Student Research Addressing Marine Ecosystem Management Issues in the Face of Climate: Coral Reef Ecosystem Case Study

E. Moses, SCUBAnauts International
M. Jaroensutasinee, GLOBE Thailand
K. Jaroensutasinee, GLOBE Thailand
P. Maurin, NOAA CRCP
F. Niepold, NOAA Climate Office

Science and Management Issues

- SST does not always reflect bottom temperatures experienced by benthic organisms at shallow depths
- Poor understanding of spatial variations in coral bleaching due to differences in local conditions (e.g., sea state, cloud cover, turbidity) and individual coral susceptibility to these conditions
- Large # of marine habitats remain unmapped and many are being lost at rapid rates
- Assessment of extreme events (e.g., mass bleaching) require coverage of large areas in short period of time

Value of Student-Research to Science

- Satellite calibration (e.g., AVHRR and IKONIS) though increased observations
- Coverage of larger geographic areas
- Student observations of atmospheric and oceanic conditions can help interpret spatial or temporal variations
- Photo and video documentation

“Cognitive understanding of science concepts is increased when learners are conducting authentic science projects under the apprenticeship of expert scientists.”

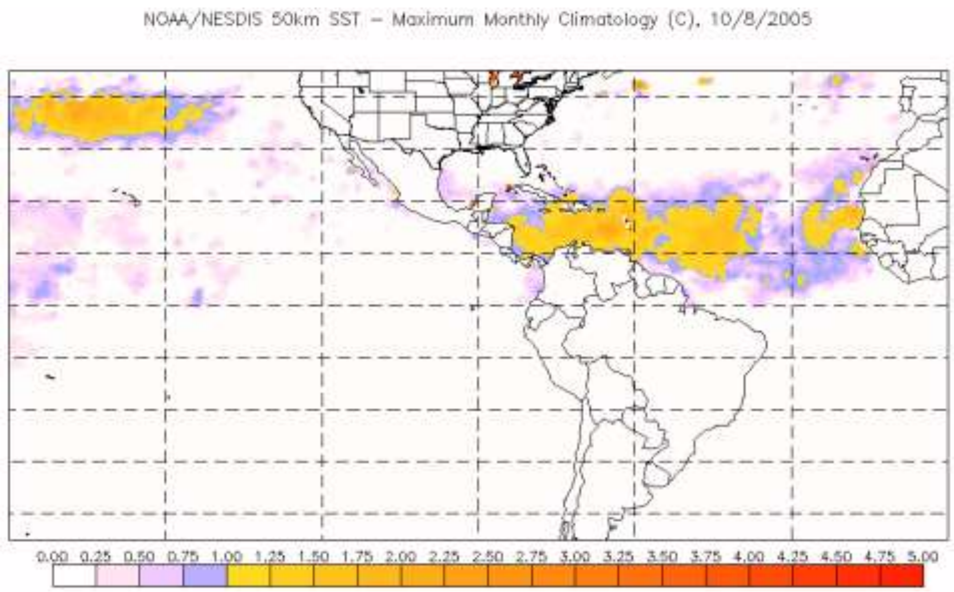
[*Collins et al. 1989, Barab & Hay 2001]*

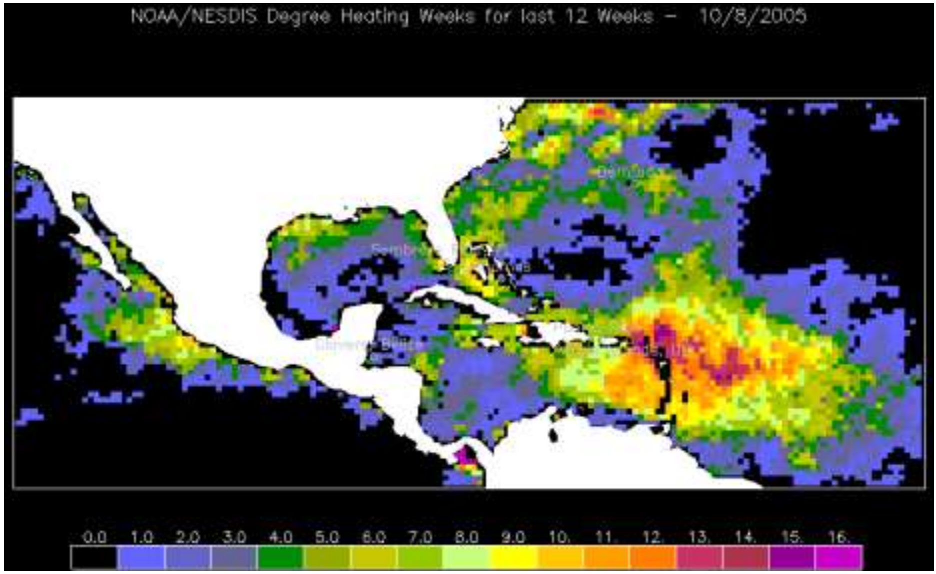
Education Value

- Examples of Climate and Ocean Literacy principles covered:
  - Students understand that organisms survive within specific ranges of temperature
    - *Students observe first hand response (e.g., bleaching, disease, mortality) to extreme temperature events*
  - Understanding the climate system is improved through observations, theoretical studies and modeling
    - *Students compare their observations with data collected from technological advancements (e.g., satellites, buoys)*
    - *Enhance skills in technology, mathematics*
  - Life on Earth depends on, is shaped by, and affects climate
    - *Students investigations can contribute to their improved understanding of organisms and ecosystems responses to a changing climate system.*
  - Climate change will have consequences for the Earth system and human lives
    - *Students investigations can contribute to their improved understanding of marine species and the ecosystems responses as the ocean water becomes warmer and more acidic.*
  - Ocean is a major influence on weather and climate (e.g., ENSO)
    - *Through virtual conferences w/ students across the globe, students will gain an awareness and understanding of global processes*

Coral Reef Case Study

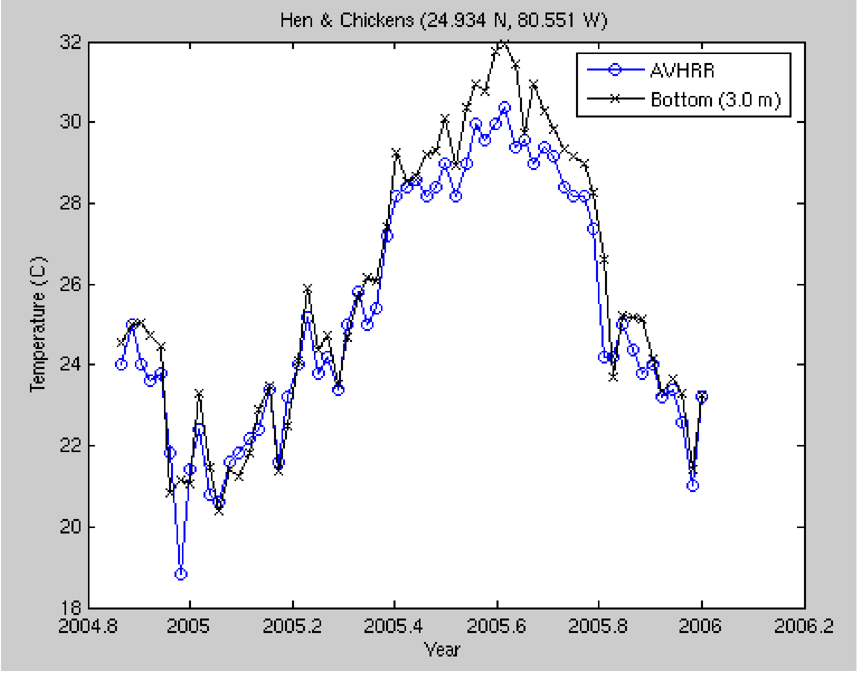
- AVHRR (Advanced Very High Resolution Radiometer) is a satellite used for accurately estimating sea surface temperature (SST)
- NOAA Coral Reef Watch uses AVHRR to predict areas with a high probability for bleaching based on anomalies in SST





- SST does not always reflect bottom temp. experienced by benthic organisms at 1-5 m depth
- 1-3° C diff. critical for organisms living close to thermal limits

Florida Keys, USA



C. Moses and H. Hudson

Gulf of Thailand and the Andaman Sea

Table 1. Mean ± SD of SST and SSTa at Tan and Racha Islands during 1982 to 2010.

	Mean ± SD (°C)	Range (°C)
SST (HOBO)		
Tan Island	29.70 ± 1.06	26.54-33.96
Racha Island	29.78 ± 0.99	26.49-33.12
SST (NOAA)		
Tan Island	29.12 ± 0.82	26.62-31.61
Racha Island	29.24 ± 0.72	27.22-31.57
SSTa (NOAA)		
Tan Island	0.20 ± 0.47	-1.33-1.69
Racha Island	0.24 ± 0.40	-0.96-1.74

Koad et al. 2010, NECTEC Technical Journal

- Science Value: Student collected water temperature data can be used to model bottom temperature using AVHRR satellite
- Education Value:
  - Students gain understanding of:
    - Science: Spatial and temporal variability in water temperature
      - **Scale-up: NOAA Data in The Classroom** – provide comparisons with current and historical temperature using technology (e.g., satellites, buoys)
    - Mathematics: Basic Statistics
    - Technology and Computer Skills



GLOBE Thailand, Institute for the Promotion of Science Teaching and Technology

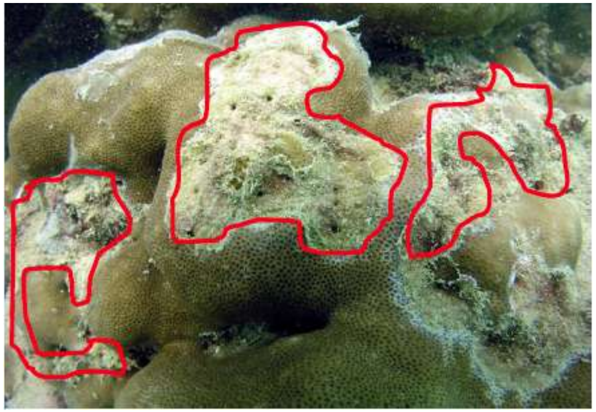
Using standardized methods student *in situ* observations and photography can be used to document unmapped benthic systems and organism response to climate-related events (e.g., ENSO)

SCUBAnauts conducting benthic survey using Atlantic and Gulf Rapid Reef Assessment Protocols

- *In situ*: Atmospheric and oceanic physical observations (e.g., sea state, cloud cover, turbidity)
- *In Situ*: Benthic cover, coral bleaching and disease prevalence
- Standardized video or photo transects
  - Changes in mortality, cover and diversity

Power of photographs

In July 2009, SCUBAnauts estimated Nauty Reef had 52 (±9%) live coral cover (mean cover in Keys ~7%). In Jan. 2010, this reef suffered massive mortality due to a severe cold water event (coldest temps. experienced in 30 years; pers. comm. FWC and NOAA scientists). The 2009 youth-survey was the first conducted on this reef.



GLOBE Thailand students use image-analysis software to calculate area of dead coral

- Documentation of “before” and “after”
- Scientists can utilize for more detailed analyses
- Images can be analyzed by students from any location worldwide (not restricted to coast)
- Increase understanding of susceptibility of different organisms to extreme events
- Standardization and scaling is key for in-depth analyses

Increasing Confidence in Student Data Training –Sample Program:

Level I: (“Novice”)

- Complete 2 “dry” training sessions
- Complete 2 in-water training dives
- Pass (>79%) Level I written exam (basic questions about method and identification, etc.)
- Entered in data with assistance from instructor

Level II:

- Complete 6 in-water surveys (conducted with a Level 1 buddy)
- Entered in data with assistance of Level 1 buddy

Level III:

- Complete 10 in-water surveys
- Pass (>89%) Level III written exam (more in depth, more on identification, etc.)
- Demonstrate capability of completing surveys independently
- Capable of entering in data independently
- Can assist with training of Level I and II

Level IV: (“Expert”)

- Complete 20 in-water surveys
- Demonstrate ability to analyze and draw conclusions from data

Potential Implementation Issues

- *In situ*
  - Benefits: First-hand experience for students; fast response to extreme events (information can quickly be made to resource managers)
  - Water Safety – proper precautions and training are a must
  - Moderate cost for equipment (e.g., temp. sensors, cameras)
  - Difficulty with access to study sites
  - Difficult/impractical for traditional formal classrooms

- Video/Photographs/NOAA Data in the Classroom
  - Benefits: SCALING UP – Use by students beyond coastal region; Images can be analyzed anywhere; Professional scientists can use images/videos for further analysis
  - Minimal costs for equipment (image analysis software freely available)
  - Difficult to determine some parameters from photograph

Potential Implementation Issues

- Standardization in student-based observations
  - Training is key and varies with sophistication of observations
  - Training levels (scientists can filter to only look at “expert” data)
  - Mentorship by professional scientists (recruitment, time commitment)
- Database Management (need for a central location; video/images are memory intensive)
- Long-term (temporal sampling) vs. short-term (geographical sampling)