

# Emergent field survey on present status of chemical pollution by typhoon ‘*Yolanda*’ in coastal environment of the central Philippines

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Japan-Philippine Urgent Collaborative Projects  
regarding “Typhoon Yolanda” within the J-RAPID Program

# Members and contributors

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- Leader** : **Haruhiko NAKATA** (Associate professor, Kumamoto University)
- Sub-leader** : **Izumi WATANABE** (Tokyo University of Agriculture and Technology [TUAT])
- Members** : **Yuta NAKAMURA** (Kumamoto Univ.).  
: **Takashi TOKUMARU** (TUAT).  
: **Manami YOSHIDA** (Kumamoto Univ.).

## *Philippines side*

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: **Richard Brun** (Assistant Professor, Eastern Visayas State University)  
: **Ricardo MAGNO** (Associate Professor, West Visayas State University)  
: **Lulu LOYOLA** (Director of Research, West Visayas State University)

## Supporting organizations

- : **Eastern Visayas State University, Tacloban, Leyte Island.**  
: **West Visayas State University, Iloilo, Panay Island.**  
: **Bureau Fisheries Aquatic Resources, Tacloban, Leyte Island.**  
: **Bureau Fisheries Aquatic Resources, Estancia, Panay Island.**  
: **Philippines Coast Guard.**

# Introduction – *Yolanda and Tacloban, Leyte Is.*



Date : November 8, 2013.

Wind speed : 125 kt (64.3 m/s)

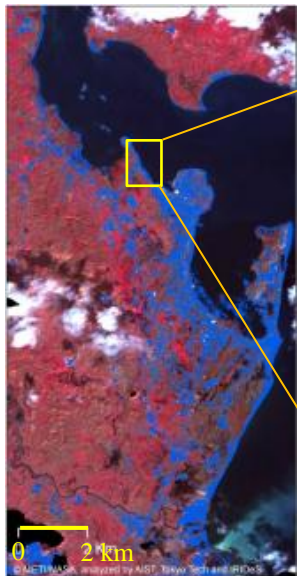
Central pressure : 895 hPa  
(Category 5 on the Saffir-Simpson Hurricane Scale)

Casualties : 6,293  
Missing : 1,061 } 7,354

Affected population: 16,078,181 (17% of total)

Damaged houses : 1,140,332

## Tacloban City, pre- and post event<sup>3)</sup>



Blue area:  
Experienced Flooding.



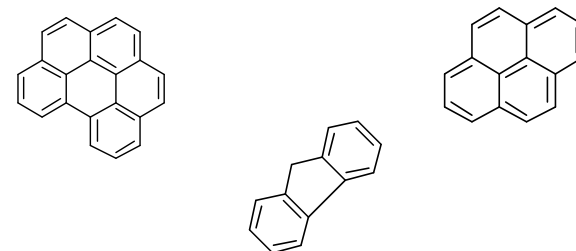
More than 50% of roof was reduced, due to strong wind and storm surge.



- 1) The Meteorological Agency, Japan.
- 2) NDRRMC (<http://www.ndrrmc.gov.ph>).
- 3) IRIDeS Fact-finding missions to Philippines, Tohoku University, Japan. (2014)

# What is PAHs ?

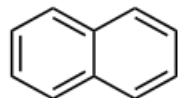
## Polycyclic aromatic hydrocarbons (PAHs)



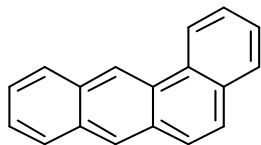
### Environmental Sources

#### Parent PAHs (Par-PAHs)

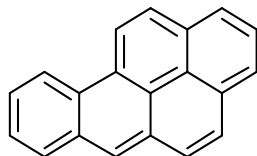
Incomplete combustion of organic materials.



Naphthalene



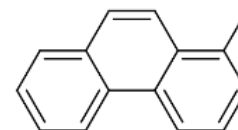
Benz[a]anthracene



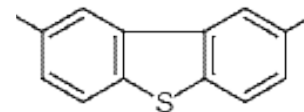
Benzo[a]pyrene

#### Alkylated PAHs (Alk-PAHs)

Occurrence of high conc. in crude oil



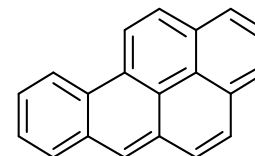
1-Methylphenanthrene



2,8-Dimethyldibenzothiophene

### Toxicity

Carcinogenicity, Mutagenicity etc.



**IARC categorized BaP as Group I**  
(Carcinogenic activity in human)

# Objectives

- To understand the present status of pollution by toxic **organic pollutants and heavy metals** in environmental matrices in disaster-affected areas due to typhoon *Yolanda*.
- To evaluate exposure risks to pollutants in the biota.



# Sampling at Estancia, Panay Is.

*June 6-7, 2014*

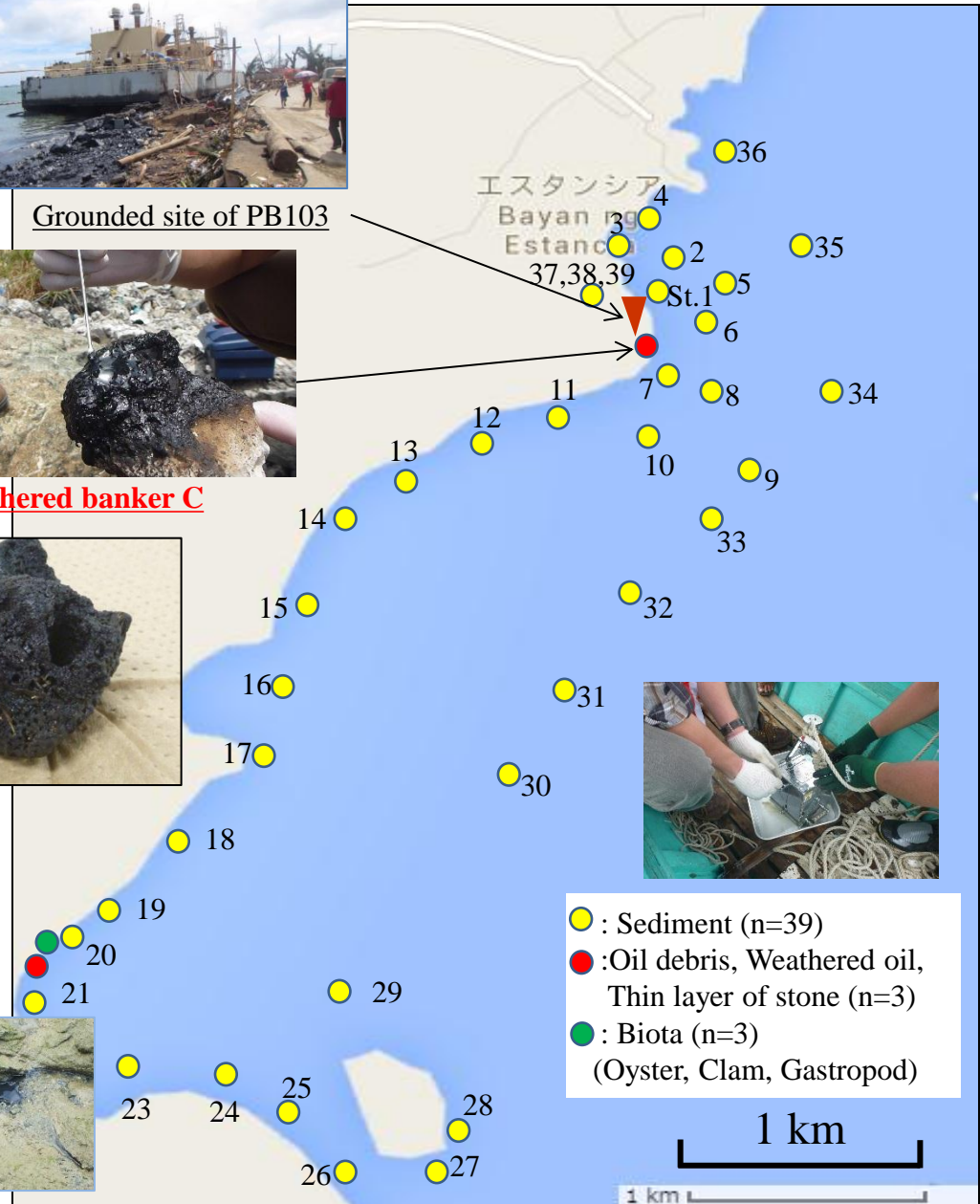
*March 1-7, 2015*



Grounded site of PB103



Weathered tanker C





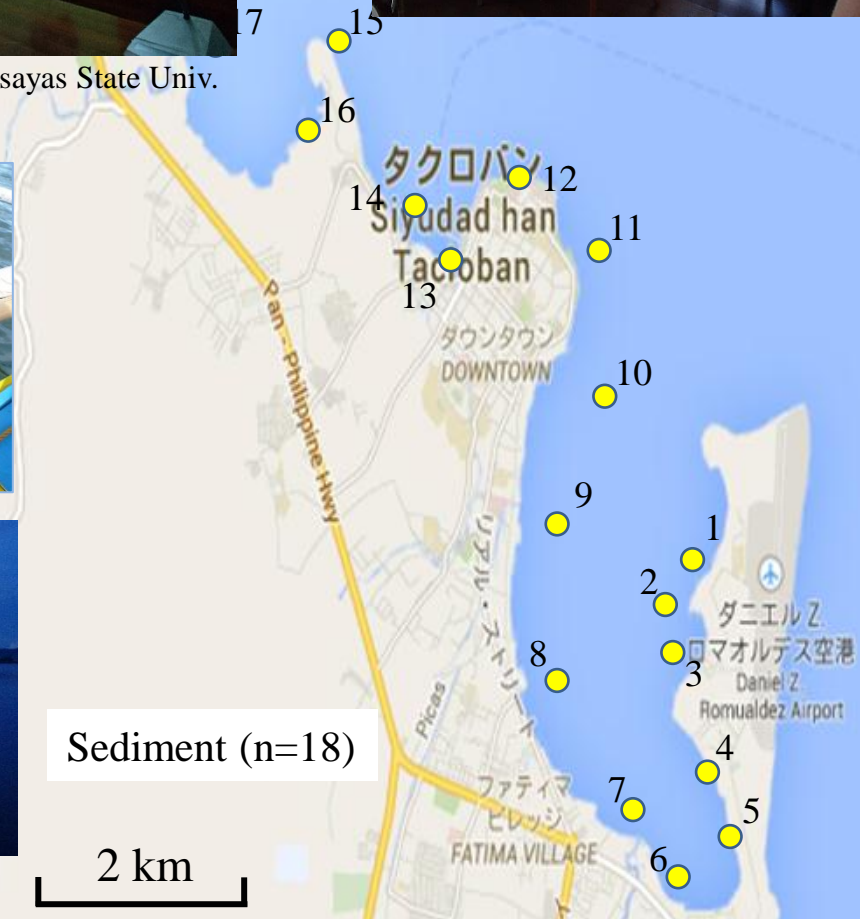
# Sampling at Tacloban, Leyte Is.

June 3-4, 2014

March 1-7, 2015



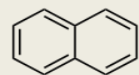
Meeting at Eastern Visayas State Univ.



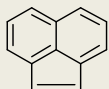
# Target Analytes -PAHs

## Par-PAHs (n=22)

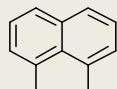
### 16 Priority PAHs



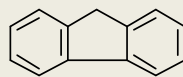
Naphthalene  
(Naph)



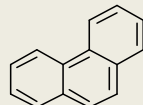
Acenaphthylene  
(Acl)



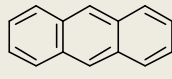
Acenaphthene  
(Ace)



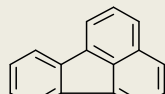
Fluorene  
(Fl)



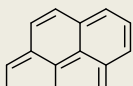
Phenanthrene  
(Phen)



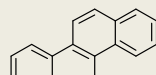
Anthracene  
(Ant)



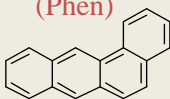
Fluoranthene  
(Flth)



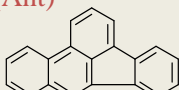
Pyrene  
(Py)



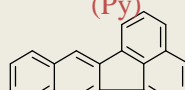
Chrysene  
(Chry)



Benz[a]anthracene  
(BaA)



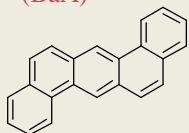
Benzo[b]fluoranthene  
(BbF)



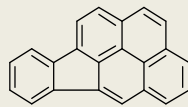
Benzo[k]fluoranthene  
(BkF)



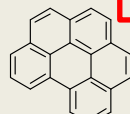
Benzo[a]pyrene  
(BaP)



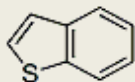
Dibenzo[a,h]anthracene  
(DahA)



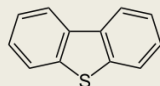
Indeno[1,2,3-cd]pyrene  
(IcdP)



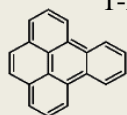
Benzo[ghi]perylene  
(BghiP)



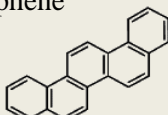
1-Benzothiophene  
(BT)



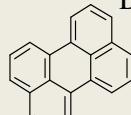
Dibenzothiophene  
(DBT)



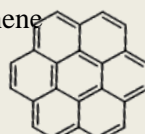
Benzo[e]pyrene  
(BeP)



Picene  
(Pic)

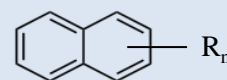


Perylene  
(Pery)

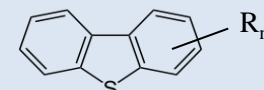


Coronene  
(Coro)

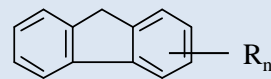
## Alk-PAHs (7groups)



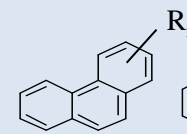
$C_n$  - Naphthalene  
( $n = 1 \sim 4$ )



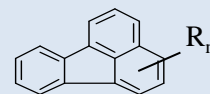
$C_n$  - Dibenzothiophene  
( $n = 1 \sim 4$ )



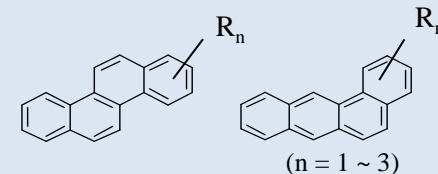
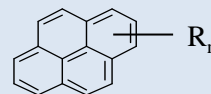
$C_n$  - Fluorene  
( $n = 1 \sim 3$ )



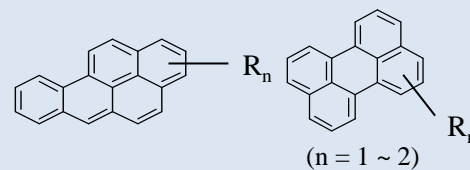
$C_n$  - Phenanthrene/Anthracene  
( $n = 1 \sim 4$ )



$C_n$  - Fluoranthene/Pyrene  
( $n = 1 \sim 3$ )



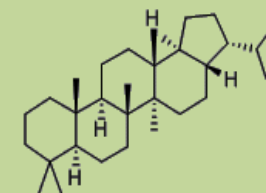
$C_n$  - Benz[a]anthracene/Chrysene  
( $n = 1 \sim 3$ )



$C_n$  - Benzopyrene/Perylene  
( $n = 1 \sim 2$ )

\*R : Substitution of alkylated group

## Hopane

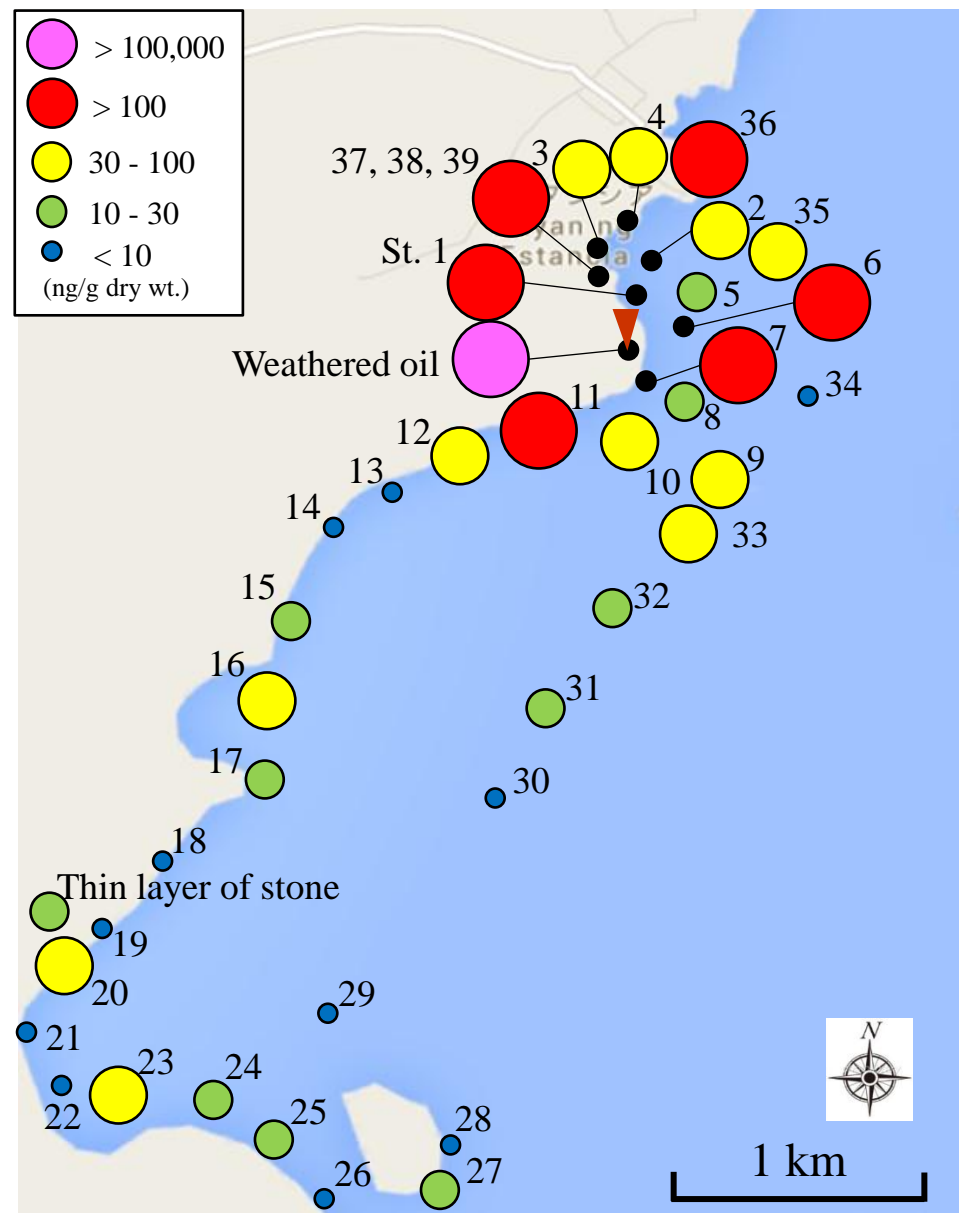


17 $\alpha$ (H),21 $\beta$ (H)-hopane  
( $C_{30}17\alpha$ )

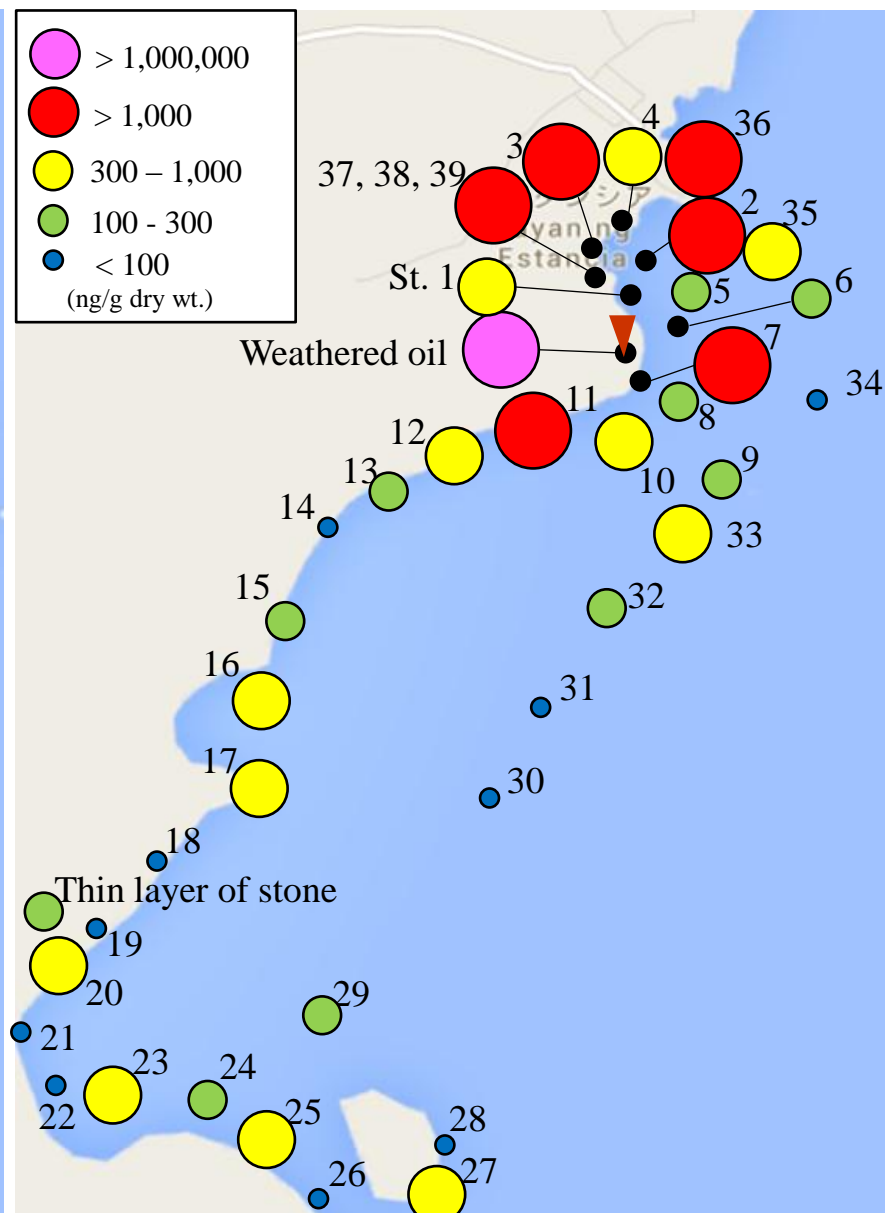


# PAHs concentrations in sediments from Estancia, Panay Island

## Par-PAHs

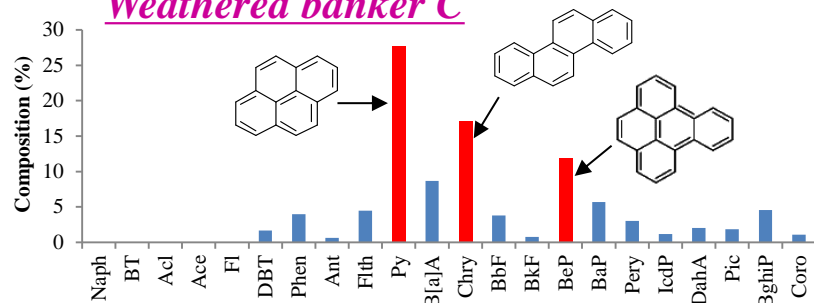


## Alk-PAHs

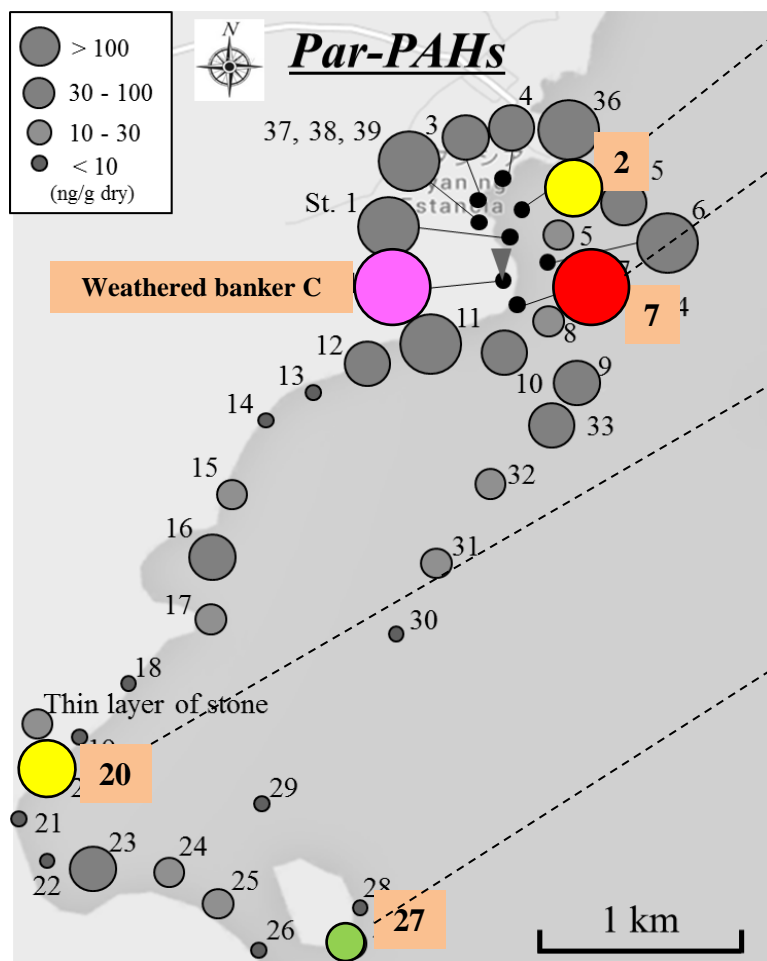
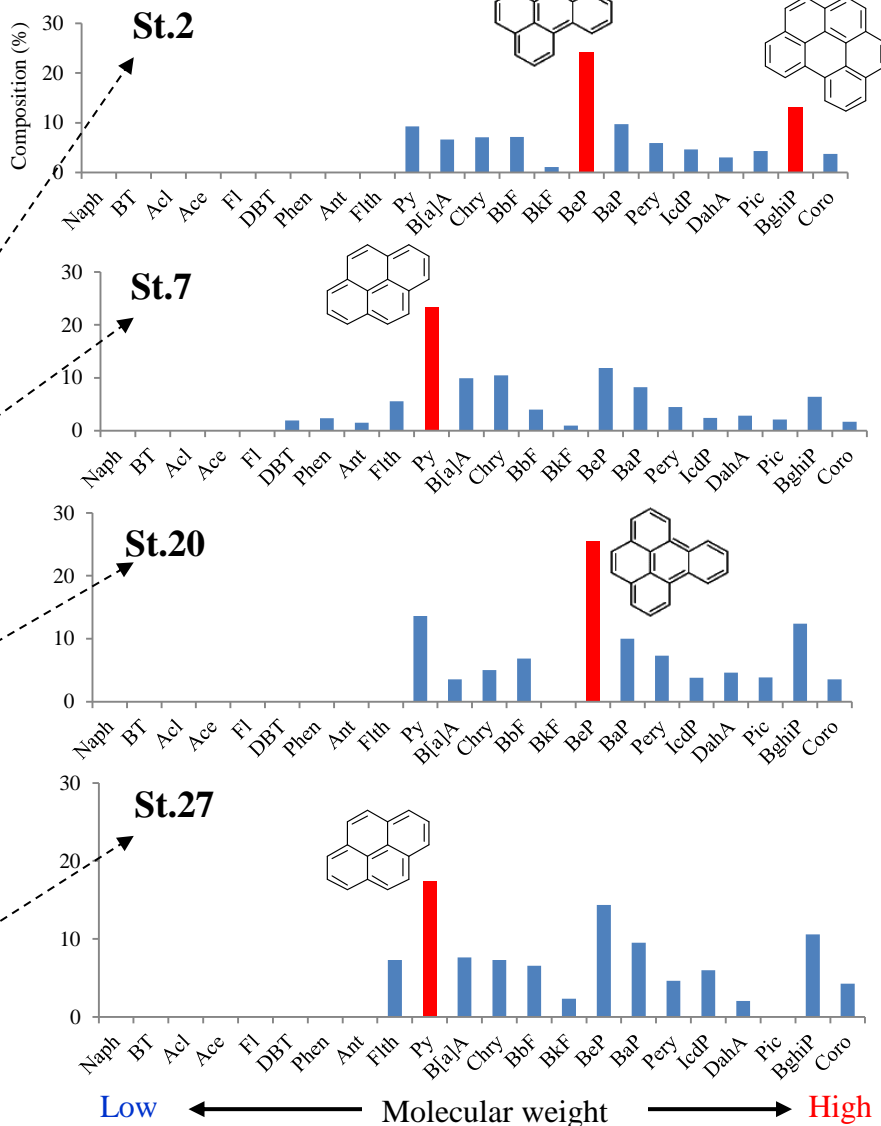


# Compositions of Par-PAHs in sediments from Estancia

## Weathered tanker C

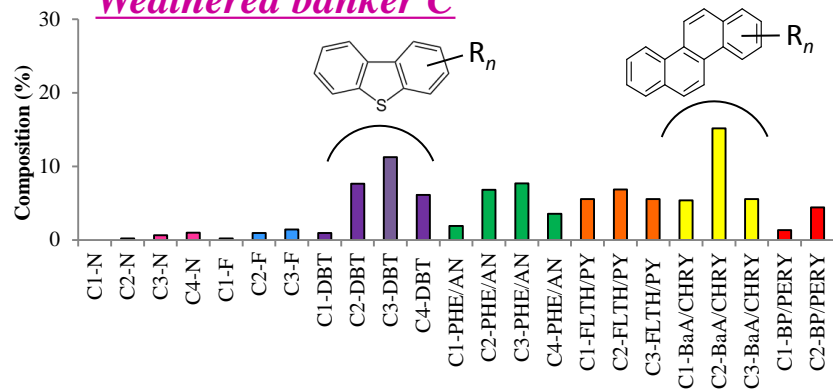


## Sediments

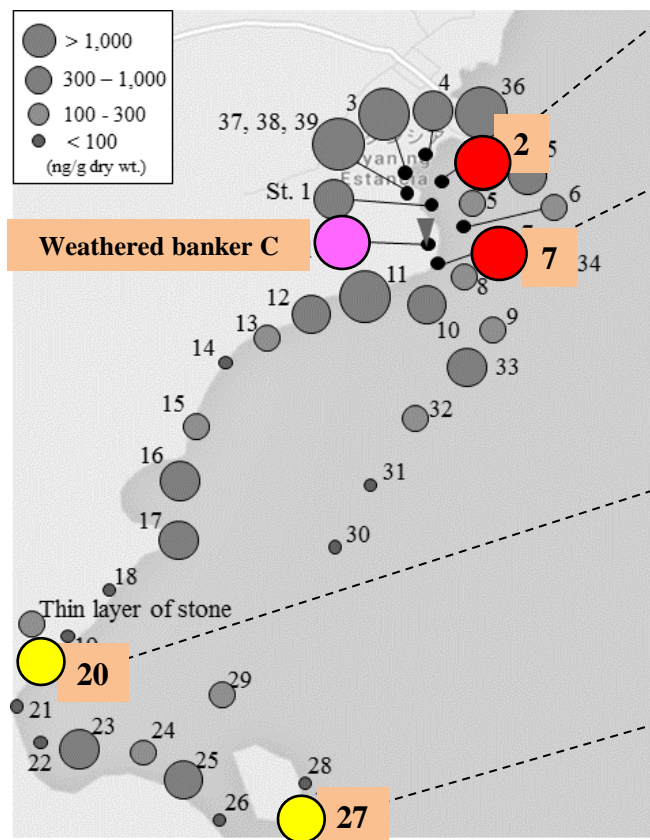


# Compositions of Alk-PAHs in sediments from Estancia

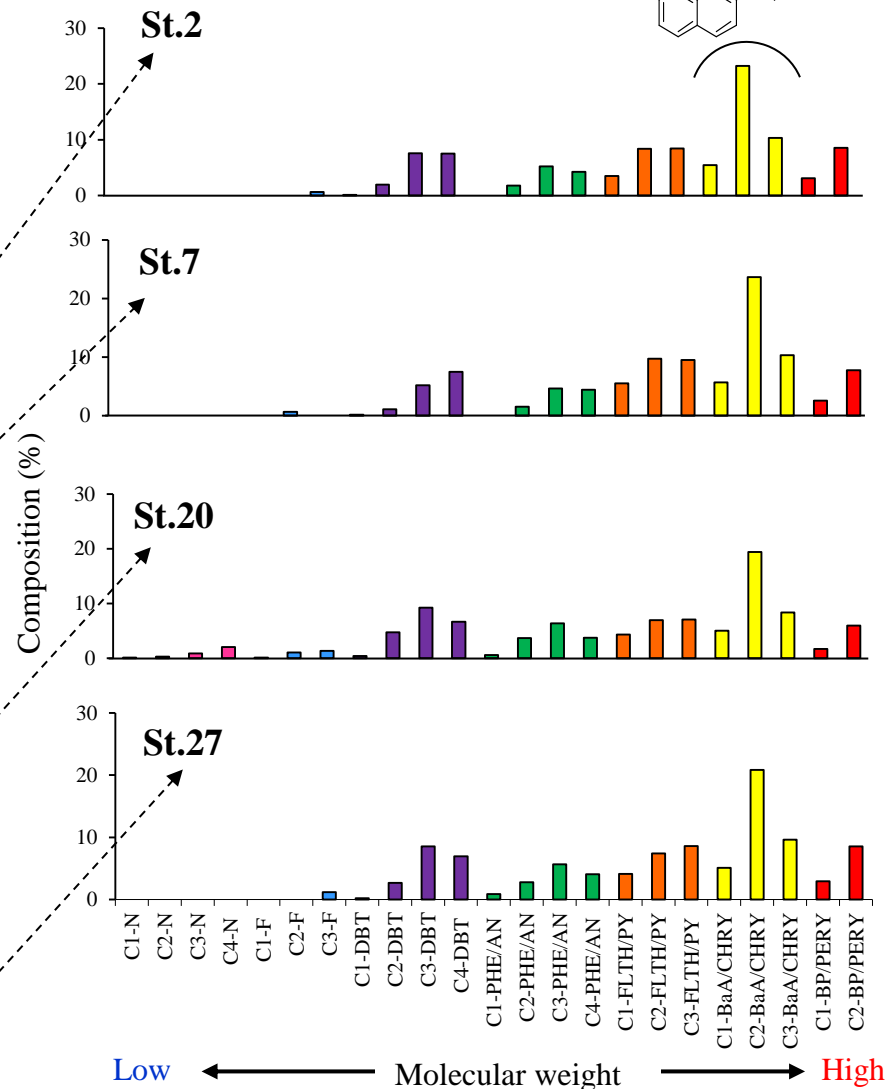
## Weathered tanker C



Low ← Molecular weight → High



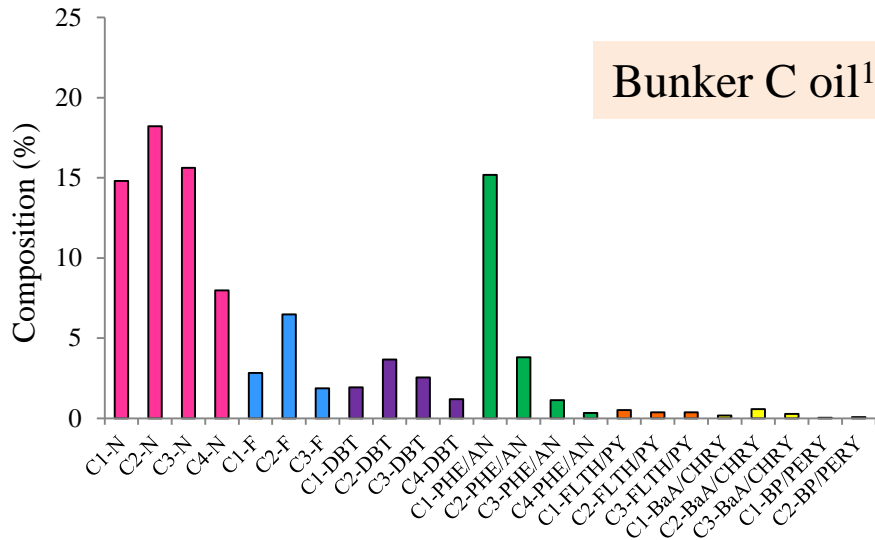
## Sediments



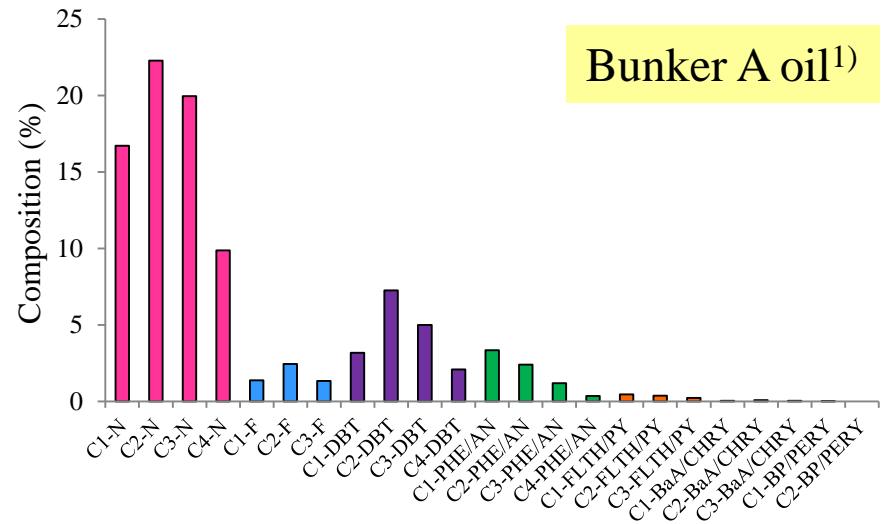


# Temporal variations of Alk-PAHs compositions in Estancia sediments

Bunker C oil<sup>1)</sup>

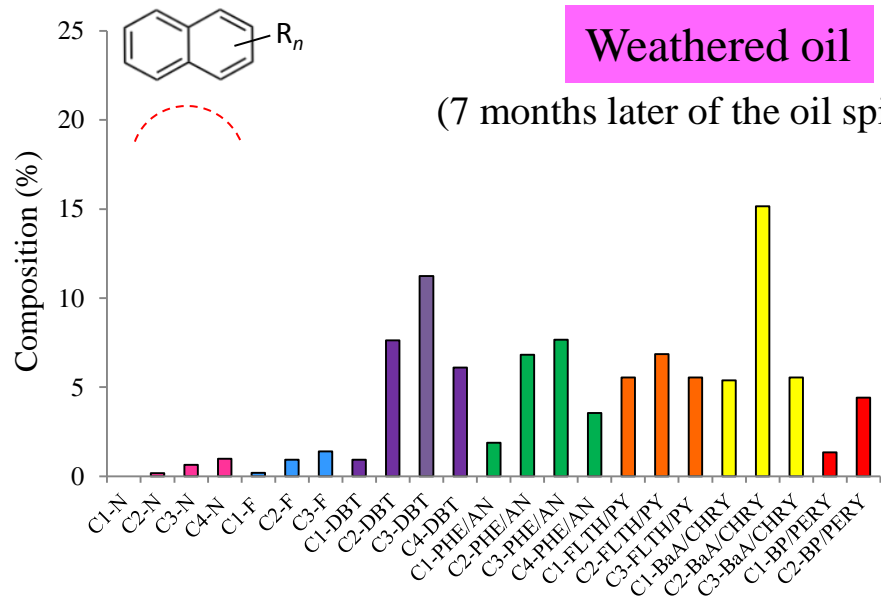


Bunker A oil<sup>1)</sup>



Weathered oil

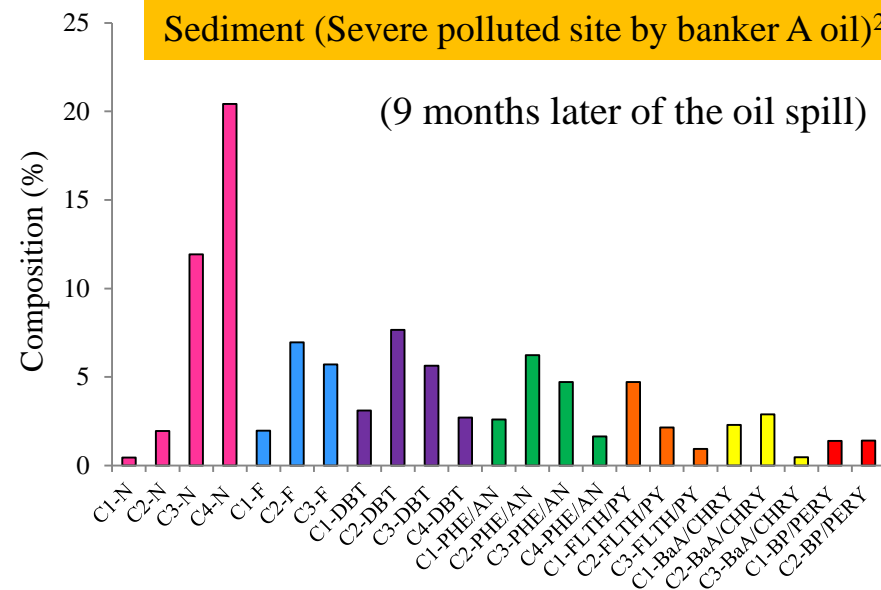
(7 months later of the oil spill)



Low ← Molecular weight → High

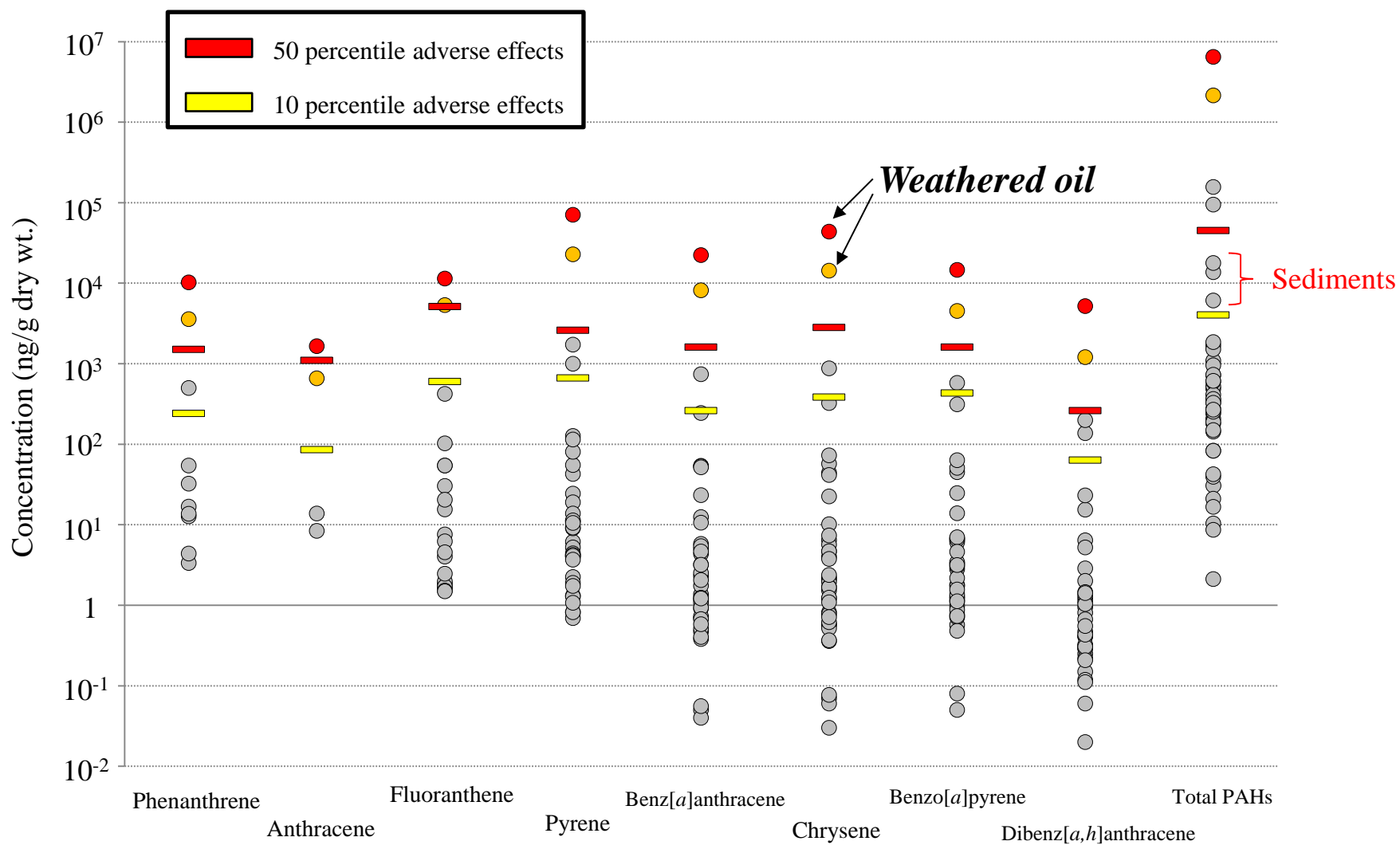
Sediment (Severe polluted site by bunker A oil)<sup>2)</sup>

(9 months later of the oil spill)

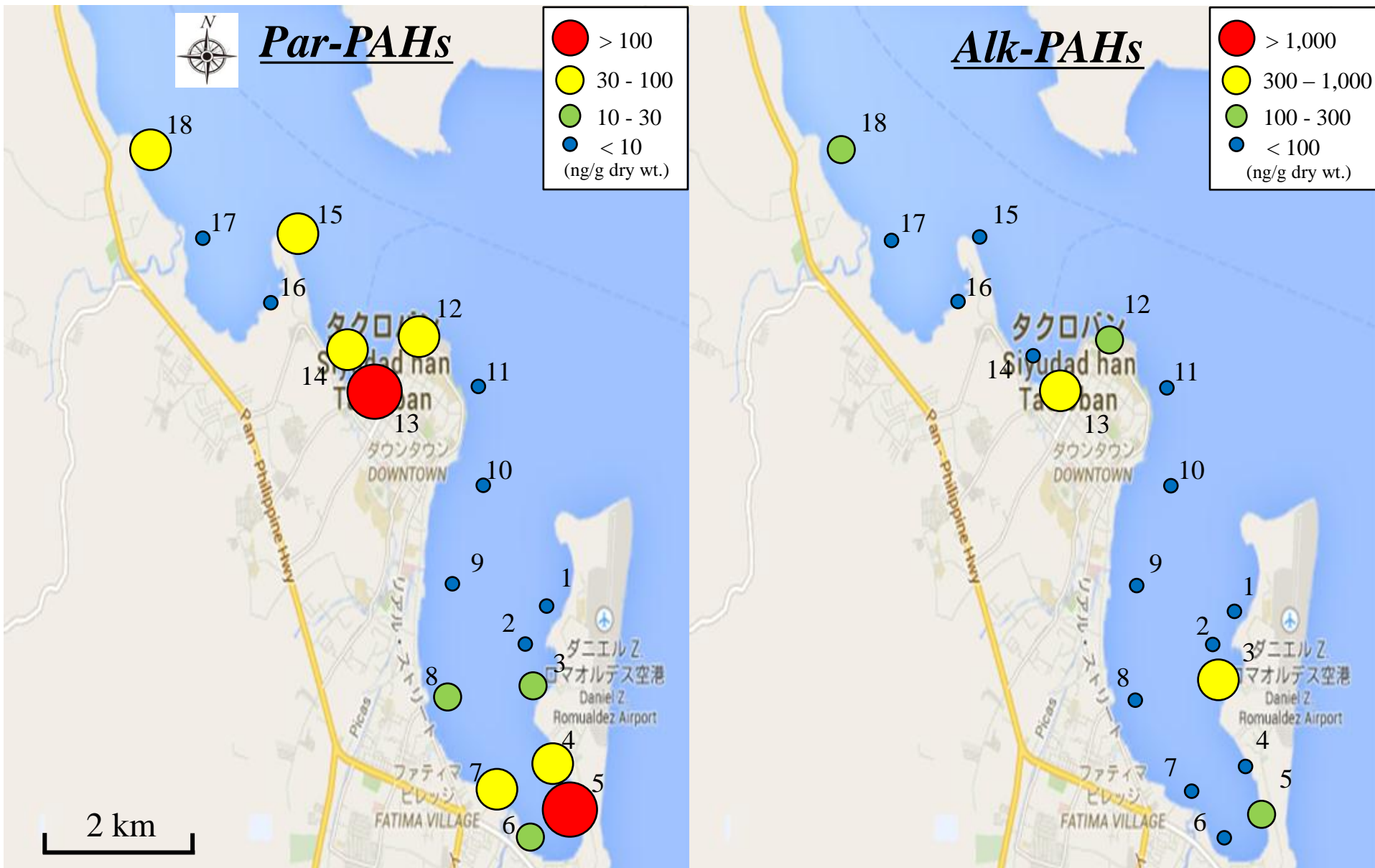


Low ← Molecular weight → High

# Evaluation of adverse effects in benthic organisms -Estancia coast sediments

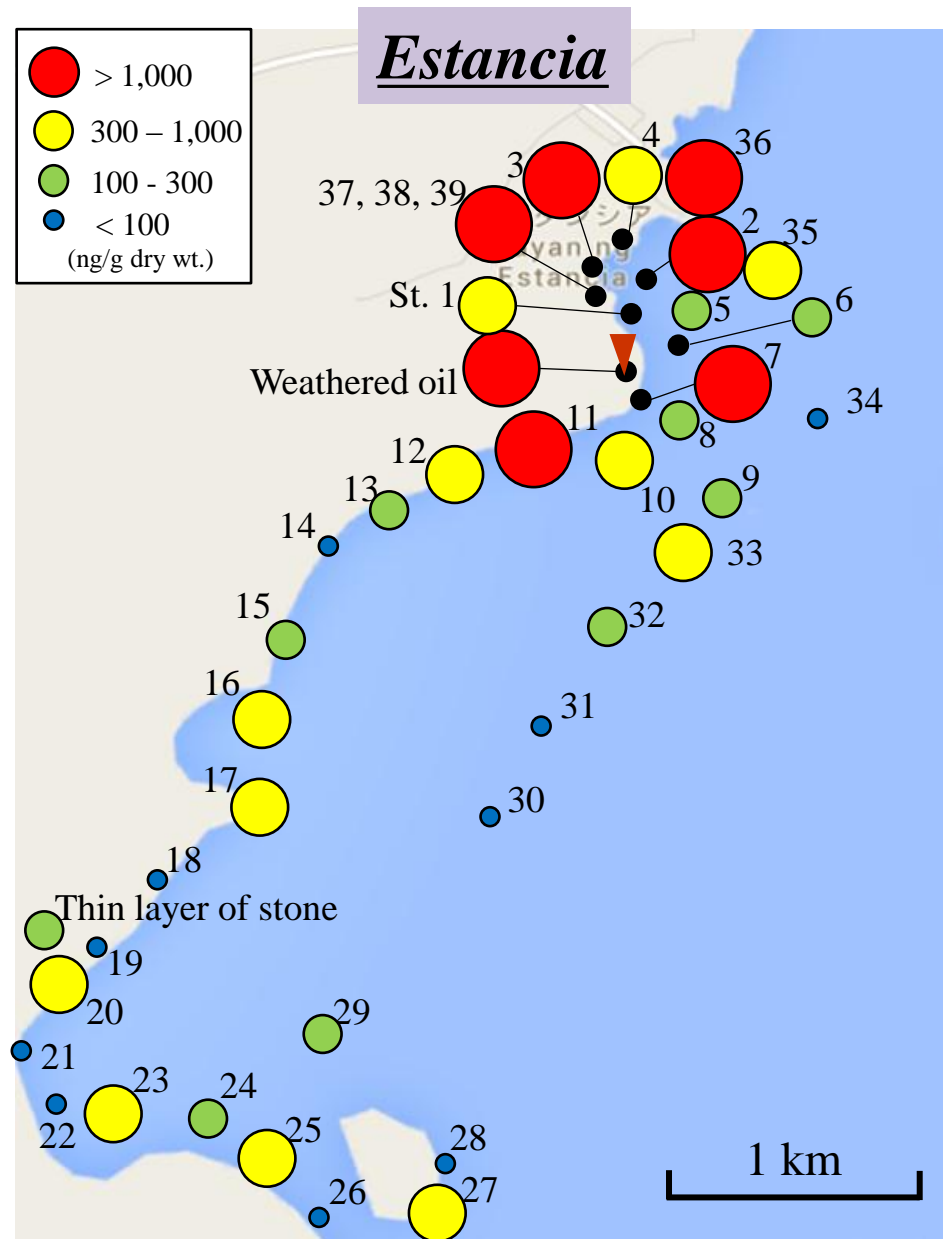
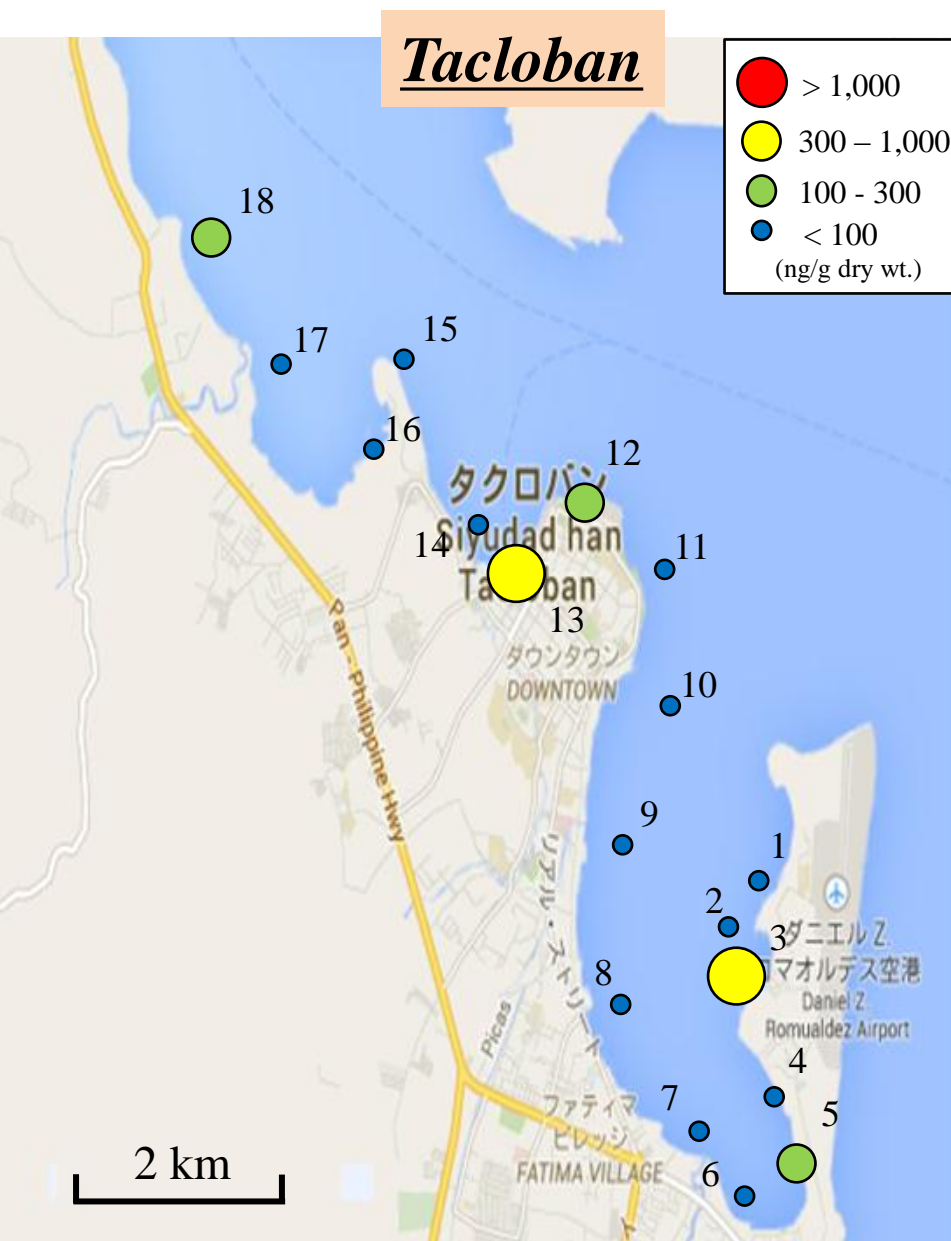


# Concentrations of PAHs in sediments from Tacloban coast





# Comparison of PAHs concentrations in sediments between Tacloban and Estancia



# Heavy metals –Method and analytes

## ■ Sediments ■

Estancia : 39 samples

Tacloban : 18 samples



Dryness and Digestion  
with HF, CCl<sub>4</sub> and HNO<sub>3</sub>



## ■ Marine organism ■

Estancia: Oysters, Blue crabs

Tacloban: Mussels, Blue crabs



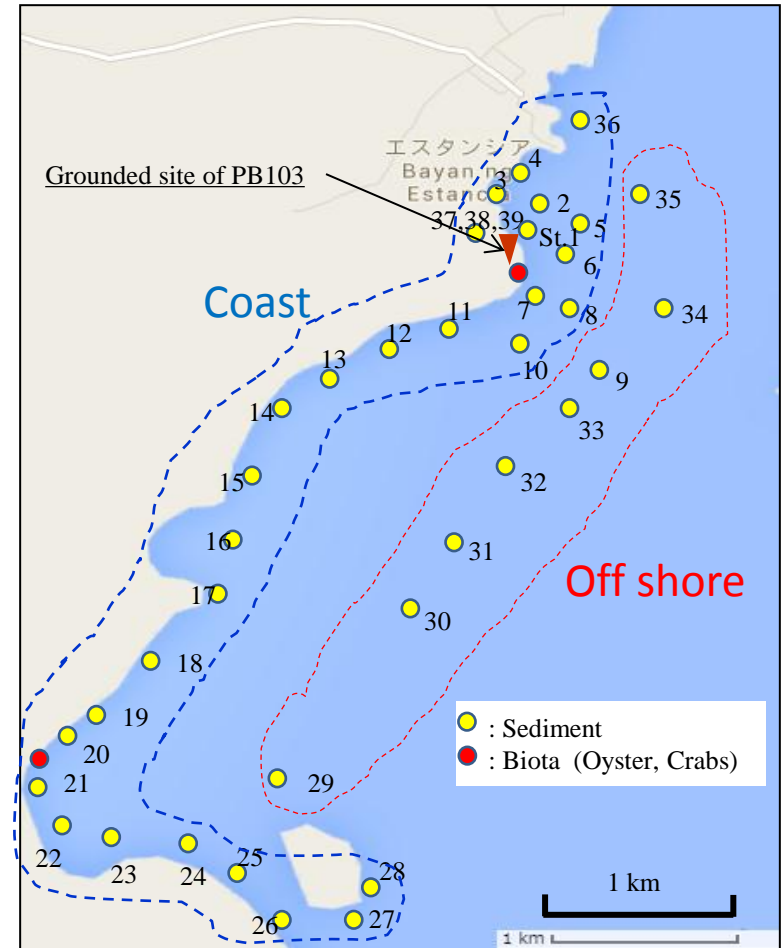
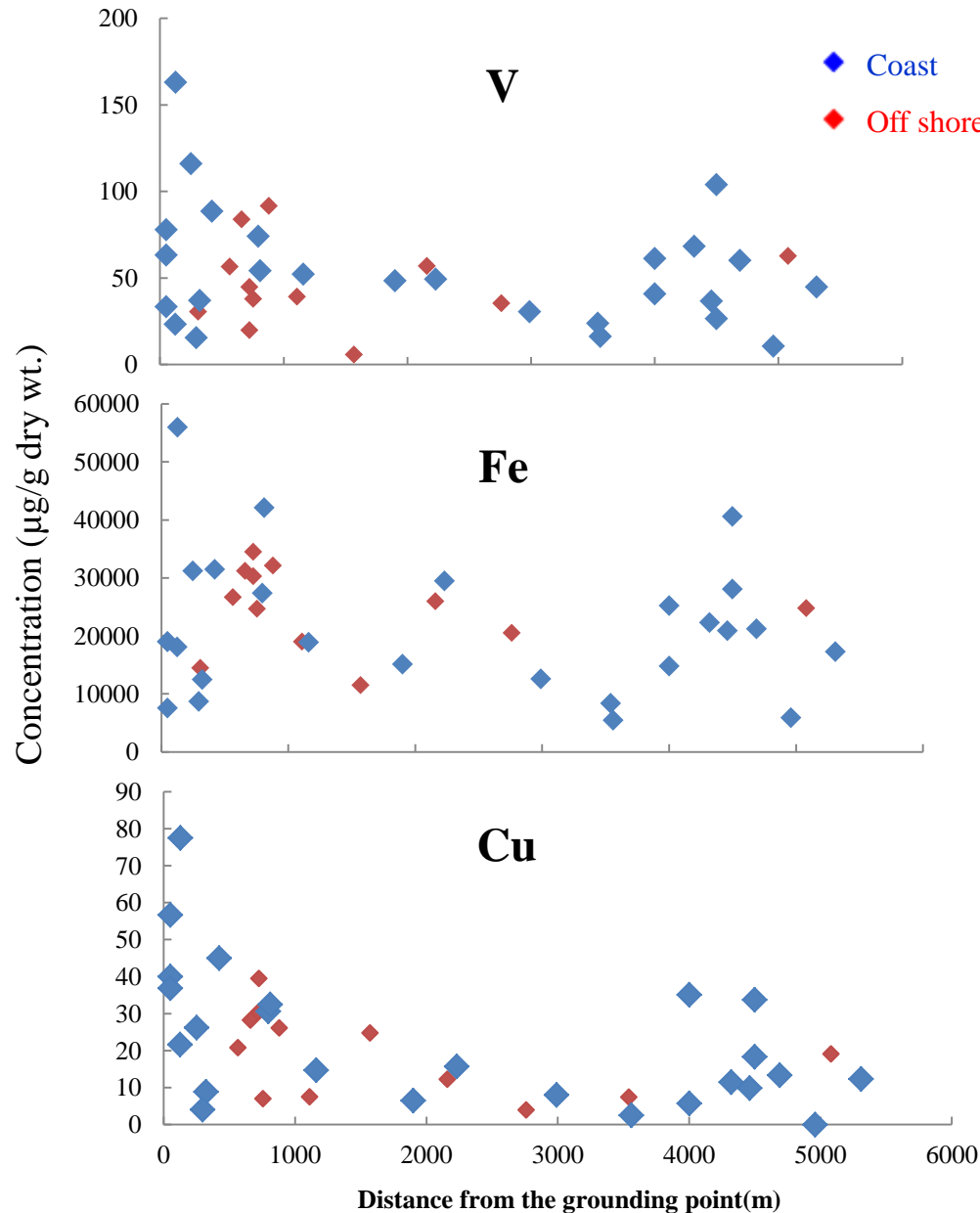
Dryness and Digestion  
with HNO<sub>3</sub>



— ICP-MS (32 elements) —

<sup>7</sup>Li, <sup>23</sup>Na, <sup>24</sup>Mg, <sup>27</sup>Al, <sup>39</sup>K, <sup>43</sup>Ca, <sup>51</sup>V, <sup>52</sup>Cr, <sup>55</sup>Mn, <sup>56</sup>Fe, <sup>59</sup>Co, <sup>60</sup>Ni, <sup>63</sup>Cu,  
<sup>66</sup>Zn, <sup>71</sup>Ga, <sup>75</sup>As, <sup>82</sup>Se, <sup>85</sup>Rb, <sup>88</sup>Sr, <sup>89</sup>Y, <sup>95</sup>Mo, <sup>111</sup>Cd, <sup>115</sup>In, <sup>118</sup>Sn, <sup>121</sup>Sb,  
<sup>133</sup>Cs, <sup>137</sup>Ba, <sup>139</sup>La, <sup>140</sup>Ce, <sup>205</sup>Tl, <sup>208</sup>Pb, <sup>209</sup>Bi

# Concentrations of V, Fe and Cu in sediments from Estancia

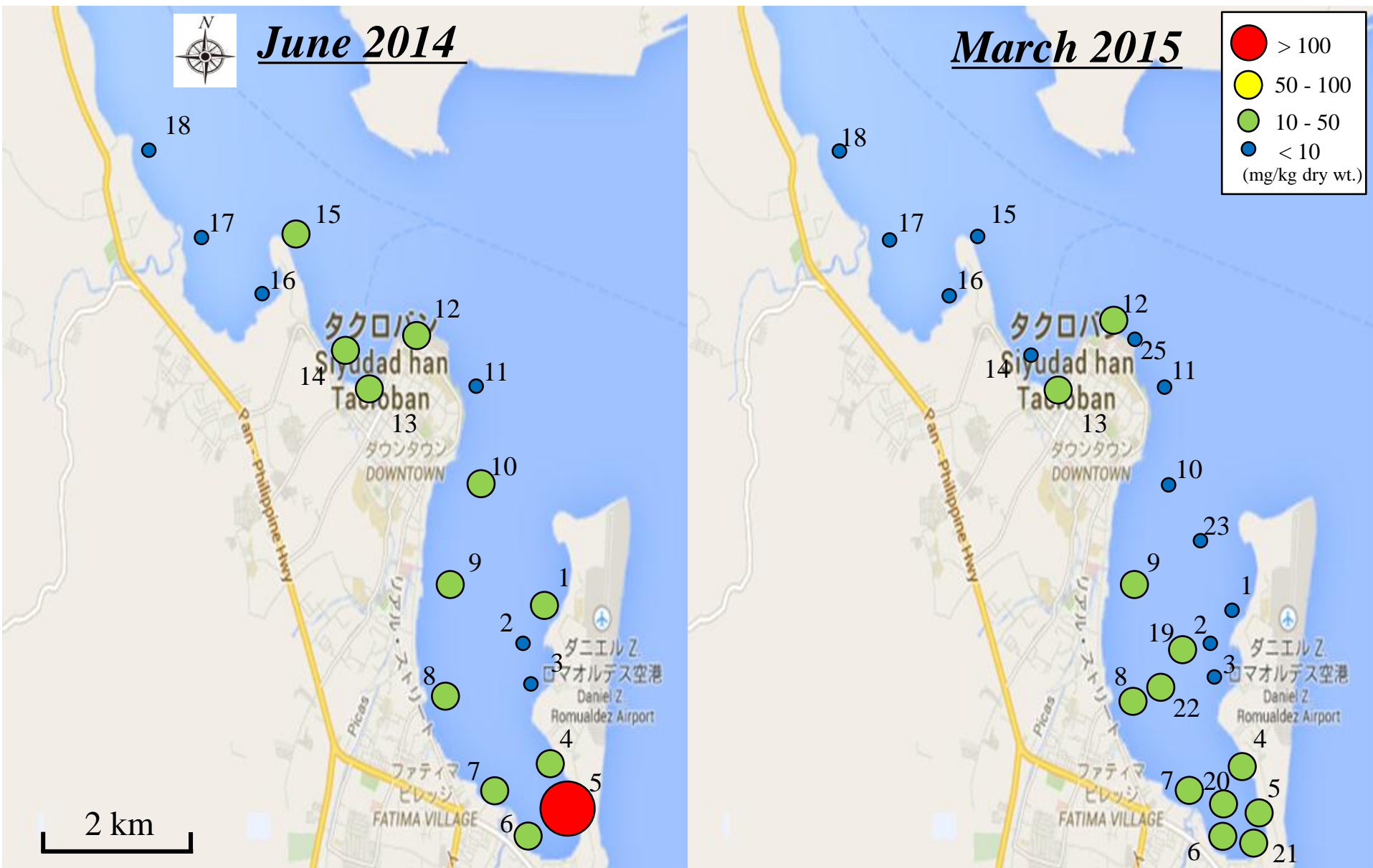


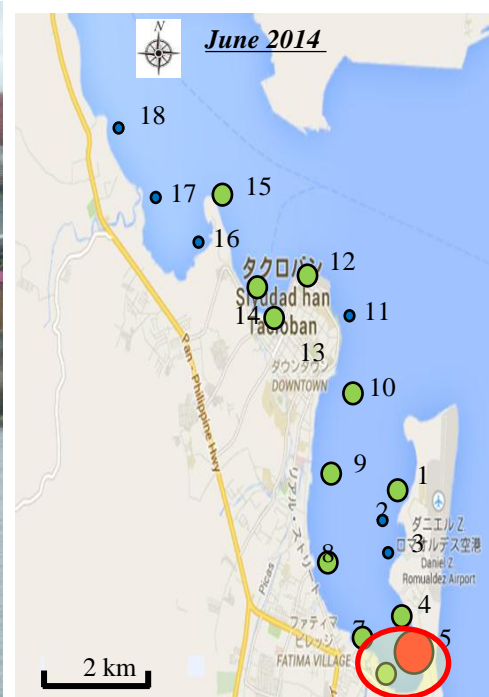
Estancia coast, Panay Island

\*: Long et al. (1995)



# Concentrations of Pb in sediments from Tacloban coast



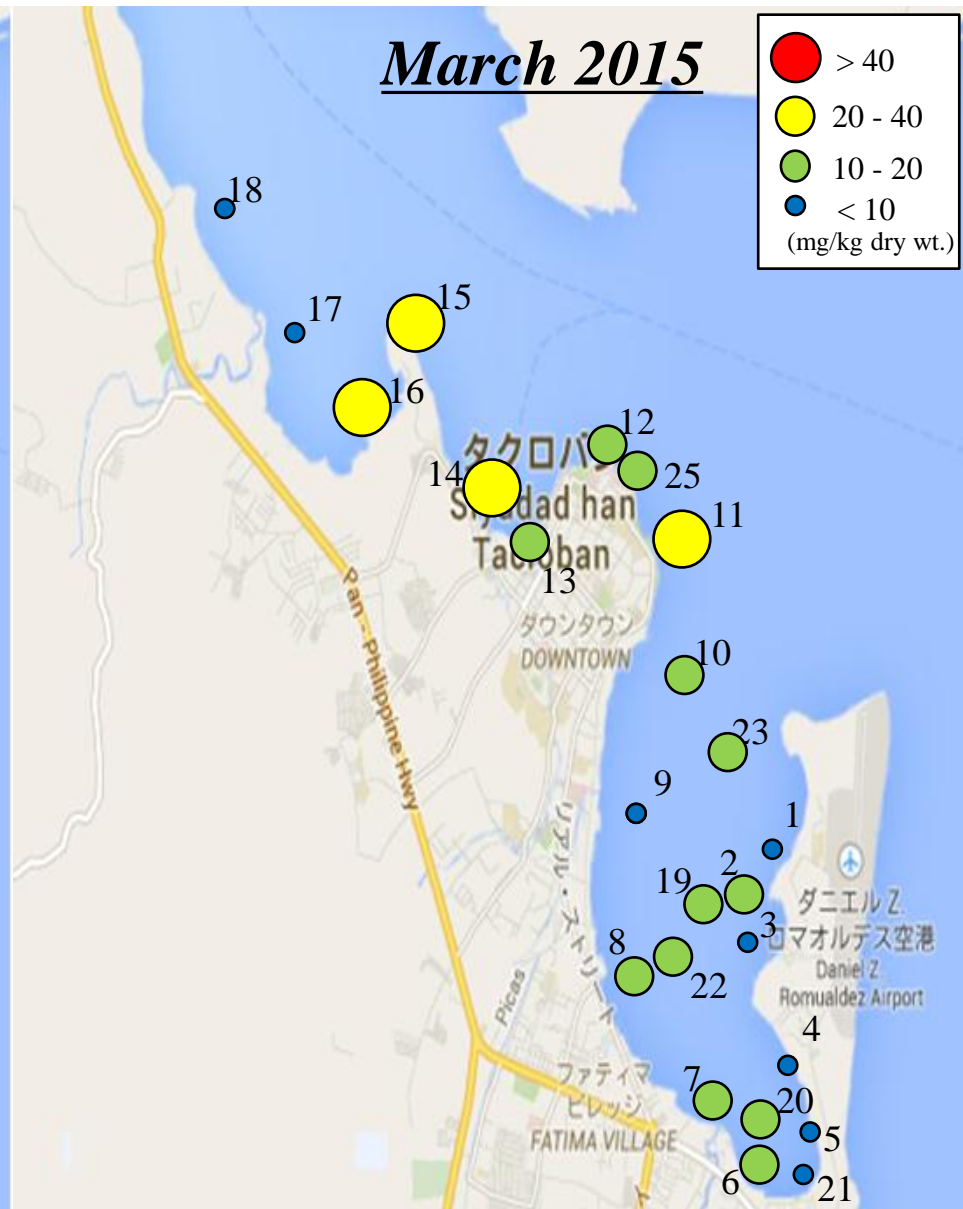
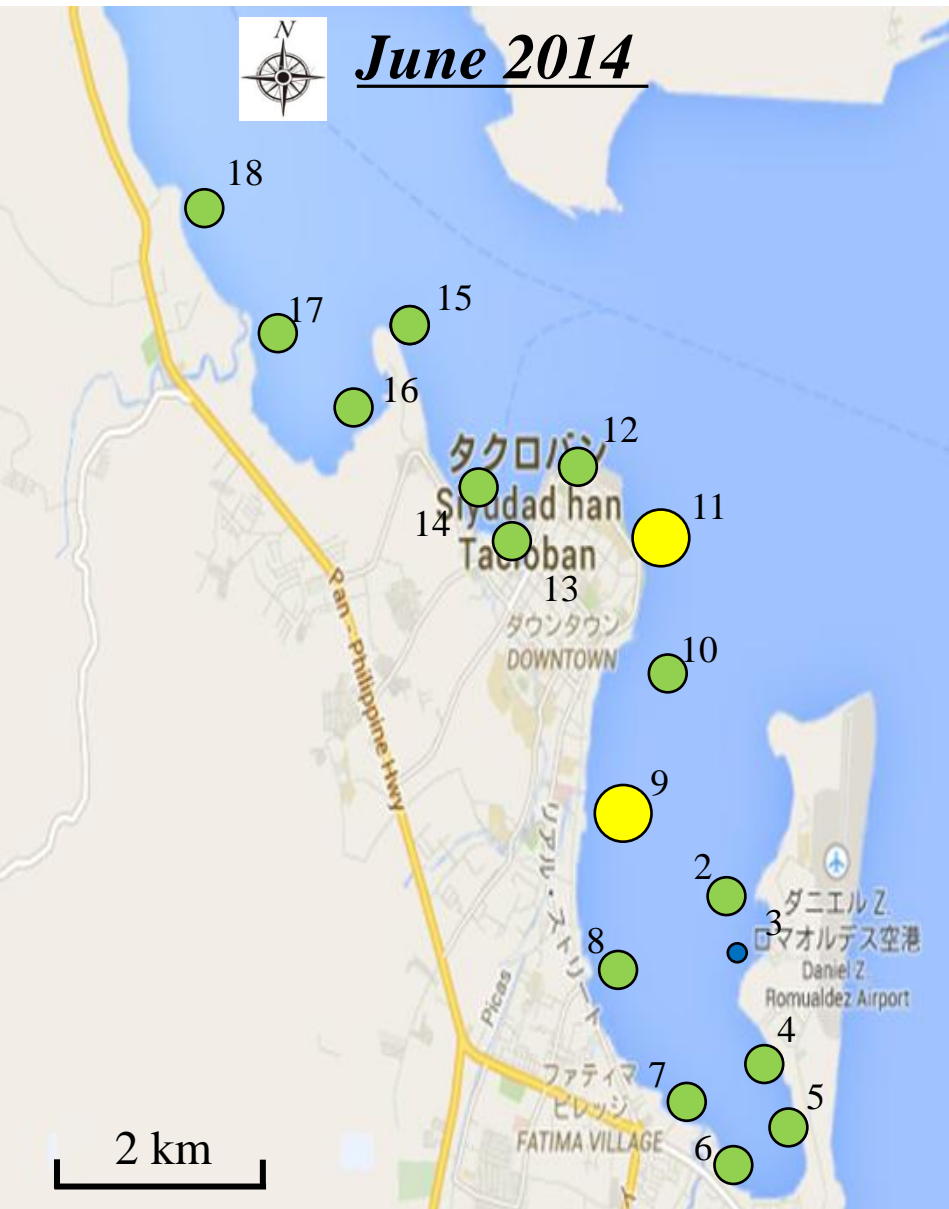


Pictures: Tacloban coast  
(Sts. 4 and 5).  
Mar. 2015.






# Concentrations of As in sediments from Tacloban coast





# Summary

- Significant pollutions of Alk-PAHs and heavy metals, such as V, Fe and Cu, were found in sediments from estancia coastal water, Panay Island, due to the spill of tanker C by *Yolanda* disaster.
- Specific accumulation of Alk-PAHs was identified in oysters from Estancia, implying different profiles of PAHs metabolism among species.

 **Continuous monitoring on PAHs levels is necessary to understand temporal trend of the pollution and to evaluate adverse effects in benthic organisms in the aquatic environment.**

- PAHs and heavy metals concentrations in sediments from Tacloban were relatively low, suggesting less pollution of these compounds.