PICES Press

WINTER 2019
VOL. 27, NO. 1

Newsletter of the North Pacific Marine Science Organization

PICES science in 2018: Notes from the Science Board Chair

Our Earth System is in transition. In 2000, Nobel Laureate, Paul Crutzen, and Eugene Stoermer proposed a new epoch known as the Anthropocene, the human epoch. They claimed that human activities were having a significant impact on climate, geology and ecosystems of the Earth. However, the scientific evidence to distinguish human activities from natural variation were not fully prepared for some parameters at the end of the 20th century which caused a great deal of heated argument from environmental sceptics. Now, 18 years after this proposal was introduced, there is robust evidence of human-induced changes and, unfortunately, the speed of the changes is faster than previously expected for many parameters. In the North Pacific, the biggest-ever heat wave, the Blob, occupied the eastern North Pacific from 2013 to 2016. The Blob induced not only extreme weather in North America but changes in ecosystem components and production, including a massive *Pyrosoma* bloom (see PICES Press pp. 22–27, Vol. 26, No. 1), mass death of sea birds, and decline in fishery production. In the western North Pacific, geographic-scale coral bleaching occurred repeatedly after 1998 due to high sea surface temperatures. Ocean acidification in parallel with the accumulation of atmospheric CO_2 is the other threat to corals and calcifiers. In the Arctic Sea, the area of sea ice cover is decreasing and it is predicted to be ice-free in summer by the 2030s. Microplastic contamination has spread throughout the World oceans, from the Arctic to Antarctic and from the sea-surface to the bottom of deep-water trenches. Many scientists, including myself, are seriously concerned that the tipping point of climate change is approaching.

These anthropogenic forcings are changing the quality and amount of marine ecosystem services on which our society depends. Finding the best way to adapt and/or mitigate these impacts, as well as decelerate the changes, are the most urgent issues for society in the Anthropocene. Scientific organizations are monitoring the status of and providing forecasts for the future of marine ecosystems for a sustainable society. However, understanding the mechanisms of change and forecasting of the future is quite a difficult task since each marine ecosystem has its own components and intrinsic characteristics to respond to single and multiple stressors. Also, the North Pacific and its marginal seas interact with each other and are influenced by the atmosphere and other oceans. In order to respond to the request from society, it is essential to integrate our understanding under an international collaboration scheme.

Workpia Yokohama.

In This Issue

ISSN 1195-2512

The PICES–MAFF-sponsored Project on "*Building capacity for coastal monitoring by local small-scale fishers*" (FishGIS): Mobile phone-based monitoring technology and training workshop

by Shion Takemura, Shigeharu Kogushi, Mark Wells and Mitsutaku Makino

The overall goal of a 3-year (2017–2020) PICES project on "*Building capacity for coastal monitoring by local small-scale fishers"* (FishGIS), funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, is to enhance the capacity of local small-scale fishers to monitor coastal ecosystems and coastal fisheries in Pacific Rim developing countries. Indonesia was chosen as a country to implement the project, and our local counterpart is Prof. Suhendar I. Sachoemar of the Agency for the Assessment and Application of Technology (BPPT) who works in close cooperation with the Ministry of Maritime Affairs and Fisheries (MMAF), Indonesian Institute of Science (LIPI), and local governments of Muara Gembong, Indramayu, and Banten.

Key questions of the project are: a) How do global changes in climate and economy affect coastal ecosystems? and b) How can enhanced capacities for monitoring activities by local fishers help to improve fisheries management in coastal areas? The project is expected to interact with, and support relevant activities of PICES Scientific Committees on Human Dimensions (HD) and Fishery Science (FIS), PICES Technical Committee on Monitoring (MONITOR), and PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Ecosystems) Program (specifically, Research Theme 3 on "How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?"). The project is being directed by the Project Science Team (PST), and all PICES member countries and all above mentioned groups are represented on the PST co-chaired by Drs. Mitsutaku Makino (Fisheries Research and Education Agency, Japan) and Mark Wells (University of Maine, USA).

Mobile-phone-based technology for local fishers

In March 2018, we visited three communities in Indonesia to discuss the concrete design of this project with local people (see Makino and Wells's article, pp. 20–24 in PICES Press, Vol. 26, No. 2, 2018). Based on these discussions, it was decided to introduce new easy-to-use technologies for the local communities to monitor the following 5 items: 1) aspects of water quality (suspended sediments, chlorophyll), 2) phytoplankton community composition, with emphasis on harmful algal bloom (HAB) species, 3) fish landings, 4) illegal fishing vessels, and 5) floating garbage. These items are expected to be monitored by local people (mainly fishers) in close collaboration with Indonesian scientists, as described below.

The water quality assessment application HydroColor (Apple App Store, Google Play Store, Facebook Page) employs a similar methodology as precision radiometers and Ocean Color satellites to estimate three key water quality parameters: turbidity (NTU), suspended particulate matter (g/cm^3), and chlorophyll concentrations (when calibrated). Three images are collected using a smartphone camera (Fig. 1). The first is an 18% photographer's grey card to calibrate the camera, the second is the incoming (sky) radiation, and the third is the light leaving the water surface. The application uses internal GPS, compass, gyroscope, and clock to compute the position of the sun, and with this information it directs the user to hold the smartphone at the correct angles where sun glint off the water surface is minimal and at 135° from the azimuth angle of the sun (Fig. 2). This ensures the image is either taken at 40° (for the water image) or 130° (for the sky image) from nadir.

Fig. 1 Example images of the 18% photographer's grey card (left), the sky (middle), and the water surface (right) collected by a HydroColor user for calculating the remote sensing reflectance (http://misclab.umeoce.maine.edu/research/HydroColor.php).

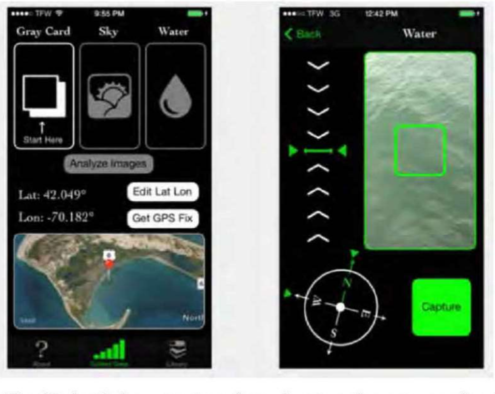

Fig. 2 The HydroColor user interface showing the prompts for the three images: grey card, sky, and water (left). On selecting the image, the screen changes to display the inclinometer and compass to guide the user to the correct smartphone angle to capture the image (right). When the green elements of the compass and inclinometer are properly aligned with the green triangles, the capture button turns green enabling the photo to be taken.

Table 1 The parameters derived by HydroColor along with the estimated uncertainty for each method (http://misclab.umeoce.maine.edu/research/HydroColor.php).

Parameter	**Equation**	**Source**	**Uncertainty**
Remote Sensing Reflectance	$R_{rs} = \frac{L_{water} - 0.028L_{sky}}{\frac{\pi}{0.18}L_{card}}$	Mobley 1999	±15% (mean absolute relative error from figure 4, for all channels)
Turbidity	$Turbidity = \frac{27.7R_{rs}(Red)}{0.05 - R_{rs}(Red)}$	Figure 5	±36% (mean absolute relative error from figure 5)
Suspended Particulate Matter	$log_{10}(SPM) = 1.02log_{10}(Turbidity) - 0.04$	Neukermans et al. 2012	±38% (propagation of error in turbidity and the relationship between turbidity and SPM)
Backscatter Coefficient	$r_{rs} = 0.0949(\frac{b_b}{b_b + a_p + a_w}) + 0.0794(\frac{b_b}{b_b + a_p + a_w})^2$ Solved for b_b assuming constant a_p^*	Gordon et al. 1998	±41% (propagation of error in SPM and R_{rs})

When the incoming radiation is normalized, it is proportional to the water backscattering coefficient and inversely proportional to the water absorption coefficient. Any increase in turbidity then will increase the intensity of light returning from the water. Phytoplankton and other particles containing pigments alter the color emanating from the water, which can be estimated from the ratios of radiance at different wavelengths. Colored dissolved organic matter (CDOM) absorbs light with only negligible scattering, decreasing the intensity of light emanating from water. HydroColor saves the remote sensing reflectance data and estimates of turbidity, suspended particulate matter, and the backscatter coefficient (Table 1) as well as the three images, and these are uploaded to a central server at BPPT when cellphone coverage is strong.

HydroColor provides high technology but simple methodology for accurate measurement of remote sensing reflectance data. It is available for both Android and iPhone products, and has been translated into Indonesian Bahasa for community member use.

The second technology being used in the project aims at collecting phytoplankton community composition data and, in particular, the presence of toxin-producing dinoflagellates. This effort utilizes Foldscopes: origami-based microscopes for the masses (https://www.foldscope.com). Foldscopes are ultra-affordable ($3 USD) durable field microscopes that give remarkably high optical qualities similar to those of standard research microscopes. Foldscopes can provide optical magnifications of 140× with resolutions down to 2 µm. They can be attached to any smartphone, and the camera then can be used to collect still images or videos of swimming phytoplankton, which can be a taxonomic diagnostic. The image quality is remarkably good, and with little training it is possible to obtain high quality images that then are uploaded to a central server. The project is collaborating closely with LIPI which is the central organization responsible for HAB monitoring in Indonesian waters. Initially, images collected by community members will be sent to LIPI staff for manual examination. These communities harvest bivalves from coastal waters for consumption, and LIPI currently lacks the personnel to monitor the presence of toxins or HAB species. The Foldscope program enables LIPI to provide this service to the participating communities.

For monitoring fish landings, the project has developed a new smartphone application software named "FishGIS App" (Fig. 3). Using this software, local fishers can take photos of their catch with additional information such as location, gear used, species, and catch trends (size and amount). This information will be then used for the preliminary stock assessment by local fisheries researchers, and shared with the local community.

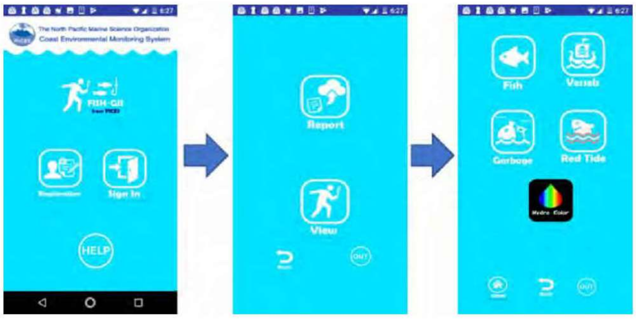

Fig. 3 The FishGIS App user interfaces: user registration (left), top menu (center), and monitoring items (right).

The local fishers follow fisheries rules such as national laws, local regulations, traditional norms, religious taboos, *etc*. However, illegal or unregulated vessels sometimes violate such rules. The FishGIS App can be used to take a photo and record the date and location of such vessels, and share this information with the local community and governmental authorities. Another very serious problem for coastal communities is floating garbage, and the FishGIS App can also be used to record the abundance and location of garbage to enable clean-up as well as to monitor changing community practices.

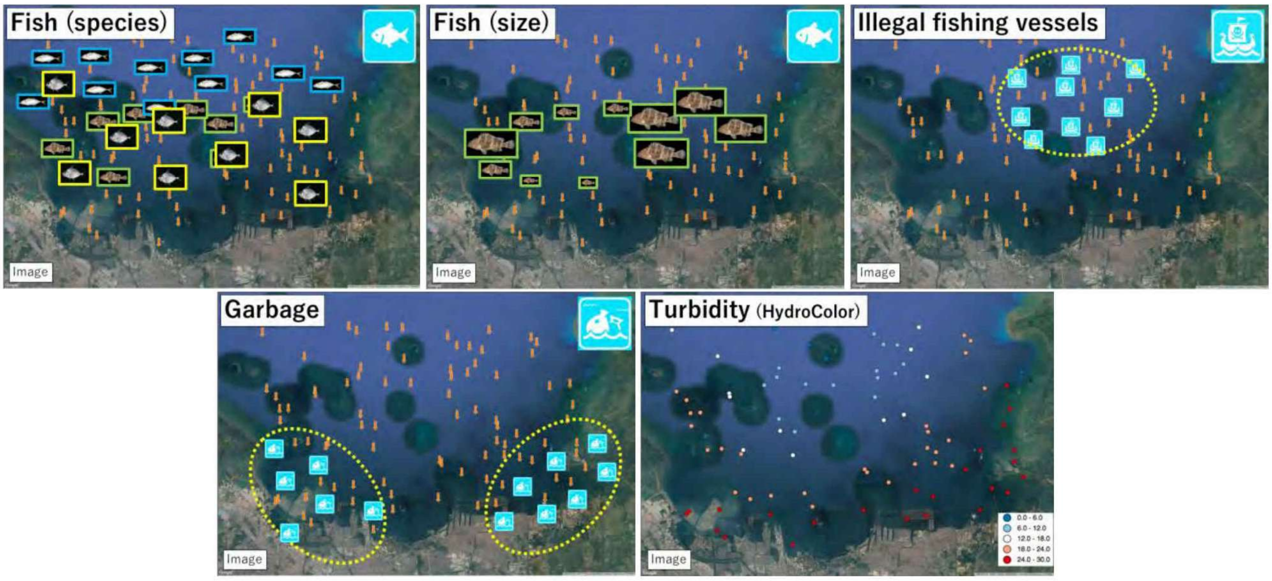

Fig. 4 FishGIS App maps: the fish, catch trends (size and amount), illegal fishing vessels, floating garage, and turbidity by HydroColor.

All the monitoring results, from water quality to garbage, are shown on a map provided by the FishGIS App (Fig. 4). Using this application, local fishers will be able to keep track of the coastal environmental conditions and share that information in their communities.

Training workshop for the community

On July 10–12, 2018, PICES and BPPT, with support from MMAF and LIPI, conducted a training workshop in Jakarta on the new technologies described above (Fig. 5). Overall, more than 100 participants (fishers, community leaders, local government officers, *etc.*) from Muara Gembong, Indramayu, and Banten attended the workshop where they learned how to install and practice HydroColor and FishGIS applications. Also noteworthy is that two scientists from LIPI who gave lectures on HABs at this forum were the trainees of the past PICES MAFF-funded project entitled "*Development of prevention systems for harmful organisms' expansion in the Pacific Rim*" (2007–2012).

We believe the reason the community members showed such strong interest during the 3 days of training was due to us laying the groundwork by holding community meetings in March 2018 to understand the local needs and issues (see Makino and Wells' article, pp. 20–24 in PICES Press, Vol. 26, No. 2, 2018), and then developing a training course based on those needs and issues. We were gratified that they were all very willing and enthusiastic to contribute to the project. The participants were deeply interested and expressed lots of excitement when they were able to view images of phytoplankton on their own mobile phone with Foldscope. Some of them also took additional training on the use of plankton nets.

At the last session of the workshop, very productive discussions were held among community members, central and local government officers, researchers, and PICES experts. For example, it was decided to develop simple guidelines for using the applications in the local languages. Part of the design would be a YouTube movie performed by local community members. It was also found that the OS version of many of participants' mobile phones was too old, and the applications could not be installed. For those phones, down-graded versions of the applications need to be developed. Some people who successfully downloaded

Fig. 5 Training workshop in Jakarta: community members investigate the Foldscope (left) and smartphone applications (middle), and take part in very productive discussions (right).

(continued on page 26)