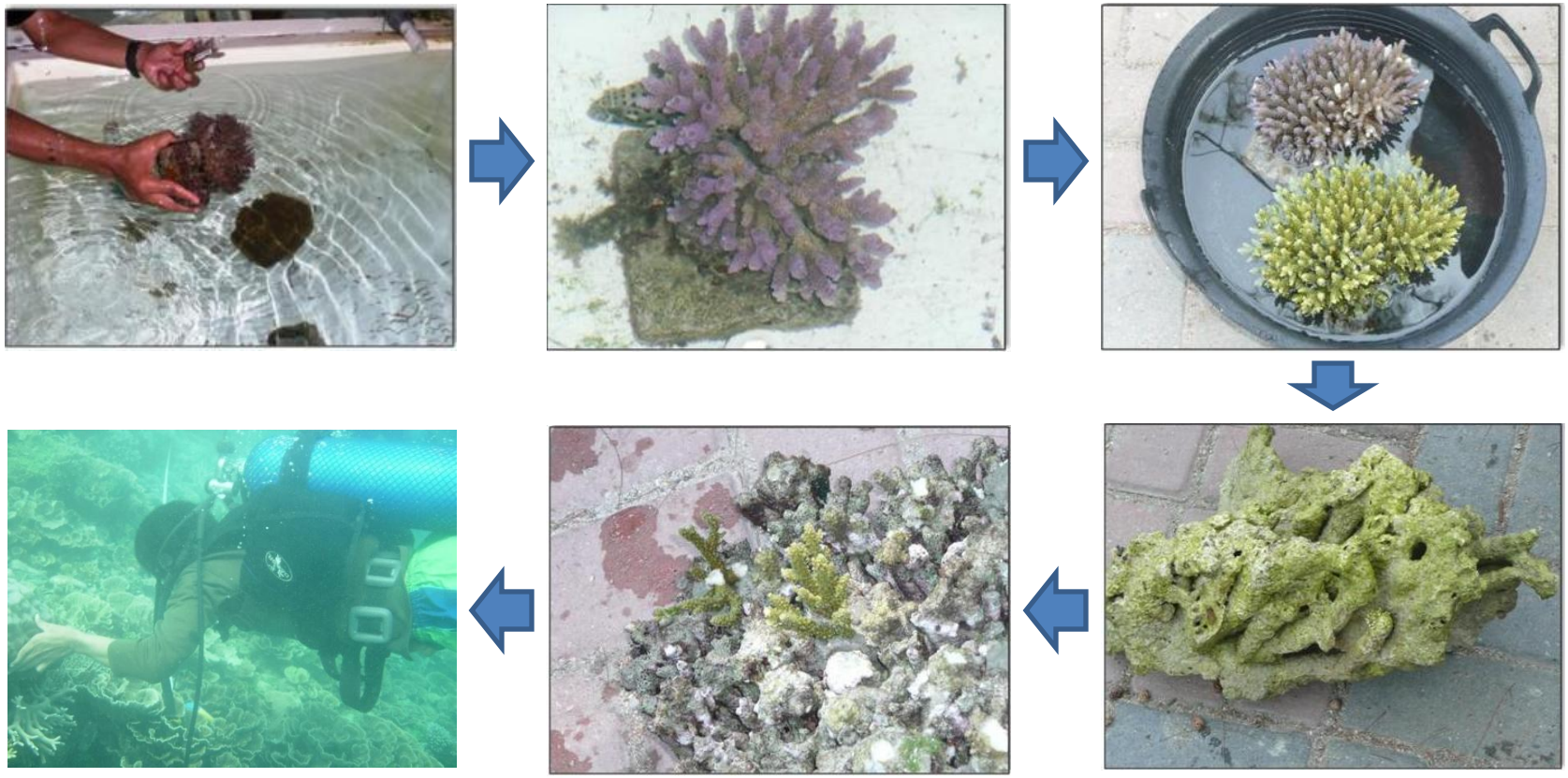
A BLUE ECONOMY : Ecosystem Restoration

Coral Reef Rehabilitation



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A BLUE ECONOMY : Ecosystem Restoration

Seagrass Rehabilitation

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A BLUE ECONOMY : Capacity Building of Local Communities

- Training on marine aquaculture management
- Training on improved business management
- Training on marine aquaculture management
- Training on monitoring and evaluation
- Training on provision of feed management
- Training on fish health management
- Training on water quality management
- Training on household scale of hatchery and seed-fish handling managements
- Training on environmental water management

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A BLUE ECONOMY : Household Level of Hatchery

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A BLUE ECONOMY : Mariculture Activities

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A BLUE ECONOMY : Marine-ecotourism Activities

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BENEFIT : Blue Economy Approach

- **Improving water quality**
  1. Fisheries status
  2. Capture fisheries: fishermen productivity
  3. Mari-culture fisheries: seaweed culture productivity

- **Improving value of coral reef ecosystem**
  1. Tourism value: snorkeling and diving activities
  2. Supporting value of tourism

VALUATION TOOLS: Blue Economy Approach

- **Improving water quality**
  1. Fisheries Status – Bionomic Model
  2. Capture fisheries: fishermen productivity – Effect on Production
  3. Mari-culture fisheries: seaweed culture productivity – Effect on Production

- **Improving value of coral reef ecosystem**
  1. Tourism value: snorkeling and diving activities – Travel Cost Method
  2. Supporting value of tourism - Contingent Valuation Method

ECONOMIC VALUATION: Effect on Production

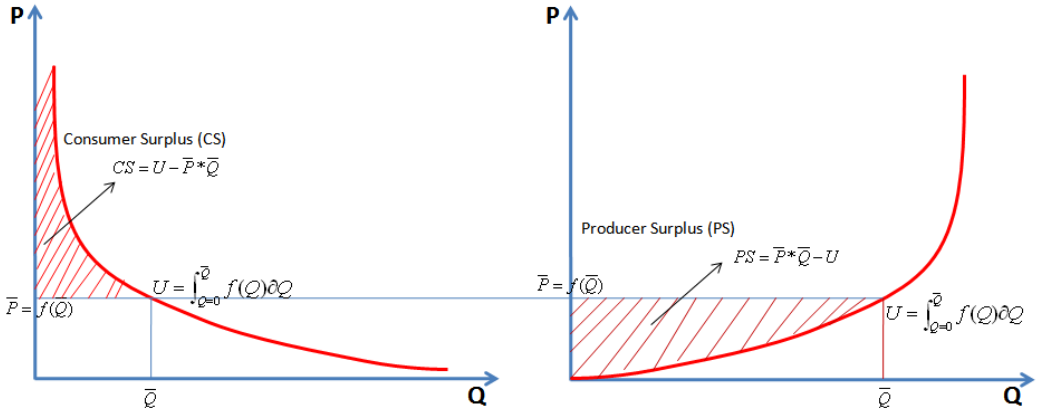
$$Q = f(P, Age, Edu, Income, Family, Others)$$

$$\ln Q = a + b\ln P + c\ln Age + d\ln Edu + e\ln Income + g\ln Family + h\ln Others$$

$$\ln Q = a + b\ln P + A \longrightarrow Q = \exp(a + A) * P^{b} \longrightarrow f(Q) = \left(\frac{Q}{B}\right)^{\left(\frac{1}{b}\right)}$$

$$CS = \int_{0}^{\overline{Q}} f(Q)dQ - \overline{Q} * f(\overline{Q})$$

$$EcV = CS * Users$$



ECONOMIC VALUATION : Contingent Valuation Method

$$WTP = f(Age, Edu, Income, Family, Others)$$

$$WTP = a + b * Age + c * Edu + d * Income + e * Family + g * Others$$

$$\overline{WTP} = A$$

$$EcV = \overline{WTP} * Populations$$

ECONOMIC VALUATION : Travel Cost Method

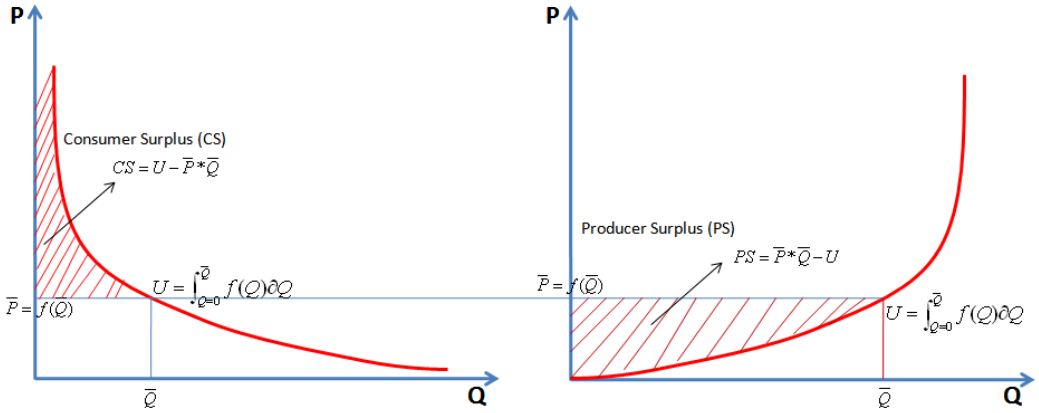
$$V = f(TC, Age, Edu, Income, Family, Others)$$

$$\ln V = a + b\ln TC + c\ln Age + d\ln Edu + e\ln Income + g\ln Family + h\ln Others$$

$$\ln V = a + b\ln TC + A \longrightarrow V = \exp(a + A) * TC^{b} \longrightarrow f(V) = \left(\frac{V}{B}\right)^{\left(\frac{1}{b}\right)}$$

$$CS = \int_{0}^{\overline{V}} f(V)dV - \overline{V} * f(\overline{V})$$

$$EcV = CS * Visitors$$



RESOURCE VALUE: Economic Value of Grouper

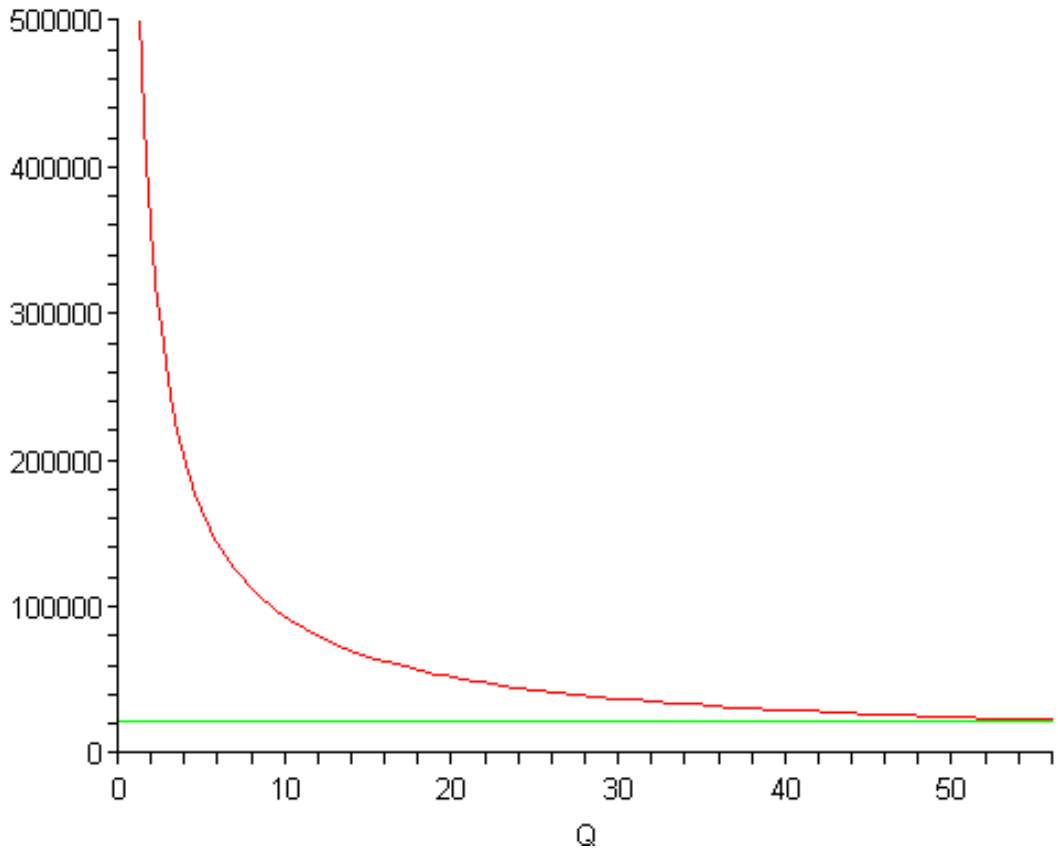
$$f(Q) = \frac{7424504.38}{Q^{0.8261}}$$

$$P^* = 22326$$

$$\overline{Q} = 56$$

$$CS = 5979011.65$$

$$Users = 1120$$



$$EconomicValue = CS * Users = 7{,}294{,}394{,}213.00$$

RESOURCE VALUE: Economic Value of Seaweed

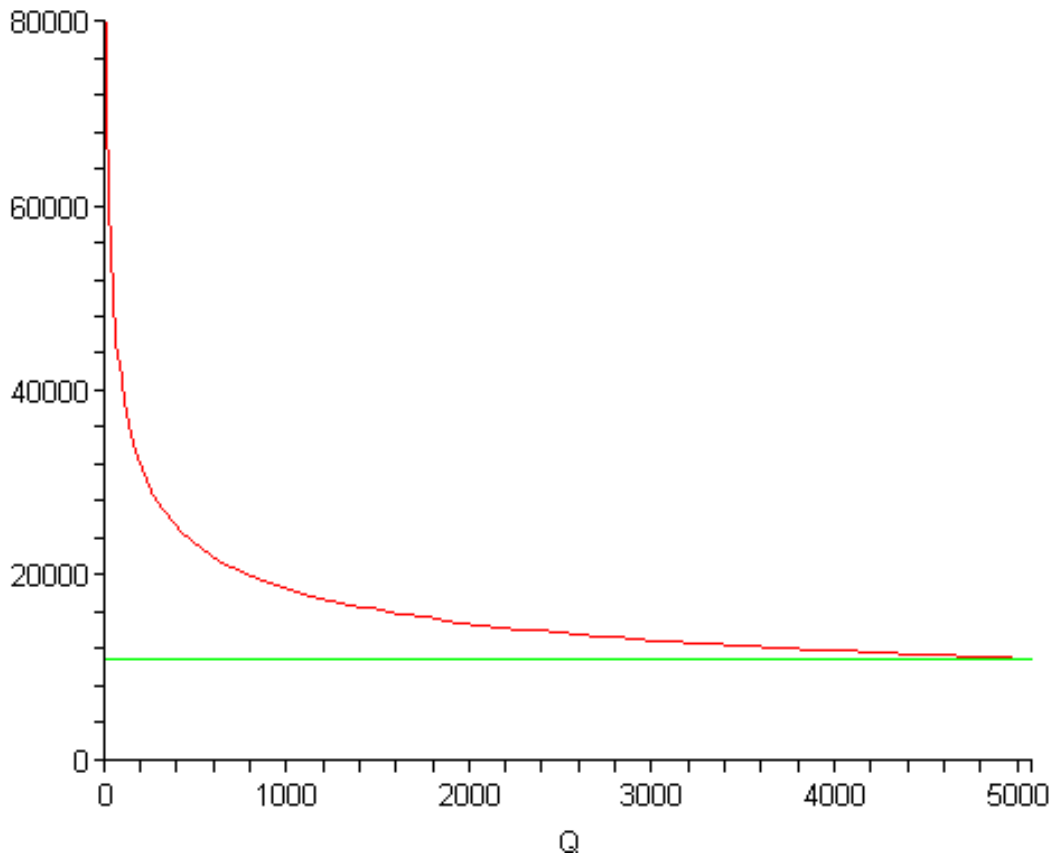
$$f(Q) = \frac{178635.40}{Q^{0.3273}}$$

$$P^* = 10942.84$$

$$\overline{Q} = 5081$$

$$CS = 27048308$$

$$Users = 250$$



$$EconomicValue = CS * Users = 6{,}762{,}077{,}000.00$$

ECOSYSTEM VALUE: Economic Value of Tourism

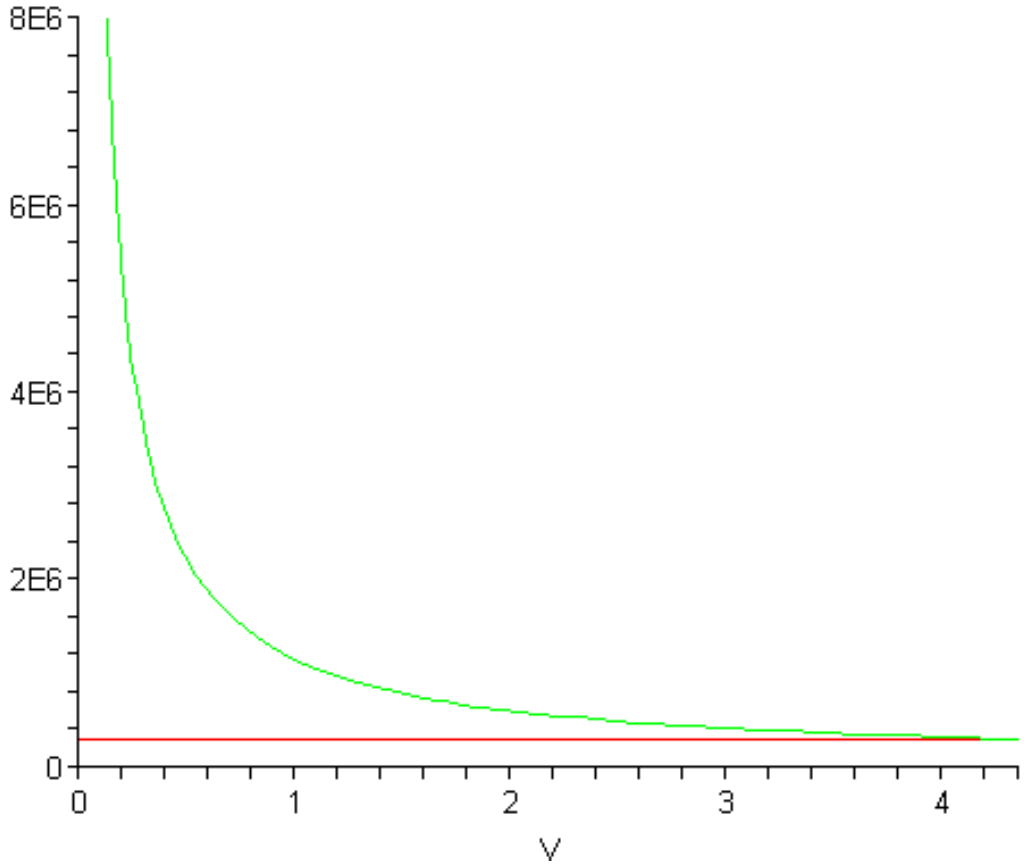
$$f(V) = \frac{1159625.11}{V^{0.9430}}$$

$$TC^* = 289078$$

$$\overline{V} = 4.36$$

$$CS = 20883170$$

$$Visitors = 231020$$



$$EconomicValue = CS * Visitors = 4{,}824{,}429{,}933{,}400.00$$

ECOSYSTEM VALUE: Economic Value of Tourism

$$WTP := 1227084 - 307333.X1 + 2502.X2 - 384.X3 - 108.X4 - 2382.74\,X5 + \frac{7.27}{100000}.X6 - 2039.X7 + 103770.X8$$

$$\overline{WTP} = 112530.52$$

$$Population = 21082$$

$$EconomicValue = \overline{WTP} * Population = 2{,}372{,}368{,}422.64$$

TEV: Blue Economy Implementation

- **Improving water quality impact to resource value**

  1. Fisheries Status – IDR 474,880,660.65
  2. Capture fisheries: fishermen productivity – IDR 7,294,394,213.00
  3. Mari-culture fisheries: grouper - seaweed culture productivity – IDR 6,762,077,000.00

- ***Improving ecosystem value***

  1. Tourism value: snorkeling and diving activities – IDR 4,824,429,933,400.00
  2. Supporting value of tourism – IDR 2,372,368,422.64

- ***Total Economic Value*** **:** IDR 4,840,858,773,035.64

THANK YOU
TERIMA KASIH

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ALTERNATIVE/SUPPLEMENTAL LIVELIHOOD PROGRAMS IN THE PHILIPPINES

Issues in coastal areas

- Fast growing coastal population
- Excessive resource extraction
- Uncontrolled development
- Pollution
- Conflicting uses
- Problematic enforcement of pertinent laws

Impacts/Cost to society

- Destruction of natural habitats of coastal and marine organisms
- Resource depletion
- Loss of/threat to biodiversity
- Increasing/worsening poverty in coastal areas
- Continuing threat to food security
- Loss of tourism/recreational value of coastal resources

Scope

- Sea-based culture livelihoods
- Land-based economic activities

Objectives

- Reduced fishing effort and other coastal resource extraction
- Income diversification
- Micro-enterprise development in coastal communities

Features

- Participatory
- Community-based
- Technology aided
- Supportive of gender mainstreaming
- Dynamic/evolving

Examples of Alternative/Supplemental Livelihoods

Sea-based culture livelihoods

- Aqua-silvi
- Mariculture
  - production of seaweeds, finfishes, shellfishes

Land-based economic activities

- Value-adding
  - processing of fish, seaweeds, shellfishes; handicrafts
- Distribution/marketing
  - selling of fisheries and agricultural commodities
- Ancillary services
  - boat repair, net repair

Supporting Financing

- Initially, with grant or subsidy from the programs of the government, NGOs, development agencies
- With credit component in the programs

Incentives

- Access to technical, marketing and financing support from national government agencies and other development partners
- Access to credit if with satisfactory performance in the subsidized start-up operations

Institutional Mechanisms

- A program management office or PMO facilitate capacity building of local implementers to ensure continuity even after project life
- Especially in ecosystem-based initiatives, local executives are at the forefront of bodies like a bay management council which has multi-sectoral composition
- Set up of provincial enterprise development units as a sustainability mechanism

Opportunities

- Demand-driven project development
- Increasing appreciation and adoption of value chain approach
- More value adding activities
- Further mainstreaming of women
- Alternative livelihoods toward resiliency to climate change impacts

Expected Outcomes

- Protection and rehabilitation of coastal and marine ecosystems
- Increased income of coastal households

Benefits

- Increased understanding of connectivity or interdependence of ecosystems
- Reduced illegal fishing practices
- Mobilization of communities toward coastal and marine resource protection
- Developed/enhanced business skills among fisherfolk groups
- Increased women involvement in economic activities

Factors that would ensure...

Government commitment

- Strong self-determination among fisherfolk groups
- Complementary support from NGOs and the private sector
- Participatory monitoring and evaluation or M & E of initiatives

Support from the private sector, NGOs, community-beneficiaries and other stakeholders

- Sincerity of implementing agencies
- Strong buy-in from the local government units or LGUs
- Mutual trust between the producers and buyers

Factors that would ensure...

Sustainability of the livelihood programs

- Community organizing with proper social preparation, organizational development, capability building and alliance building
- Initiated from internally generated resources of the people's organizations or POs
- Business orientation in livelihoods development in the communities
- Strong self-determination of the POs
- Value adding activities
- With projection for upscaling

Challenges…

- Livelihoods development being project-driven or co-terminus with duration of initiatives
- Most livelihood programs are supply-/production-oriented rather than market-driven
- Lack of post-harvest facilities
- Lack of economies of scale leading to inefficient marketing chain
- Coastal households/POs resist adoption of new technologies and improved business operation techniques
- Scheming marketing practices instead of developing good relationship with business partners

Challenges…

- Capacity building, especially organizational, is not always an integral part of livelihood development programs
- Empowering communities for needed networking/allinace-building and advocacy
- Grants from development organizations reinforce dependency rather than self-reliance; dole-out mentality in communities remain
- Capacitating fisherfolk groups toward sustained credit access/support; perception on non-bankability of fisherfolk groups remains due to bad experiences of financial institutions

Challenges…

- Counter-productive microfinance interventions in a number of communities
- Collateral requirements of formal lenders or banks
- No insurance facility yet for mariculture projects

Challenges…

- Open access/lack of tenurial rights in coastal waters conflicting uses and coastal pollution
- Impact of natural disasters on thriving alternative livelihoods
- Conflicting uses and coastal pollution are harming mariculture projects
- Most fishing households and their POs are without land to securely locate alternative livelihoods

Good practices

- Participatory livelihood development planning and implementation
- Strong organizational development
- Projects initiated from internally generated resources (in cash, kind or service)
- Backed by business planning
- Women highly engaged in livelihoods
- Tolling scheme for common service facilities

Lessons learned

- Household financial discipline can have direct positive translation to the PO level especially in the aspect of budgeting, transparency and accountability
- Organizational maturity can make or break a group's livelihood project
- Complementation of supporting development organizations can be:

  NGOs: community organizing

  NGAs: business development

  Financial institutions: credit intermediation

Role of livelihoods in helping ensure sustainable and inclusive coastal development

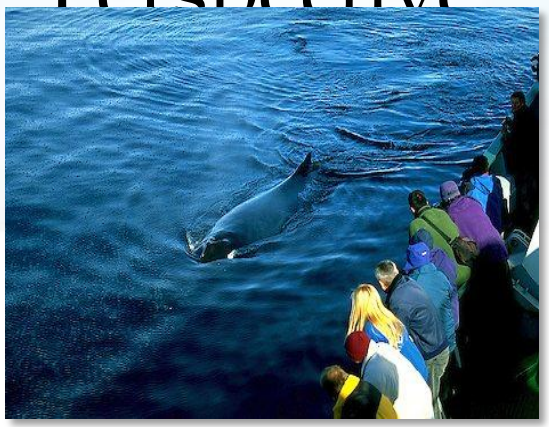
- Income diversification/augmentation would help address poverty in coastal communities
- Keeping fisherfolk away from extractive coastal activities would help ensure natural habitat rehabilitation, and eventually, food security
- Mariculture activities would even mobilize fisherfolk to protect the coastal ecosystem as this hosts their livelihood

Role of ICM in promoting alternative livelihoods

- Effectiveness of alternative livelihood programs is dependent on the proper implementation of the other ICM aspects

- ICM can be instrumental in addressing the identified challenges in alternative livelihood development that are mainly on institutional development
  - An enabling environment can be worked out at the national and local levels, and community organizing-based livelihood development on the ground

Research on Investigating the Possibility of Whale Watching Tourism in Korea: Economic Valuation Perspective



July 10. 2012

Shin, Chul-Oh (shin@kmi.re.kr)

KMI 한국해양수산개발원
KOREA MARITIME INSTITUTE

– CONTENTS –

I Introduction

II Valuation Methods

III Empirical Analysis

IV Conclusion and Implications

Introduction of Study

Research Background

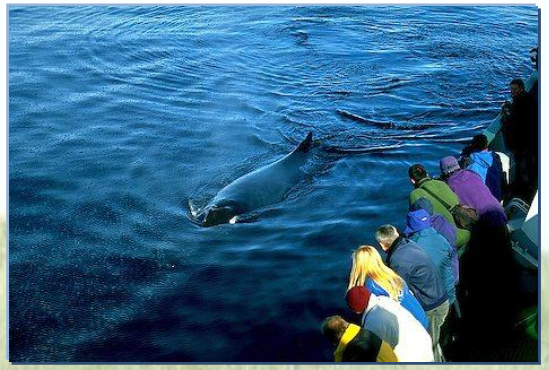
Growing Demand for New Tourism	+	*Natural Environment Interest*	+	*Increasing Political Interest*
Sustainable tourism Participatory Tourism ↓ Diversification of Tourism types		Green Tourism Eco Tourism ↓ Improvement of Environmental Awareness through Tourism		Increase Coastal Municipalities' income and Expend PR Efforts through Systematic Development ↓ Efforts to Establish Policy Means for Promotion of Local Tourism

- There is some movement for legalizing whale hunting…
- Limited to some areas, but small scale industry as food consumption…
- Korea plans to resume hunting whales for research purposes
- On the other hand, content such as marine tourism through whale watching industry is underway
- Thus, estimating the economic value of whale watching is required

Introduction of Study

Whale Watching Industry

- 1950s California coastal area
- Increasing visitors from the early stage
- Year 2009, 122 countries



Current Situation

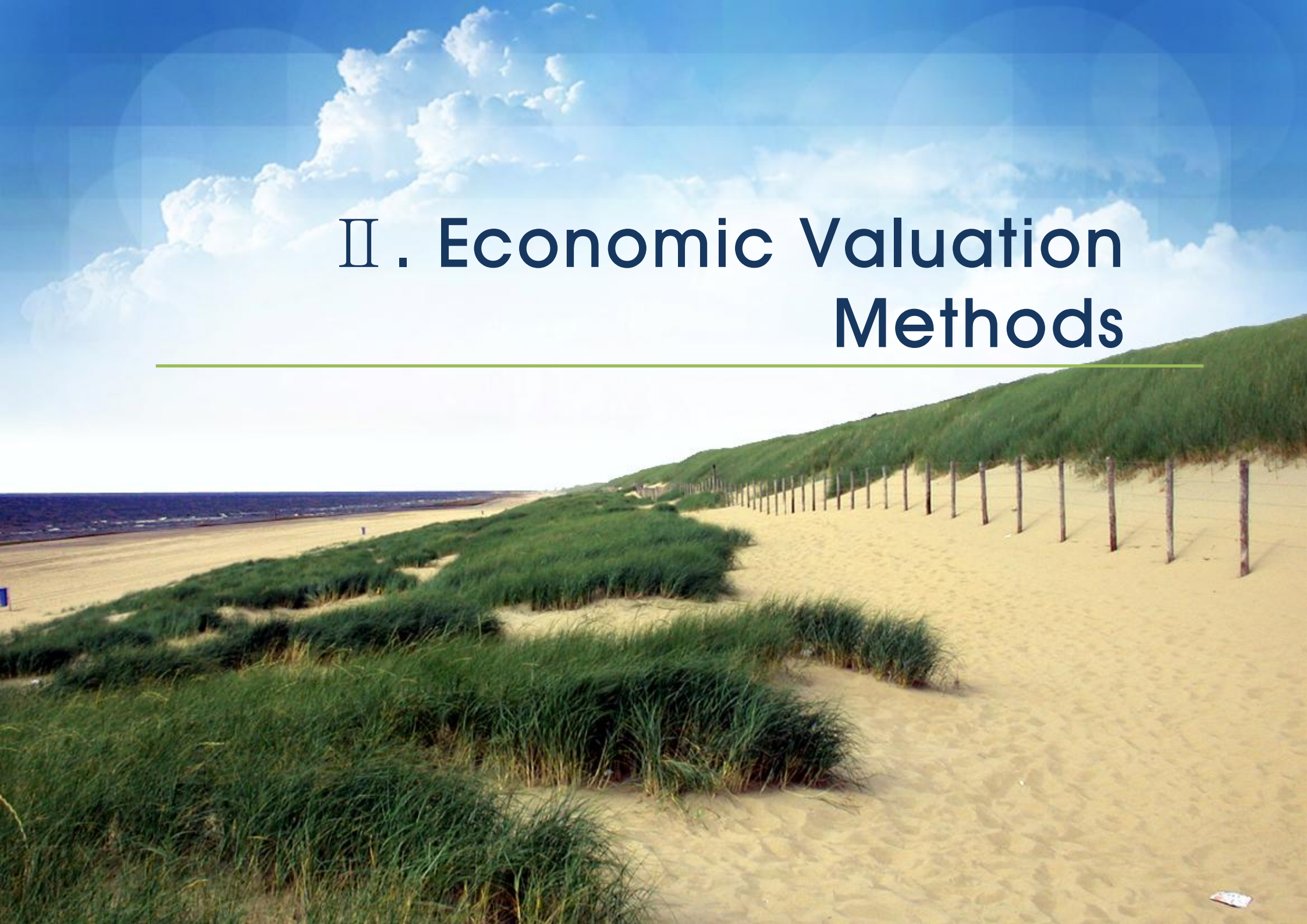
Introduction of Study

Korea's Case

Ulsan area

▲고래박물관 옆에 정박해 있는 고래바다여행선.

Ⅱ. Economic Valuation Methods



Economic Valuation Methods

Valuation Methods for Environmental and Non-market Goods

- Major approaches for valuing marine-related environmental resources : Revealed Preference (travel cost method, Hedonic model), Stated Preference (contingent valuation, conjoint analysis), Productivity approach, Emergy model etc.
- CV method and conjoint analysis can be applied to marine environmental tourism such as whale-watching

Revealed Preference Method, RP

I. Difficult to apply real-world data
II. Possibility of over/under estimation

Stated Preference Method, SP

I. Suitable for the valuation of non-market goods
II. Popular, high degree of flexibility
III. Takes a lot of research costs

Combined Model (SP+RP Method)

I. Difficult to obtain the available realistic data

Considering budget, feasibility, related procedures, etc.

Stated Preference Methods

Contingent Valuation Method

I. Asked directly about people's willingness-to-pay (WTP)
II. Relatively handy and well-known for statistical process
III. Guidelines and procedures for CVM organized systematically

Conjoint Analysis

I. Compare and rank alternate outcomes
II. Each outcomes has various characteristics
III. Research setting requires careful approach

Economic Valuation Methods

Research Method

- One-and-One-Half-Bound Dichotomous Choice (Cooper et al., 2002)
- Typically, a random sample of the population is asked a 'yes' or 'no' question identifying their willingness to contribute a specific amount toward the preservation of some environmental resource or the provision of a public good.
- Merits and demerits of SBDC and DBDC

Economic Valuation Methods

Research Method

- OOHB Model (Cooper et. al., 2002)
  - Sing-bound (SB) CVM, Double-bound (DB) CVM
  - DB is more efficient than SB in estimation, but possible non-consistency in response
- Theoretical basis
  - Log-likelihood of SB

$$\pi_i^Y \equiv Pr\{Yes \ \ to \ \ B_i^*\} \equiv Pr\{B_i^* \leq C_i\} = 1 - G(B_i^*;\theta)$$

$$\pi_i^N \equiv Pr\{No \ \ to \ \ B_i^*\} \equiv Pr\{B_i^* > C_i\} = G(B_i^*;\theta)$$

$$lnL^{SB}(\theta) = \sum_{i=1}^{N} \{d_i^Y ln[1 - G(B_i^*;\theta)] + d_i^N lnG(B_i^*;\theta)\}$$

  - Log-likelihood of DB

$$lnL^{DB}(\theta) = \sum_{i=1}^{N} \begin{array}{l} \{d_i^{YY} ln[1 - G(B_i^U;\theta)] \\ + d_i^{YN} ln[G(B_i^U;\theta) - G(B_i^0;\theta)] \\ + d_i^{NY} ln[G(B_i^0;\theta) - G(B_i^D;\theta)] \\ + d_i^{NN} ln[G(B_i^D;\theta)]\} \end{array}$$

  - Log-likelihood of OOHB

$$lnL^{OOHB}(\theta) = \sum_{i=1}^{N} \begin{array}{l} \{d_i^Y ln[1 - G(B_i^+;\theta)] \\ + d_i^{YN} ln[G(B_i^+;\theta) - G(B_i^-;\theta)] \\ + d_i^N ln[G(B_i^-;\theta)]\} \end{array}$$

Ⅲ. Empirical Analysis

Economic Valuation Methods

Empirical research procedures

- Economic benefits of whale watching in Ulsan area
  - ✓ by constructing the general situation of the contingent market
- National Oceanic and Atmospheric Administration (NOAA) guidelines
- The validity and accuracy of a CV study

Procedures	Contents
Valuation target	▪ Economic valuation of whale watching
Setting hypothetical market	▪ Offers realistic depiction of whale watching ▪ To explain the need for payment and user's consent
CV survey format	▪ Payment vehicle : tourism fees
Face-to-face interview	▪ Nation-wide survey, 754 respondents
Empirical analysis	▪ To draw Mean WTP

Empirical Results

Results of Estimation Model

Variables	Results
A(Constant)	1.805 (12.2111)***
B(Bid)	0.0628 (16.4270)***
Num. of Observation Log Likelihood Wald (p-value)	754 -829.0818 597.82815 (0.0000)

WTP Estimation Results

	Estimations results
Mean WTP (t-value) 95% confidence interval	KW 28,737 (USD 25) (24.4502)*** [26,727 ~ 30,964]

For calculating the 95% confidence intervals for each attribute, the Monte Carlo simulation technique of the Krinsky and Robb (1986) is used

Ⅳ. Conclusion and Implications

1. Conclusion
2. Policy Implications

Conclusion and Implications

Conclusion

- **This study demonstrated the feasibility of extending the use of CV study to marine tourism industry**
  - ✓ **Estimated the value of tourism before the trial whale watching tour**
  - ✓ **Elicited the measurement in a reasonable range**
  - ✓ **Reasonable model estimation results**
- **The cost of the tour is comparable to Ulsan's Whale watching tour's**
- **Confirmed activation possibility of Whale Watching tour in the consumer's perspective**

Conclusion and Implications

Policy Implications

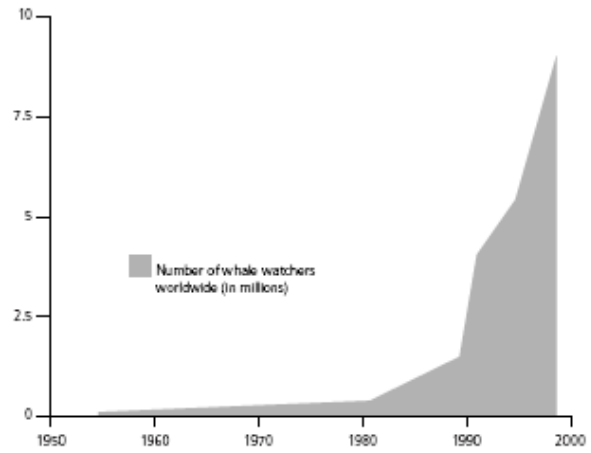
- **The results offer a useful framework for incorporating such quantitative information in their evaluation of various policies with regard to marine tourism encouragement efforts under consideration**

WORLD WW VISITOR EXPENDITURES

Year	No. of whale watchers	Direct expenditures	Total expenditures
1991	4,046,957	USD $77,034,000 or GBP £44,787,000	$317,854,000 £184,799,000
1994	5,425,506	$122,445,000 £75,583,000	$504,278,000 £311,283,000
1998	9,020,196	$299,509,000 £186,924,000	$1,049,057,000 £654,716,000

Average annual % increase 1991–94: 10.3%.
Average annual % increase 1994–98: 13.6%.
Average annual % increase 1991–98: 12.1%.

THE GROWTH OF WHALE WATCHING WORLDWIDE, 1955–1998



Source : International Fund for Animal Welfare(2001)

Conclusion and Implications

Policy Implications

- **Efforts to promote a Blue Economy is very important to the development of marine tourism industry.**

- **Identification of determinants and demand for marine tourism in Korea**
- **Develop the varied resources of marine tourism to satisfy demands**
- **Need to promote seasonable goods to be able to enjoy throughout the year**

- **ICM has introduced, which is in cooperation with local tourism and to protect marine ecosystems and endangered species**

Thank You

Environmental Responsibility Based Watershed Eco-compensation: Case Study of JRW, China

Benrong Peng PhD
Coastal and Ocean Management Institute (COMI), Xiamen University

July, 2012

Outline

- Background
- Method and model
- Models of defining the environmental responsibility
- Model of estimation eco-compensation standard
- Conclusion

Background

- **Integrated watershed management (IWM)**
  - Takes into account the relationships between up and downstream, the ecological and hydrologic complexities of the entire water system rather than focusing on an isolated segment or administrative unit
  - Solution to the transfer-boundary environmental problems
  - A means of balancing the many, often competing demands placing on watershed resources
- **IWM vs. ICM**
  - Scaling up the ICM programmes to the watershed scale—IWM
  - From politically defined space to ecologically defined space
  - Integrated approaches of ICM are implemented at ecosystem scale

- **Problem of participation motivation**
  - Upstream: ecologically sensitive areas. Their participation is very important to the success of IWM
  - Economically less developed. Their financial capacity, and the resulted political wills of pollution control are in question
- **Watershed ecological compensation(WEC)**
  - A effective solution to promote the environmental protection motivation and capacity of upstream communities without sacrificing their welfare
- **China's Eco-compensation programs**
  - Conversion of Cropland to Forest and Grassland Program (1999): $19 billion
  - Forest Ecosystem Compensation Fund (2001): $2 billion
  - WEC Scheme (1998): $7.8 billion

- **Problems of current WEC**
  - Downstream: PPP ***vs.*** Upstream: Beneficiaries compensation; right to good lives
  - Downstream: not getting clean water despite their yearly compensation ***vs.*** Upstream: the current compensation was too less comparing to the high environmental expenditure
- **Heart of the matter**
  - Ignorance of defining the environmental responsibility of upstream and downstream
  - Current compensation amount which was not commensurate with environmental responsibility casts doubts over the effectiveness of the WEC scheme

WEC: Based on the environmental responsibility

Method and Model

- **Components of the models**
  - Model identifying the environmental reasonability
    - Equity and environmental target
    - Defining the ER in terms of Abatement quantity and Abatement Cost
  - Minimum cost of pollutant reduction model
    - Efficiency and environmental target
    - Estimating the optimal Abatement quantity and Abatement Cost
  - WEC estimation model
    - Difference of optimal abatement cost and the responsible cost

➢ ER defining model

- Equity
  - Equal basic emission: absolute equality of basic rights
  - No basic emission: proportional to the contribution to the economy: proportional equality of no-basic rights;
- Pre-specified environmental targets

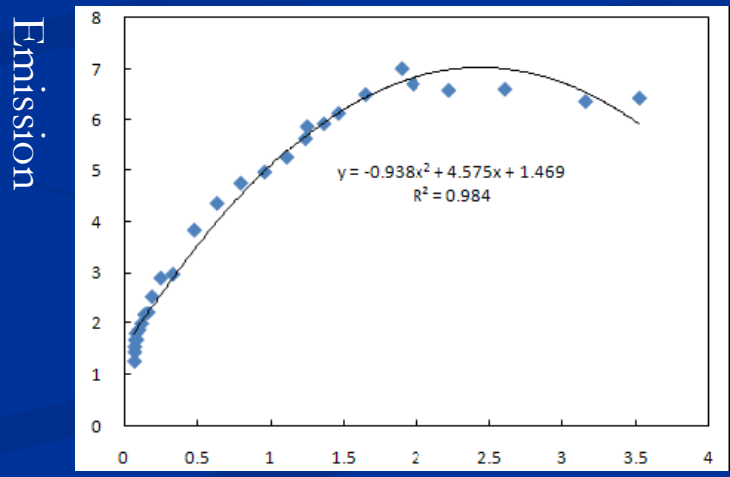
$$\min \sum_{i=1}^{i=n} (E_{0i} - \sum_{k=1}^{k=m} x_{ik})$$

s.t.

$$\frac{E_{0i} - e_0 p_i - \sum_{k=1}^{k=m} x_{ik}}{\sum_{i=1}^{i=n} (E_{0i} - \sum_{k=1}^{k=m} x_{ik}^{p})} = \frac{GDP_i}{\sum_{i=1}^{i=n} GDP_i}$$

$$\sum_{i=1}^{i=n} (E_{0i} - \sum_{k=1}^{k=m} x_{ik}) r_i \le (1-\partial) T^p$$

$$AC_i^E = \sum_{k=1}^{k=m} C(x_{ik}^E)$$



Modeling the minimum cost solution of pollution reduction

$$\min \sum_{i=1}^{i=n} \sum_{k=1}^{k=m} C(x_{ik})$$

Minimizing the abatement cost

$$\sum_{i=1}^{i=n} (E_{0i} - \sum_{k=1}^{k=m} x_{ik}) r_i^j \le (1-\beta_j) T_j^p$$

Achieve the specified environmental target

$$h_i^k(x_i) \le h_i^k \max$$

Scale constraints

$$x_{ik}, T, T_j \ge 0; E_{0i} \ge \sum_{k=1}^{k=m} x_{ik}$$

No negative constraints

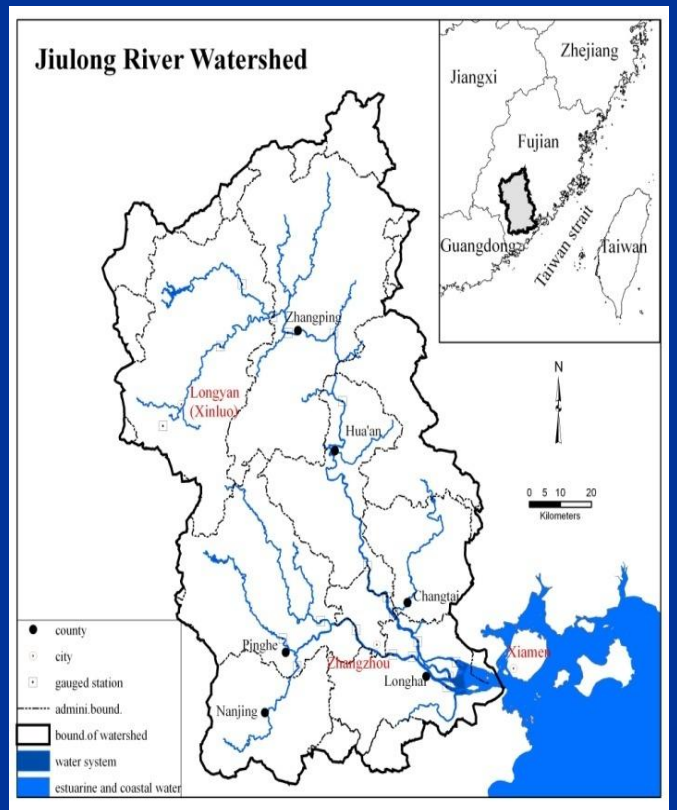
$$AC_i^O = \sum_{k=1}^{k=m} C(x_{ik}^O)$$

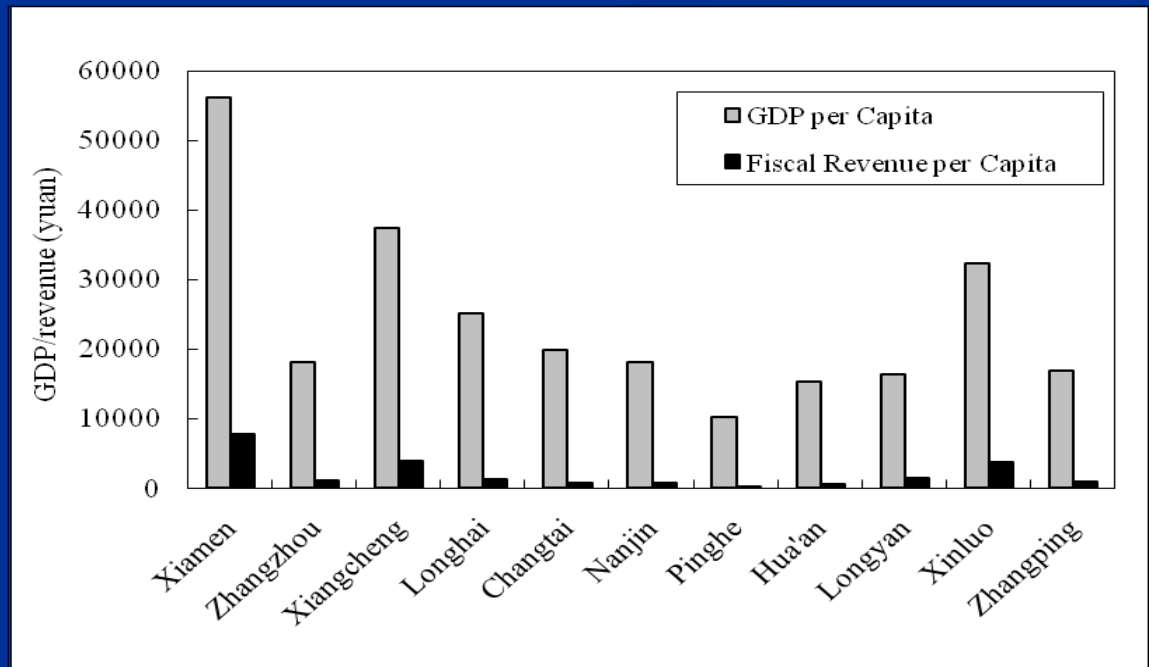
- **Estimation of WEC standard**
  - Difference of optimal abatement cost and the responsible cost

$$WEC_i = AC_i^E - AC_i^O = \sum_{k=1}^{k=m} C(x_{ik}^E) - \sum_{k=1}^{k=m} C(x_{ik}^O)$$

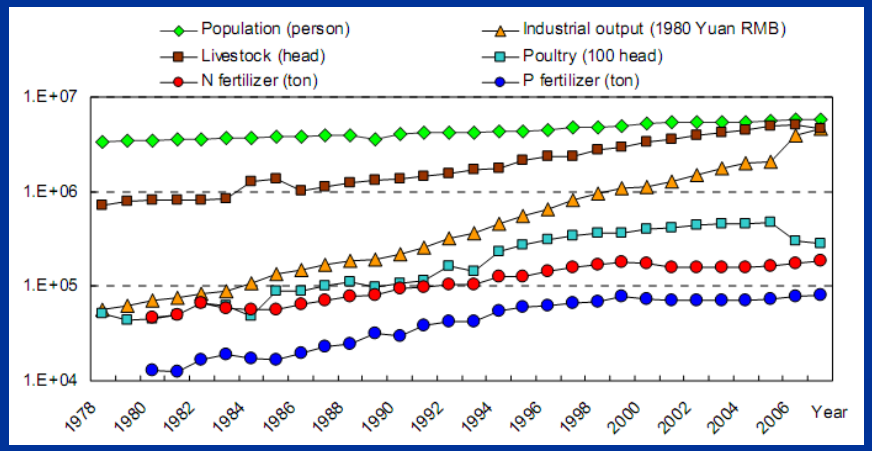
Case Study of JRW

- Jiulong River Watershed
  - The second largest river of Fujian Province
  - A predominantly agricultural watershed covering 1.47×10^4 km^2.
  - More than 5 million residents in the watershed
- Economic development level varies greatly in the watershed





- **The watershed and adjacent coastal water was increasing polluted over the past 30 years**
- **Fujian Provincial government initiated the JRWMP in 1999**
  - **Goals** and **Targets**
  - **Measures:** sewage plants, reducing fertilizers, eco-agriculture…
  - **Planned investment and projects**
  - **Incentive mechanism**
  - Constraint mechanism

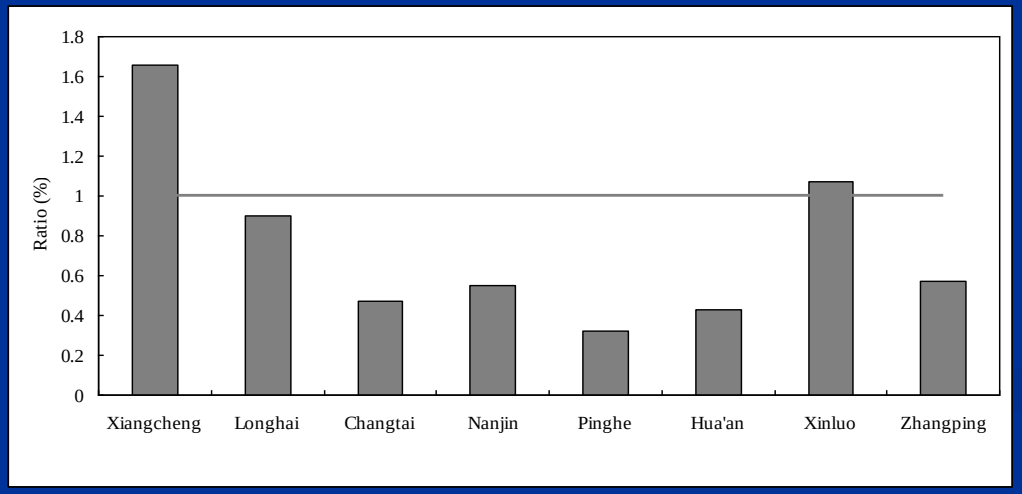


Change human stress on JRW

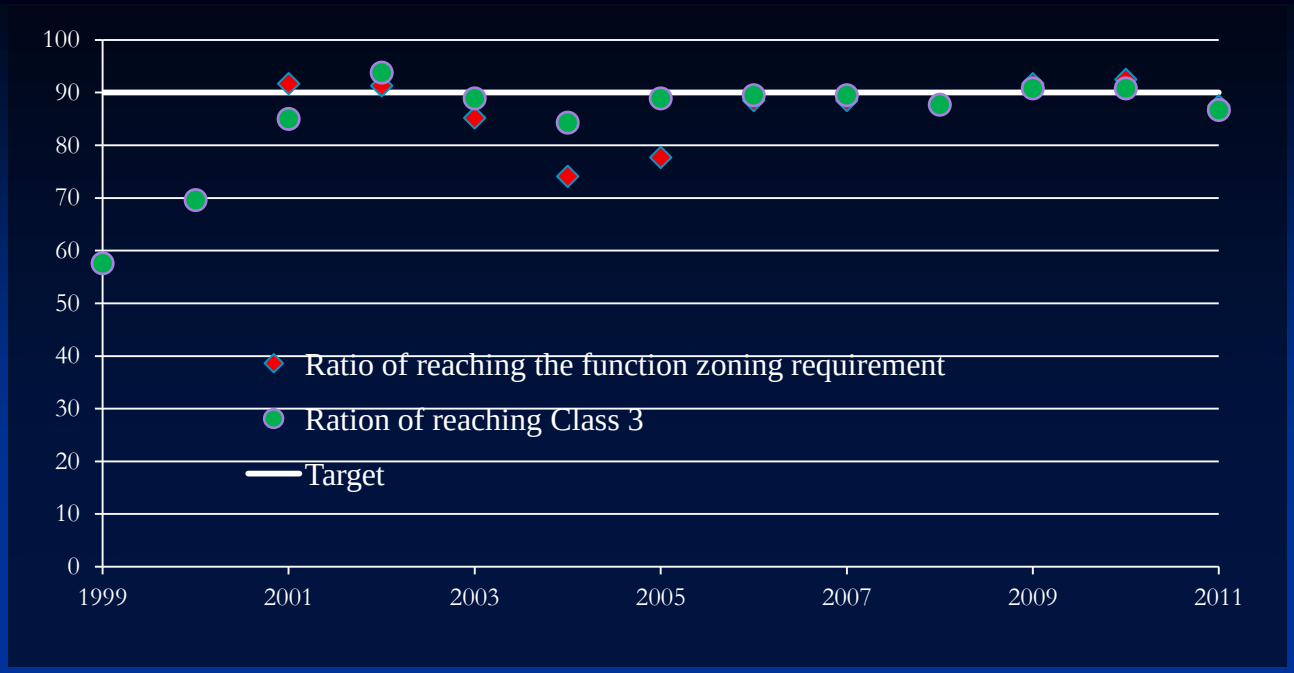
Jiangdong Reservior (2009) Xiaoqi reservoir (2006) Xiamen Bay (2005)

HAB in JRW and Xiamen Bay

- **Existing WEC scheme under JRWMP**
  - Xiamen (10 million) and provincial government (8 million) to upstream (2000-2009)
  - Xiamen: 30 million, Provincial government: 20 million

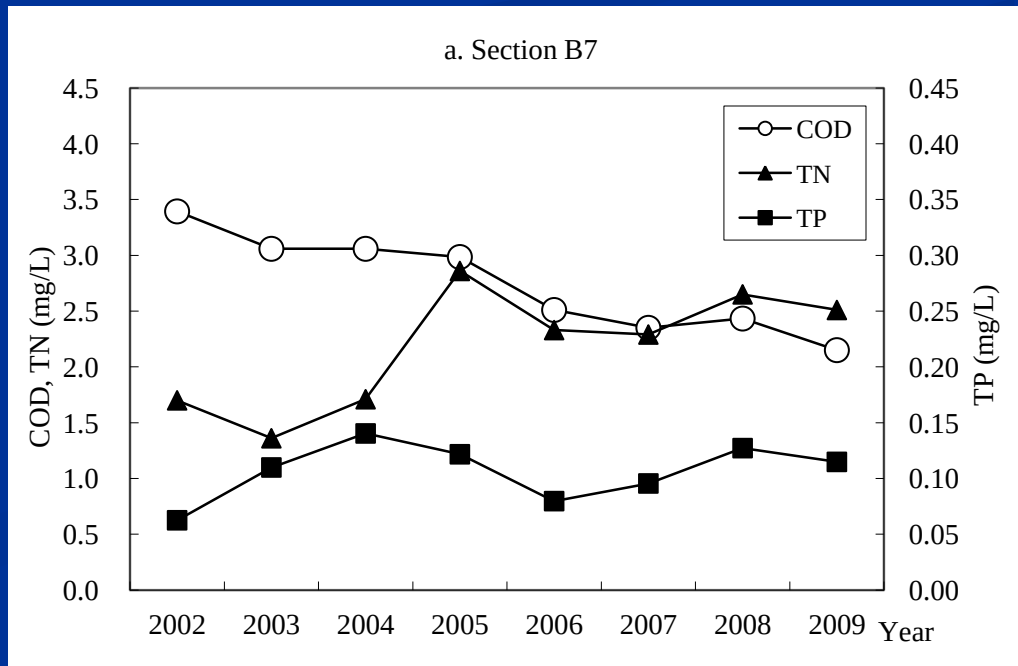


The fiscal revenue and expenditure ratio of counties in JRW is less than 1: financial difficulty of county level governments



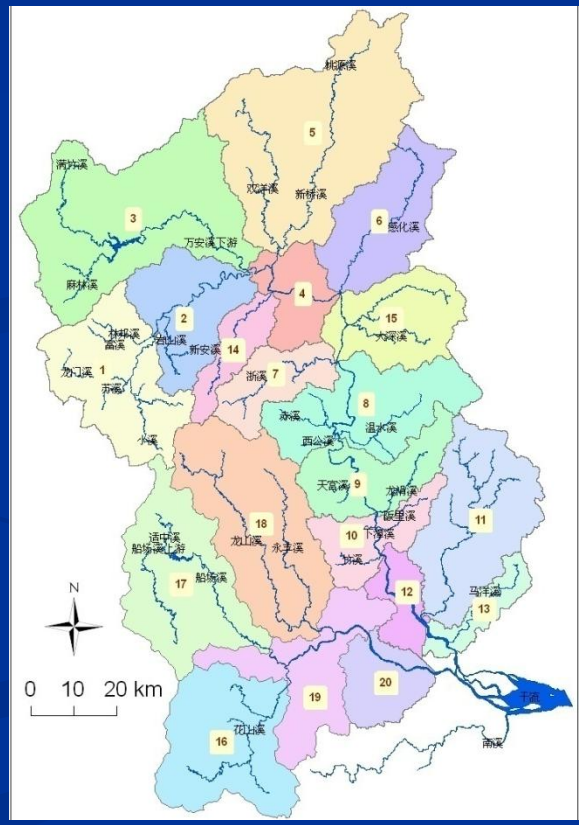
Water quality change of JRW

WEC scheme in JRW plays important role in improving the water quality.



Empirical estimation of WEC in JRW: Steps

- Sub-basins of JRW: 20
- Identifying the pollution sources
  - Domestic wastewater, chemical fertilizers, livestock
- Identifying the main abatement measures
  - sewage plant, wetland, reducing chemical fertilizers, reducing the livestock, catch crop
- Establishing the abatement functions of above measures in different sub-basin
- Identifying the target waterbody and specifying the environmental targets: 25%
- Estimating the response coefficient of load in target waterbody to different sub-basin



Sub-basins of JRW

➢ Empirical estimation of WEC in JRW: Results

	Responsible AC RMB Million	Optimal/required AC RMB Million	WEC RMB Million
Xinluo	69.02	69.31	0.29
Zhangping	46.94	79.8	32.86
Longyan Total	115.96	149.11	33.15
Urban Area	35.15	64.05	28.9
Longhai	15.44	25.7	10.26
Changtai	74.91	75	0.09
Nanjin	88.59	94.21	5.62
Pinghe	66.41	78.44	12.03
Huaan	32.16	30.44	-1.72
Zhangzhou Total	312.66	367.84	55.18
Total	428.62	516.95	88.33

Current WEC: 50 M. 43.4% low than the suggested standard

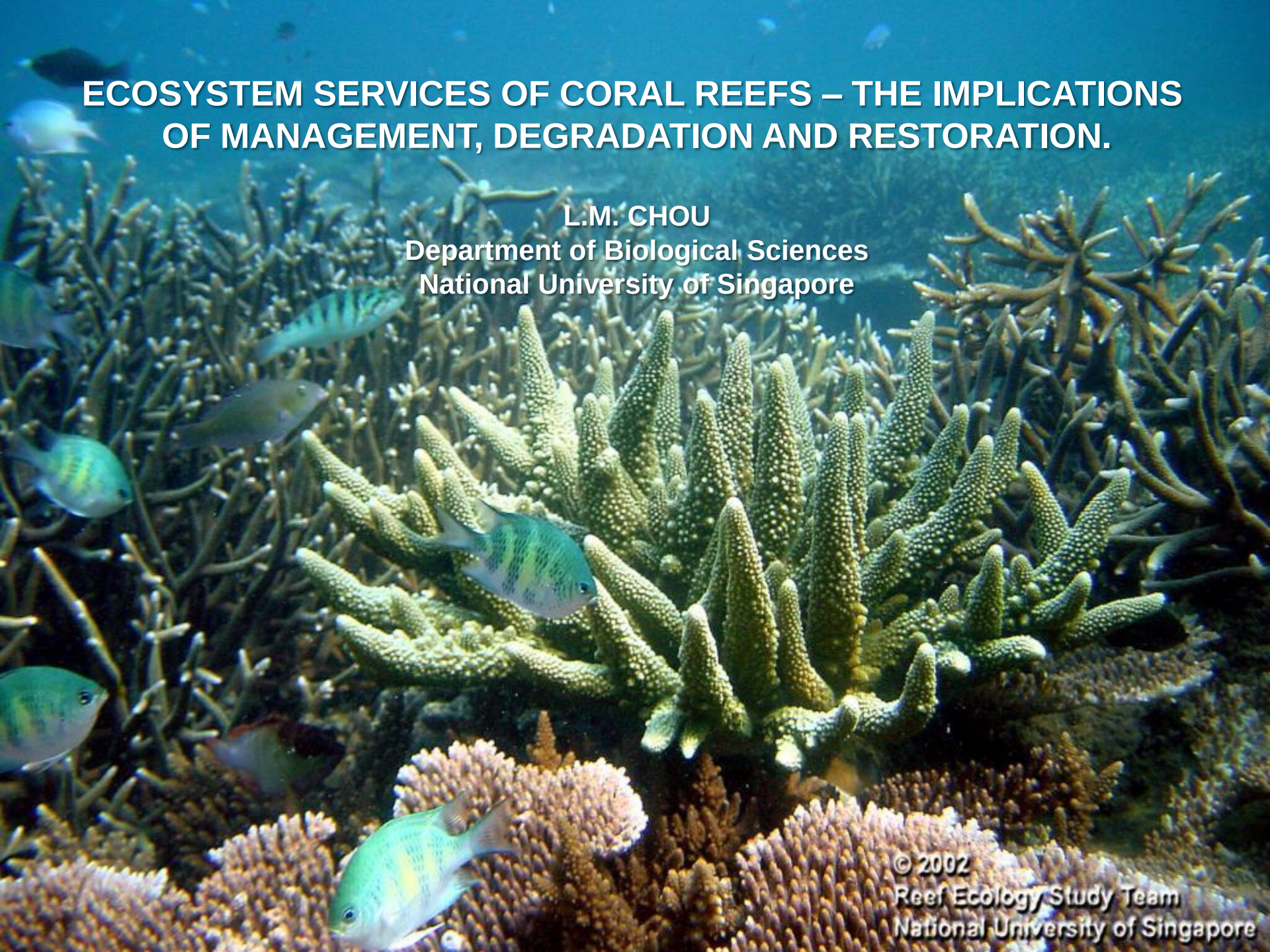
Conclusions

- Eco-compensation is a means of establishing the financial mechanism at watershed scale to deal with the transboundary environmental problems.
- The En-compensation standard depends on the definition of environmental responsibility of each party
- The suggested models need a large amount of data, and also the cooperation of various discipline.
- Current WEC standard in JRW
  - not commensurate with environmental responsibility
  - Too low to meet the need of upstream communities
  -

Thank you

ECOSYSTEM SERVICES OF CORAL REEFS – THE IMPLICATIONS OF MANAGEMENT, DEGRADATION AND RESTORATION.

L.M. CHOU
Department of Biological Sciences
National University of Singapore



Southeast Asia has the richest coral reef biodiversity in the world (30% of world's coral reefs)

They provide valuable ecosystem services.

Southeast Asia's coral reefs can boost ecotourism and provide good economic returns.

Strong management is needed to prevent coral reef degradation.

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Reef Ecology Study Team
National University of Singapore

CORAL REEFS

Goods
food
construction materials
whitewash
cement
ornaments
traditional medicine
pharmaceuticals

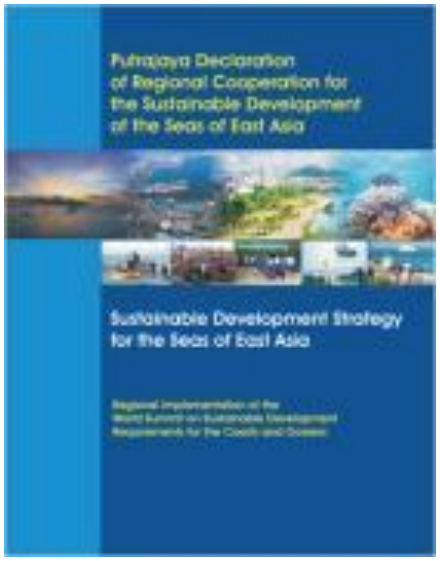
Services
shore protection
pollutant filter
sediment binding
source of beach sand
marine tourism
nursery and shelter
carbon fixation

IMPLICATIONS OF MANAGEMENT

If management is effective, Southeast Asia will benefit from ecosystem services valued in terms of billions of dollars.

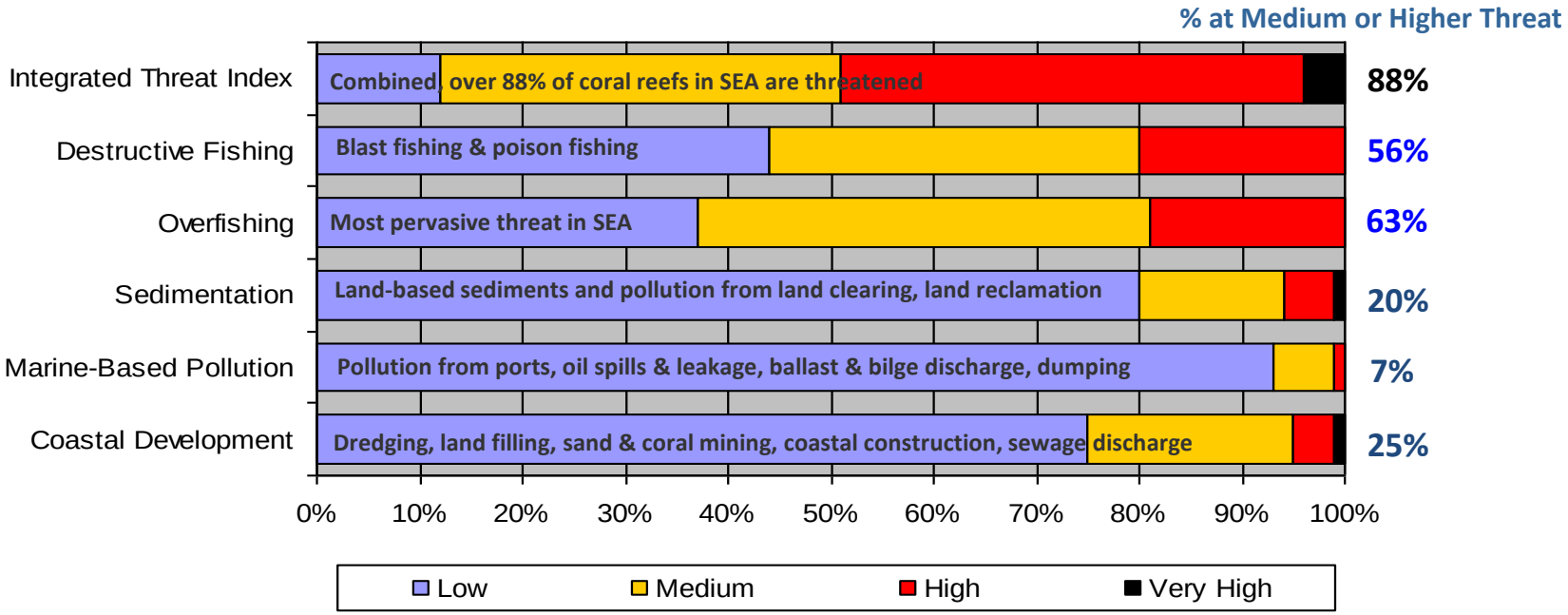
Annual estimated value of ecosystem services from SEAsia's coral reefs – $112.5 b
(PEMSEA, 2003)

Annual benefits from various studies:
$23,100 - $270,000 per km^2



Reefs at Risk in Southeast Asia 2002 & 2008

- 88% of SEA coral reefs at medium to high overall threat
- Over-fishing and destructive fishing are the leading threats
- Threats from coastal development and marine-based pollution estimated by country experts to INCREASE in future



Data from Burke *et. al*. (2002) with 2008 update from region's reef researchers.

Prepared by Ms. Karenne Tun.

How many MPAs are effectively managed?

Kelleher *et al.*, 1995 (GBRMPA, World Bank, IUCN)
Cheung *et al.*, 2002 (ARCBC)
Burke *et al.*, 2002 (WRI, UNEP-WCMC)

All assess that only about 10% of the region's MPAs are effectively managed.

Are MPAs serving their purpose?

If conservation target is coral reefs, is the present system of MPAs adequate?

Are MPAs targeting coral reefs?

Only 8% of SE Asia's reefs lie within MPAs.

Only 1% within MPAs that are effectively managed.

Burke *et al*, 2002

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Reef Ecology Study Team
National University of Singapore

IMPLICATIONS OF DEGRADATION

TOURISM AND RECREATION POTENTIAL OF CORAL REEFS

(CI, 2008, Economic values of coral reefs, mangroves and seagrasses: A global compilation. Center for Applied Biodiversity Science, Conservation International.)

Pulau Weh MPA (Indonesia) - US$230,000 / yr
Bunaken National Park (Indonesia) - US$110,000 / yr
Wakatobi National Park (Indoensia) - US$ 286,000 / yr

Pulau Payar (Malaysia) - US$390,000 / yr
Pulau Redang (Malaysia) - US$545,000 / yr

Hon Mun MPA (Vietnam) - US$243,190 / yr

Lingayan Gulf (Philippines) - US$4.7m / yr
Bohol Marine Triangle (Philippines) - US$5.06m / yr

CORAL REEF RESTORATION

IMPLICATIONS:

Costly, mostly small-scale, labor-intensive, requires long time before reduced level of ecosystem services can be realized.

Unavoidable because of widespread degradation.

Restoration appears to raise community awareness on reef management (Chou et al, 2009)

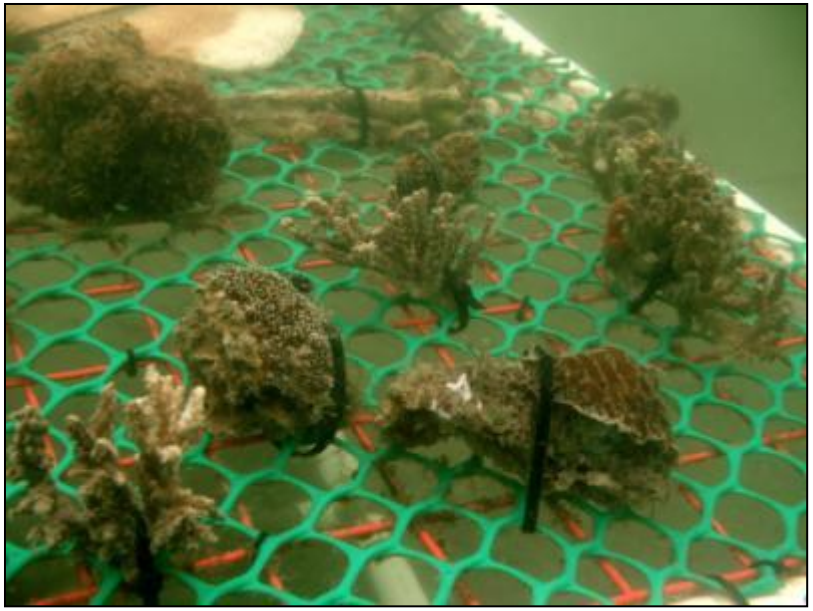
REEF RESTORATION COST

(Edwards, 2010. Reef Rehabilitation Manual. CRTR & CMP, St Lucia, Australia.)

Rehabilitation approaches: substrate stabilization, artificial substrates, coral fragment transplantation.

Rehabilitation area: 0.008 to 2.75 ha.

Cost per hectare: US$ 60 to 1,617.



- Reef protection should be the first management option as it is more effective and less costly than restoration.

- Restoration unavoidable because of the large extent of degradation.

Apo Island

Destructive fishing in past degraded much of the reefs resulting in low fish catches.

Management interventions:

Raise community awareness on long-term impact of destructive fishing.

Set aside 25% of the coral reef as strict no-take zone to continue replenishing the rest of the reef and allow sustainable extraction.

Alcala & Russ.

Tunku Abdul Rahman Marine Park, Sabah.

San Salvador Marine Sanctuary, Masinloc, Philippines.

Belitung coral reef demonstration site, Indonesia.

Phu Quoc Marine Protected Area, Vietnam.

THANK YOU

Approach	Ecosystem services	Cost
Management	Full	Efficient
Degradation	Partial	High
Restoration	Partial	High

厦门大学
Xiamen University

Coastal and Ocean Management Institute (COMI), Xiamen University
厦门大学海洋与海岸带发展研究院

Marine ecosystem services damage and compensation of sea area use: case study of Xiamen, China

Speaker: Huanhuan Rao

Outline

- Introduction
- Method and Models
- Empirical estimation
- Relationship with ICM
- Conclusion

Introduction

- **Abuse use of the oceans has resulted in the diminishing of productive capacity of marine ecosystems.**

- **g IEDC),**

- **se nities**

to develop an empirical ecological damage assessment and the related

a

Methodology and model

Five steps:

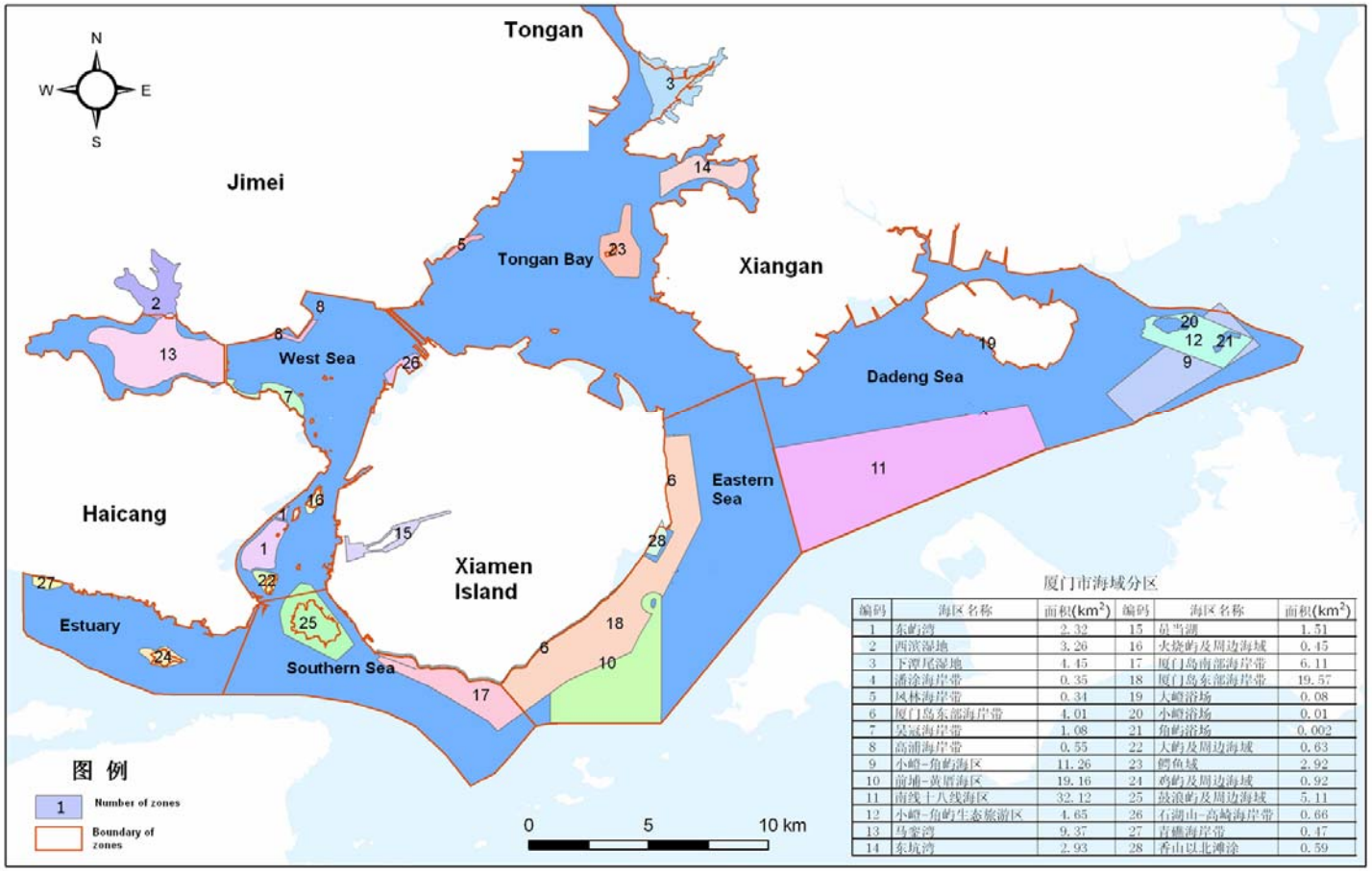
1. Divide the relevant sea areas into different zones
2. Identify the ecosystems and the services they provided in zones
3. Put a value on the identified ecosystems service in different zones
4. Estimate separately the damage degree of different sea areas use pattern to the identified different ecosystem services
5. Using the following models to calculate the MEDC standards:

$$MEDC_{ik} = \sum_{j=1}^{j=m} v_{ij} d_{kj}$$ ——— MEDC standard for every year

$$MEDC^{p}{}_{ik} = \sum_{j=1}^{j=m} v_{ij} d_{kj} / r$$ ——— MEDC standard for one time

Empirical estimation
--the case of Xiamen

1. Division of sea areas



厦门市海域分区

编码	海区名称	面积(km²)	编码	海区名称	面积(km²)
1	东屿湾	2.32	15	员当湖	1.51
2	西滨湿地	3.26	16	大嶝屿及周边海域	0.45
3	下潭尾湿地	4.45	17	厦门岛南部海岸带	6.11
4	潘涂海岸带	0.35	18	厦门岛东部海岸带	19.57
5	凤林海岸带	0.34	19	大嶝沿场	0.08
6	厦门岛东部海岸带	4.01	20	小嶝沿场	0.01
7	吴冠海岸带	1.08	21	角屿沿场	0.002
8	高浦海岸带	0.55	22	大屿及周边海域	0.63
9	小嶝-角屿海区	11.26	23	鳄鱼域	2.92
10	前埔-黄厝海区	19.16	24	鸡屿及周边海域	0.92
11	南线十八线海区	32.12	25	鼓浪屿及周边海域	5.11
12	小嶝-角屿生态旅游区	4.65	26	石湖山-高崎海岸带	0.66
13	马銮湾	9.37	27	青礁海岸带	0.47
14	东坑湾	2.93	28	香山以北滩涂	0.59

- 6 zones
- 48 sub zones

2. Identification of ecosystems and services

		Ecosystem Indentify	Ecosystem service Indentify										
Sea areas	Sub zones		Climate regulation	Flood control/shoreline stabilization	Nutrient regulation	Waste treatment/ control	Ecological control/ habitats	Fisheries	Biodiversity	Tourism/ entertai-nment	Scenery	Scientific research/ education	Agriculture
Western Sea	Dayu island and surrounding waters	2；3；5；7	○	○	○	○	○	○	○	○	○	○	
	Shihushan-Gaoqi coast	3；5；	○	○	○	○	○	○	○	○	○	○	
	Dongyu bay	3；5；7	○	○	○	○	○	○	○	○	○	○	
	Gaopu coast	3；5	○	○	○	○	○		○	○	○	○	
	Wuguan coast	2；3；4；5；7	○	○	○	○	○		○	○	○	○	
	West coast	3；5	○	○	○	○	○		○	○	○	○	
	Huoshao island and surrounding waters	2；5；7	○	○	○	○	○	○	○	○	○	○	
	Maluan bay	3；5	○		○	○	○	○	○	○	○	○	○
	Yuandang lake	3；5	○		○	○	○		○	○	○	○	
	others		○	○	○	○	○	○	○	○	○	○	
Estuary sea	Jiyu Islet and surrounding waters	2；3；5；7	○	○	○	○	○	○	○	○	○	○	○
	Qingjiao coast	2；3；5	○	○	○	○	○	○	○	○	○	○	○
	others		○	○	○	○	○	○	○	○	○	○	○

1,2,3,4,5,6,7 stand for cliffs, rocky beach, mud flat, sand beach, mangrove, estuary, coastal areas, respectively

3. Evaluation of the ecosystem services

Standard evaluation method, such as

- Market Price Method
- Productivity Method
- Hedonic Pricing Method
- Travel Cost Method
- Replacement Cost Methods
- Contingent Valuation Method

The social, economic and environmental data

- Primary productivity
- Seawater quality
- Fisheries and mariculture
- Biodiversity
- Tourist and entertainment revenues
- GDP and residents' WTP
- Et. al

Assess the monetary value of identified specific ecosystem service.

3. Evaluation of the ecosystem services

- **Climate regulation**

$$CO_2(264g) + H_2O(108g) \xrightarrow{6772cal} C_6H_{12}O_6(180g) + O_2(192g) \longrightarrow Amylase(162g)$$

$$P_{ar} = (1.63C_{CO_2} + 1.19C_{O_2})X$$

- **Flood control/shoreline stabilization**

$$P_{dr} = B_{dc} \cdot S_m$$

- **Nutrient regulation**

$$P_{nr} = \frac{QC}{S}$$

- **Waste treatment/control**

$$P_{ev} = h\sum_{i=1}^{n} x_i c_i / Q$$

- **Ecological control/habitats**

$$P_{hr} = \frac{P_0 E}{\delta} \sigma P_s \rho_s$$

- **Fisheries**

$$P_{mf} = \frac{R_{mf} - C_{mf}}{S}$$

- **Biodiversity**

$$v_i = \frac{a_i}{\sum_{i=1}^{i=n} a_i^2} \times \frac{TV_i}{TS_i}$$

- **Tourism/entertainment**

$$P_{tr} = \frac{V_{tr}}{S_{tr}}$$

- **Mariculture**

$$P_{mc} = \frac{R_{mc} - C_{mc}}{S}$$

3. Evaluation of the ecosystem services

Table 1 Ecosystem Services and Their Value (RMB yuan/m^2.y)

Sea Areas	Sub zones	Climate regulation	Flood control/shoreline stabilization	Nutrient regulation	Waste treatment/ control	Ecological control/ habitats	Fisheries	Biodiversity	Tourism/entertaimment	Scenery	Scientific research/ education	Agriculture
Western Sea	Dayu island and surrounding waters	1.098	0.8	2.703	0.6	1.477	0.096	2.844	0.417	3.5	0.05	0
	Shihushan-Gaoqi coast	1.098	0.8	2.703	0.6	1.477	0.096	2.111	0.417	3.5	0.05	0
	Dongyu bay	1.098	0.8	2.703	0.6	1.477	0.096	2.111	0.417	3.5	0.05	0
	Gaopu coast	1.098	0.8	2.703	0.6	1.477		2.111	0.417	3.5	0.05	0
	Wuguan coast	1.098	0.8	2.703	0.6	1.477		2.111	0.417	3.5	0.05	0
	West coast	1.098	0.8	2.703	0.6	1.477		2.111	0.417	3.5	0.05	0
	Huoshao island and surrounding waters	1.098	0.8	2.703	0.6	1.477	0.096	2.111	0.417	3.5	0.05	0
	Maluan bay	0.134		2.703	0.6	1.477	0	1.118	0.417	3.5	0.05	0.94
	Yuandang lake	0.134		2.703	0.6	1.477	0	1.118	0.417	3.5	0.05	0
	others	0.134	0.8	2.703	0.6	1.477	0.096	2.111	0.417	3.5	0.05	0
Estuary sea	Jiyu Islet and surrounding waters	1.098	0.8	4.677	0.6	1.137	0.126	2.607	0.427	3.5	0.05	0.94
	Qingjiao coast	1.098	0.8	4.677	0.6	1.137	0.126	2.199	0.417	3.5	0.05	0.94
	others	0.103	0.8	4.677	0.6	1.137	0.126	2.199	0.427	3.5	0.05	0.94
Tongan sea	Inlet of Tongan Bay	0.134		2.237	0.6	1.477	0.09	1.876	0.417	3.5	0.05	0.94
	Eyu Islet and surrounding waters	1.098	0.8	2.237	0.6	1.477	0.09	2.745	0.417	3.5	0.05	0.94
	Fenglin coast	1.098	0.8	2.237	0.6	1.477	0.09	1.715	0.417	3.5	0.05	0.94
	Pantu coast	0.134	0.8	2.237	0.6	1.477	0.09	1.715	0.417	3.5	0.05	0.94
	Xiatanwei coast	1.098	0.8	2.237	0.6	1.477	0.09	1.715	0.417	3.5	0.05	0.94

4. Estimation of the damage degree

Human Activities	Climate regulation	Flood control /shoreline stabilization	Nutrient regulation	Waste treatment / control	Ecological control/ habitats	Fisheries	Biodiversity	Tourism/ entertainment	Scenery	Scientific research/ education	Agriculture
Land Reclamation	1	1	1	1	1	1	1	1	1	1	1
Reclaimed aquaculture	0.221	0.250	0.332	0.438	0.662	0.541	0.353	0.141	0.485	0.485	0.488
Open-ended aquaculture	0.103	0.116	0.103	0.206	0.384	0.241	0.166	0.038	0.241	0.256	0.263
impermeable structures	0.346	0.358	0.444	0.534	0.516	0.719	0.534	0.594	0.528	0.441	0.422
Bridge construction	0.172	0.163	0.138	0.128	0.175	0.353	0.350	0.356	0.350	0.179	0.209
Permeable structures	0.134	0.159	0.194	0.184	0.238	0.403	0.431	0.447	0.388	0.297	0.319
Harbor basin and channel	0.088	0.109	0.175	0.166	0.194	0.531	0.534	0.772	0.441	0.397	0.359
Channel	0.038	0.053	0.059	0.056	0.138	0.413	0.400	0.728	0.338	0.276	0.094
Tourism	0.056	0.075	0.078	0.097	0.263	0.441	0.444	0.744	0.375	0.028	0.059
Seabed engineering	0.022	0.019	0.025	0.041	0.059	0.219	0.188	0.178	0.178	0.051	0.006
Mining	0.116	0.222	0.366	0.247	0.413	0.753	0.650	0.747	0.531	0.528	0.531
Water intake/ outlets	0.131	0.147	0.128	0.263	0.331	0.456	0.441	0.494	0.400	0.400	0.403
Sewage discharge	0.119	0.134	0.056	0.275	0.400	0.363	0.378	0.491	0.316	0.386	0.331
Waste discharge	0.178	0.259	0.091	0.313	0.556	0.628	0.538	0.747	0.494	0.534	0.488
Temporary Construction	0.123	0.187	0.117	0.137	0.237	0.307	0.300	0.357	0.253	0.353	0.340

5. The MEDC standard

Table 3 MEDC Standard of Sea Areas Use in Xiamen

(RMB yuan/m^2.y)

	Sub zones	Land Reclamation (yuan/m^2)	Harbor basin and channel	Bridge construction	Mining	Ship manufacture/ repair	Tourism	Seabed engineering	Waste discharge	Temporary Construction
Western Seas	Dayu island and surrounding waters	905.67	1.04	2.46	2.57	3.26	1.30	0.85	3.22	2.71
	Shihushan-Gaoqi coast	856.80	1.86	2.18	2.57	2.82	1.08	0.63	2.93	2.39
	Dongyu bay	856.80	1.86	2.18	2.57	2.82	1.08	0.63	2.93	2.39
	Gaopu coast	850.40	1.84	2.15	2.51	2.78	1.05	0.63	2.88	2.36
	Wuguan coast	850.40	1.84	2.15	2.51	2.78	1.05	0.63	2.88	2.36
	West coast	850.40	1.84	2.15	2.51	2.78	1.05	0.63	2.88	2.36
	Huoshao island and surrounding waters	856.80	1.86	2.18	2.57	2.82	1.08	0.63	2.93	2.39
	Maluan bay	729.27	1.83	2.00	2.51	2.43	1.02	0.34	2.91	2.30
	Yuandang lake	666.60	1.59	1.77	1.95	2.19	0.75	0.34	2.49	1.92
	Others	792.53	1.86	2.18	2.33	2.82	1.08	0.63	2.93	2.39
Estuary	Jiyu Islet and surrounding waters	1064.07	2.16	2.53	3.00	3.25	1.41	0.78	3.43	2.90
	Qingjiao coast	1036.20	2.06	2.38	2.99	3.01	1.29	0.66	3.26	2.71
	Others	970.60	2.06	2.38	2.75	3.01	1.29	0.66	3.27	2.72
Tongan Bay	Inlet of Tongan Bay	754.67	2.04	2.32	2.56	2.92	1.27	0.56	3.25	2.66
	Eyu Islet and surrounding waters	930.20	2.26	2.65	3.13	3.44	1.54	0.82	3.60	3.04
	Fenglin coast	861.53	2.00	2.26	3.13	2.83	1.23	0.51	3.19	2.59
	Pantu coast	797.27	2.00	2.26	2.88	2.83	1.23	0.51	3.19	2.59
	Xiatanwei coast	861.53	2.00	2.26	3.13	2.83	1.23	0.51	3.19	2.59

Relationship with ICM

- **Three types of ICM measures**
  - **Legal Measures**
  - **Administrative Measures**
  - **Economic Incentive Measures**

- **Institutional arrangements under the ICM program can facilitate the adoption of the MEDC standards**

- **e.g. Xiamen**

Conclusion

- **Sea area is the carrier of marine natural resources and ecosystems. Almost all of the sea areas use pattern will lead to some extent damage of marine ecosystems.**

- **But the fact that the normal sea areas use get approval of government and pay the sea use charge hinders the implementation of MEDC in sea areas.**

- **This study develops a set of methods and models to build the MEDC standard of sea area use. The compensation standards of different sea areas use pattern in different sea area in Xiamen are established employing the built model. Moreover, this simplified and low cost method can be applied by other places to establish their own MEDC standard.**

Thank you!

natural capital PROJECT

Nature's Benefits: Getting more for restoration dollars

EASC Workshop
9-13 July 2012

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The Natural Capital Project
Stanford University

Woods Institute for the Environment Stanford University

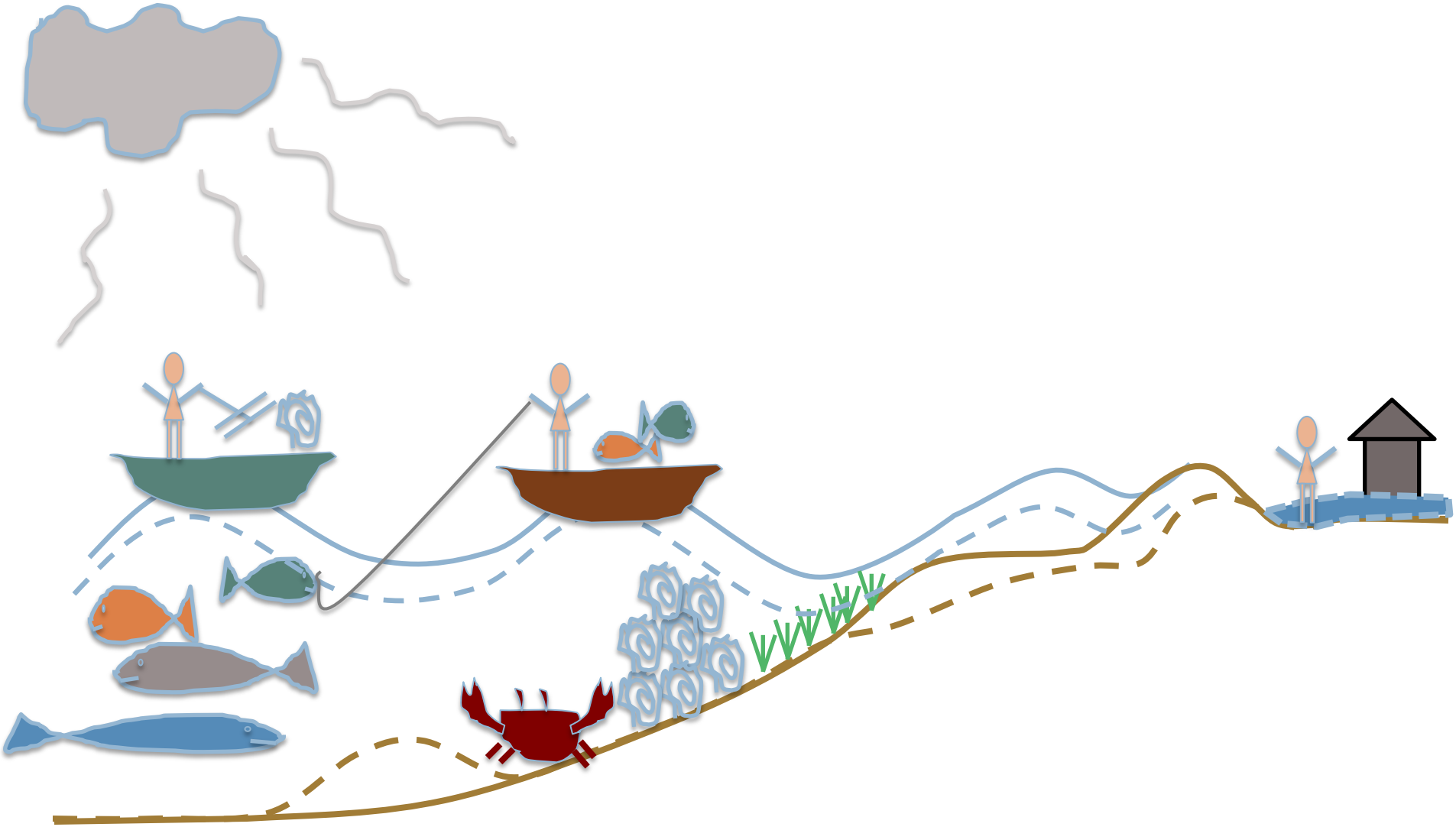
WWF

The Nature Conservancy

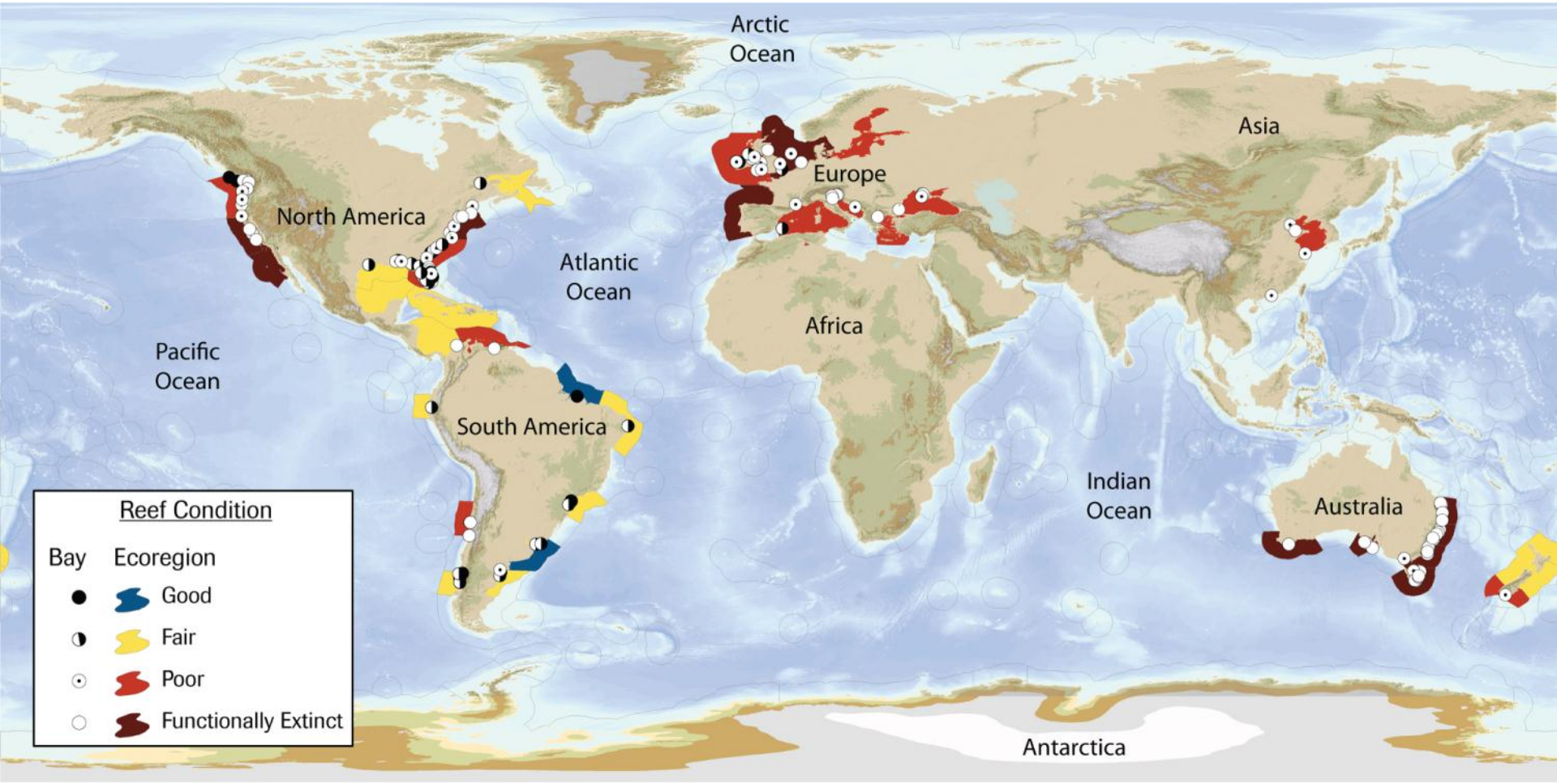
Institute on the Environment
University of Minnesota
Driven to Discover

Oceans and coasts provide many diverse benefits to people

Benefits provided by Oysters



Oyster Reefs at Risk



85% loss of oyster reef ecosystems in bays and ecoregions; mangrove and saltmarsh (~50%) and coral reef (~20%)

Beck et al BioScience 2011

Degraded systems provide fewer benefits

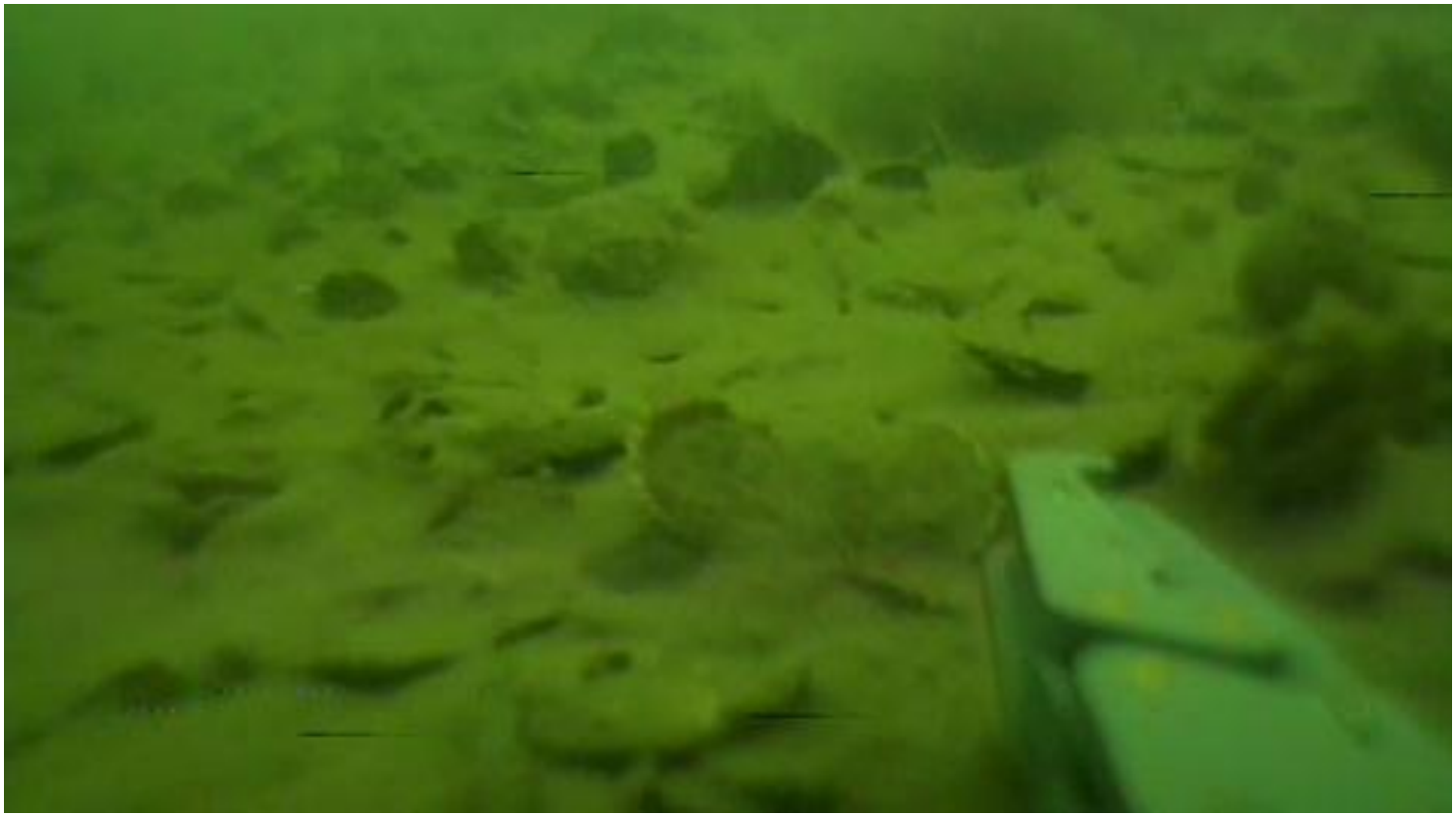


Photo: VIMS

Unprecedented Restoration of a Native Oyster Metapopulation

David M. Schulte, Russell P. Burke, Romuald N. Lipcius*

Native oyster species were once vital ecosystem engineers, but their populations have collapsed worldwide because of overfishing and habitat destruction. In 2004, we initiated a vast (35-hectare) field experiment by constructing native oyster reefs of three types (high-relief, low-relief, and unrestored) in nine protected sanctuaries throughout the Great Wicomico River in Virginia, United States. Upon sampling in 2007 and 2009, we found a thriving metapopulation comprising 185 million oysters of various age classes. Oyster density was fourfold greater on high-relief than on low-relief reefs, explaining the failure of past attempts. Juvenile recruitment and reef accretion correlated with oyster density, facilitating reef development and population persistence. This reestablished metapopulation is the largest of any native oyster worldwide and validates ecological restoration of native oyster species.

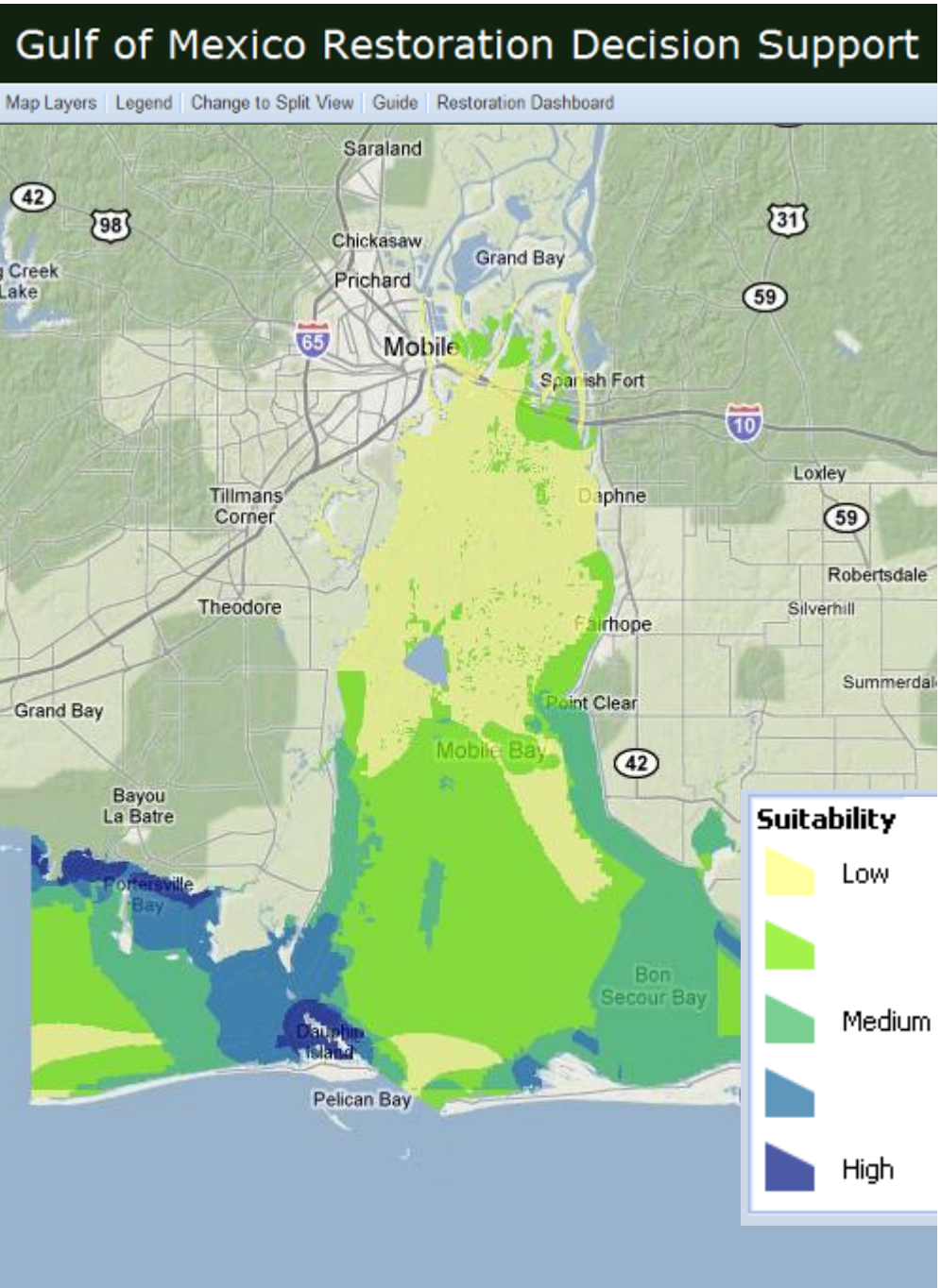
OYSTER REEF
RESTORATION
IN PROGRESS
Please Do Not Disturb
This project is made possible through the generous support of:
University of Central Florida
The Nature Conservancy
NOAA Community Based Restoration Program
Canaveral National Seashore
Indian River Lagoon National Estuary Program
St. Johns River Water Management District
Disney Wildlife Conservation Fund
Royal Caribbean International
Brevard Zoo

Rebuild Reef Natural Capital

long-term sustainable harvests of oysters
increased resilience to storms
full spectrum of benefits

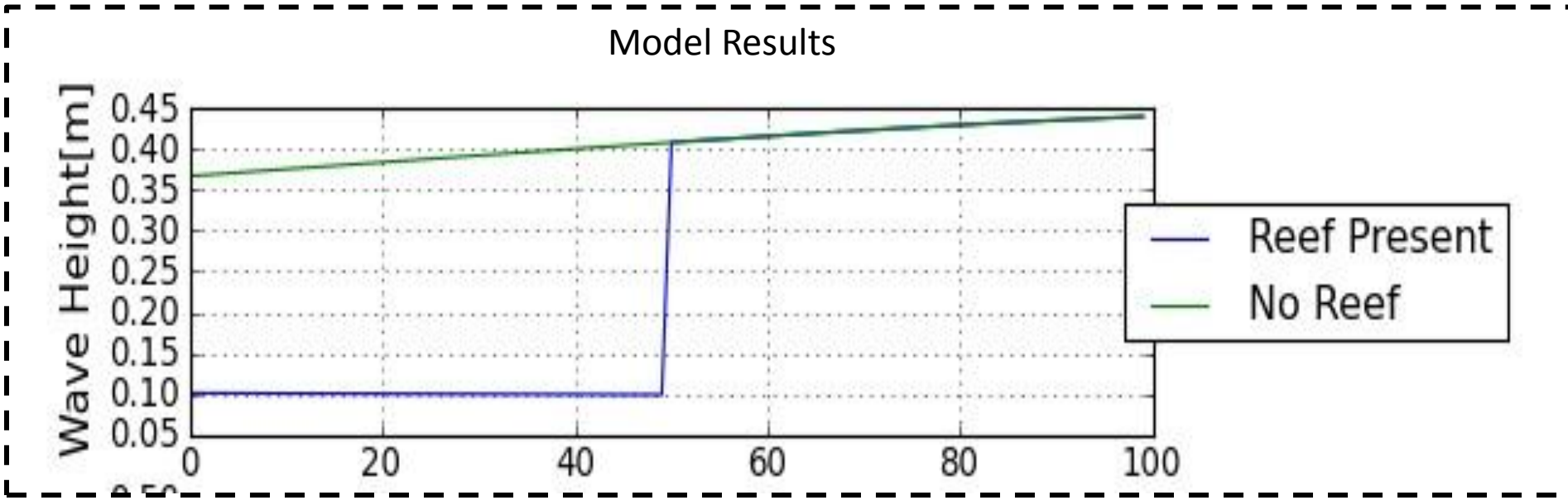
The American Recovery and Reinvestment Act and NOAA helped TNC build oyster reefs and create marshes in Mobile Bay

3.5 miles of oyster reef designed as shoreline protection



- Used habitat suitability in design
- Poised to put shells in the water
- Expected protection benefits

Smart use of science helped get more for the restoration $



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Action: restore 10 ha of

Scenario: major

For every $1 spent in restoration, get $1.83 back

Arkema et al in prep

ARRA job creation

$1M in coastal restoration → 17-30 jobs

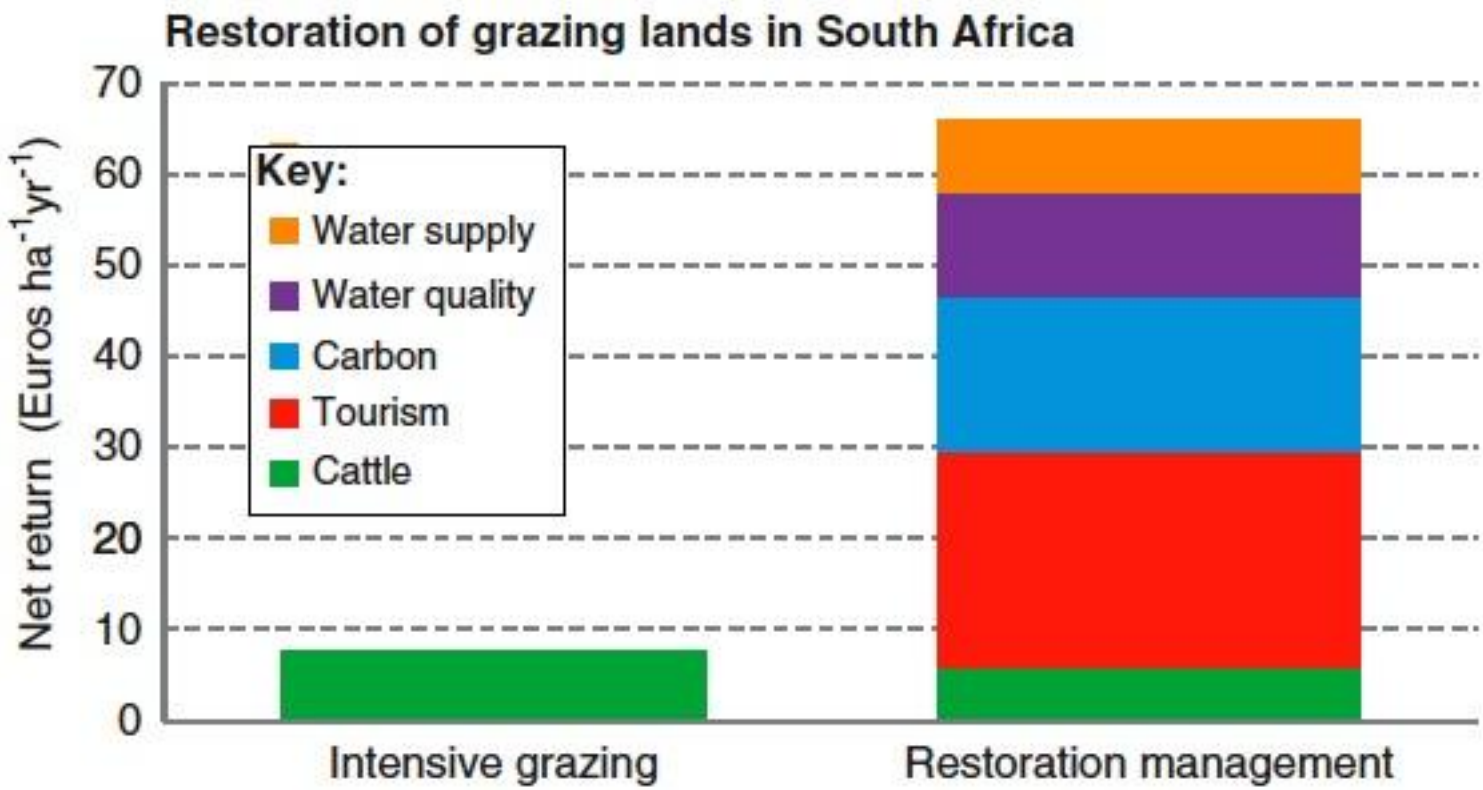
Over 2x the job creation of oil, gas & transportation sectors combined

Full Time Employees

FTE at Height of the Project: **31 FTE = 83 positions**

Average FTE for the Project (20 months): **17 FTE = 44 positions**

Economic benefits of restoration across sectors can outweigh costs



Bullock et al 2011 (from Blignaut et al. 2010)

SUMMARY

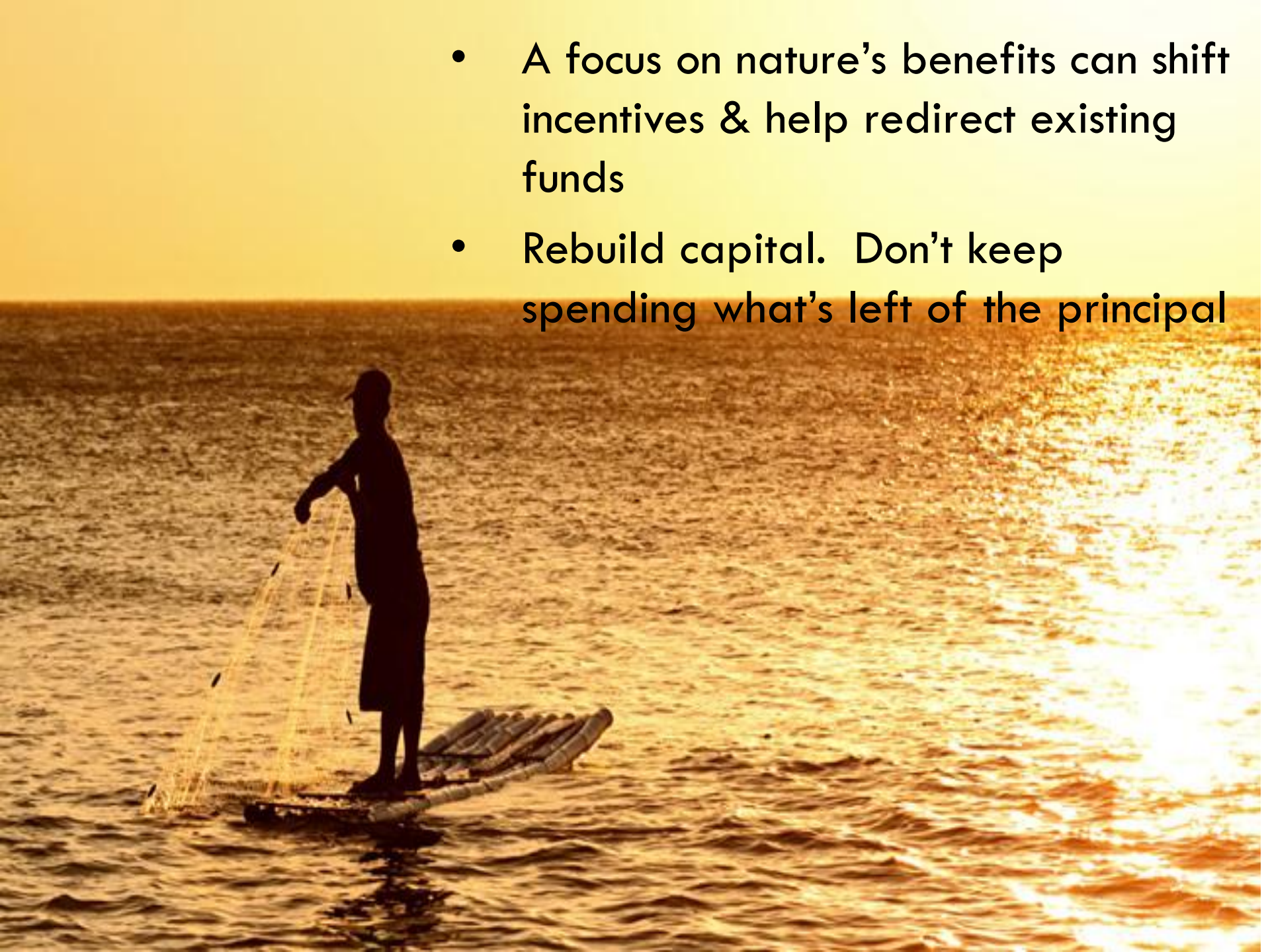
Smart restoration provides many benefits

use best available
science to inform choices

Restoration can be a good investment

consider diverse benefits

- A focus on nature's benefits can shift incentives & help redirect existing funds
- Rebuild capital. Don't keep spending what's left of the principal



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www.naturalcapitalproject.org