

## C-10: Biochemical oxygen demand (BOD) and concentration of ammonium in rivers

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## 1) General description

### 1.1) *Brief definition*

The level of oxygen concentration in water bodies, expressed as biochemical oxygen demand (BOD)—which is the amount of dissolved oxygen required for the aerobic decomposition of organic matter present in water—and the level of concentrations of ammonium (NH<sub>4</sub>/N-NH<sub>4</sub>) in rivers.

### 1.2) *Units of measurement*

The annual average BOD after five days of incubation (BOD<sub>5</sub>) at 20 degrees Celsius is expressed in mg of O<sub>2</sub>/litre; the ammonium concentration is expressed in mg of N/litre.

### 1.3) *Context*

Context – Relation to other indicators from the Guidelines - This indicator relates to indicators “C-11: Nutrients in freshwater”.

## 2) Relevance for environmental policy

### 2.1) *Purpose*

The indicator provides a measure of the state of rivers in terms of biodegradable organic load and ammonium.

### 2.2) *Issue*

Large quantities of organic matter (microbes and decaying organic waste) can reduce the chemical and biological quality of river water and result in impaired biodiversity of aquatic communities and microbiological contamination that can affect the quality of drinking and bathing water. Sources of organic matter include discharges from wastewater treatment plants, industrial effluents and agricultural run-off. Organic pollution leads to higher rates of metabolic processes that demand oxygen. This could result in a lack of oxygen (anaerobic

conditions). The transformation of nitrogen into reduced forms under anaerobic conditions in turn leads to increased concentrations of ammonium, which is toxic to aquatic life above certain concentrations, depending on water temperature, salinity and concentration of acidity (pH).

### **2.3) International agreements and targets**

#### *a) Regional level*

The ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes and its Protocol on Water and Health

#### *b) Subregional level*

In the European Union, the Water Framework Directive (2000/60/EC) requires the achievement of a “good ecological status” or “good ecological potential” for rivers throughout the European Union by 2015. The Urban Waste Water Treatment Directive (91/71/EEC) aims to decrease pollution of surface waters. Industrial discharges are controlled by the Directive 2010/75/EU on industrial emissions (IPPC). Recent requirements related to water quality are laid down by the Directive 2008/105/EC on environmental quality standards in the field of water policy.

## **3) Methodology and guidelines**

### **3.1) Data collection and calculations**

This indicator illustrates the current situation and trends regarding BOD and concentrations of  $\text{NH}_4$  in rivers. The programme of monitoring BOD and concentrations of ammonium should be structured taking into account the spatial and temporal dynamics of the indicator. The number of surveillance points and their location should enable collection of information on BOD and  $\text{NH}_4$  background values for the main morphological types of watercourses and values of this indicator in the areas subject to anthropogenic load. Time parameters should correspond to hydrological phases, while the frequency of sampling should reflect the need for statistically authentic information. Efforts should be made to ensure methodological and metrological uniformity in surveillance and data processing; microbiological and chemical tests should be performed by accredited laboratories with QA/QC systems. The values for BOD and  $\text{NH}_4$  concentrations should be provided aggregated per monitoring station. For each station a separate table should be completed. The type of sampling sites as well as the monitoring frequency should be provided in the production table. Furthermore, for both BOD and  $\text{NH}_4$  the highest measured value per station (maximum), the lowest measured value (minimum), the arithmetic mean of all measured values, and the standard deviation for all measures should be provided. When providing aggregated data as mean values, sample

concentrations below the limits of quantification must be replaced with a value equivalent to half the limit of quantification.

### **3.2) Internationally agreed methodologies and standards**

General rules for reporting are presented in the International Recommendations for Water Statistics (IRWS), United Nations 2012. The method of determining BOD in countries of South-Eastern and Eastern Europe, Caucasus and Central Asia is in compliance with ISO 5815-1:2003 and ISO 5815-2:2003. The maximum permissible value of BOD<sub>5</sub> pursuant to Directive (78/659/EEC) on the quality of fresh waters needing protection or improvement in order to support fish life is 3 mg/l of O<sub>2</sub> for salmonid waters and 6 mg/l of O<sub>2</sub> for cyprinid waters. In the majority of countries, the limit value for the concentration of ammonium in rivers is set as 0.39 mg/l. The method of determination of ammonium complies with ISO 7150-1: 1984 and ISO 6778:1984 in many countries.

## **4) Data sources and reporting**

Countries of South-Eastern and Eastern Europe, Caucasus and Central Asia, have departmental and, in some cases, national databases on the indicator. In some countries, databases include the results of analysis of BOD and ammonia concentrations in surface water bodies for several decades. Data in these countries are published in annual surface water quality reports. Statistical agencies report data to the UNSD International Environment Statistics Database.

## **5) References at the international level**

- Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment;
- Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive): [http://ec.europa.eu/environment/water/water-framework/index\\_en.html](http://ec.europa.eu/environment/water/water-framework/index_en.html)

- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council
- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
- ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992): <http://www.unece.org/fileadmin/DAM/env/water/pdf/watercon.pdf>; amendment 2003: <http://www.unece.org/fileadmin/DAM/env/documents/2004/wat/ece.mp.wat.14.e.pdf>
- Environmental Indicator Report 2012, EEA 2012
- European Commission – Water Policy: [http://ec.europa.eu/environment/water/index\\_en.htm](http://ec.europa.eu/environment/water/index_en.htm)
- European Environment Agency (EEA): <http://www.eea.europa.eu/themes/water>
- Europe's Environment, The 4th Assessment, EEA 2007
- Eurostat: <http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/indicators>
- GEMS/WATER Operational Guide, 3rd ed. (WHO, 1992)
- Global water information system of the Food and Agriculture Organization (AQUASTAT): [http://www.fao.org/ag/agl/aglw/aquastat/water\\_res/waterres\\_tab.htm](http://www.fao.org/ag/agl/aglw/aquastat/water_res/waterres_tab.htm)
- International Organization for Standardization (ISO): <http://www.iso.org>
- International Recommendations for Water Statistics (IRWS): <http://unstats.un.org/unsd/envaccounting/irws/irwswebversion.pdf>
- ISO Water Quality – determination of BOD after five days, ISO 5815. (1989)
- Protocol on Water and Health to the ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes:

<http://www.unece.org/fileadmin/DAM/env/documents/2000/wat/mp.wat.2000.1.e.pdf>

- Standard Methods for the Examination of Water and Wastewater, 19th ed. (American Public Human Health Association, 1992)
- The European Environment-State and Outlook 2010: Synthesis, EEA 2010
- The Protocol on Water and Health: Guidelines on the Setting of Targets, Evaluation of Progress and Reporting, ECE/WHO 2010: [http://www.unece.org/env/water/publications/documents/guidelines\\_target\\_setting.pdf](http://www.unece.org/env/water/publications/documents/guidelines_target_setting.pdf)
- United Nations Statistics Division (UNSD): <http://unstats.un.org/unsd/environment/>
- United Nations Statistics Division (UNSD)/United Nations Environment Programme (UNEP) Questionnaire on Environment Statistics (2013): <http://unstats.un.org/unsd/environment/questionnaire2013.html>
- World Health Organization (WHO): <http://www.euro.who.int/en/home>
- World Meteorological Organization (WMO): [www.wmo.ch](http://www.wmo.ch)