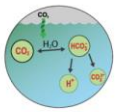
Climate Change Impacts on Food Security from Marine Resources

L.David, T. de la Cruz, R. Azanza

extreme average temperatures

extreme rainfall & intense storms



ocean acidification

sea level rise

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2nd Expert Group Meeting on the Impact of Climate Change on Food Security

PCAARRD Actions towards a Climate Resilient Future

APEC Symposium/Workshop on Planning a Collaborative Research, Development and Extension Program on Climate Change among APEC Member Economies

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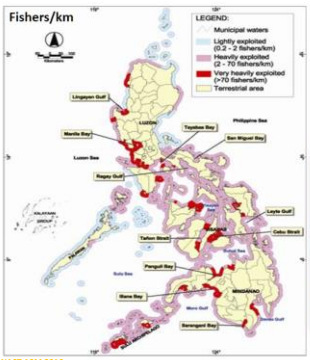
Livelihood



Coastal population rely heavily on coastal agriculture and fisheries in terms of livelihood. Artisanal fishers are typically also seasonal farm hands.

But fishers are also identified as the most impoverished sector of the society with poverty incidence of 39.2 %

Slide from Dr. P. Aliño

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Consumption

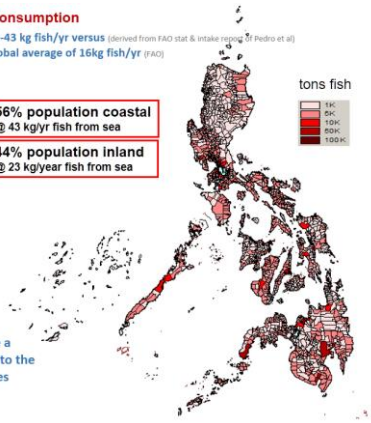
23-43 kg fish/yr versus (derived from FAO stat & intake report of Pedro et al)
global average of 16kg fish/yr (FAO)

Protein Requirement
– PDRI 62-71 g/day*

Philippine Dietary Reference Intakes 2015: Summary of Recommendation, FNRI-DOST

56% population coastal
@ 43 kg/yr fish from sea

44% population inland
@ 23 kg/year fish from sea

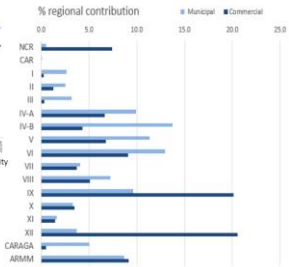


Marine resources contribute a significant portion (19-36%) to the food supply of the Philippines

LTDavid et al., UPMSI

Supply status – commercial & municipal catch

Philippine Statistics Authority



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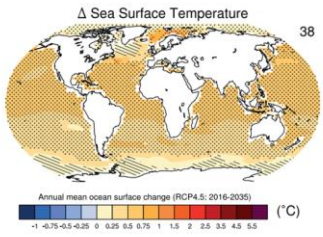
Reliability of the supply - commercial

Temperature changes

There is a projected overall temperature increase of 0.75°C in the Philippine waters



Persistent change in temperature have been linked with changes is species distribution limits (Cambridge et al., 1990; Gaston, 2000; Cerricart-Garivet, 2004) with migration to higher latitudes or deeper waters of temperature sensitive species is a potential adaptation strategy.

For those that cannot migrate, reproduction is predicted to be negatively affected and recruitment failures are also likely (Donelson et al. 2010, Pankhurst and Munday 2011).

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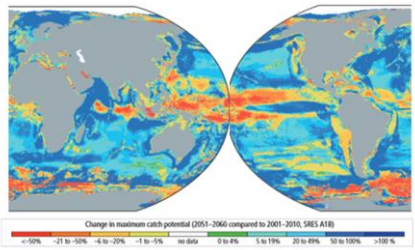
Projected global redistribution of maximum catch potential of ~1000 exploited marine fish and invertebrate species.



*Projections compare the 10-year averages 2001–2010 and 2051–2060 using ocean conditions based on a single climate model under a moderate to high warming scenario, without analysis of potential impacts of overfishing or ocean acidification.

Source: IPCC

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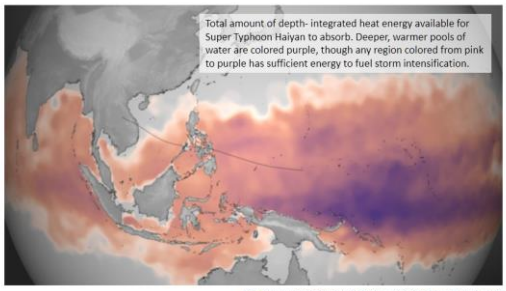
Cyclonicity changes

Models agree that storms will become more intense but the frequency will either decrease or remain unchanged.



http://www.climatecentral.org/news/record-ocean-heat-typhoons-18427

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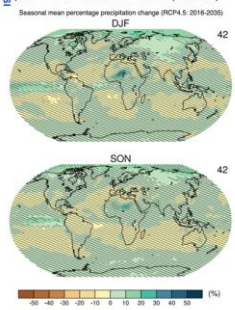
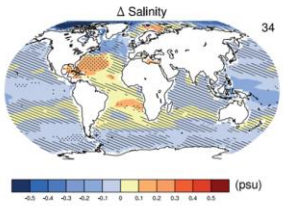
Rainfall changes

There is a projected seasonal mean percentage precipitation change of up to 10% and a consequential reduction of up to 0.1 psu in the West Philippine Sea (WPS) and up to 0.2 psu in the Pacific Seaboard (PacSea).





Juveniles are most affected by salinity as it affects their osmosis stress.

Prolonged changes in salinity also inhibits reproduction of existing population allowing for dominance of more salinity-tolerant species .

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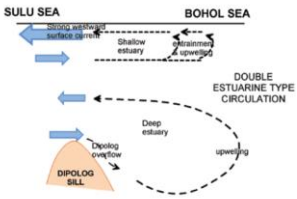
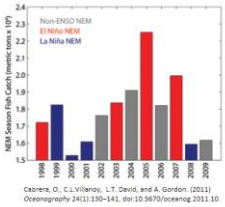
Changes in intensity of wind or precipitation have been shown to have significant impact where pelagic fisheries aggregation are linked with upwelling (e.g. Roundscad or Galunggong; Anchovies or Sardinas).



In southern Philippines for example, there is an observed significantly reduction of sardine fish catch when extreme rainfall limits surface manifestation of the upwelling near the coast (Cabrera et al., 2011).



Cabrera, O., C.L.Villanoy, L.T. David, and A. Gordon. (2011) Oceanography 24(1):130–141, doi:10.5670/oceanog.2011.10.

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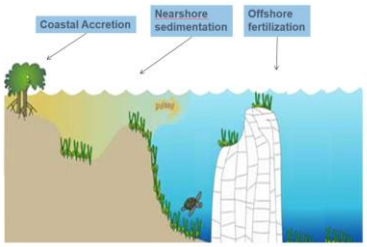
In addition, storms & intense precipitation bring about sedimentation

Sediment fate at the coast



Coastal ocean productivity is enhanced from nutrient-rich sediments (Eadie et al.)

This could either lead to increase in fish productivity

OR

Lead to a potential HAB

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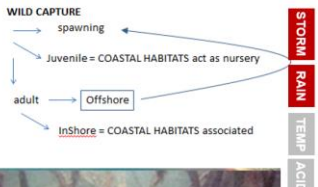
Reliability of the supply – municipal & commercial

Increase Nearshore Sedimentation

One of the most damaging perennial stress for coastal habitats is sedimentation resulting in compromised health due to murky waters and outright burial leading to mortality.



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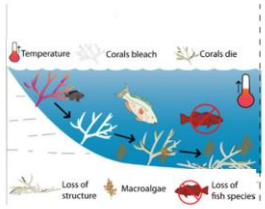
LTDavid et al. (UPRMSI)

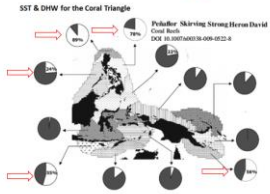
Ocean heating & Coral Reefs

Increase in temperature result in coral bleaching. Prolonged bleaching can lead to coral death; loss of coral reef structure and macroalgae overgrowth. This can eventually lead to loss of habitat-attached fish species.



During the 1998, mass heating event in the coral triangle, majority of the bleaching happened in the the east/west corner of the Coral Triangle and the Philippines.

Rates of recovery are site-specific with some lasting months while other sites have never fully recovered.



STORM
RAIN
TEMP
ACIDIFICATION
SLR

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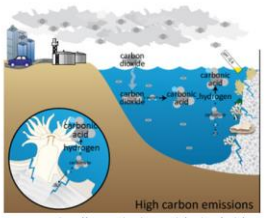
LTDavid, (UPRMSI)

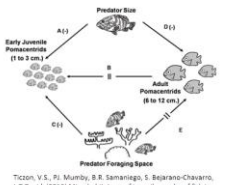
Ocean Acidification

Between 1751 and 1994 surface **ocean pH** is estimated to have decreased from approximately 8.25 to 8.14.
Ocean pH is globally projected to decrease another 0.1 unit by 2035.



https://www.e-education.psu.edu/earth103/node/722

Change in ocean pH can lead to additional loss of coral reef structure.



Ticzon, V.S., P.J. Mumby, B.R. Samaniego, S. Bejarano-Chavarro, L.T. David. (2012) Microhabitat use of juvenile coral reef fish in Palau. Environmental Biology of Fishes 95(3): 355-370. DOI 10.1007/s10641-012-0010-9

The complexity of the reef structure has direct influence on the adult and juvenile fish population

STORM
RAIN
TEMP
ACIDIFICATION
SLR

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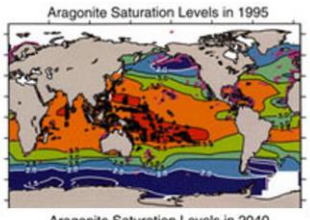
LTDavid, (UPRMSI)

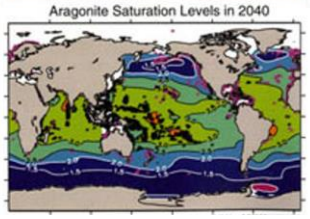
Ocean Acidification projections

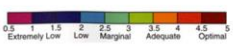
Distribution of aragonite saturation at 50 meters (160 feet) depth.

Areas with lower aragonite saturation levels are that are most vulnerable to ocean acidification.

Aragonite is a calcium carbonate mineral that shellfish use to build their shells.







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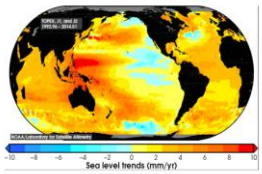
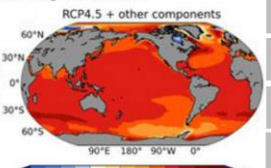
Sea Level Rise

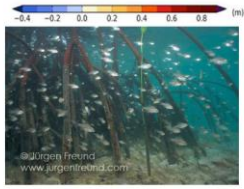
Global sea-level rise is projected at 20-90 cm per decade with the Western Equatorial Pacific region likely experiencing the higher of these global estimates.



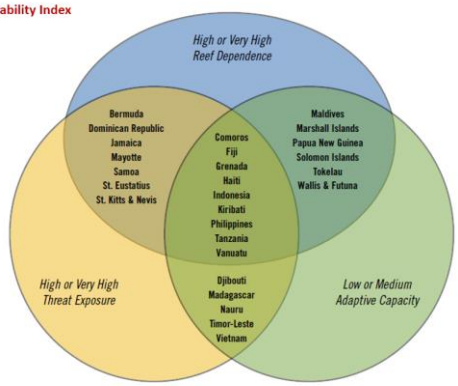


STORM
RAIN
TEMP
ACIDIFICATION
SLR

SLR would most affect mangrove areas – recognized as nursery ground for demersal and pelagics



Vulnerability Index



World Resources Institute

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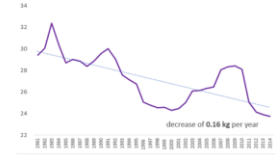
Supply vs Demand

As a consequence of climate & demographic pressure, less fish food captured from the wild are available for every Filipino. There is an overall decrease of 0.16 kg/year/person.



The Bureau of Fisheries and Aquatic Resources (BFAR) has been responding to the food fish shortage by promoting aquaculture.

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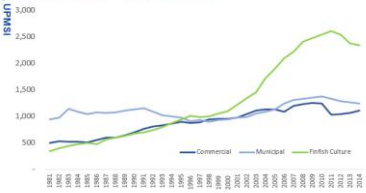
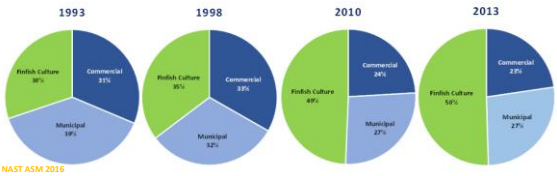
Supply status – finfish culture



Currently, finfish culture provides 52% of the overall food fish provision of the Philippines. Brackishwater culture is 73% milkfish by MT; freshwater culture is 79% tilapia; marine water culture 99% milkfish.



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Aquaculture is not climate-proof either.

Increase in the intensity of storms might compromise the integrity of the mariculture structures

Misamis Oriental's 'mariculture' park loses P134M due to typhoon, earthquake

January 22, 2015 12:58 am

MISAMIS ORIENTAL, Jan. 21 — The marine culture (mariculture) park in Balingasag, Misamis Oriental lost more than P134 million due to a typhoon and earthquake, a fisheries official said Wednesday.

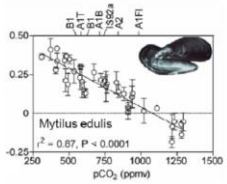
Visa Tan Demiren, Regional Director of the Bureau of Fisheries and Aquatic Resources (BFAR), said that typhoon "Seniang" on Dec. 29, 2014 destroyed the Mariculture Park's 109 fish structures in Balingasag.

She said that the amount of losses on fish structure, labor cost, fingerlings, broad stock, floating structures and maintenance reached P53,128,660.82 million.

Demiren said that the losses in fisheries production totaled 857.625 metric tons valued at PB1,474,367.40 computed at the prevailing farm price of P95 per kilo of milkfish.

The **Mariculture Park** in Balingasag is one of the major producers and suppliers of bangus (milkfish) in Northern Mindanao and in the Central Visayas region due to its superior quality, the BFAR official said.

Ocean acidification is also likely to compromise large-scale commercial shellfish culture.



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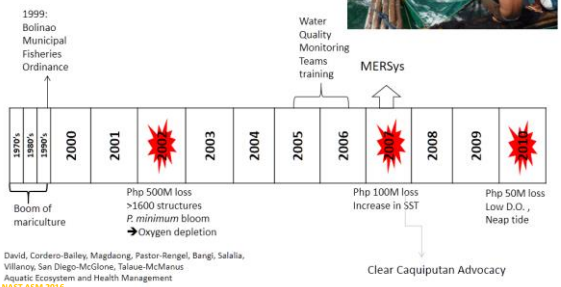
Anomalous warming of ocean water affects the oxygen content of the water and has historically resulted to massive fish kills within mariculture sites. Increase in surface ocean temperature might also be conducive to formation of algal blooms.



David, Cordero-Bailey, Magdaong, Pastor-Rengel, Bangi, Salalia, Villanoy, San Diego-McGlone, Talaue-McManus
Aquatic Ecosystem and Health Management
NAST ASM 2016

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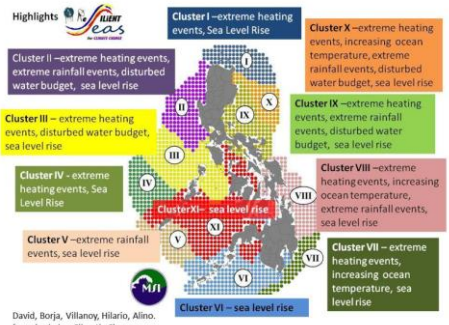
Hazards of marine food resources

Analysis of the remotely sensed data of sea surface temperature (SST), wind and rainfall (TRMM), sea surface height (SSH), show that the Philippines naturally sub-divides into 11 clusters



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The most significant contributor to pelagic commercial fisheries at present are Region XII and IX. Fisheries in region IX is dependent on the upwelling & will be vulnerable to extreme rainfall events.

For municipal fisheries, Region IV-A, IV-B, V, VI, IX, ARMM are the highest source. Region IX will be vulnerable to extreme rainfall. Region IV-A, V and XIII will be vulnerable to extreme heating events.

For finfish production the biggest contribution comes from Regions I, III, IV-A, VI. Finfish culture in general are sensitive to oxygen depletion brought about by increase temperature or anoxia. Extreme heating events have been plaguing the Philippines in all regions except in Region VII, IX and XII. Regions I, III, and IV-A will also be vulnerable to extreme rain events. Efforts have to be made to sustain milkfish fry source.

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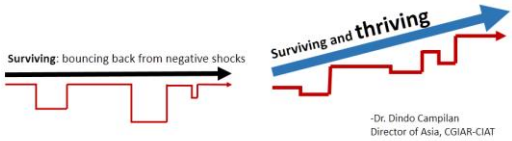
GOAL - Resilient Food Fish

– Adapted to have increased ability to survive future shocks



-Dr. Dindo Campilan
Director of Asia, CGIAR-CIAT

Marine food sources are already under stress from climate anomalies

Therefore provide the environment for the resource to recover by
(1) taking away stress that can be controlled by man, and
(2) providing "recovery space" and "recovery time"

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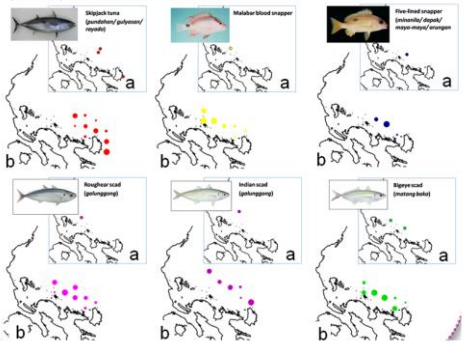
Care of Spawning and Nursery grounds

Identify potential spawning grounds of economically important fisheries & put into place seasonal harvest closures.



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Care of Spawning and Nursery grounds

Based on hazards these are the exposed coastal habitats per region

Region	CORAL	SEAGRASS	MANGROVE
I	x	x	x
II	x	x	x
III	x	x	x
IV-A	x	x	x
IVB	x	x	x
V	x	x	x
VI			x
VII	x		x
VIII	x	x	x
IX			x
X			x
XI	x		x
XII			x
CARAGA	x	x	x
ARMM			x

In addition, studies have shown that MPAs that have mangrove, seagrass and corals perform better at being a fish refugia.

Therefore, all three coastal habitats should be the priority.

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Ridge-to-reef management

PROTECTION of watershed
MANAGEMENT of coastal integrity by ensuring existence of healthy mangrove & beach forest
Limited ACCOMMODATION of traditional fish ponds
RESTRICTION in building structures that would affect coastal sediment transport
RELOCATION of existing mariculture structures away from reefs
PROTECTION of coral reefs (which includes seagrass & seaweed habitats)

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➢ Explore more indigeneous resource tolerant to variable physic-chemical factors

Species	Temp.	Salinity	Dissolved Oxygen (DO)	References
Seaweeds				
Gracilaria spp.	15-30°C	Needs FW and SW		MacHugh, Dennis J. (2003).
Kappaphycus alvarezii	25-30°C	30-35 ppt		MacHugh, Dennis J. (2003).
Eucheuma spp.	25-30°C	30-35 ppt		MacHugh, Dennis J. (2003).
Milkfish				
Chanos chanos	>20°C[1] 22-35°C[2, 3]	18-32 ppt[2, 3]	3-5 ppm[2, 3]	[1]FAO. © 2007-2010. [2]Department of Agriculture. © 1999. [3]Bureau of Agricultural Research. © 2008.
Tilapia				
Oreochromis niloticus	31-36°C[1]		3 ppm and above[2]	[1]FAO. © 1-2010. [2] Bureau of Agricultural Research. © 2008.
Shrimps/Prawns				
Penaeus vannamei	23-30°C	7-34 ppt 10-15 ppt (optimum)		Briggs, M., Funge-Smith, S., Subasinghe, R., & Phillips, M. (2004).
Penaeus monodon	27-30°C	5-25 ppt		FAO. © 2005-2010.
Macrobrachium rosenbergii	28-31°C	<10 ppt	3-7 ppm	New, Michael. (2002).
Crabs				
Scylla spp.	23-32 °C	15-30 ppt	≥ 4 ppm	Trino, A.T., Rodríquez E.M., Cuesa E.B., & Juanga, B.P. (1999).
Oyster				
Crassostrea iredalei	27-32 °C	17-20 ppt		Bureau of Agricultural Research. © 2008.
Sea bass				
Lates calcarifer	26-32 °C	10-31 ppt	4.0-8.0 ppm	Tookwinas S., & Charnsmid, S. (1998).
Sea cucumber				
Holuthuria scabra	27-30 °C	28-36 ppt 17-36 ppt*	3-5 ppm	Agudo, N., (2006). *NIFRDI pond trials

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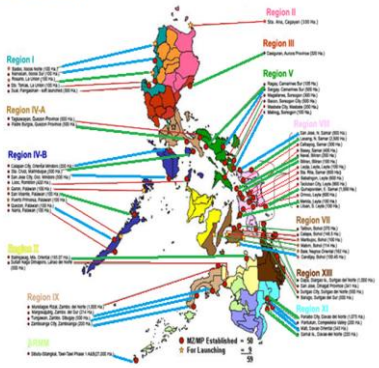
➢ Site selection & Stocking intensity

The assessment of sites should consider trends and projections in heating events, water movement and potential entrainments, presence of sensitive coastal habitats.



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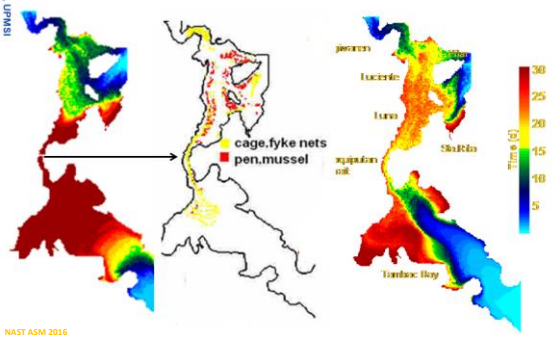
Magdaong et al., UPMSI

WISE MARICULTURE



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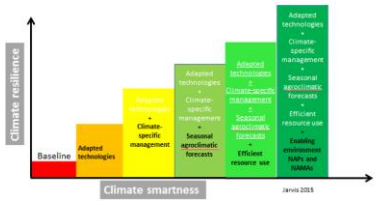
- Economic Assessment of Resource, Ecosystem Services, Innovations, Adaptation

"Our duty is to **provide CLARITY** (identify **Strategic Actions**) to re-convert current uncertainties to CALCULABLE RISK"

- Dr. Segfredo R. Serrano
Undersecretary, Philippine DA
-Dr. Dindo Campilan
Director of Asia, CGIAR-CIAT

Climate-smart *innovations* for climate-resilient agriculture



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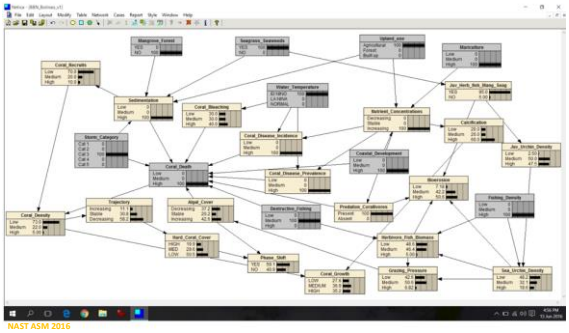
- Develop local predictive models based in multi-stressor observations and experiments



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- Strengthen the science-to-policy communication sector

RA 9729 - Climate Change Act of 2009	• Mainstreaming climate change into government policy formulations • Establishing the framework strategy and program on climate change • Creating for this purpose the climate change commission
RA 10121 - Disaster Risk Reduction & Management Act of 2010	• Strengthening the Philippines disaster risk reduction and management system • Providing funds for the national disaster risk reduction and management framework and • Institutionalizing the national disaster risk reduction and management plan
RA 10174 - The People Survival Fund Act 2012	• Establishing the people's survival fund to provide long-term finance streams to enable the government to effectively address the problem of climate change • Amending Republic Act No. 9729, otherwise known as the "Climate Change Act of 2009"

Slide from Maripaz L. Perez summarizing inputs from DA-BAR & SEARCA as presented at APEC

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Additional research thrusts for CAPTURE FISHERIES

1. Spatial distribution and migration patterns of fish and socio-economic implications of changes in resources availability;
2. Development of early warning systems inclusive of marine biodiversity and habitat;
3. Improvement of post-harvest technologies and food safety of major food fish species;
4. Recommendations for enhancing resiliency of fisheries infrastructures;
5. Vulnerability assessment studies of coastal areas.

Slide from Maripaz L. Perez summarizing inputs from DA-BAR & SEARCA as presented at APEC

Additional research thrusts for CULTURE

1. Development/improvement of inputs & infrastructures for aquaculture of high value species and other species with potential for food and aquaculture;
2. Improvement of aquaculture production amidst CC;
3. Development & improvement of post-harvest technologies;
4. Development of climate responsive market for aquaculture products; and
5. Saline tolerant fish species

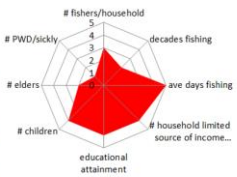
Slide from Maripaz L. Perez summarizing inputs from DA-BAR & SEARCA as presented at APEC

Dimensions of Food Security

- **Food Availability**
- **Physical Access**
- **Economic Access**
- **Utilization**
- **Stability**

- Dr. Paul Teng, RSIS

DNA of a fisher family



Among the coastal sectors, those families that have the following characteristics have the highest vulnerability:

(1) Long-term fishers since it has already become an established way of life
(2) Households that have plenty of dependents
(3) Households that have no alternative source of income
(pure fishers/farmers or low educational attainment)
(4) Households of special needs
(with elderly, toddlers, persons with disability, persons with long-term illness)