Temporal variability of upwelling parameters in the Zamboanga Peninsula, Philippines and its relationship with sardine production

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Zamboanga Peninsula
Seasonality of upwelling

Villanoy et. al., 2011
Wind stress curl

UPWELLING AREAS
El Niño Southern Oscillation

NORMAL

EL NIÑO

LA NIÑA

Weak easterlies
Less rain
Low SST
LOW STRATIFICATION

Strong easterlies
More rain
High SST
HIGH STRATIFICATION

UPWELLING

Ashok et. al., 2009
Oceanography

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2007/2008 La Niña may also be related to the weakening of the prevailing winds during the 2007/2008 NEM season. However, unlike rainfall, the seasonal QuikSCAT wind anomalies from January 2000 to October 2009 for the area off the Zamboanga shelf did not show a clear relationship with ENSO events.

CONSEQUENCES OF UPWELLING

Because algal blooms and an increase in primary production are some of the consequences of upwelling, chlorophyll a pigment concentrations measured from satellites are good tracers for upwelling, particularly in the tropics where the temperature differences between upwelled and ambient surface waters are small. Chlorophyll concentrations vary seasonally, with the highest surface concentrations occurring during the NEM months. EOF analysis of monthly chlorophyll images (2003–2009) with the spatially averaged concentration removed show the highest concentration at the shelf and a decrease off shore up to more than 50 km from the coast (Mode 1 accounting for 65% of the variability). The temporal pattern of the first EOF peaks during the first quarter of the year is consistent with upwelling induced by NEM winds. It is interesting to note that the results of the EOF analysis of chlorophyll yielded a more significant dominant mode than the EOF analysis of SST (65% variance explained for chlorophyll a and only 23% for SST). This is an indication that the upwelling signal is much more evident in remotely sensed chlorophyll than in remotely sensed SST. Udarbe and Villanoy (2001) earlier reported the lack of manifestation of upwelling in the SST signal.

The most dramatic change in chlorophyll concentration since 2002 occurred during the NEM seasons of 2006/2007 and 2007/2008. The former was an El Niño year and surface chlorophyll concentrations were among the highest since 2002, while the latter was a La Niña year and chlorophyll concentrations off Zamboanga Peninsula were among the lowest (Figure 7).

Villanoy et. al., 2011
Sardine catch vs ENSO

Villanoy et. al., 2011
OBJECTIVES

• To describe the temporal variability of upwelling parameters in the Zamboanga Peninsula

• To relate this variability to climate indices

• To determine the possible relationships between sardine volume production and environmental factors in the study area
METHODOLOGY - WINDS

ASCAT (U component)
www.apdrc.soest.hawaii.edu
July 1999 to January 2015

FOURIER TRANSFORM

LOW FREQUENCY SIGNALS
Signals with period > 365 days
Compare with climate indices
METHODOLOGY – CHL, SST and RAINFALL

- ENSO 3.4 INDEX
  www.cpc.ncep.noaa.gov

- MODIS SURFACE CHLOROPHYLL
  oceancolor.gsfc.nasa.gov

- TRMM RAINFALL
  apdrc.soest.hawaii.edu

- MODIS SURFACE TEMPERATURE
  oceancolor.gsfc.nasa.gov

- INDIAN SARDINE VOLUME PRODUCTION
  countrystat.bas.gov.ph
METHODOLOGY – CHL, SST and RAINFALL

SPATIAL LIMITS
Dipolog–Sindangan Bay
Longitude: [122.5 123.5] Latitude: [8 9]

TEMPORAL LIMIT
July 2002 to March 2014

DATA PROCESSING
Spatially–averaged
Monthly mean
Monthly climatological signal removed
5–month running mean applied
RESULTS

FOURIER TRANSFORM OF WIND DATA
Correlation of U-wind with ENSO = -26%
Correlation of U-wind with PDO = -14%
RESULTS

CHLOROPHYLL, SST and RAINFALL
La Niña
→ High SST
→ High RAINFALL
→ LESS favorable to upwelling
→ Low Chlorophyll
El Niño
→ Low SST
→ Low RAINFALL
→ MORE favorable to upwelling
→ High Chlorophyll

Correlation with MODIS chlorophyll
→ ENSO 3.4 Index: 
  \( r = 0.5541 \)
→ MODIS SST: 
  \( r = -0.5573 \)
→ TRMM rainfall: 
  \( r = -0.6003 \)
RESULTS

VOLUME OF SARDINE CATCH
Mean Fish Catch Non-ENSO: 4237
Mean Fish Catch El Niño: 2129
Mean Fish Catch La Niña: 3164

Mean Fish Catch Non-ENSO: 4616
Mean Fish Catch El Niño: 2382
Mean Fish Catch La Niña: 4232
SUMMARY

Variability of upwelling parameters is influenced by ENSO
Wind variability could be influenced by ENSO and PDO
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REFERENCES
