

Assessing and Predicting Socioeconomic Impacts of Coral Bleaching and Climate Change



Acknowledgement: Christy Loper (NOAA)

The Nature
Conservancy



Protecting nature. Preserving life.™



Outline

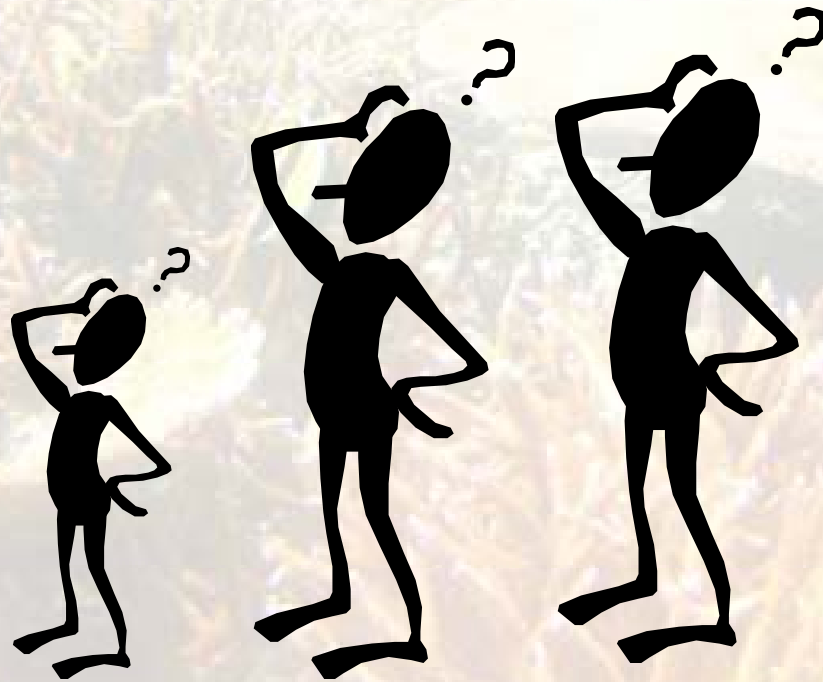
1. Why socioeconomic information is important to address climate change effectively
2. Socioeconomics of coral reefs
3. Frameworks for assessing and predicting socioeconomic impacts
4. Socioeconomic assessment tools
5. Case studies

Climate change impacts

Compared to other natural disasters, climate change impacts are multi-sectoral, multi-spatial and multi-temporal.

Climatic changes can be sudden or gradual. They can be highly localized, but can also have ramifications that extend well beyond acutely impacted areas.

1. Why socioeconomic information is important to address climate change effectively?



Climate change research to date has focused mainly on biological, physical and environmental impacts.



Pacific Island region is home of over 9 million people.

Most Pacific island communities live on the coast and are at acute risk from the impacts of climate variability and change.



Photo credit: Supin Wongbusarakum



Photo credit: Supin Wongbusarakum



Photo credit: Reginald.White

Climate change is more than a biophysical or environmental issue.

Climate change impacts are significantly altering and damaging the limited resource bases of coastal and island communities and their related demographic social, cultural, and economic structures.



Photo credit: Supin Wongbusarakum



Photo credit: Supin Wongbusarakum

Photo credit: Supin Wongbusarakum
Photo credit: Supin Wongbusarakum
Photo credit: Supin Wongbusarakum



Photo credit: GBRMPA



Photo credit: GBRMPA



Photo credit: Supin Wongbusarakum



Photo credit: GBRMPA

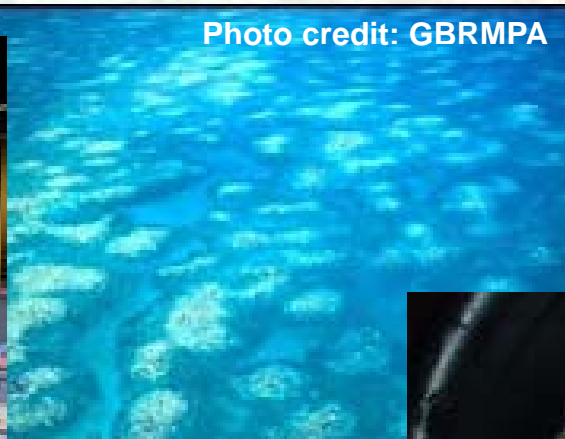


Photo credit: Supin Wongbusarakum

Impacts of climate change for small islands

(IPCC 2007)

Very high confidence:

1. Small islands are especially vulnerable to the effects of climate change, sea level rise (SLR), and extreme events
2. SLR is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards
3. Water resources are likely to be seriously compromised

High confidence:

4. Coral reefs and fisheries will be heavily impacted
5. Some local species have already been replaced due to warming
6. Subsistence and commercial agriculture will be adversely affected
7. Climate change will have largely negative impacts on tourism

The Nature Conservancy 
Protecting nature. Preserving life.



Source: IPCC, 2007

Why socioeconomic information is useful for climate adaptation?

Vulnerability to climate change and **adaptive capacities** substantially depend on socioeconomic characteristics of societies affected.

Vulnerability is a function of exposure and sensitivity, which depend on adaptation.

Adaptation is adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities. Can be anticipatory or reactive.

(Malone 2004).

Adaptation is a function of adaptive capacity, which is influenced by....

- Public's perceptions about risks and exposure
- Human skills and capabilities
- Relationship and dependency on natural resources
- Institutional structure, and decision-making and implementing authorities
- Social capital and social network
- Governance and political trends
- Available technological options



Photo credit: Supin Wongbusarakum

Socioeconomic assessment provides information that allowing us to develop adaptation options that are locally relevant and context-driven.

What are Socioeconomic Impacts?

What types of use and value the reefs have?

What are socioeconomic impacts of coral bleaching?

How do we take socioeconomic impacts into management consideration?

How has community dealt with impacts of changing climate?

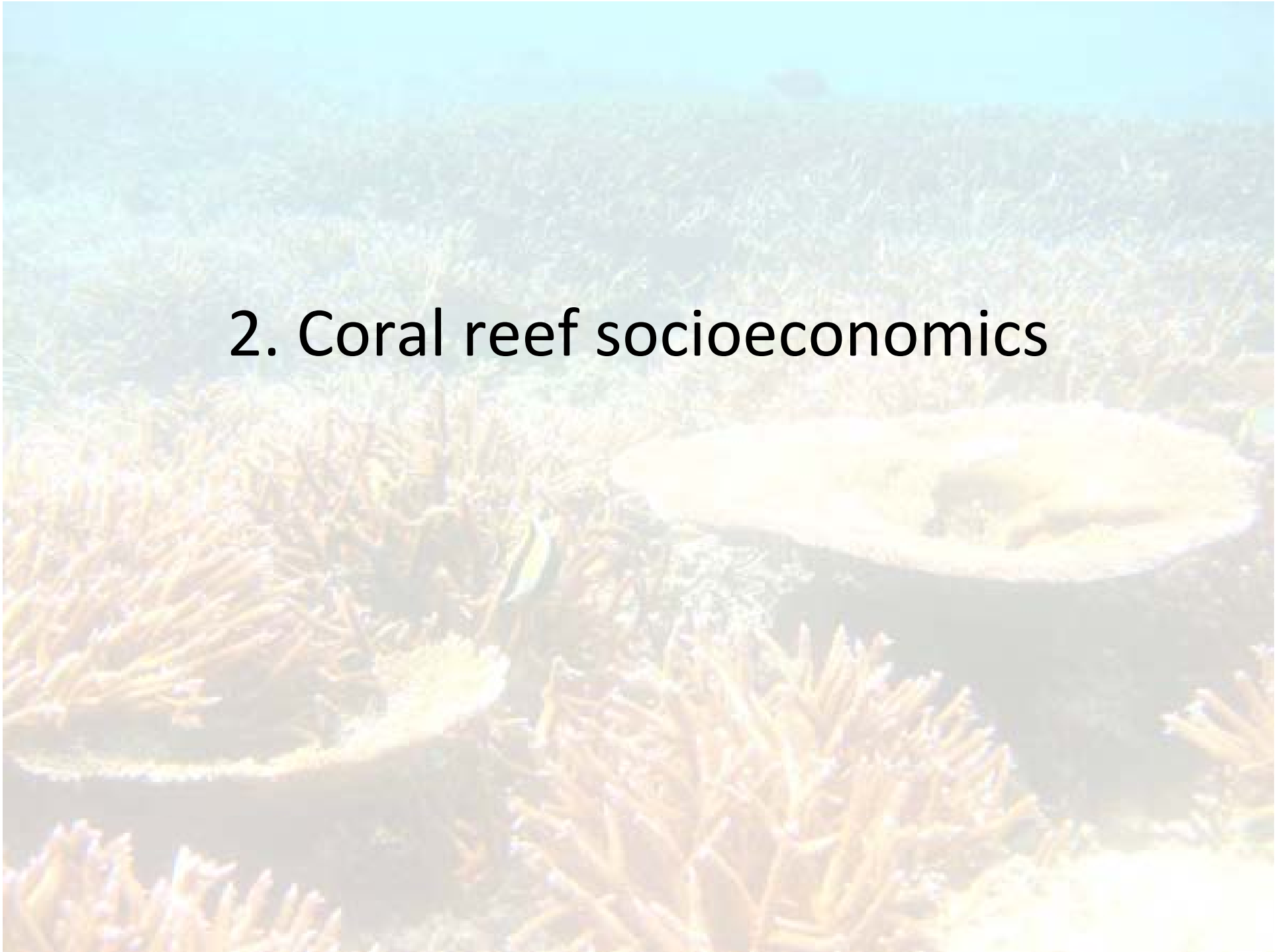




Why measure socioeconomic impacts?

- Determine importance of marine and coastal resources to local economy and livelihood
- Identify the potential social and economic impacts of mass bleaching
- identify solutions and opportunities to bleaching
- Increase public involvement in the monitoring of bleaching impacts
- Integrate local knowledge with technical expert
- Evaluate the social and economic costs and benefits of various coral bleaching management strategies

2. Coral reef socioeconomics



Value of healthy coral reefs

- Fishery/Fishing
 - Subsistence
 - Commercial
 - Recreational
- Tourism
- Coastal protection
- Biodiversity
- Recreation
- Amenity value
- Scientific research and educational value
- Cultural foundation and traditional practices
- Non-use value (existence, option and bequest values)



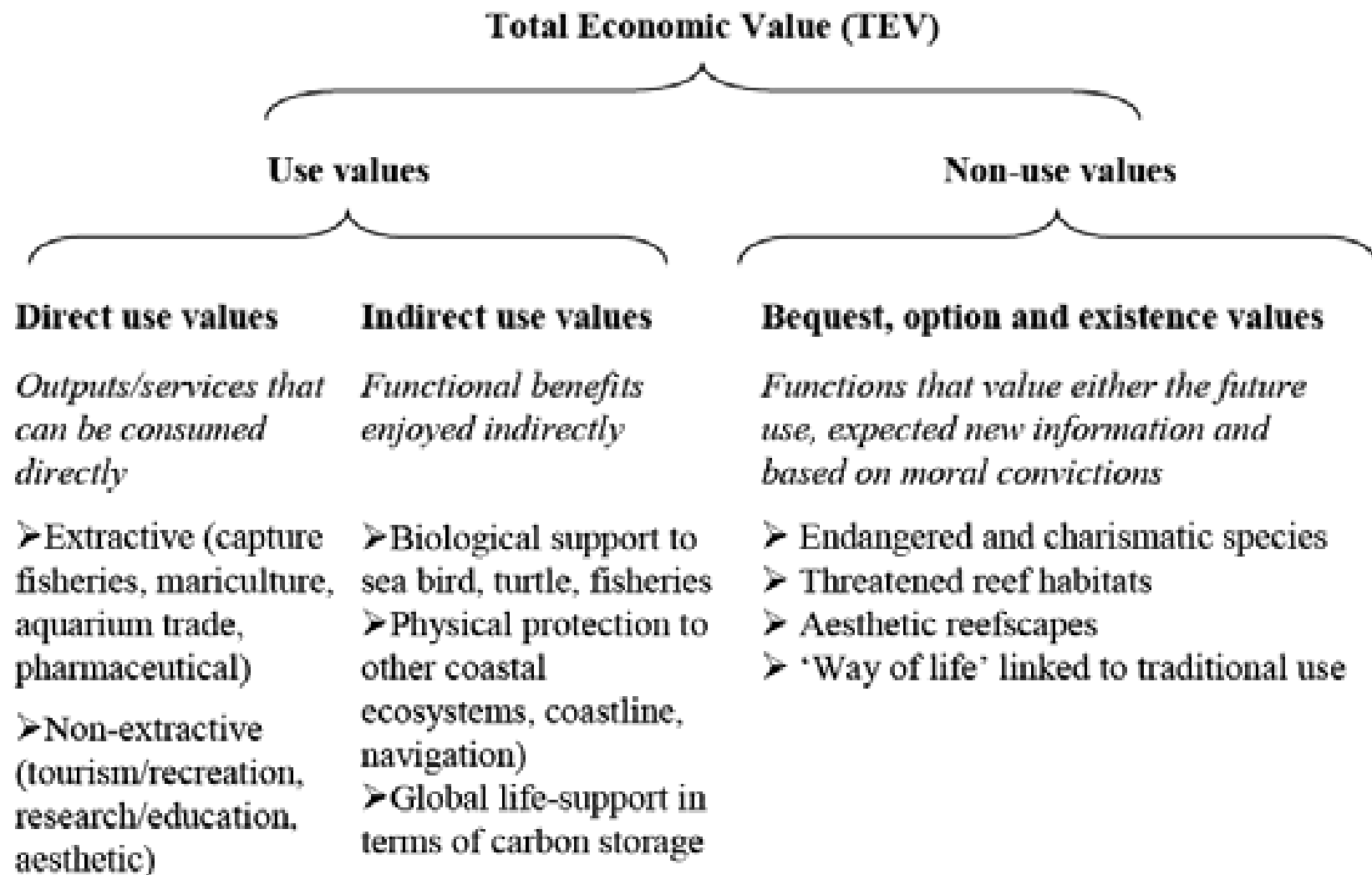


Figure E-3: Subdivision of the total economic value of coral reefs.

Fish Consumption in Pacific Island Countries (Bell et al 2009)

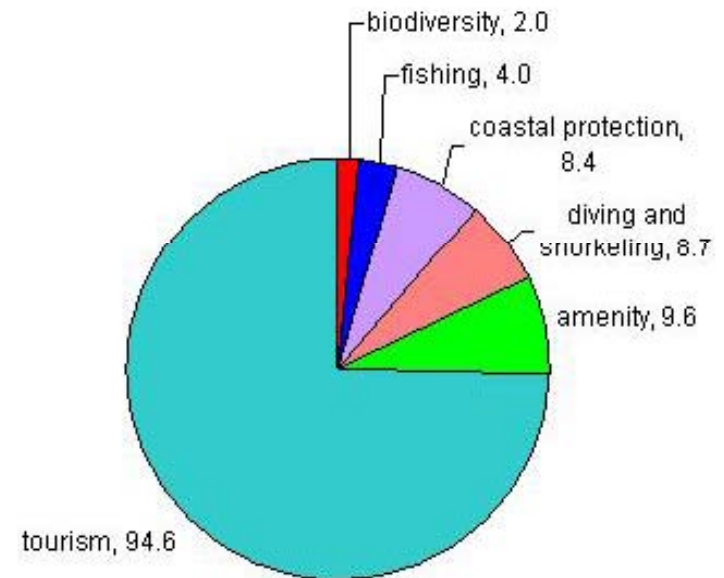
Annual per capita fish consumption (kg) for Pacific island countries and territories (PICTs), determined from household income and expenditure surveys (HIES)

PICT	HIES			SES
	National	Urban	Rural	Coastal \pm SE
Melanesia				
Fiji	20.7	15.0	25.3	113.0 \pm 6.18
New Caledonia ^a	25.6	10.7	54.8	43.2 \pm 3.16
Papua New Guinea	13.0	28.1	10.2	53.3 \pm 2.29
Solomon Islands	33.0	45.5	31.2	118.3 \pm 3.98
Vanuatu	20.3	19.3	20.6	29.9 \pm 3.10
Micronesia				
FSM	69.3	67.3	76.8	96.0 \pm 6.36
Kiribati	62.2	67.3	58.0	115.3 \pm 5.32
Nauru ^b	55.8			62.3 \pm 2.78
Palau	33.4	27.8	43.3	78.6 \pm 7.91
Polynesia				
Cook Islands	34.9	24.8	60.9	78.5 \pm 4.90
French Polynesia	70.3	52.2	90.1	60.9 \pm 4.16
Niue ^b	79.3			49.5 \pm 2.01
Samoa	87.4	45.6	98.3	94.1 \pm 4.35
Tonga ^b	20.3			84.6 n/a
Tuvalu	110.7	68.8	147.4	145.5 \pm 5.45
Wallis & Futuna ^b	74.6			56.2 \pm 5.13

Guam

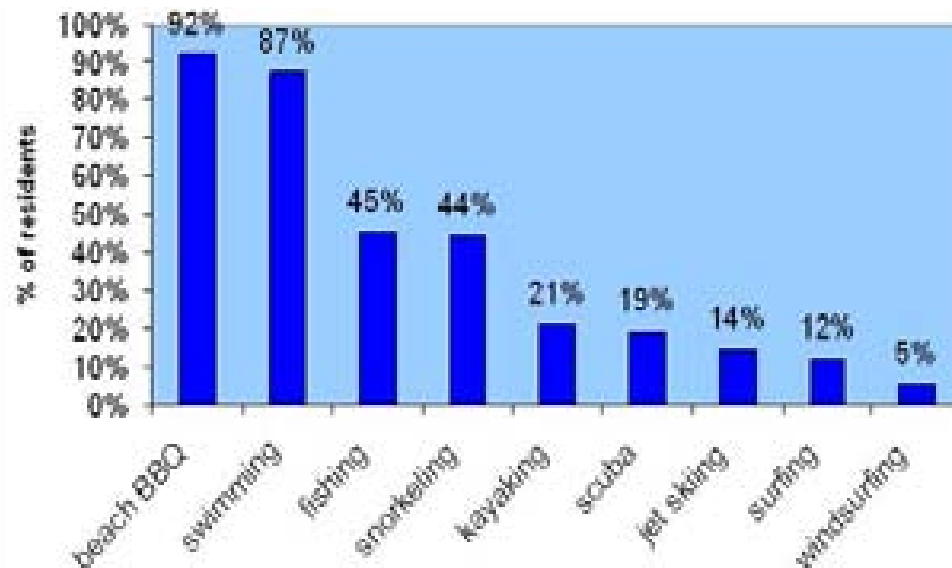
- almost all residents recreate in marine and coastal environment
- fishing important contributor to strong social bonds, supporting culture of food sharing

Total economic value of coral reefs in Guam, (millions of dollars per year) *Van Beukering, et al., 2007*



Recreational activities in Guam

Van Beukering et al., 2007



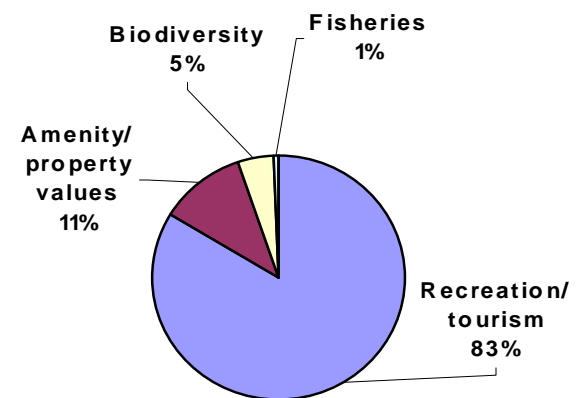
Total economic value calculation **US\$127 million per year**

Hawaii

- 550,000 visitors per month
- 52% of visitors dive or snorkel during their visit
- Economic importance of reefs US\$385 million per year
- the overall asset value of the state of Hawai'i's 1660 km² (410,000 acres) of potential reef area in the main Hawaiian Islands is estimated at nearly \$10 billion (Cesar et al 2002)



Total economic value of Hawaii's coral reefs



Socioeconomic impacts of bleaching

- Hinge on dependency of coastal community on coral reefs
- Most significant impacts from bleaching are often incurred by tourism and fishing sectors
- Ecological and physical changes → socioeconomic impacts
 - Bleaching events
 - Coral mortality
 - Change in fish assemblages
 - Weaken coastlines, eroding beaches

Fishing impacts

- Changes in fish assemblages from bleaching
 - coral mortality or structural loss → decline in the abundance of reef-related fishes
 - declines in reef fish biodiversity may lead to a reduction in energy transfer to higher trophic levels → reduced biomass of higher-order predators
 - many fishes can be negatively affected by a high abundance of late-successional algae that may dominate after coral mortality
 - coral mortality → reduction in abundance of some ornamental coral-feeding and coral-dwelling fishes
 - macroalgae habitats attract some invertebrates → invertebrate feeders may increase (Pratchett et al. 2008).
- Difficult to show impacts on fishing yields and income
- Impossible to study bleaching in a vacuum

Tourism impacts

During bleaching event

- Lost revenue
- Consumer surplus

Post-coral mortality

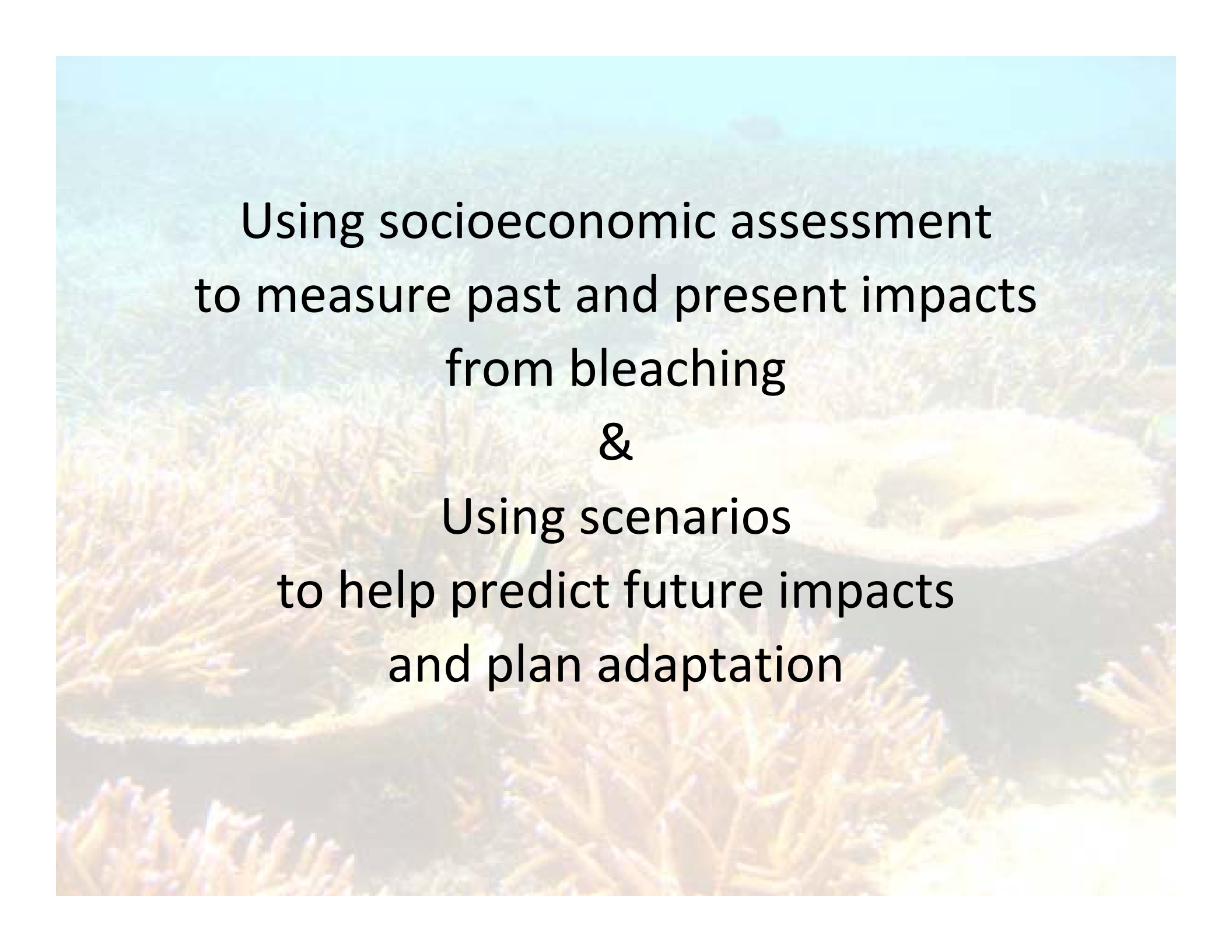
- Impacts depend on community's dependence on healthy coral reefs, response of tourism industry to changing conditions



3. Framework for assessing and predicting socioeconomic impacts



Photo credit: Supin Wongbusarakum

The background of the slide is a photograph of a coral reef. A large, prominent, white, circular patch of coral is visible on the right side, indicating coral bleaching. The surrounding coral is a mix of brown and orange colors, suggesting it is dead or dying. The water is a light blue color.

Using socioeconomic assessment
to measure past and present impacts
from bleaching
&
Using scenarios
to help predict future impacts
and plan adaptation

Steps in Socioeconomic Assessment

1. Define assessment objectives (what exactly you would like to assess and why)
2. Establish baseline
3. Select indicators
4. Determine data collection methods
5. Collect data
6. Analyze results
7. Share outcomes
8. Use outcomes



1. What do you want to assess?

- Objectives of assessment will inform the selection of indicators
- Imperative to involve stakeholders and end users at this point



2. Establish a baseline

- When is the baseline?
- What socioeconomic data are available?
- Use existing information pre-bleaching event, such as:
 - Past coral reef valuation studies
 - Tourism data
 - Creel surveys

3. Select indicators

Indicator is a quantitative or qualitative parameter that provides a simple and reliable basis for assessing change.

- appropriate and relevant to study objectives
- useful for management of the study site and address stakeholders' needs for information
- availability of resources (people, time, and budget)

Examples of Socioeconomic Indicators

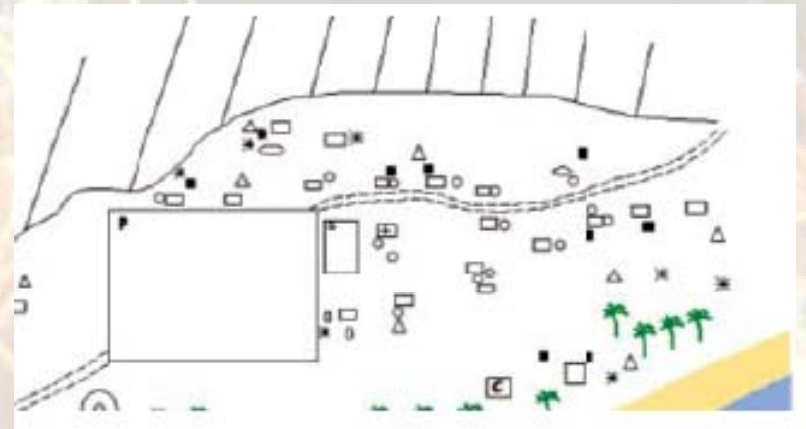
Examples of indicator categories

- Demographics
- Infrastructure and technology
- Livelihood and resource use
- Governance
- Social network and cultural support systems for natural hazards



Demographics

- population size and growth rate
- distribution of people
- migration
- household economic status/
employment/income level
- socioeconomic vulnerable groups
- health characteristics
- Others: age structure, sex,
marital status,
education/literacy,
ethnicity/clan,
language, religion



Infrastructure and Technology

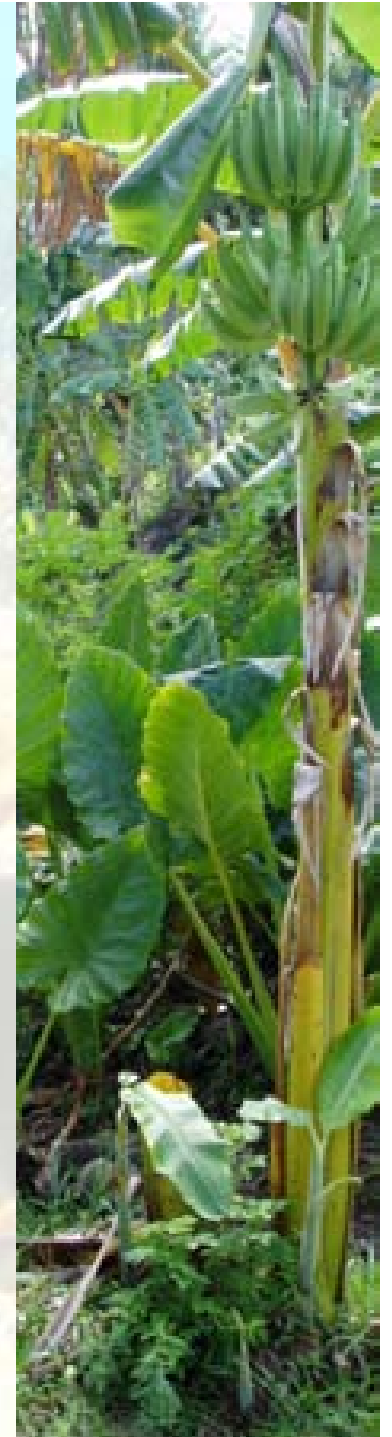
- community/social infrastructure and services
- communication infrastructure
- transportation infrastructure
- overall level of modern technology



Photo credit: Jay Wicker

Livelihood and resource use

- food security (local basic diet, food sources, availability, accessibility, costs)
- livelihood activities
- degree of household dependency on local natural resources
- markets
- livelihood role among household members
- human capital
- type of household assets
- access to resources needed for livelihood recovery
- state or national economic development plans and policy, international dynamics
- natural resource use and management practices
- social and cultural value of resources
- perception of condition of resources



Governance

- **Existing program and policies related to adaptation** (coastal resource management, disaster management and planning, economic development policies, welfare service and their evaluation on perceived effectiveness)
- **Supporting processes** (coordination among different agencies; enabling legislation, formal rules and regulations related to mitigation and adaptation, treaties and agreement regarding adaptation, willingness to invest in adaptation, local and traditional ways to cope with climate impacts, participation of stakeholders in climate change preparedness and adaptation)
- **Adaptive capacity to implement programs and plans** (stakeholders, roles, skills, effectiveness)

Social network and cultural support systems for natural hazards

- social network and traditional mutual support systems
- gender roles and responsibility
- community groups/organizations
- local support for particular vulnerable groups
such as the elderly, the poor, women and children



4. Choose data collection methods

- Secondary source
 - Census
 - Previously conducted studies
- Observation
- Key informant interviews
- Focus groups
- Surveys of individuals/households



5. Collect data

- Demographics
- Economic indicators
- Coastal and marine activities
- Attitudes and perceptions
- Community infrastructure and technology
- Management and governance



6. Analyze data

Do not try this at home.
Seek professional help!



7. Share outcomes

- Identify the target audience
- Different audience may require different forms of communication
- One-way communication
 - written material (report, paper)
 - visual material (posters, pictures)
 - oral presentations
 - mass media (newspaper, radio, TV, Internet)
- Two-way communication
 - group/one-on-one discussions
 - remote communication (telephone, web camera)
- Results should be utilized for adaptive management



8. Use outcomes

- Adaptive management in coastal and marine sectors
- Adaptation options
 - at the same time, as a part of broader development
 - require participation and multi-stakeholder involvement, including governments and communities
 - link bleaching with national economic and development policies, planning process and projects

Case Study: Climate-Related Socioeconomic Assessment in American Samoa



Photo credit: Supin Wongbusarakum

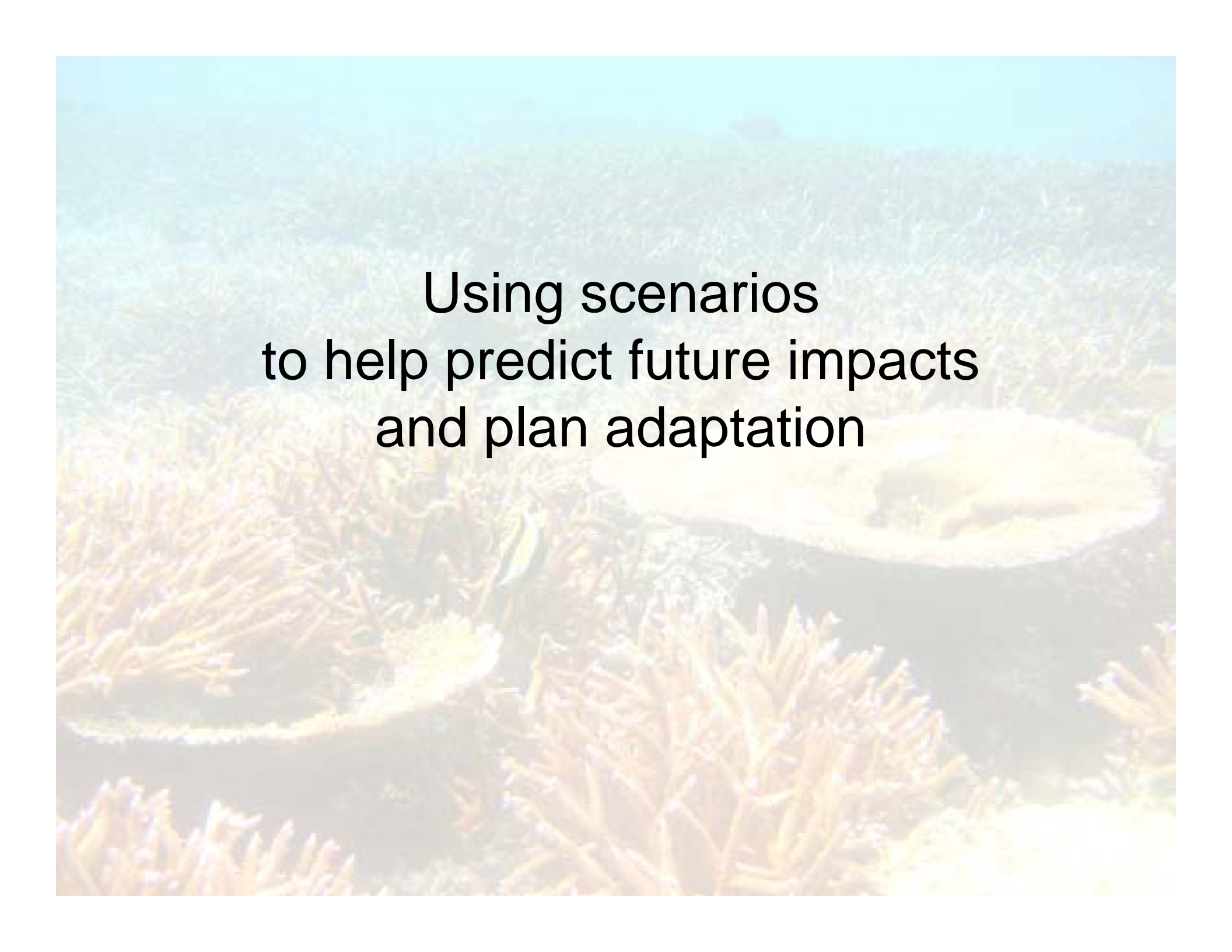


Photo credit: Jay Wicker

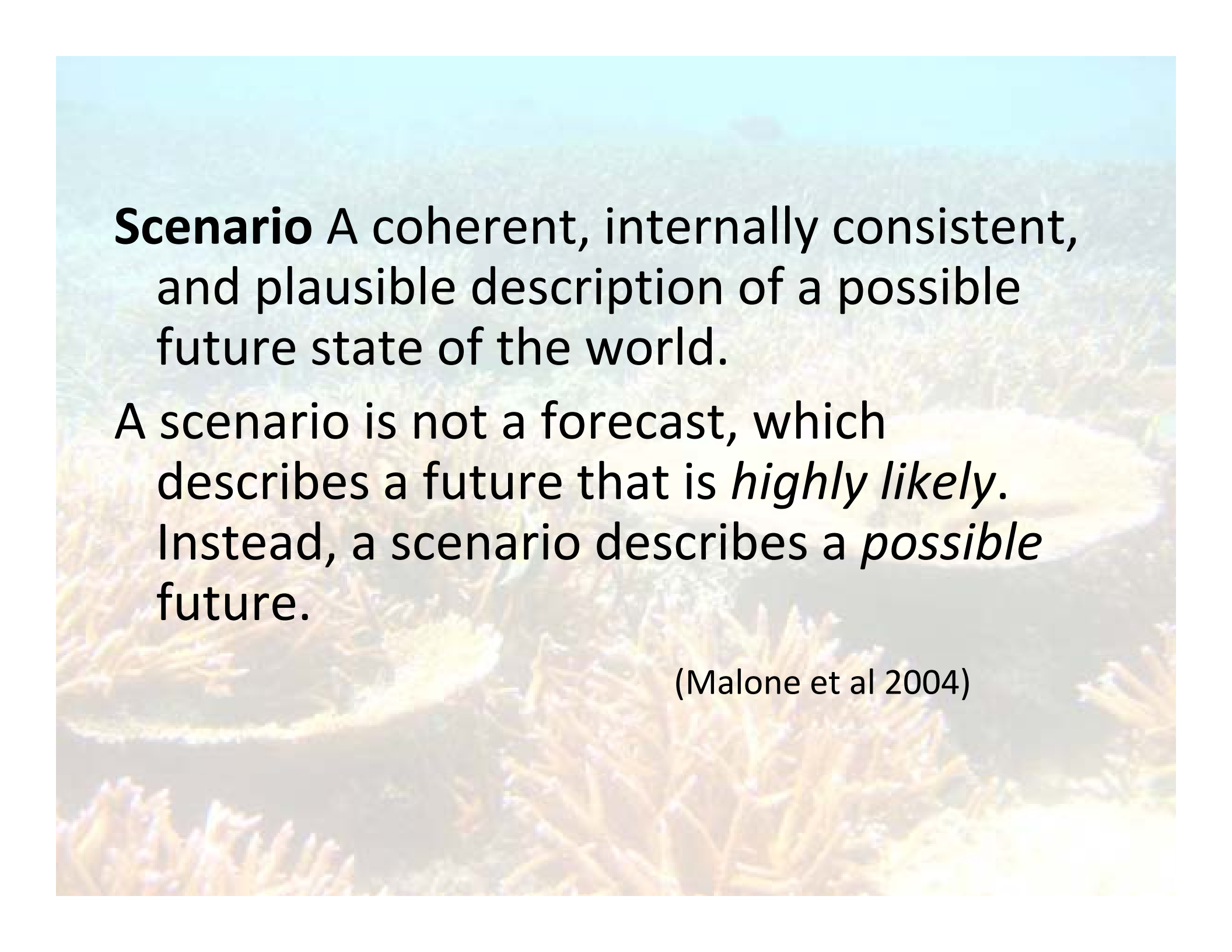
Case Study: Climate-Related Socioeconomic Assessment in American Samoa

Objectives:

1. To update demographic data of study sites
2. To find out economic and livelihood activities and dependency on coastal and marine resources
3. To determine the availability of lifelines and food security during extreme events
4. To identify types and level of impacts of climate events and degree of perceived vulnerability and resilience
5. To examine household leaders' perception and awareness of climate change issues

An underwater photograph of a coral reef. The scene is filled with various types of coral, including branching corals and large, flat, plate-like corals. The water is clear, and the lighting is bright, suggesting a sunny day. The text is overlaid in the center of the image.

Using scenarios
to help predict future impacts
and plan adaptation

The background of the slide is a photograph of a coral reef. In the foreground, there is a large, white, spiny sea urchin. Behind it, there are various types of coral, including branching and table corals, in shades of brown, orange, and yellow. The water is clear and blue.

Scenario A coherent, internally consistent, and plausible description of a possible future state of the world.

A scenario is not a forecast, which describes a future that is *highly likely*. Instead, a scenario describes a *possible* future.

(Malone et al 2004)

Methodological Approaches for Creating Scenarios

Top down analysis

Bottom up Analysis

**Involving stakeholders
to develop storylines
of the future**

Methodological Approaches for Creating Qualitative Scenarios

(Malone et al 2004)

1. Form stakeholder group and ask for input to identify the important issues in socioeconomic development and how best to represent them for policy or management purposes
2. With stakeholder input, develop storylines for scenarios
3. Determine key sectors (e.g., coral reef and tourism or fishery) targeted for development
4. With stakeholder input, characterize the key sectors and their connections to national processes for business-as-usual and alternative scenarios (i.e., with and without climate change).
5. Report results for use in vulnerability and adaptation assessment

Challenges and Other Considerations

- Overlapping of bleaching and other types of climate and non-climate impacts
- Other uncontrollable external factors and global trends (e.g. tourism, economic crisis)
- Challenges of multi-disciplinary work that integrate natural, physical and social sciences
- Integration of traditional and local knowledge and modern science

Challenges & Other Considerations

- Involvement of key stakeholders in the planning and implementation of socioeconomic assessments
 - Extractive versus participatory
 - Process versus products

An underwater photograph of a coral reef. The image is slightly blurred and has a soft, ethereal quality. In the foreground, there are various types of coral, including some with long, thin, branching structures and others that are more rounded and fleshy. The colors are muted, with a lot of browns, tans, and soft blues. The background shows more coral and the faint outline of a diver's head and snorkel in the distance.

4. Tools for socioeconomic assessment

Global Socioeconomic Monitoring Initiative (SocMon)

Facilitates community-based socioeconomic monitoring in six regions worldwide:

- Caribbean
- Southeast Asia
- Western Indian Ocean
- Pacific
- South Asia
- Red Sea

Provides tools, trainings, funding, and technical assistance for socioeconomic assessments of coastal communities



SEM-Pasifika

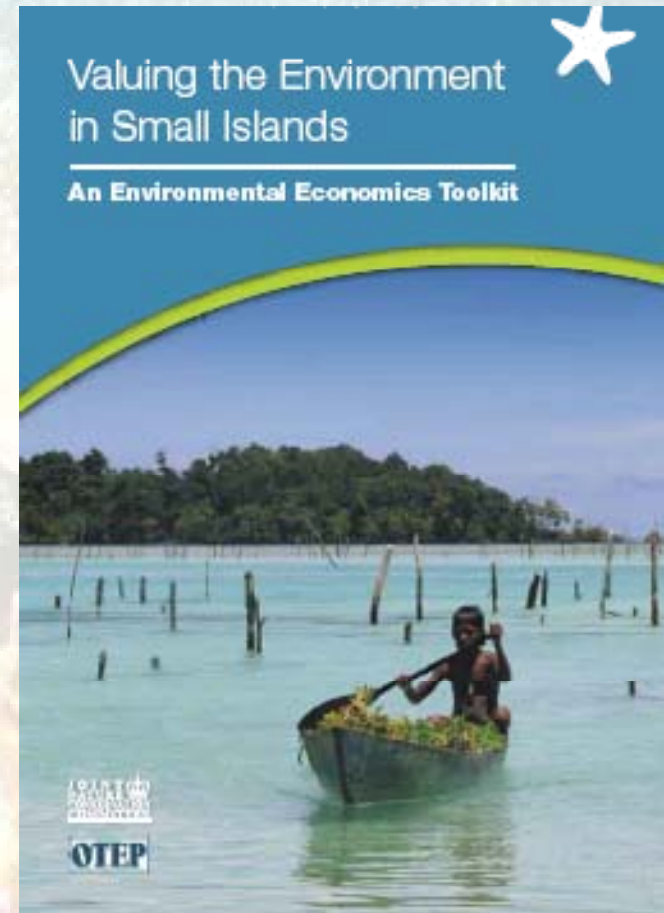
Socioeconomic Monitoring Guidelines for
Coastal Managers in Pacific Island Countries

Economic valuation tool for small islands

Information, ideas, tools and techniques for those who want to include the value of the environment in decisions but do not know where to begin.

Aimed at government officials, policy makers, and researchers on small islands

Those with some basic knowledge of environmental valuation techniques may find it useful to help them conduct, manage and/or use economic analysis in their jobs or useful as a basis on which to hire and steer consultants.



WRI Economic Valuation Methodology

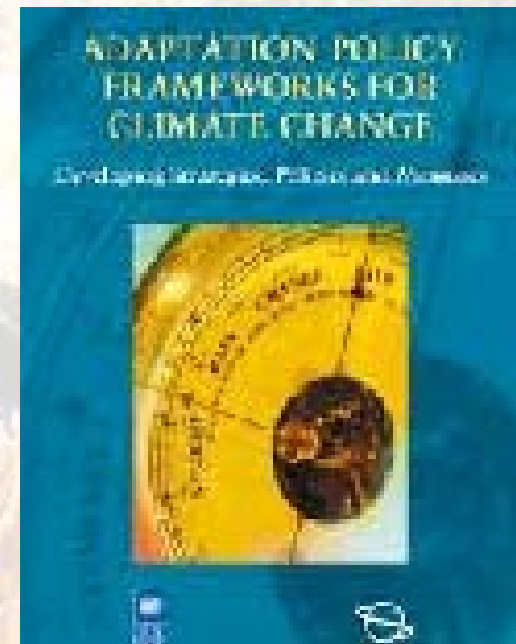
- Specifically designed for the Caribbean region
- Excel based resource to value:
 - Coral-reef associated tourism
 - Coral-reef associated fisheries
 - Shoreline protection services



<http://www.wri.org/project/valuation-caribbean-reefs>

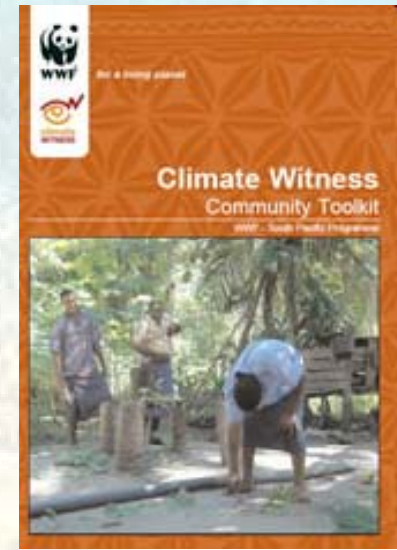
Technical paper #6 of Adaptation Framework Policy (APF) Assessing Current and Changing Socio-Economic Conditions

- demographic analysis,
- economic analysis,
- natural resource use analysis,
- analysis of governance and policy,
- and cultural analysis

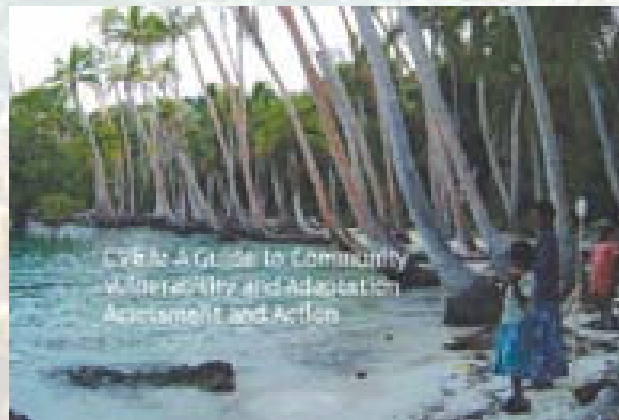


Other socioeconomic tools for the Pacific island region

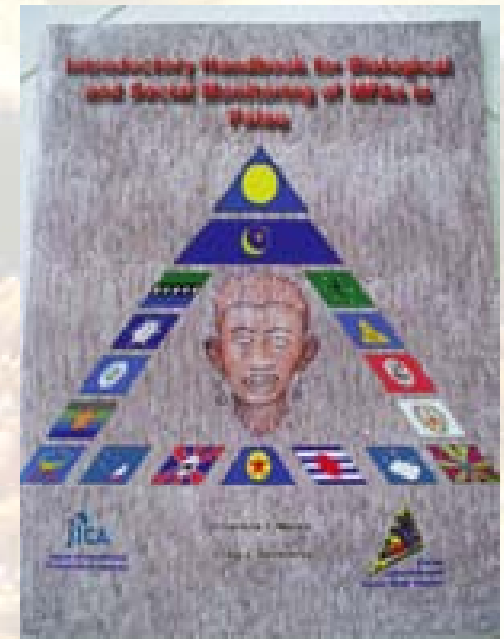
WWF Climate Witness



SPREP CV&A



Introductory Handbook for Biological and Social Monitoring of MPAs in Palau



- Mapping of resource availability
- infrastructure and cultural significance
- Seasonal calendar
- Community timeline
- Community value
- Assessment of adaptation option
- Community action plan



SPREP CV&A

Research questions	Participatory tools that can be used
What makes the different socio-economic groups vulnerable to climate variability/change/events?	<ul style="list-style-type: none">• Stakeholder analysis of different socio-economic groups, may also include the role of governments (local and national), NGOs, churches, etc.• Cause-and-effect diagram
Do men and women give different weights/ importance to climate change-related vulnerabilities?	<ul style="list-style-type: none">• Semi Structured Interview• Questionnaire• Focus Group Discussion
Do different occupational groups (e.g. fishermen, day labourers, farmers) rank climate change-related vulnerabilities differently?	<ul style="list-style-type: none">• Attitude ranking matrix• Semi Structured Interview• Focus Group Discussion
Identify the types of 'social capital' that exists in communities (i.e., social organisations, networks, trading systems, etc.) in order to surmise their adaptive capacity under current oceanic and climatic conditions.	<ul style="list-style-type: none">• Semi Structured Interview• Questionnaire• Focus Discussion

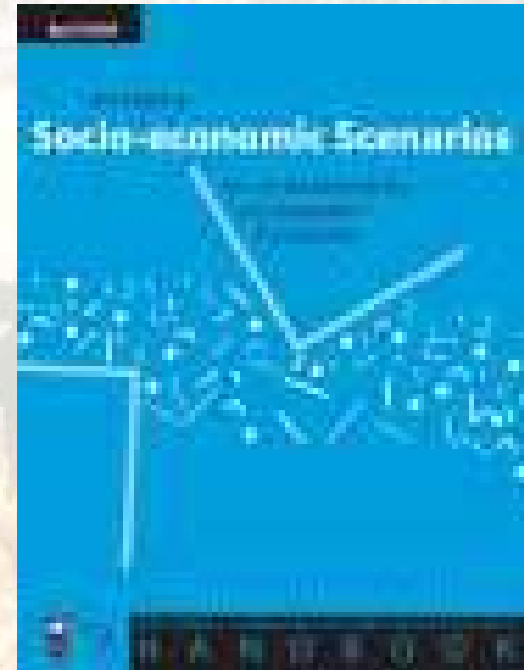
Introductory Handbook for Biological and Social Monitoring of MPAs in Palau

- Identifying and understanding management issues
- Identifying community perceptions and attitudes
- Demonstrating the benefits and impacts
- Identifying human resource use patterns and needs

UNDP & GEF National Communications Support Handbook: Developing Socio-economic Scenarios for Vulnerability and Adaptation Assessment

To assist countries in developing socioeconomic scenarios for analyses of vulnerability and adaptation as part of their national communications under the UNFCCC

Guiding steps in developing Scenarios.



5. Case Studies


Focus on Fishing and Tourism Impacts



Photo credit: Supin Wongbusarakum



Photo credit: Supin Wongbusarakum



What have been some impacts from
past bleaching events?

(PHILIPPINES, PALAU, INDIAN OCEAN)

Fishing Case study: Philippines (Bolinao)

- Short-term trends: no change
- Long-term trends: not well studied
- Slight increase in catch of herbivorous fish
- 10 year CPUE data: variable trends; no discernable impact from bleaching
- Difficult due to external factors: overfishing, seasonality of fishery, etc.

Cesar, et al., 2001 and Pet-Soede, 2000

Fishing Case study: Indian Ocean

40-50% coral cover loss during 1998 bleaching events in Kenya, Tanzania, Seychelles

Fishing impacts

- Composition of species changed
- Overall catch and income unchanged
- External factors
 - CPUE in Kenya decreased by 25%
 - Increase in fishers by 16%



Tourism Case study: Philippines

(El Nido, Bacuit Bay, Palawan)

- 17,000 tourists per year (mainly diving and snorkeling)
- Socioeconomic evaluation of 1998 bleaching event to tourism industry
- Methods
 - Questionnaire surveys of backpackers and resort tourists
 - Willingness to pay for reef quality improvements
 - Key informant interviews
 - Dive operators, cottage owners, resort managers
 - Trends in coral cover, mortality, tourism trends, tourism satisfaction
 - Secondary data sources
 - Official tourism statistics of El Nido and Palawan State, consulting reports
- Total damages (2000-2025): \$6 million-\$27 million

Tourism Case study: Indian Ocean

- Tourism welfare losses by combining the results of a willingness to pay (WTP) survey with estimates for coral recovery.
- Tourists willing to pay more per holiday to experience healthy coral reefs
 - US\$98.70 in Seychelles
 - US\$87.70 in Zanzibar
 - US\$59.00 in Kenya
- NPV of total welfare loss (20 year period, 10% discount rate)
 - US\$71.5 million for the Seychelles
 - US\$47.2 million for Mombasa
 - US\$39.9 million for Zanzibar

Tourism Case study: Palau

- 50,000 divers visit Palau each year
- mortality of 50% of live hard coral cover at popular dive sites during 1998 bleaching event
 - Also: economic depression in many Asian countries
- 1997 study
 - Local tour operators, dive guides, visiting divers
 - Visitation and activity patterns, visitor satisfaction, changes in marine environment
- In 1999: 5-10% fewer tourists than without bleaching event
 - Visitor survey data: 59% knew of bleaching event; 53% noticed effects; 42% reported negative impact on diving experience
- Loss to tourism industry: \$750,000 over two years



An underwater photograph of a coral reef. The scene is dominated by dense, branching coral structures in shades of brown and orange. A large, flat, light-colored coral plate is visible in the center-right. The water is clear, and the lighting is bright, suggesting a sunny day. The text is overlaid on this background.

Predicted future impacts of climate change

(CASE STUDY FROM BONAIRE AND BARBADOS)

Survey of 650+ tourists to Bonaire and Barbados

Quantify relative importance of 16 environmental attributes to island visitors

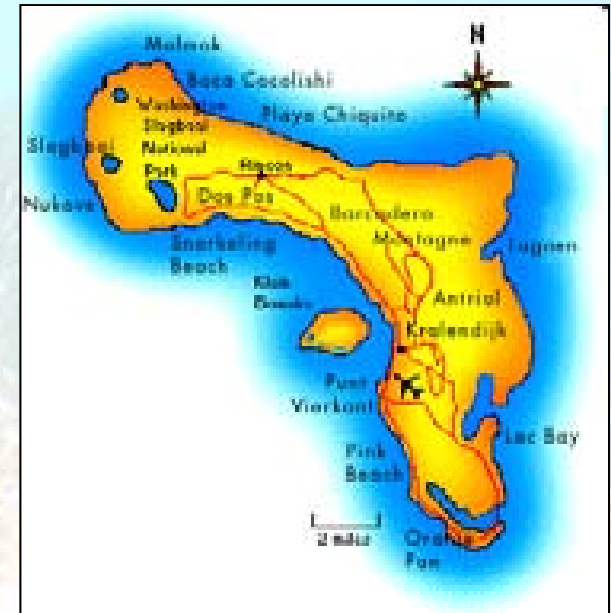
- Marine wildlife
- Beach structure
- Presence of tropical disease
- Water clarity
- Number of tourists

Included question to gauge willingness of tourists to pay the same price to return if coral reefs and beaches were negatively affected by climate change



Bonaire

- Tourism contributes 40% of GDP
- Environmentally-friendly tourism
- Majority of tourists snorkel or dive, attributes such as large fish and high coral cover are important
- ~80% of survey respondents would not return to Bonaire if corals were “severely bleached” as a result of warming temperatures
- Recommendation: maintaining healthy corals and fish populations vital to economic health



Barbados

- Tourism contributes 12.3% of GDP
- Beach-oriented tourism
- Tourists mainly attracted to land-based features, particularly beach size and sand quality
- ~80% of survey respondents would not return to Barbados if “beaches largely disappeared” as a result of SLR
- Recommendation: maintaining and enhancing beaches is of greater concern than coral bleaching to ensure continued tourism revenues



Questions/discussion

