A DISCUSSION ON THE MAIN REASONS CAUSING THE MASS MORTALITY OF CORALS AND BENTHOS IN CONDAO ISLAND DURING OCTOBER 2005.

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ABSTRACT ... During Mid October of 2005 a mass mortality of the corals occurred surrounding Con Dao Islands (South Vietnam) where is the recognized as one of the most famous marine parks of Vietnam. Results from the field survey in October 2005 showed that the mass mortality of corals and benthos focused only on the North-West of the islands whereas there was almost no death recorded in the South - East parts. Based on field data it was assumed that an overlap between high water temperature (>30°C) and low salinity (<25‰) during short term was the impact causing the situation. In this paper, we try to explain this phenomenon based on the hydrographical view together with analyzing ocean colour images. A coral bleaching warning system also is proposed for Condao site.

KEY WORDS: Coral bleaching, warning system, ocean colour image, hotspot, SST, Turbidity

INTRODUCTION:

Coral reefs are found in circumtropical shallow tropical waters along the shores of islands and continents. The reef substrate is mainly composed of calcium carbonate from living and dead scleractinian corals. Corals live in very nutrient poor waters and have certain zones of tolerance to water temperature, salinity, UV radiation, opacity, and nutrient quantities. Coral reef ecosystems world-wide have been subject to unprecedented degradation over the past few decades. Disturbances affecting coral reefs include anthropogenic and natural events. Recent accelerated coral reef decline seems to be related mostly to anthropogenic impacts (overexploitation, over-fishing, increased sedimentation and nutrient overloading. Natural disturbances which cause damage to coral reefs include violent storms, flooding, high and low temperature extremes, El Nino Southern Oscillation (ENSO) events, sub-aerial exposures, predatory outbreaks and epizootics.

During Mid October of 2005 a mass mortality of the corals occurred surrounding Con Dao Islands (South Vietnam) where is the recognized as one of the most famous marine parks of Vietnam. Condao Island is far from River mouths of Mekong river system about 100 km. Affect of fresh water plume from Mekong rivers rarely hit to it but during October 2005 is an exception case. Results from the field survey in October 2005 showed that the mass mortality of corals and benthos focused only on the North-West of the islands whereas there was almost no death recorded in the South - East parts. Another record showed that the mass mortality happened mainly in the shallow waters (2-3m) while in the deeper water (5-6m) the amount of dead organisms was negligible. Meteorological news recorded (http://iri.columbia.edu/climate/cid/october2005/impactc.html): Upstream floods from the Mekong River, coupled with heavy rains in October 2005, caused strong flooding in the provinces of Mekong delta and perhaps will effect into Condao Island.

On the global scale, the year 2005 was the hottest on record. The average global surface temperature of 14.77 degrees Celsius was the highest since recordkeeping began in 1880. In fact, the six hottest years on record have all occurred in the last eight years. After 2005, 1998 was the second warmest, with an average global temperature of 14.71 degrees Celsius and third one peak happens at 2002. But there was an important difference between 1998 and 2005: the strongest El Niño of the past 100 years lifted the average 1998 temperature 0.2 degrees Celsius, whereas the record warmth last year was not buoyed by such an effect.

Nearly all of the world's major coral reef regions (Caribbean/ western Atlantic, eastern Pacific, central and western Pacific, South East Asia, Indian Ocean, Arabian Gulf, Red Sea) experienced some degree of coral bleaching and mortality during the 1998, 2002 as well as 2005. Mass bleaching and mortality of coral also happened in Condao during these period, so which do main reasons cause mass mortality of coral in here? Based on field data as well as information from global climate change as mention above, it was assumed that an overlap between high water temperature, low salinity and high turbidity during short term was the impact causing the situation. In this paper, we try to explain this phenomenon

based on the hydrographical view together with analyzing ocean colour images.

USED DATA AND METHODOLOGY:

Used data sources include:

- Reef check data from survey of October 2005 in Con dao (after we receipt urgent information from local stakeholders).
- Images source of MODIS level 2b (**MOD**erated resolution **I**maging **S**pectroradiometer) with spatial resolution 1.1 km have been downloaded from NASA website http://oceancolor.gsfc.nasa.gov/
- Images source of TERRA MODIS 250m have been downloaded from NASA website http://oceancolor.gsfc.nasa.gov/
- Data series of SST, Chlo-a, K490 (from 1998 - 2006) in area obtain from data source of Giovanni http://reason.gsfc.nasa.gov/OPS/Giovanni/
- The remote sensing software ENVI4.0 have been used for data processing

RESULT AND DISSCUSION:

Con dao Islands lie in Southern of Vietnam sea in geography bounders from 106° 31' to 106°45'E longitude and 08°37' – 08°45' N Latitude . Location of survey area show in figure 1

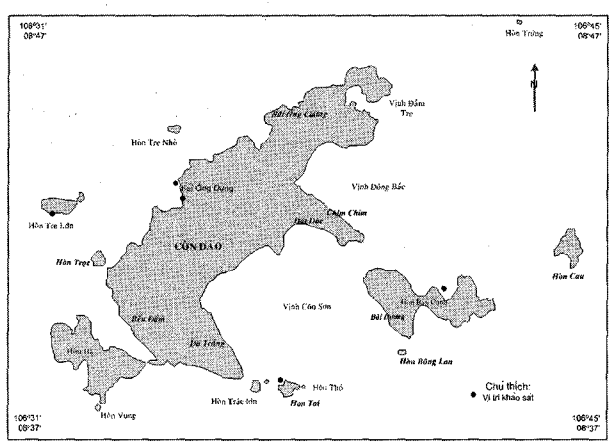

Figure 1 : Condao and relevance place names.

1, Mass coral mortality event from survey data: Results from the field survey in October 2005 showed that the mass mortality of corals and benthos focused only on the North-West of the islands whereas there was almost no death recorded in the South - East parts. Another record showed that the mass mortality happened mainly in the shallow waters (2 -3 m) while in the deeper waters (5 - 6 m), the amount of dead organisms was negligible (table 1, table 2 and figure 2)

Composition	Tan Du ground			Ong Dung ground		
	Shallow section	Deep section	Average	Shallow section	Deep section	Average
Cover level of hard coral (%)	1,25	20,62	10,93	1,25	3,12	2,18
Cover level of death coral (%)	72,50	3,12	37,81	53,75	36,87	45,31
Percentage (%) of died coral	**98,30**	**13,15**	**55,73**	**97,72**	**92,18**	**94,95**

Table 1 : Some investigated data on the mass mortality of corals in Condao during November 2005

Sites / Benthos species	Tan Du ground	Ong Dung ground	Vong Ground
Giant Clam	4	17	0
Sea Urchin	0	2	1
Strotus spp	1	6	0
Sum	**5**	**25**	**1**

Table 2 : Some investigated data on the died Benthos (invidual/400 m^2) in Condao during November 2005

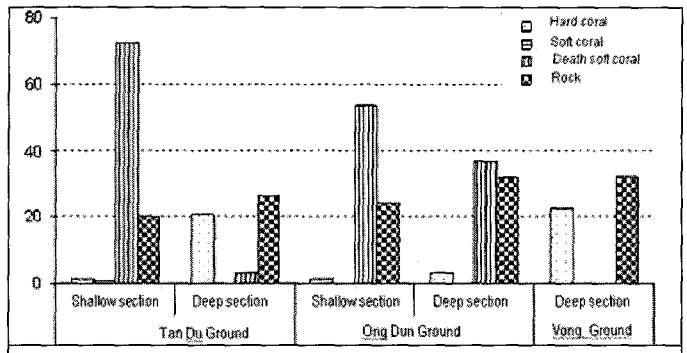

Figure 2: Cover level of coral in Condao Island from reef-check data during October 2005

Data series from September to November 2005 in meteorology station Condao show that a high water temperature (>30°C) and low salinity (<25‰) happen in October 2005 (figure 3). A suppose state that the extreme increasing of sea surface temperature and sudden reducing of water salinity in same time is main reason causing mass bleaching and mortality of coral and benthos in Condao Island. The data from ocean color images will clarify above conclusion

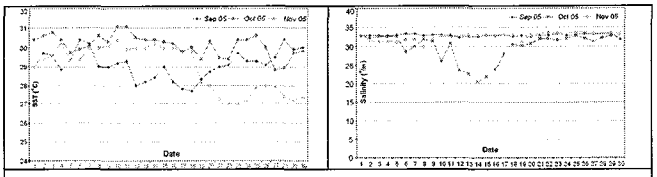

Figure 3: Daily Variability of Sea Surface Temperature (left) and Sea Water Salinity (right) from September to October 2005 in Condao (Source: Condao Meteorology-Hydrology Station)

2, *Mass coral mortality event under light of ocean color remote sensing:* The distribution pictures of sea surface temperature, Chlorophyll-a and K490 (instead of turbidity and water salinity) obtained from MODIS images showed clearly the effects of the warm, fresh water tongue which carried high concentrations of TSS from the Mekong river system to the sea and hit to Condao during October 2005 (fig 4, 5, 6).

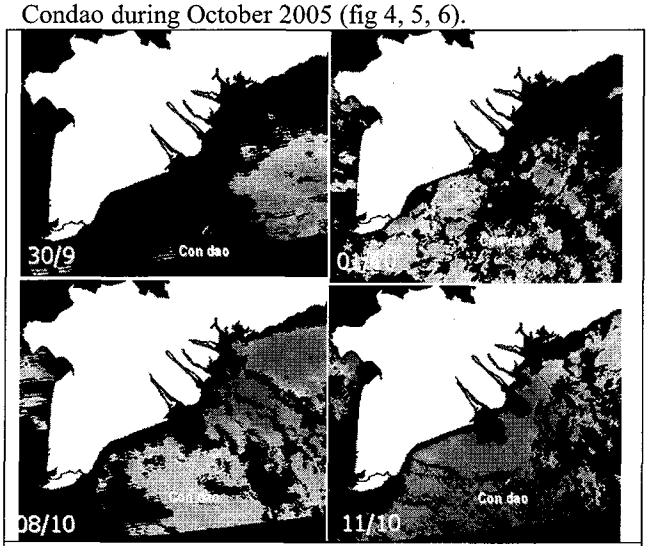

Figure 4 : The distribution map of SST from MODIS images

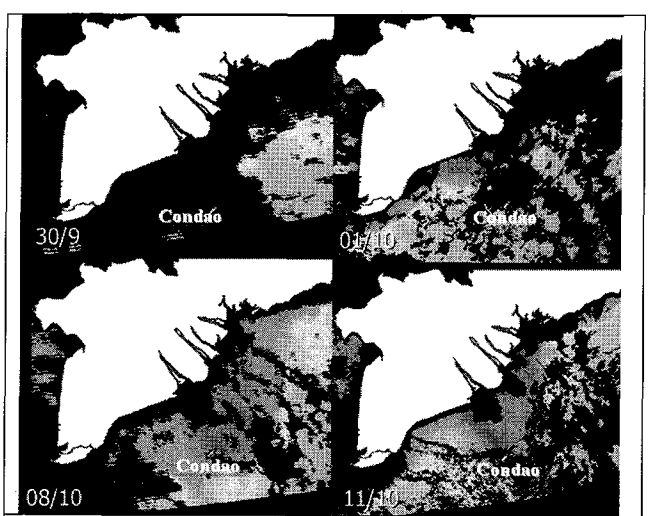

Figure 5: The distribution map of Chlo-a from MODIS images

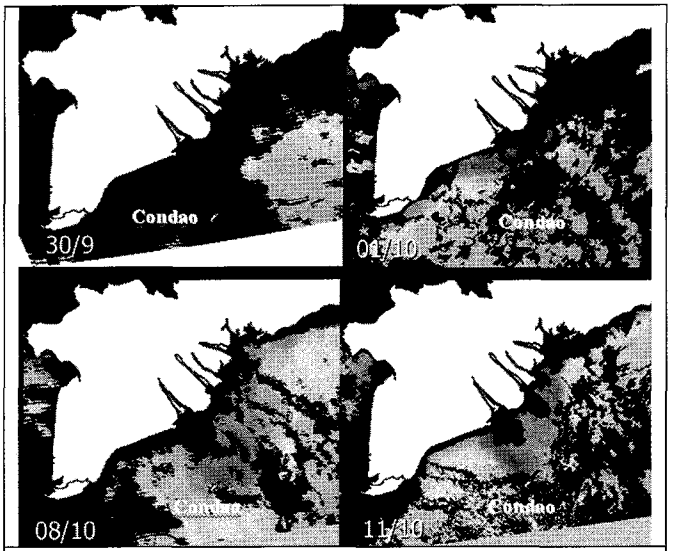

Figure 6: The distribution map of K490 from MODIS images

It broke up the temperature structure of the cold water mass coming from northern side of South China Sea (see pictures of Giovanni) impacted Con Dao island during the highest rainfall period of year (October) appear clearly from http://reason.gsfc.nasa.gov/OPS/Giovanni/

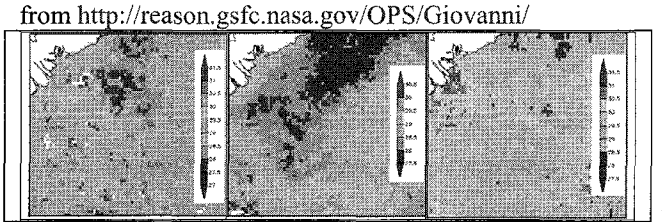

Figure 7: SST distribution in October 2003, 2004 and 2005 in Condao show that the sudden effect of warmer water plume from Mekong rivers (they broken up normal thermal structure of cold water mass (Giovanni data)

Time series analysis of satellite data http://reason.gsfc.nasa.gov/OPS/Giovanni/ also showed that during October 2005, the concentration of chlorophyll-a and suspended matter (K490) increased drastically (chlorophyll-a increased 6 times, K490 increase 3 times compared with the monthly average value of the data series from 1998 – 2006).

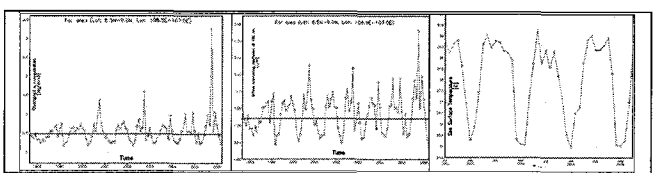

Figure 11: The monthly variability of Chlorophyll-a (left) and K490 (mid) and SST (right) show that extreme increasing of Chlorophyll-a and light attenuation coefficient –K490 as well as hottest in October 2005

3, Mass coral bleaching and global warning system: On the global scale, October 2005 was considered as one of the hottest months in history. Nearly all of the world's major coral reef regions (Caribbean/ western Atlantic, eastern Pacific, central and western Pacific, South East Asia, Indian Ocean, Arabian Gulf, Red Sea) Tuan 2000 /1/, Wilkinson (1998) /2/, (2000) /3/ experienced some degree of coral bleaching and mortality during the 1998 as well as 2005. Condao Island is one of places in coastal waters of Vietnam where coral bleaching and mortality occur in these periods. By using NOAA's Coral Reef Watch (base on mainly SST) allow to monitor coral bleaching around the world. Corals start to feel stressed when the sea surface temperature is more than 1°C above the average, can be expect to see in the hottest month. Some indicators use for coral bleaching warning system are "Hotspot" and Degree Heating Weeks (DHWs). Used principle and categories for warning system have been showed detail in website of NOAA on the satellite coral bleaching monitoring http://coralreefwatch.noaa.gov/satellite/.

The detrimental exaggeration of the natural occurrence can be explained by the increasing temperature of the oceans which is accused to be a result of the "Greenhouse Effect," or global warming (Blackman and Hughes).

By using Hotspot maps in July 1998 and October 2005 in South East Asia from website of NOAA http://coralreefwatch.noaa.gov/satellite/ (figure 12)

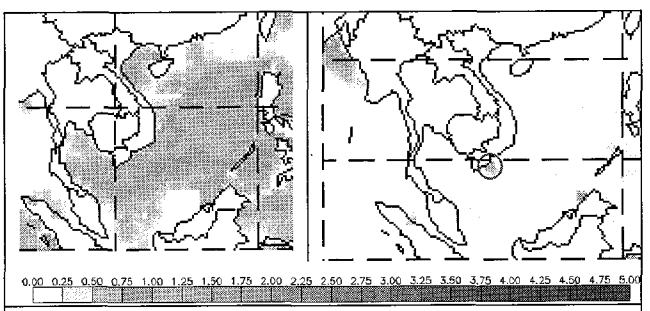

Figure 12: Hotspots maps in July 1998 (left) and October 2005 (right) in South East Asia as well as Condao

show that due to El-Nino event that occur during summer 1998 with increasing extreme high SST is main reasons causing mass coral mortality in everywhere with strong intensity whereas the record warmth in October 2005 was not buoyed by such an effect. The higher increasing of hotspots only appears in somewhere (Condao – South of Vietnam, North of Myanmar, Malaysia, Brunei, Philippine,...) with weak intensity. Can be said that: Thermal agent only secondary factor that causing mass mortality in Condao during October 2005. The random coincidence of the extreme increase of sea surface temperature with lower reducing sea water salinity as well as high turbidity (mainly due to fresh, warmer and high turbidity water plume from Mekong rivers) during mid October 2005 is main reason causing mass mortality of corals in Con Dao Island.

CONCLUSION:

- October 2005 was especial period with larger event of coral bleaching and mass mortality of coral in worldwide in Caribean / Western Atlantic as well as South of Vietnam sea – Condao island.
- The global warming is main reason cause coral bleaching in many places in the world but in Condao island – Vietnam in October 2005, It is only secondary agent.
- The random coincidence of the extreme increase of sea surface temperature with lower reducing sea water salinity as well as high turbidity (mainly due to water plume from Mekong rivers) during 10-13th October 2005 is main reason causing mass mortality of corals and benthos in Con Dao Island.
- Con Dao may be more sensitive/susceptible to coral bleaching than other areas in Vietnam and we may need to monitor Con Dao island more intensively in the future. We propose that a monitoring program be put in place in Con Dao island, consisting of in-situ monitoring programs, as well as remote sensing monitoring. Both of these measures can then be used to adapt the current NOAA tool for the bleaching warning of risk level on the impact of global warming on coral reefs.

REFERENCE:

Tuan V. S. 2000: The coral at Con dao Archipwelago (South Vietnam): Before, during and after the bleaching event in 1998. *In proceeding 9 th International Coral Reef Symposium, Bali, Indonesia 23 – 30 October 2000 Vol 2: 895-899*

Wilkinson . C., 1998: Status of coral reef of the world. In: *Book of GRCMN 1998*

Wilkinson . C., 2000: Status of coral reef of the world. In: *Book of GRCMN 2000*

MODIS website: http://oceancolor.gsfc.nasa.gov/

Giovanni : http://reason.gsfc.nasa.gov/OPS/Giovanni/

Coral reef watch website http://coralreefwatch.noaa.gov/satellite/.