Current status of implementation for OA studies in Malaysia
Location of the proposed study site
Pulau Bidong (UMT Marine Research Station)
Investigating the diurnal variation of the seawater pH and alkalinity in shallow water coral reef of Pulau Payar (Strait of Malacca), Pulau Bidong and Pulau Gaya (South China Sea) as the proposed sites of the ocean acidification study.
Diurnal variability of pH and total alkalinity

3 day period of observation at a shallow water coral reef area

Hydrolab DS 5X recorded reading every 15 minute (pH, Temperature, Salinity, Dissolved Oxygen, DO)

In-situ measurement & water sample collection

Every 3 hours, water sample were collected and measured for the Total Alkalinity ($A_T$)

Aragonite saturation were determined using the CO2SYS program (Lewis and Wallace, 1998) through in situ $A_T$, pH, salinity, temperature data.
Methods that were used to determine the seawater carbonate parameter

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Measurement Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>Hydrolab DS 5X</td>
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<tr>
<td>Salinity</td>
<td>ppt</td>
<td>Hydrolab DS 5X</td>
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<tr>
<td>pH</td>
<td></td>
<td>Hydrolab DS 5X</td>
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<tr>
<td>Dissolved Oxygen (DO)</td>
<td>mg/L</td>
<td>Hydrolab DS 5X</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>µmol/kg</td>
<td>Potentiometric Titration (Dickson et al. 2007)</td>
</tr>
<tr>
<td>Aragonite Saturation</td>
<td>$\Omega_{\text{Aragonite}}$</td>
<td>CO2SYS program (Lewis and Wallace, 1998)</td>
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</table>
Diurnal variation in seawater pH at the study area

- pH trend fluctuates daily following the diurnal pattern which is regulated by the biological activity such as photosynthesis and respiration.
Seawater pH at Pulau Payar, Pulau Bidong and Pulau Gaya

- Decreasing surface seawater pH trend from the Strait of Malacca to the South China Sea

![Graph showing seawater pH trend](image-url)
Diurnal variation of total alkalinity

- Total alkalinity ($A_T$) did not show any diurnal trend throughout this study.
- However, the largest difference of $A_T$ was recorded at Payar with the value of 28.92 μmol/kg.
- Changes in $A_T$ are attributed to calcification or carbonate dissolution (Murillo et al., 2014)
Relationship between total alkalinity and salinity

- Precipitation and evaporation mainly controls the $A_T$ variability of surface ocean (Brewer et al., 1986; Millero et al., 1998a)

- Concentrations of the key chemical species (i.e., $\text{HCO}_3^-$, $\text{CO}_3^{2-}$) that contribute to $A_T$ proportionally increase with increasing salinity (Lee et al., 2006)
**CO₂ Parameter Variation**

**pH**
- pH ranged 7.2 to 7.8°C
- Lower pH observed at the southern region

**ρCO₂ (µatm)**
- ρCO₂ ranged 710 to 3151 µatm
- Higher ρCO₂ observed at the southern region
Aragonite saturation ranged 0.57 to 2.26

- Low saturation state observed at the southern region
- At extremely marginal state

Saturation state in our region

(Reefs at Risk Revisited 2011)

(Shamberger et al. 2011)
Carbonate environment comparison

**Pulau Bidong and Pulau Gaya**
- Higher $A_T$ were recorded at these sites, 2161.78 μmol kg$^{-1}$ and 2160.45 μmol kg$^{-1}$ respectively.
- The pH at both sites are lower than Payar as denoted by the higher H$^+$ concentration in the seawater.
- Aragonite saturation in the seawater at both sites were recorded at adequate (3.41) and marginal (2.99) level respectively.

**Pulau Payar**
- Lower $A_T$ (2140.77 μmol kg$^{-1}$) means the capacity of the seawater buffer system to neutralize acidic pollution is reduced.
- At present, the seawater carbonate system is maintained because of the pH value (pH 8.14).
- Only a small amount of acidic pollution is needed to disrupt the carbonate system equilibrium.
- Optimal aragonite saturation state in Payar contributes to the high coral calcification rate in the area.
Current status of implementation for OA studies in Malaysia

• All required CAUs, BMUs and ARMs have been manufactured but as yet not deployed

• diurnal variation survey of selected station has been completed for temperature, salinity, pH DO, aragonite saturation and total alkalinity

• Coral cover and diversity studies are planned for 2016-2017). Biotic survey (georeferenced, cover, diversity) is currently being analysed.
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• IOC/WESTPAC
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