Trial application of the **Screening procedure** of the **NOWPAP Common Procedure** and WebGIS activity of CEARAC

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1.Background

- NOWPAP CEARAC developed Procedures for the assessment of the eutrophication status including evaluation of land-based sources of nutrients for the NOWPAP region (the NOWPAP Common Procedure)
- Procedure was used to assess the eutrophication status in the selected sea areas in the member states, and results have been published in 2011 as “Integrated Report on Eutrophication Assessment in Selected Sea Areas in the NOWPAP Region: Evaluation of the NOWPAP Common Procedure”.
- After that the NOWPAP Common Procedure was refined and re-applied to selected sea areas in the NOWPAP region.
- Two steps scheme was suggested to assess the eutrophication status: **Screening Procedure** (initial diagnosis) to detect symptoms of eutrophication with the minimum required parameters; and **Comprehensive Procedure** (second diagnosis) to assess the status and possible causes of eutrophication.
- CEARAC has proposed a new project for the 2014-15 biennium to apply the **Screening Procedure** to the entire NOWPAP sea area for the identification of the potential eutrophic zones which require application of the NOWPAP Comprehensive Procedure.

2. Implementation

The MoU has been signed for the collection and analysis of the data for the Russian part of the NOWPAP sea area on the following tasks:

3. Tasks

3.1. Collection and analysis of data on COD (or TOC) trend

3.2. Collection of data of occurrences of red tides and hypoxia

3.3. Evaluation of satellite chlorophyll-*a* (Chl-*a*)

3.4. Preparing brief summaries of potential eutrophic zones in Russia

Collection and analysis of data on COD (or TOC) trend (1)

- There are two state organizations which proceed environmental monitoring within Russian part of the NOWPAP area and provide the storage of the information observed: 1) Prymorsky Center on Hydrometeorology and Environmental Monitoring (PCHEM) with main goal to carry out environmental monitoring of atmosphere, hydrosphere and soils, and

2) Far Eastern Regional Hydrometeorological Research Institute (FERHRI) with main goals to develop the methods of monitoring systems, and modeling for forecasting of environmental changes.

- The Annual Reports of the State Oceanographic Institute (SOI), which are available in open access, give general information about contaminations and ecological status of the coastal waters around Russia.

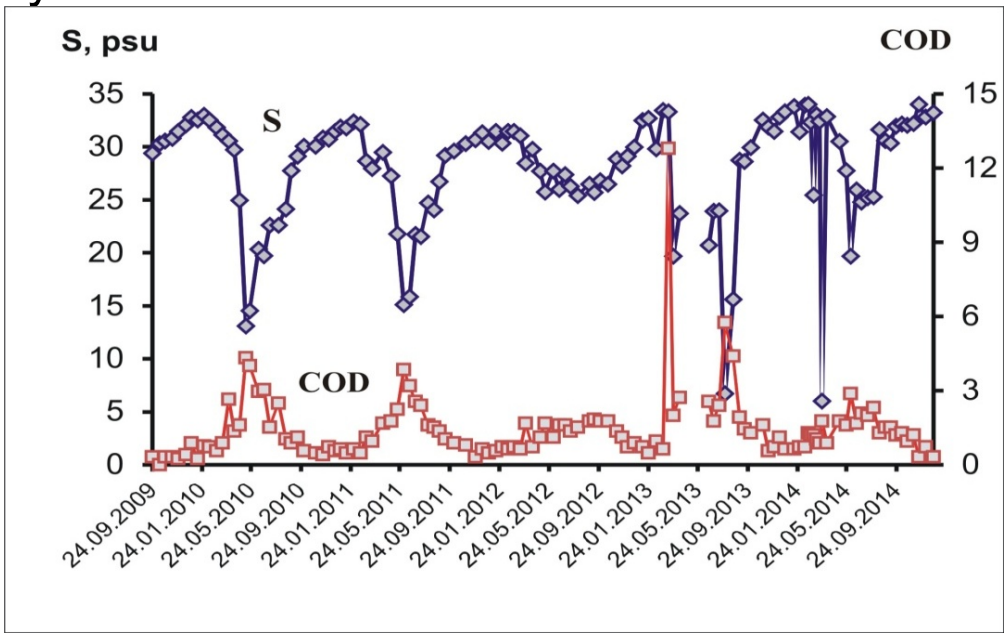
- Unfortunately, the COD parameter is not used for the characteristic of organic substances in the seawaters at the state monitoring network in Russia.

- The methods for the determination of COD in the fresh waters are similar in all NOWPAP countries: oxidation by moderately strong $KMnO_4$ (permanganate) or strong $K_2Cr_2O_7$ (bichromate) acid oxidative reagents.

- However, in seawater, the oxidation by $KMnO_4$ is only method for the COD determination in saline waters approved in the state monitoring systems of China, Japan and ROK, but not of Russia. **Therefore, it is impossible to present the database on COD in the seawater at the Russian part of the NOWPAP region**.

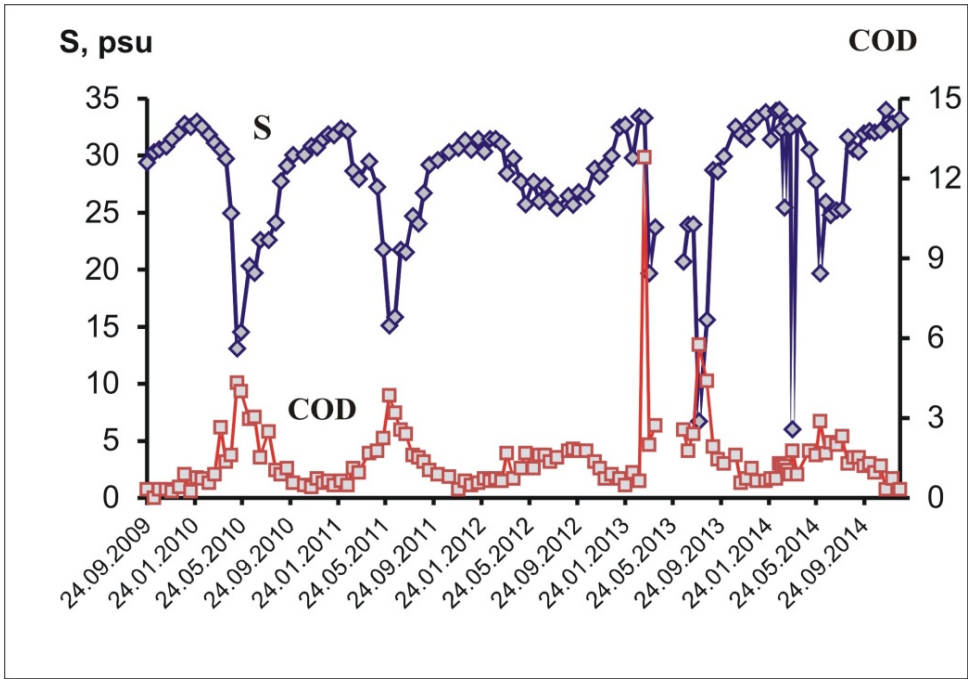
Collection and analysis of data on COD (or TOC) trend (2)

- There are some restricted data on COD in coastal waters obtained at the scientific investigations carried out by the universities and research institutes. Most of this data deal with spatial distribution of COD during the limited time span or at the short time scale (diurnal) experiments.
- There is restricted time series at the coastal waters of the Amursky Bay (43°11′58″N, 131°55′09″E) where COD_{Mn} along with nutrients were measured twice per mouth last 5 years.
- The distinct seasonal changes of COD parameter was characterized by the dominance of maximum COD (3.8-6.1 mg O_2/L) in May and June, which coincided with the minimum of salinity



Collection and analysis of data on COD (or TOC) trend (3)

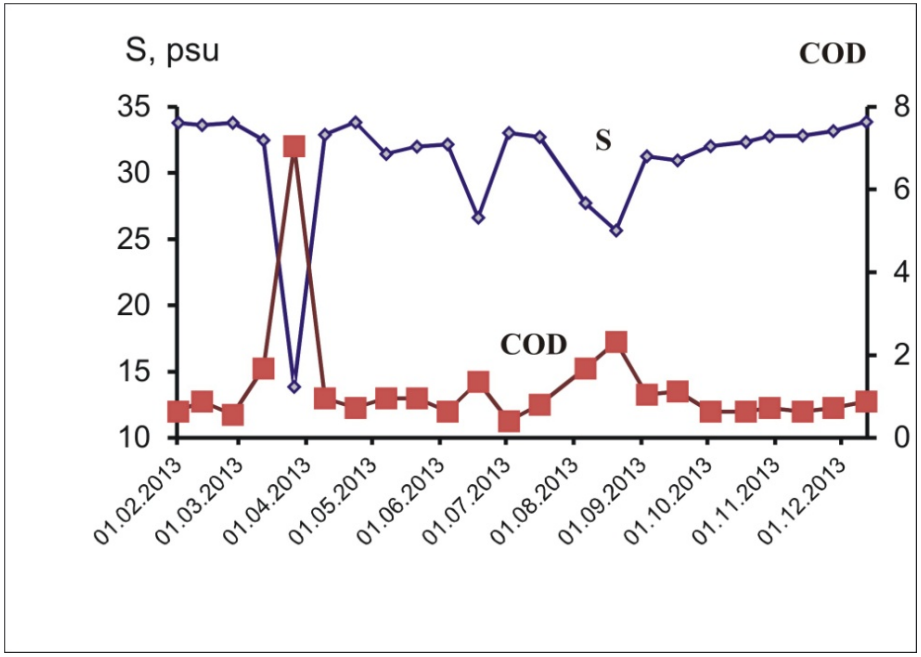
- Runoff from the land is a main factor controlling the seasonal variability of the concentration of dissolved organic matter in coastal waters.
- Against this background, the influence of biogeochemical factors was recorded – mass development of flagellates and their decay in late March, and diatoms in late July was accompanied by increase in COD up to 13 and 4 mg O_2/L, respectively.
- In autumn and winter, the COD value did not exceed 0.5-1.0 mg O_2/L even in the semi enclosed and anthropogenically loaded Amursky Bay.



- **Water quality criteria for COD in sea waters are the same in China and Japan, and are equal to 2 mg O_2/L for the most valuable and protected waters, and 3 mg O_2/L for the next grade of waters.**

- Amursky Bay could be characterized as having high quality: only 12-24% of the samples with diminished salinity had COD > 2 mg O_2/L, and only single samples at the decay of the phytoplankton bloom had COD > 4 mg O_2/L.

Collection and analysis of data on COD (or TOC) trend (4)



- In the middle seaward part of the Amursky Bay (43º00'27"–43º01'50"N, 131º54'20"–131º55'51"E) COD level continues to show significant seasonal variability with common level 0.4-0.7 mgO_2/L, and elevation up to 1.4-2.1 mgO_2/L at the summer increase of land based runoff.
- Against this background the sharp short term rise of COD up to 7 mgO_2/L has observed in March similar to the inner part of Amursky Bay at the finish of non-diatom phytoplankton bloom.
- Water quality by the COD parameter in the middle part of the Amursky Bay is quite good, the only elevated short time increase was observed in the end of March due to decay of non-diatom phytoplankton bloom.

Collection and analysis of data on COD (or TOC) trend (5)

- Scarcity and the short length of the time series on COD parameter in the Amursky Bay (Peter the Great Bay) area restrict the applicability of this part of trial procedure for the assessment of eutrophication. The Mann-Kendall test has been applied to the only time series of COD in the north part of the Amursky Bay in 2010-2014 (5 years), and no trend has been observed (Annex 1). The length of time series was not enough for the Sen's slope estimation.
- TOC and DOC parameters obtained by the Shimadzu or similar analyzer are widely used in the scientific research in Russia, but not in the routine monitoring.
- There are some data on TOC and DOC spatial distribution or their changes along some natural gradients (salinity, depth, hydrometeorological conditions etc.), but rather long time series of TOC/DOC in the Russian part of the NOWPAP area are absent.

Collection of data of occurrences of red tides and hypoxia (1)

- Information on occurrences of red tides in the NOWPAP sea area in Russia was collected in accordance with unified formats provided by CEARAC.
- Harmful algal monitoring was carried out during 2004-2015 in Russian zone of NOWPAP by the Center for Monitoring of Harmful Algal Blooms and Biotoxicity, Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Sciences (www.imb.dvo.ru/misc/toxicalgae/index.htm).
- Cases of human poisoning or losses in the aquaculture industry due to harmful algal blooms were not recorded.
- The greatest numbers of HABs in the Russian waters are caused by dinoflagellate. *Noctiluca scintillans* is one of the most common species (Orlova, 2014). In the past 10 years, it has caused most of the visible red tides recorded in this area. The density of *Noctiluca scintillans* reached hundreds of thousand cells per liter, and the water surface was colored bright red-orange.

Collection of data of occurrences of habs and hypoxia (2)

- In the past 10 years, raphidophyte blooms have been observed in Russian waters. Short-lived outbreaks of *H. akashiwo* were recorded in Peter the Great Bay in 2004-2006, 2009, 2010, 2014 (Orlova et al., 2014).
- Red tide, caused by toxic diatom *Pseudo-nitzschia calliantha* was observed in November, 2004 in Amurskii Bay (Orlova, 2014).
- Potentially toxic epiphytic dinoflagellate *Ostreopsis cf. ovata* can form a significant aggregation on macrophytes from the coastal zone of Peter the Greta Bay (Selina et al., 2014).
- The list of publications on the HABs issues (49) and list of the registered HABs events in the Russian part of the NOWPAP area (16) are presented in the Annex 1 and 2.

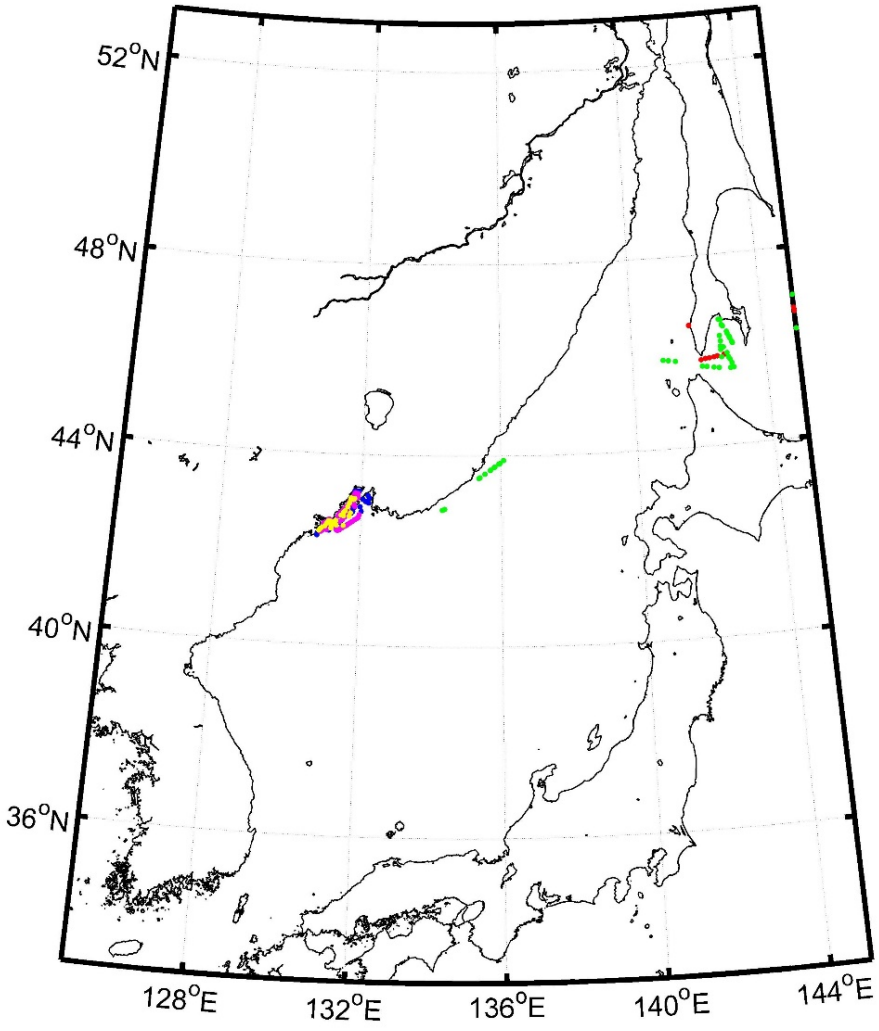
Collection of data of occurrences of red tides and hypoxia (3)

- Regarding hypoxia, all past publications about occurrences of seasonal hypoxia in the Russian part of NOWPAP area were collected as much as possible (11) and presented in Annex 3.
- List of the recorded hypoxia events includes 6 happenings.
- There is obvious and significant increase of the research and publications on the hypoxia issues within the Russian coastal waters of NOWPAP region.
- It is difficult to distinguish the contribution to such increase due to research intensification, and real trend of the hypoxia events caused by the changes of environmental factors.
- For the time being the seasonal hypoxia is registered every summer from 2005 in the north part of the Amursky Bay.
- In August 2013 seasonal hypoxia has been observed in the southwestern part of Peter the Great Bay within the borders of Far Eastern Marine Reserve.
- Seasonal hypoxia has been detected in September 2014 in the upper part of Razdolnaya River estuary at the diminished river runoff, and elevated flushing time.

Collection of data of occurrences of red tides and hypoxia (4)

- The damage from the seasonal hypoxia in Russia is restricted due to the limited scale of the fishing activity within even most developed Peter the Great Bay.
- It can be assumed that in other less populated and developed Russian coastal areas within NOWPAP region the socio-economical influence of possible seasonal hypoxia events will be negligible.
- At the same time the absence or small scale of the anthropogenic influence give the opportunity to use the occurrence and characteristics of seasonal hypoxia in the region as an indicator of regional or even global changes.

Evaluation of satellite chlorophyll-*a* (Chl-*a*)



- For the time being we have collected Chl”a” data obtained at the northwestern part of the NOWPAP sea area by the radiometer on the OS-2 algorithm from the small boat.
- This data is characterized by the absence of the atmosphere biases in comparison with regular remote sensing We have data set for September 2009, August 2010, October 2010, September 2013 and September 2014 (Annex 4)
- Besides there is time series of in-situ Chl”a” data obtained from acetone extracts of suspended solids at the coastal long-lasting station in the northeastern part of Amursky Bay (43°11′58″N, 131°55′09″E)

Brief summaries of potential eutrophic zones in Russian part of NOWPAP area (in terms of their distinguishing by screening procedure**)**

- There is obvious scarcity of the reliable time series of COD because this parameter is not used for the characteristic of water quality at the state monitoring of sea areas in Russia;
- Existing time series of COD have duration no more than 5 years and demonstrate strong seasonal variability due to land based inputs through river and surface runoff, and intra system processes of phytoplankton destruction;
- Elevated COD exceeding most strict criteria 2 mgO_2/L takes place only at the above mentioned short time periods do not covered more than 20-24% of year;
- The total phosphorus (TP) and total nitrogen (TN) could be a proxy of organic substances concentration in the coastal sea waters, and there are some time series of TP and TN for the different parts of Peter the Great Bay for the 2004-2013 period;
- **Due to scarcity of data the time series on COD, and TOC/DOC, and TP/TN could be only supplementary tool at the assessment of eutropication status within Russian part of the NOWPAP region.**
- Existing data though are limited do not indicate significant worsening of the water status within Russian part of the NOWPAP region

Brief summaries of potential eutrophic zones in Russian part of NOWPAP area (in terms of their distinguishing by screening procedure**)**

- The number and features of HAB and hypoxia events are rather direct indicators of the eutrophic status, but strongly depend on the research efforts and development level of the aquaculture and fishing industry in the areas of interest;
- Peter the Great Bay continues to be the most intensively used sea area within Russian part of the NOWPAP region, and increased number of the hypoxia events is observed here;
- The new potentially harmful microalgae blooms are registered in Peter the Great Bay as well;
- It is impossible to distinguish the real trend in these indicators from the result of research efforts;
- The use of remote sensing data to assess the chlorophyll “a” level in the different sea areas seems the most promising first step instrument to select potentially eutrophic zones taking into account the affinity of these areas to the estuarine zones where satellite data need to be checked;
- The comparison of situation between less controlled and exploited Russian coastal sea areas and more intensively used and studied sea areas of other NOWPAP states gives opportunity to distinguish the influence of different controlling factors and has mutual interest.

Comments to WebGIS

- For the time being WebGIS is a visualization of the collected data bases: a) eutrophication assessments; b)COD, c) HAB events, d)hypoxia events, e) Chl “a” composites for the east and west parts of NOWPAP area;
- (a)?, (b), (c) and (d) data are temporally distributed, though (e) is just 2 multiyear composites (?)
- Some corrections are needed in the location of some symbols
- Some corrections could be made in size of symbols (green – smaller, red – bigger)

Future development could be connected with transformation of existed WebGIS from visualization of collected data bases to the analysis tool:

- temporal and spatial variability of (b), (c), (d)
- analysis of multiyear variability of COD
- composites for typical periods of possible HABs

Thank you for attention!