Introduction to Bloom Species in Singapore and its vicinity

Sandric Chee Yew Leong

http://oceanservice.noaa.gov/hazards/hab/
Aquatic primary producers

- Small
- Microscopic plants;
- Size: 2-200 µm

Basic taxonomic classification

- Diatoms
- Dinoflagellates
- Raphidophytes

Motility varies across groups
Algal Blooms

Refer to situation when there is an increase in algal cell density to thousands of cells per ml e.g. 10,000-500,000 cells/ml, usually dominated by one species or a few species.

Effects depend upon species present.

Common bloom-forming species include:
- Diatoms;
- Dinoflagellates;
- Cyanobacteria & …..
Harmful Algal Blooms (HABs)

Refer to when an algal bloom has negative effects.

HABs may affect many living organisms of the coastal ecosystem, from small organisms to fish to people.
In Southeast Asia, many regions are affected by regular HABs occurrence.

Causing massive shellfish poisoning, fish kills and great economic losses.

Harmful Algal Blooms (HABs)

The occurrences of HABs is increasing world wide.

• Global climate change producing wider ranges of conditions for some species.
• Human contributions of increased nutrients and pollution in coastal waters.
• Changes in local ecosystems that may allow exotic species to thrive if introduced (e.g. coastal development)
• Increased shipping.
Harmful Algal Blooms (HABs)

Oxygen depletion
- Biomass dominance by microalgae
- Death and decomposition depletes oxygen

Physical damage
- Gill damage in fish, dermatitis

Toxin production
- Does not require biomass dominance
- Toxins differ across phytoplankton species
- Bio-accumulation in filter-feeders
- Potential public health threat

Not strictly one or the other – effects can overlap
What causes an algal bloom?

- It requires a combination of environmental factors to cause algae to bloom in an area.
- These include specific combination of parameters that trigger the growth and enhanced inputs of nutrients (e.g. nitrogen) to sustain the bloom
- Thermal stratification (stable water column with very little mixing) and light help to maintain the growth

The size and duration of a bloom is usually determined by the input of nutrients, in particular nitrogen.
Factors affecting bloom duration

Tidal conditions
• neap-tide vs spring-tide (tidal exchange)

Availability of nutrients
• Terrestrial input of nutrients
• Atmospheric input of nutrients
• Nutrient waste (fertilizer; food waste & etc)

Environmental parameters
• Stratification of water column - less mixing
• Estuaries: where freshwater plumes enter the sea help to concentrate the bloom
Toxic Algal Blooms

- Algal blooms occur when population increase rapidly with high cell density.

- Some algae produce toxins that can endanger marine organisms and humans

- > 4000 bloom-forming species

- But only < 5% are toxic (mostly motile dinoflagellates)

Many different algal species are responsible for HABs.
Harmful algal blooms (HABs)

Effects of toxins produced by HABs

- The effect depends on the type of toxins produced.
- Toxins may have species specific effects, depending on the biological mechanism of action.
- Toxicity may also vary from region to region, and between seasons.

Massive fish-kill events
- Extent of threat depends on microalgae species
- Usually a toxin was secreted into the water column – may affect fish only; some others may also cause human health problems

Shellfish-poisoning
- Bioaccumulation of toxins through filter-feeding
- Harm, human fatalities may occur when sufficient amount of shellfish was consumed
Global distribution of Paralytic Shellfish Poisoning

Causative organisms:
Alexandrium spp.,
Gymnodinium catenatum,
Pyrodinium bahamense

Toxins produced: Saxitoxins

Life threatening syndrome. Symptoms include tingling, numbness, and burning of the perioral region, ataxia, giddiness, drowsiness, fever, rash. The most severe cases result in respiratory arrest within 24 hours of consumption of the toxic shellfish. There is no antidote, supportive therapy is the rule.

Prevention: Food safety screening; ban of fish stocks from contaminated areas

Area with PSP toxins detected
Distribution of harmful algae in Southeast Asia region

Widespread of toxic dinoflagellates in Southeast Asia. Frequent and widespread of algal blooms in SEA has caused an increase in PSP. Figure was obtained from Fukuyo et al. 2011.

First PSP was reported:
- Malaysia: 1976
- Indonesia: 1977
- Philippines: 1983
Most reported human health problems from HAB in tropical SE Asia have been due to Toxic Shellfish Poisoning.

Number of poisoning cases from eating shellfish contaminated by toxins produced by plankton (based on Furio, NFRDI)

<table>
<thead>
<tr>
<th>Country</th>
<th>Poisoning</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippines</td>
<td>2267</td>
<td>134</td>
</tr>
<tr>
<td>Thailand</td>
<td>34</td>
<td>1</td>
</tr>
<tr>
<td>Malaysia</td>
<td>609</td>
<td>44</td>
</tr>
<tr>
<td>Indonesia</td>
<td>427</td>
<td>17</td>
</tr>
<tr>
<td>Brunei</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

(1976-2006)
Fish-kill events around the world
The Philippines

- The Philippines is seriously affected by HABs every year.
- It is one of the most affected regions in Southeast Asia. The first HAB event was reported in 1908 in Manila Bay.

- A major outbreak of toxic dinoflagellate *Pyrodinium bahamense* in central Philippines was reported in 1983.
- *Alexandrium* species such as *A. tamarense* are also known to be another causative organism causing PSP around the coastal regions in the Philippines.
- *Cochlodinium polykrikoides* is another known bloom-forming dinoflagellate.
Recent fish kill events – The Philippines

20,000 fishes were found dead in Purok Guang-guang along Pujada Bay on 16 January 2014, where the fish cages are located.
Malaysia

- Regular dinoflagellate blooms are observed in Malaysia particularly in Sabah, East Malaysia.
- The first report of a toxic dinoflagellate (*P. bahamense*) was in 1976, along the coast of Kota Kinabalu, Sabah. Most HABs were observed around Sabah areas until 1990.
- These blooms are mainly caused by toxic dinoflagellates *P. bahamense* and *C. polykrikoides*.
- In recent years, many other bloom-forming species have also been documented: *Gymnодinium catenatum*; *Alexandrium spp.*; benthic toxic dinoflagellates *Coolia*, *Ostreopsis*, and *Gambierdiscus*.

![Images of dinoflagellates]
Recent fish kill events - Malaysia

In Jan and Feb 2013, shellfish poisoning occurred and caused 3 deaths and over 40 people were hospitalized at Kota Kinabalu, Sabah Malaysia. It was due to toxic dinoflagellate Pyrodinium bahamense blooms.

Fish kills occurred in Tanjung Kupang, Johor on 11 Feb 2014. One of the operators reported losses of RM150,000.

Fish stocks like snappers, cods, seabass and threadfins in some nine farms were wiped out.
Toxic dinoflagellate *Pyrodinium bahamense* has been known to cause bloom in Indonesia since 1991.

Some of the bloom-forming species identified during the monitoring period *Gymnodinium* sp., *Noctiluca scintillans*, *P. minimum*, *A. affine*.
Vietnam

- Harmful Algal Blooms events have been reported in Vietnam since the early 1990s.
- In northern Vietnam, monitoring programs for phytoplankton density and harmful algae species started as early as 1991.
- Some of the identified potential harmful microalgae species belonged to the *Alexandrium* and *Dinophysis* genera.
- During 1998, 1999 and 2002, several cases of algal blooms were observed.
- Bloom species *D. caudata* and *P. minimum* were identified.
Massive fish kill was observed for the first time in Singapore waters during late December 2009, killing 200,000 farm fish.
Thousands of dead fish from fish farms were found in Lim Chu Kang area during late June 2013.

Around 90,000kg of fish were found dead.
Another massive fish kill associated with a HAB event was observed in early Feb 2014, killing both farm fish and wild fish.
List of Toxic/Harmful Organisms

Dinoflagellates:
- Gymnodinium catenatum
- Cochlodinium sp.
- Alexandrium leei
- Dinophysis caudata
- Dinophysis ovum
- Dinophysis sacculus
- Dinophysis caudata
- Gambierdiscus spp.

Raphidophytes:
- Chattonella marina
- Chattonella subsala
- Fibrocapsa japonica
- Heterosigma akashiwo

High diversity of potential toxic species in the water column, most of which have not caused any past HAB events but could potentially cause serious problem in the future.
Gambierdiscus species are present in Singapore waters: *G. toxicus*, *G. cf. belizeanus* and *G. yasumotoi*

All three species occur sporadically on fringing coral reefs in southern Singapore waters but generally in low densities. Other benthic toxic dinoflagellates *Ostreopsis*, *Coolia* and *Prorocentrum* are also detected in Singapore waters.
Problems for HABs management in Singapore waters

- Algal blooms occur regularly but these rarely cause serious impacts. HAB events have been sporadic and not associated with any one particular species.

- Insufficient information on the biology of HAB species reduce capacity to effectively detect pre-HAB conditions.

High diversity of potential toxic species in the water column, most of which have not caused any past HAB events but could potentially cause serious problem in the future.

- *Heterosigma* sp.
- *Chattonella* sp.
- *Karldinimum* sp.
Monitoring Harmful Algal Blooms

The challenges of monitoring harmful algal blooms is to conduct intensive study and comprehensive monitoring of such events.

When designing a monitoring strategy, we have to consider our goals (i.e. parameters; duration) carefully including early warning.

In order to predict, we need to conduct intensive study on:

The early detection of HAB formation, and monitoring of both their development, peak occurrence, and decay, as well as their pathways of displacement.

http://products.coastalscience.noaa.gov/pmn/habs_algae.aspx
Measures against Harmful Algal Blooms

There are currently no measures available to prevent a bloom from forming.

Only possible way is to:
Prevent poisoning of humans (e.g. eating of contaminated seafood)
A Monitoring and Predicting System can be very complex.
Thank You