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## Background

This document contains the draft monitoring guidelines for water transparency (Secchi dept) submitted by Lead Country Finland.

The draft has been reviewed by representatives from Finland, Germany, Poland and Sweden.

## Action requested

The Meeting is invited to:

– comment and amend the draft guidelines as needed.

# A template for HELCOM monitoring guidelines
# TURBIDITY

Mika Raateoja, SYKE, 7.10.2016

## 1. Background

### 1.1 Introduction

Water transparency serves as an index for the trophic state of a water body. It reflects eutrophication through changes in the phytoplankton abundance; increase in the ambient nutrient status in the water leads to higher phytoplankton biomass that diminishes the propagation of light in the water.

Water transparency is dependent of the amounts of chromophoric dissolved organic matter (CDOM) as well as of total suspended solids (i.e., organic and inorganic particles) in the water. Being unaffected by CDOM, turbidity estimates the impact of light scattering due to particles on the level of light attenuation in the water column.

Organic particles are mainly autochthonous (phytoplankton, zooplankton, bacterial cells) and thus are related to the trophic state whereas inorganic particles are largely allochthonous (e.g., sediments). This source of error has to be taken into consideration whenever eutrophication status is assessed using turbidity in the Baltic Sea that is optically classified as a Case II water body (Morel and Prieur 1977), i.e., the body where concentrations of colour producing substances (e.g. phytoplankton, inorganic particles and CDOM) vary independently from each other. For turbidity, this feature is emphasized in coastal areas subject to fluvial impact. The representativeness of turbidity as an eutrophication metrics increases towards offshore areas; here, an increasing share of particles causing turbidity is of autochthonous origin. This has been utilized in Ferrybox systems in the ship-of-opportunity (SOOP) approach and earth observation (EO) products.

The scope of this guideline is turbidity measured with bench turbidity meters in a laboratory, with turbidity sensors in the SOOP systems, and with EO.

### 1.2 Purpose and aims

The purpose for turbidity monitoring is to describe spatiotemporal trends in water transparency.

Turbidity provides information of water transparency that can be a direct effect of eutrophication (with certain limitations shown above). It is thus an element of eutrophication monitoring, although only as a supporting parameter.

## 2. Monitoring methods

### 2.1 Monitoring features

Turbidity is expressed in a formazine nephelometric unit (FNU; measurement of diffuse radiation, applicable to water of low turbidity). It measures the radiation back scatter introduced by the total suspended solid content of the sample water to the scatter caused by the formazine polymer suspension of known concentration. The FNU is measured with an infrared light source.

### 2.2 Time and area

Turbidity measurement, probing radiation back scatter that is an inherent optical property of the water, can be done all year round. However, to supplement eutrophication monitoring, it should be monitored during the period of significant biological activity.

Turbidity monitoring is carried out by a number of HELCOM contracting parties, and the monitored area covers the entire Baltic Sea area, both the open sea and coastal areas.

#this part lacks information from the contracting parties# FI employs EO for turbidity mapping in April–October. EO-based turbidity is calculated with 300-m ground resolution for the entire Baltic Sea – both the open sea and coastal areas – excluding the westernmost parts.

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## 2.3 Monitoring procedure

### 2.3.1 Monitoring strategy

Diffuse radiation technique is the only quantitative method applicable to natural waters of low turbidity.

### 2.3.2 Measuring method(s) and equipment

Turbidity of water is measured quantitatively by diffuse radiation using turbidity meters according to guidelines of ISO 7027-1 standard.

### 2.3.3 Sample handling and analysis

Turbidity of water is measured against the instrument calibration curve from individual water samples, from the flow-through water in the Ferrybox systems, or in *in situ* in the water column. Before starting the measurements, the instrument has to be calibrated according to the manufacturer's calibration instructions. A measurement is performed on a well-mixed sample in accordance with the manufacturer's instructions. The turbidity value is interpreted from the calibration curve or directly from the instrument scale, if the scale has been verified by calibration.

EO collects information from the upper layer of the surface water, depending on the transparency of the water. The analysis of turbidity via EO instruments is based on reflectance from water and scattering of light from particles.

## 2.4 Data analysis

No calculations or conversions required.

#this part lacks information from the contracting parties# For FI, ENVISAT/MERIS turbidity products were determined with C2R processor using processing steps for calculating turbidity by Attila et al. (2013).

## 3. Data reporting and storage

The results are included in the station data, stored by the contracting parties, and reported annually to the COMBINE database hosted by ICES. #this part lacks information from the contracting parties# For FI, EO turbidity data archives are available at SYKE.

Depending on the magnitude of a turbidity value, the results are reported as follows:

- turbidity < 0.99 FNU; report to the nearest 0.01 FNU
- 1.0 < turbidity < 9.9 FNU; report to the nearest 0.1 FNU
- 10 < turbidity < 40 FNU; report to the nearest 1 FNU.

## 4. Quality control

## 4.1 Quality control of methods

Laboratories carrying out turbidity analyses should have established a quality management system according to EN ISO/IEC 17025 standard.

A turbidity meter and a turbidity sensor are calibrated at constant intervals against a dilution series of a traceable commercial standard.

In a laboratory premises, the daily quality control is carried out by commercial gel control samples producing data for X-bar charts. Alternatively, a secondary standard suspension can be used as a daily calibration check, being monitored periodically for deterioration using one of the primary standards.

Repeatability of the measurement is inspected by replicate measurements amongst the sample series.

#this part lacks information from the contracting parties# For FI, EO estimation of turbidity is done via automated processing that undergoes quality check before archiving and distribution (Attila et al. 2013, 2016). Automated cloud mask is visually confirmed and complemented manually if necessary.

### 4.2 Quality control of data and reporting

For general data reporting guidelines, see HELCOM (2015).

Measurement uncertainty should be estimated using ISO 11352 standard. Estimation should be based on within-laboratory reproducibility, data from proficiency testings, and internal / commercial reference material.

Data must be flagged if normal QA routines or recommended storage conditions cannot be followed.

## 5. Contacts and references

### 5.1 Contact persons

Mika Raateoja, Finnish Environment Institute

Jukka Seppälä, Finnish Environment Institute

Jenni Attila, Finnish Environment Institute

### 5.2 References

Attila J, Koponen S, Kallio K, Lindfors A, Kaitala S, Ylöstalo P (2013). MERIS Case II water processor comparison on coastal sites of the northern Baltic Sea. Remote Sensing of Environment 128: 138-149.

Attila J. et al.  (2016). Chlorophyll-a assessment of coastal WFD water bodies using MERIS and OLCI instruments. Manuscript.

EN ISO/IEC 17025*: General requirements for the competence of testing and calibration laboratories

HELCOM (2015). Eutrophication Assessment Manual, Annex 3A. http://www.helcom.fi/helcom-at-work/projects/eutro-oper/. Last revision in 2015.

ISO 11352*: Water quality – Estimation of measurement uncertainty based on validation and quality control data

ISO 7027-1*: Water quality - Determination of turbidity - Part 1: Quantitative methods.

Morel A, Prieur L (1977). Analysis of variations in ocean color. Limnology and oceanography 22: 709-722.

* For undated references, the latest edition of the referenced document (including any amendments) applies

### 5.3 Additional literature