

# THE DEFINITION OF “SEDIMENT GOOD QUALITY” IN THE RIVER PO ECOSYSTEM: PRESENT STATUS AND PERSPECTIVES

Davide Vignati\*

Institution: IRSA-CNR, Via della Mornera 25, 20047 Brugherio (Milan), Italy

## Summary

Traditionally, sediment quality assessment has been based on numerical SQGs (sediment quality guidelines) which were derived by different regulatory boards on the basis of pertaining ecotoxicological studies. Since, for obvious reasons, such studies are conducted on a limited number of freshwater ecosystems; important natural differences between water bodies may be overlooked during the development phase of SQGs. Such a situation can result in an attempt to endorse SQGs which are unrealistically low (or, at the opposite, too high) for a given ecosystem. The concepts of “good ecological status” and “reference site” are therefore gaining increasing importance in an attempt to overcome the limitations of this numerical approach. With these two concepts, the definition of “sediment quality” acquires a flexible dimension which should allow an appropriate and specific evaluation of the overall ecological quality for any given ecosystem.

In this presentation, three chemically based quality assessment strategies are compared with an *in situ* index of biological quality (Mayfly Average Scores) in order to identify the possible links between “classical” sediment chemistry and ecological responses from the macroinvertebrate community. Results show that the two approaches agree only to a limited extent. Although the new European Framework directive stresses the importance of biological indicators, an adequate knowledge of sediment chemistry still appears important for both the choice of appropriate reference sites and the implementation of remedial actions in at polluted sites.

## Figure caption (left-right; top-down)

Figure 1. Example of sediment quality assessment in the river Po using the Waboos computer programme (Bakker and Venema, 1997)

Figure 2. Summary figures for the river Po basin and location of sampling sites along the river Po. Flow regime measured downstream site 10 over the sampling period (September 1996-March 1997) is shown in the box.

Figure 3. Classes of integrity (MAS+ index) of the mayflies communities in the river Po over the sampling period.

Figure 4. Comparison of measured nickel concentration with consensus based sediment quality guidelines (MacDonald D.D., Ingersoll C.G., Berger T.A. 2000).

Figure 5. Spatial variation of Cumulative Threshold Effect Concentration (CTEC) index in the river Po over the sampling period.

Figure 6. Enrichment factors for Cd, Cu and Ni in the river Po calculated with respect to concentrations measured at the reference site 1.

## References

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Bakker T. and Venema R. 1997. Waterbodem BOOS, version 5. RIZA, Department of Chemistry and Ecotoxicology, Lelystad, The Netherlands.

# SEDIMENT QUALITY GUIDELINES AND GOOD ECOLOGICAL STATUS: THE CASE OF TRACE METALS IN THE RIVER PO (ITALY)

Davide Vignati\*

Istituto di Ricerca sulle Acque (IRSA-CNR), Via della Mornera 25, 20047 Brugherio (Milano), Italy

## CONTEXT

Lack of toxicity in laboratory tests does not necessarily reflect a good ecological status in the field. At present, numerical concentration sediment quality guidelines (SQGs) can be effectively used for predicting sediment toxicity in laboratory experiments<sup>1</sup>, but do not have a direct link with indicators of *in situ* ecological quality such as biotic indexes. Furthermore, SQGs for trace metals do not generally consider the natural differences in background levels which often exist among freshwater ecosystems. Some results from a recent integrated study conducted by IRSA-CNR on the quality of river Po sediments are used to compare 3 chemically based sediment quality assessment strategies with an *in situ* ecological quality index (MAS<sup>+</sup>, Mayfly Average Score)<sup>2</sup>.

## METHODS

**SAMPLING**: collection of composite sediment samples at 10 sites along the main course of the river (red spots in the Study Area) using a Ponar grab sampler<sup>3</sup>. Sampling periods: Sept.-Oct. 1996 and Feb.-Mar. 1997

**CHEMISTRY**: mineralisation with a mixture of HNO<sub>3</sub>, HCl, and HF acid under microwave assisted digestion<sup>4</sup>. Cd, Co, Cr, Cu, Ni, Pb analysed by GFAAS. Fe, Mn, Zn analysed by FAAS. Hg: determined on solid samples after thermal decomposition at 750° C using an automated analyser (AMA254, FKV, Bergamo, Italy).

**BIOLOGICAL QUALITY**: Collection of benthic organism using multi-plate artificial substrata (sites 5 to 10) or a surber net (sites 1 to 4)<sup>2</sup>.

## COMPUTERISED SEDIMENT QUALITY ASSESSMENT<sup>5</sup>

Class 0 = pristine environment

Class 1 = enrichment above natural background

Class 2 } low to moderate pollution (additional studies  
Class 3 } required)

Class 4 = heavy pollution (start remedial action)

Site	Class 0	Class 1	Class 2	Class 3	Class 4
1	Cd, Cr, Cu, Hg, Pb, Zn		Ni		
2	Cd, Hg, Pb	Cr, Zn	Cu	Ni	
3	Cd, Hg, Pb	Cr, Zn	Cu	Ni	
4	Cd, Cr, Hg, Pb, Zn		Cu	Ni	
5	Cd, Cr, Cu, Hg, Pb, Zn		Ni		
6	Cd, Cr, Cu, Hg, Pb, Zn			Ni	
7	Cd, Hg, Pb	Cr, Zn	Cu	Ni	
8	Cd, Cr, Cu, Hg, Pb, Zn			Ni	
9	Cd, Hg, Pb, Cr	Zn	Cu	Ni	
10	Cd, Hg, Pb, Cr	Zn	Cu	Ni	

## STUDY AREA



### RIVER PO

Length: 646 km  
Basin: > 70,000 km<sup>2</sup>  
(1/4 of Italian territory)  
Flow: 1500 m<sup>3</sup> s<sup>-1</sup> at Pontelagoscuro  
  
Agriculture: 35% of national total  
Industry: 37% of national total  
Stockbreeding: 55% of national total

## QUALITY ASSESSMENT STRATEGIES

**COMPUTERISED ASSESSMENT**: measured metal concentrations are normalised to a standard reference sediment containing 25% of fine material (< 2µm) and 10% organic matter (expressed as LOI). Standardised concentrations are compared with built in quality criteria (Dutch regulations) and a quality index (from 0 to 4) is calculated for each metal.

**CONSENSUS-BASED<sup>1</sup> TECs and PECs**: measured metal concentrations are compared with TECs (Threshold Effect Concentrations = rare toxicity) and PECs (Probable Effect Concentrations = frequent toxicity) derived from existing databases (mainly American and Canadian).

**ENRICHMENT FACTOR**: concentrations measured at different sites along the Po are normalised to a reference site (site 1) within the river basin.

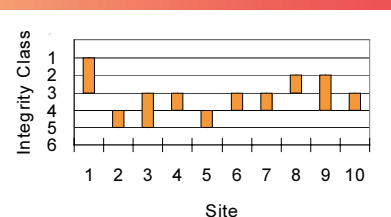
## LINKING ECOLOGICAL QUALITY AND CHEMISTRY

The MAS<sup>+</sup> (Mayfly Average Score)<sup>2</sup> index was applied at each site to evaluate the differences between the expected and the observed structure of mayfly communities. Class 1 corresponds to an unaltered natural community; while class 6 indicates the complete absence of mayflies. Cumulative Threshold Effect Concentration (CTEC) indexes, defined as the sum of the ratios of measured concentrations versus TECs for each metal, were used to get an indication on the overall chemical quality of river Po sediments. Results of ecological and chemical quality assessment agree only to a limited extent.

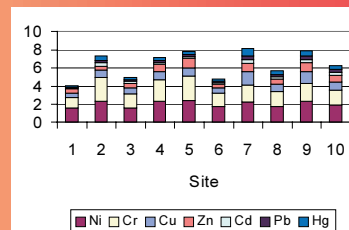
Different quality assessment strategies do not always lead to the same conclusions either. Computerised quality assessment identifies a moderate widespread risk from Ni and Cu contamination; while the use of consensus-based guidelines indicates possible toxicity from Ni, Cr and, to a lesser extent, Cu and Zn. These findings are not confirmed by the calculation of metals enrichment factors which show only moderate and local enrichment for Cr, Cu, Ni, Pb, and Zn. On the contrary Cd and Hg concentrations are often much higher than those measured at the reference site.

This study on the Po suggests that validation of sediment quality guidelines to real field situations should be conducted in addition to, and independently from, laboratory-based experiences. Furthermore, at least for some metals, specific sediment quality guidelines seem to be necessary for the river Po basin. In this sense, future studies should give particular attention to background levels and bioavailability of Ni and Cr in the river Po ecosystem.

### MAS<sup>+</sup> INDEX

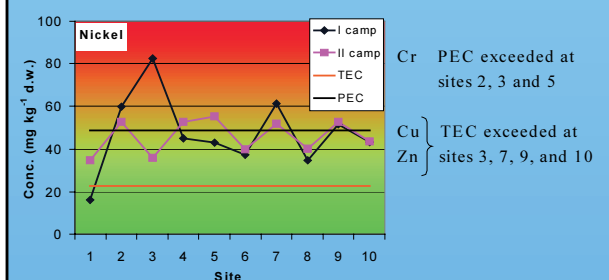


### CTEC INDEX

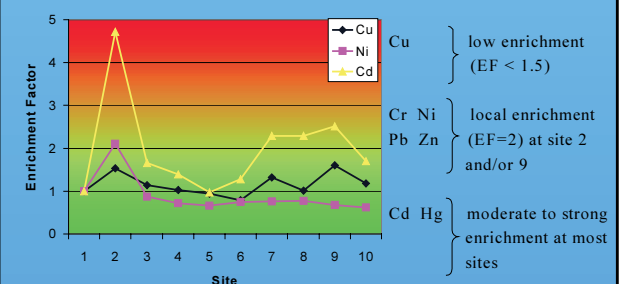


$$CTEC \text{ index} = \sum \frac{\text{Measured metal concentration}}{\text{Consensus-based TEC}}$$

### CONSENSUS BASED TECs AND PECs



### ENRICHMENT FACTOR



## REFERENCES

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\*Present address: Institute F.-A. Forel, Route de Suisse 10, 1290 Versoix, Switzerland

e-mail: davide.vignati@terre.unige.ch



## List of Participants

Name	Address
Airaksinen Outi	South Savo Regional Environment Centre Jääkärintie 14 FIN-50100 Mikkeli FINLAND tel.: +358 15 7444 562, fax: +358 15 7444509 email: outi.airaksinen@vyh.fi
Bauwens, Willy	IUPWARE - Laboratory of Hydrology Pleinlaan 2 B-1050 Brussels BELGIUM tel.: +32 2 629 3021, fax: +32 2 629 3022 email: wbauwens@vub.ac.be
Beken, André Van Der	IUPWARE-c/o Lab. of Hydrology-VUB Pleinlaan 2 B-1050 Brussels BELGIUM tel.: +32 2 629 3021, fax: +32 2 629 3022 email: avdbeken@vub.ac.be
Bennekom, A.R. van	Institute for Inland Water Management and Waste Water Treatment, RIZA P.O. Box 17 NL-8200 AA Lelystad The NETHERLANDS tel.: +31 320 298 509, fax: +31 320 280 883 email: a.r.vbennekom@riza.rws.minvenw.nl
Bijkerk Ronald	Koeman en Bijkerk BV Ecological Research and Consultancy P.O. Box 14 NL-9750 AA Haren The NETHERLANDS tel.: +31 50 363 2265, fax: +31 50 363 5205 email: koeman.en.bijkerk@biol.rug.nl
Bockelmann, Bettina	Environmental Water Management Research Centre, Cardiff University P.O. Box 925 Cardiff CF24 0YF UNITED KINGDOM tel.: +44 2920 875 737, fax: +44 2920 874 597 email: bockelmannbn@cf.ac.uk
Bousquet, Mathieu	CEMAGREF Parc de Tourvoie - BP 44 F-92163 Antony Cedex FRANCE tel.: +33 1 40 96 61 35, fax: +33 1 40 96 61 42 email: mathieu.bousquet@cemagref.fr
Caroni, Rossana	Environmental Protection Agency Pottery Road Dun Laochaire Co. Dublin IRELAND tel.: +353 1 2852 122, fax: +353 1 2851 766 email: r.caroni@epa.ie

Cavalier, Gerald	<p>CEMAGREF          Parc de Tourvoie - BP 44          F-92163 Antony Cedex          FRANCE          tel.: +33 1 40 96 61 47, fax: +33 1 40 96 61 42          email: gerald.cavalier@cemagref.fr</p>
Dannisøe, Jesper	<p>DHI Water &amp; Environment          Agern Allé 11          DK-2970 Hørsholm          DENMARK          tel.: +45 45 16 92 00, fax: +45 45 16 92 92          email: jda@dhi.dk</p>
Davidson, Tom	<p>Environmental Change Research Centre (ECRC)          University College London          26 Bedford Way          London WC1H 0AP          UNITED KINGDOM          tel.: +44 20 7679 1516/5536, fax: +44 20          email: thomas.davidson@ucl.ac.uk</p>
Donnelly, Karol	<p>Environmental Protection Agency          John Moore Road          Castlebar          Co. Mayo          IRELAND          tel.: +353 94 21588, fax: +353 94 21934          email: k.donnelly@epa.ie</p>
Esser, Birgit	<p>Bundesanstalt für Gewässerkunde          (Federal Institute of Hydrology)          P.O. Box 200253          D-56002 Koblenz          GERMANY          tel.: +49 261 1306 5325, fax: +49 261 1306 5466          email: esser@bafg.de</p>
Fejes, Jonas	<p>IVL - Swedish Environmental Research Institute          P.O. Box 21060          S-10031 Stockholm          SWEDEN          tel.: +46 8 598 563 00, fax: +46 8 598 563 90          email: jonas.fejes@ivl.se</p>
Hadjibiros, Kimon	<p>National Technical University of Athens          5, Iroon Polytechniou Str.          GR-157 80 Zografou          GREECE          tel.: +30 1 7722 896, fax: +30 1 7722 899          email: kimon@hydro.ntua.gr</p>
Haunia, Sirkka	<p>Finnish Environment Institute          P.O. Box 140          FIN-00251 Helsinki          FINLAND          tel.: +358 9 40300 669, fax: +358 9 40300 690          email: sirkka.haunia@vyh.fi</p>

Heinonen, Pertti  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 661, fax: +358 9 40300 690  
email: pertti.heinonen@vyh.fi

Kaas, Hanne  
DHI Water & Environment  
Agern Allé 11  
DK-2970 Hørsholm  
DENMARK  
tel.: +45 45 16 92 00 , (direct: +45 45 16 95 38)  
Mobile: +45 22 10 49 25, fax: +45 45 16 92 92  
email: hka@dhi.dk

Kairesalo, Timo  
Dept. of Ecological and Environmental  
Sciences, University of Helsinki  
Niemenkatu 73  
FIN-15140 Lahti  
FINLAND  
tel.: +358 3 8922 0300, fax: +358 3 8922 0331  
email: timo.karesalo@helsinki.fi

Karttunen, Krister  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 736, fax: +358 9 40300 791  
email: krister.karttunen@vyh.fi

Kauppi, Lea  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 701, fax: +358 9 40300 789  
email: lea.kauppi@vyh.fi

Klaghofer, Eduard  
Federal Agency for Water Management  
Pollnbergstrasse 1  
A-3252 Petzenkirchen  
AUSTRIA  
tel.: +43 7 416 52 108/14, fax: +43 7 416 52 08/3  
email: ikt@baw.bmlf.gv.at

Kämäri, Juha  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 771, fax: +358 9 40300 789  
email: juha.kamari@vyh.fi

Lavarde, Patrick  
CEMAGREF  
Parc de Tourvoie - BP 44  
F-92163 Antony Cedex  
FRANCE  
tel.: +33 1 40 96, fax: +33 1 40 96 61 42  
email: patrick.lavarde@cemagref.fr

Lyle, Alexander  
Centre for Ecology and Hydrology (CEH)  
CEH-Edinburgh, Bush Estate  
Penicuik EH26 OQB Midlothian  
SCOTLAND  
UNITED KINGDOM  
tel.: +44 131 445 4343, fax: +44 131 445 3943  
email: alyle@ceh.ac.uk

Menéndez, Manuel  
CEDEX  
Paseo Bajo Virgen del Puerto, 3  
E-28005 Madrid  
SPAIN  
tel.: +34 91 335 7939, fax: +34 91 335 7922  
email: manuel.menendez@cedex.es

Mimikou, Maria  
National Technical University of Athens  
5, Iroon Polytechniou Str.  
GR-157 80 Athens  
GREECE  
tel.: +30 1 7722 880, fax: +30 1 7722 879  
email: mimikou@chi.civil.ntua.gr

Mitikka, Sari  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 352, fax: +358 9 40300 390  
email: sari.mitikka@vyh.fi

Müller, Steffen  
Bayer. Landesamt für Wasserwirtschaft  
Lazarettstr. 67  
D-80636 München  
GERMANY  
tel.: +49 89 92 14 11 61, fax: +49 89 92 14 16 76  
email: steffen.mueller@lfw.bayern.de

Nõges, Tiina  
Limnological Station  
Rannu  
Tartu County  
61101 ESTONIA  
tel.: +372 7 454 543, fax: +372 7 454 546  
email: tnoges@2bi.ee

Passino, Roberto  
Istituto di Ricerca sulle Acque - IRSA  
Via Reno, 1  
I-00198 Roma  
ITALY  
tel.: +39 06 884 1451, fax: +39 06 841 7861  
email: direzione@irsa.rm.cnr.it

Pietiläinen, Olli-Pekka  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 314, fax: +358 9 40300 390  
email: olli-pekka.pietilainen@vyh.fi

Pilke, Ansa  
Finnish Environment Institute  
P.O. Box 140  
FIN-00251 Helsinki  
FINLAND  
tel.: +358 9 40300 670, fax: +358 9 40300 690  
email: ansa.pilke@vyh.fi



Rasmussen, Jørn	DHI Water & Environment Agern Allé 11 DK-2970 Hørsholm DENMARK tel.: +45 45 16 92 32, fax: +45 45 16 92 92 email: jar@dhi.dk
Reeze, A.J.G.	Institute for Inland Water Management and Waste Water Treatment, RIZA P.O. Box 17 NL-8200 Lelystad The NETHERLANDS tel.: +31 320 298 548, fax: +31 320 email: b.reeze@riza.rws.minvenw.nl
Rissanen, Jouko	Finnish Environment Institute P.O. Box 140 FIN-00251 Helsinki FINLAND tel.: +358 9 40300 357, fax: +358 9 40300 390 email: jouko.rissanen@vyh.fi
Rita, Manuel	National Laboratory of Civil Engineering, LNEC Avenida do Brasil, 101 P-1700-066 Lisboa Codex PORTUGAL tel.: +351 21 844 3300, fax: +351 21 844 3010 email:
Rocha João	National Laboratory of Civil Engineering, LNEC Avenida do Brasil, 101 P-1700-066 Lisboa Codex PORTUGAL tel.: +351 21 844 3435, fax: +351 21 844 3016 email: jrocha@lnec.pt
Runnalls, Neil	CEH Wallingford Crowmarsh Gifford Wallingford Oxon OX10 8BB UNITED KINGDOM tel.: +44 1491 692 373, fax: +44 1491 692 424 email: nrr.ih.wallingford@wpo.nerc.ac.uk
Solheim, Anne Lyche	Norwegian Institute for Water Research (NIVA) Brekkeveien 19 P.O. Box 173, Kjelsås N-0411 Oslo NORWAY tel.: +47 2218 5100, fax: +47 2218 5200 email: anne.lyche@niva.no
Somma, Giacomo	Istituto di Ricerca sulle Acque - IRSA Via Reno, 1 I-00198 Roma ITALY tel.: +39 06 884 1451, fax: +39 06 841 7861 email: g.somma@irsa.rm.cnr.it

Tilche, Andrea  
European Commission, DG Research  
Unit Head Key Action "Sustainable  
Management and Quality of Water  
Square de Meeus 8  
Rue de la Loi 200  
1049 Bruxelles  
BELGIUM  
tel.: +32 2 299 6342, fax: +32 2 296 3024  
Mobile: +32 486 535 065  
email: andrea.tilche@cec.eu.int

Toro, Manuel  
CEDEX  
Paseo Bajo Virgen del Puerto, 3  
E-28005 Madrid  
SPAIN  
tel.: +34 91 335 8001, fax: +34 91 335 7944  
email: manuel.toro@cedex.es

Uijterlinde, Rob  
Institute for Inland Water Management and  
Waste Water Treatment, RIZA  
P.O. Box 17  
NL-8200 AA Lelystad  
The NETHERLANDS  
tel.: +31 320 298 662, fax: +31 320 298 514  
email: r.uyterlinde@riza.rws.minvenw.nl

Vaate, Abraham bij de  
Institute for Inland Water Management and  
Waste Water Treatment, RIZA  
P.O. Box 17  
NL-8200 AA Lelystad  
The NETHERLANDS  
tel.: +31 320 298 701, fax: +31 320 298 398  
email: b.bdvaate@riza.rws.minvenw.nl

Wagner, Walter  
WWF  
Hohlstrasse 110  
CH-8010 Zurich  
SWITZERLAND  
tel.: +41 1 297 2252, Mobile: +41 79 230 9917  
fax: +41 1 297 2100  
email: walter.wagner@wwf.ch

Wallace, Jim  
CEH Wallingford  
Crowmarsh Gifford  
Wallingford  
Oxon OX10 8BB  
UNITED KINGDOM  
tel.: +44 1491 838 800, fax: +44 1491 692 216  
email: jsw@ceh.ac.uk

Wallgren, Oskar  
IVL - Swedish Environmental Research Institute  
P.O. Box 21060  
S-10031 Stockholm  
SWEDEN  
tel.: +46 8 598 563 00, fax: +46 8 598 563 90  
email: oskar.wallgren@ivl.se

Wallin, Mats  
Swedish University of Agricultural Sciences  
Box 7050  
SE-750 07 Uppsala  
SWEDEN  
tel.: +46 18 673 125, fax: +46 18 673 156  
email: mats.wallin@ma.slu.se

Wasson, Jean-Gabriel

CEMAGREF – UR BEA  
'Biologie des Ecosystèmes Aquatiques'  
BP 220  
F-69336 Lyon Cedex 09  
FRANCE  
tel.: +33 4 72 20 87 99, fax: +33 4 78 47 78 75  
email: jean-gabriel.wasson@cemagref.fr

Wetzel, Volkhard

Bundesanstalt für Gewässerkunde  
(Federal Institute of Hydrology)  
Kaiser-Augusta-Anlagen 15-17  
D-56068 Koblenz  
GERMANY  
tel.: +49 261 1306 5300, fax: +49 261 1306 5148  
email: wetzel@bafg.de

Vignati, Davide

Institute F.-A. Forel  
Route de Suisse 10  
CH-1290 Versoix  
SWITZERLAND  
tel.: +41 22 950 9210/+41 22 950 9724  
fax: +41 22 755 1382  
email: davide.vignati@terre.unige.ch

Wolfstein, Kirsten

Institute for Inland Water Management and  
Waste Water Treatment, (RIZA)  
Zuiderwagenplein 2  
NL-8200 AA Lelystad  
The NETHERLANDS  
tel.: +31 320 298 728, fax: +31 320 298 398  
email: k.wolfstein@riza.rws.minvenw.nl



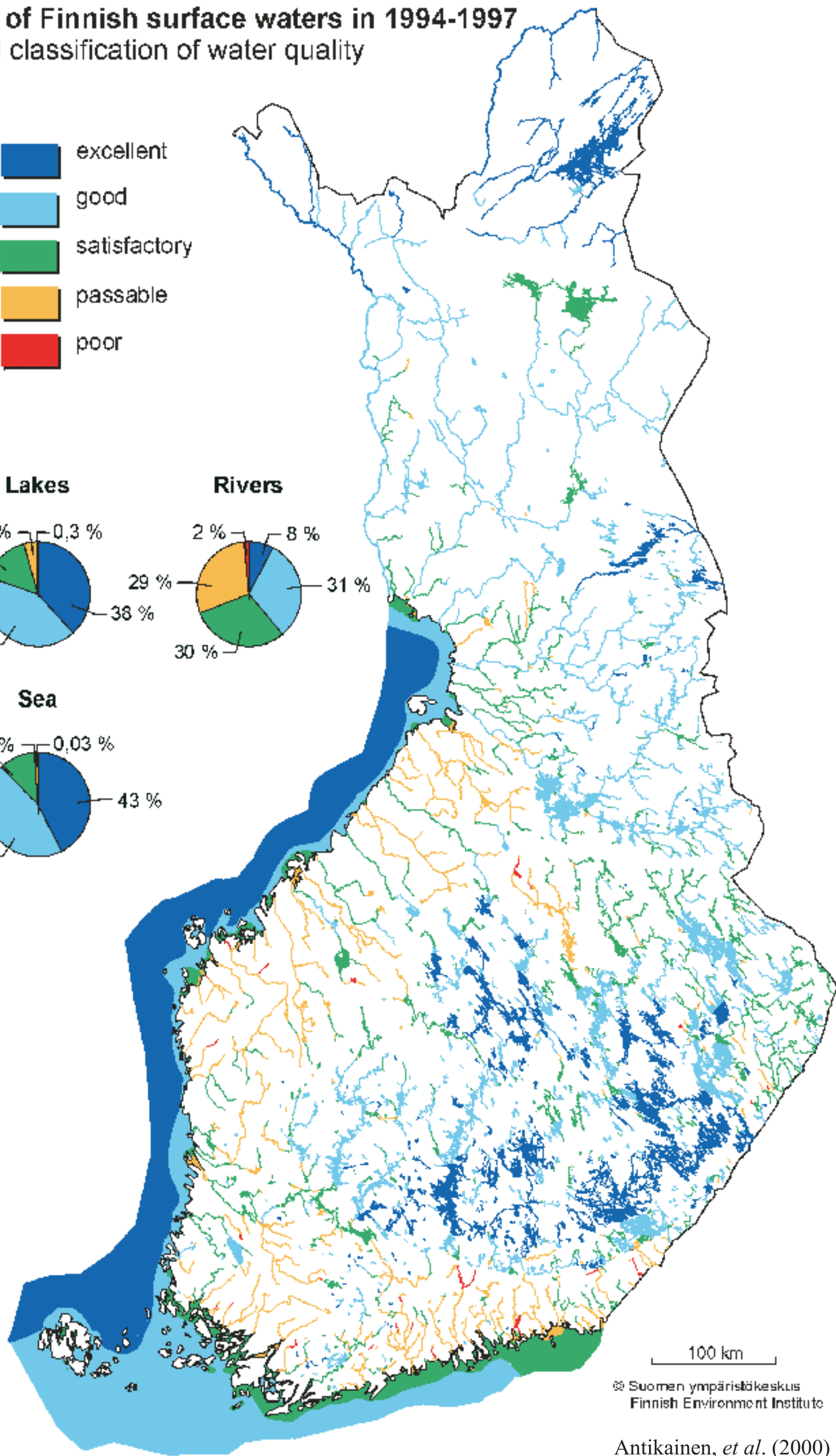
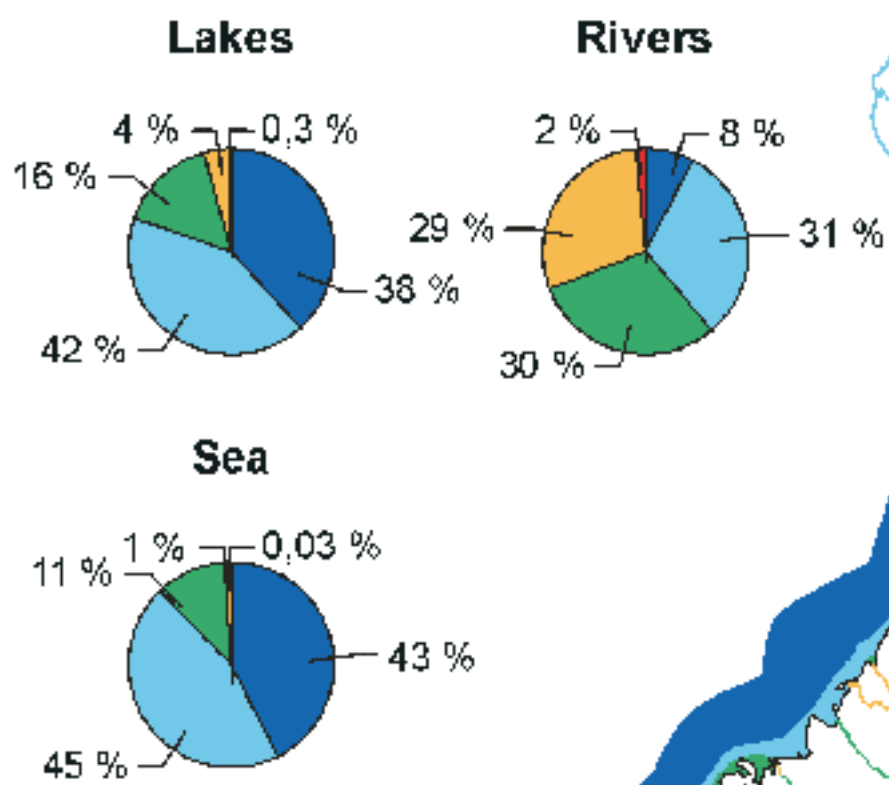
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- No. 4: "Let the fish speak: The quality of aquatic ecosystems as an indicator for sustainable development", Koblenz, Germany in 1997
- No. 5: "Farming without harming: The impact of agricultural pollution on water systems", Oslo, Norway in 1998
- No. 6: "Urban water management", Lisbon, Portugal in 1999, [under preparation]
- No. 7: "Water modelling as a tool in river basin management within the Framework Directive", Madrid, Spain in 2000, [under preparation]
- No. 8: " Good ecological status: Reference conditions for surface waters", Helsinki, Finland in 2001



# Quality of Finnish surface waters in 1994-1997

## General classification of water quality



100 km

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Antikainen, *et al.* (2000)





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Eduard KLAGHOFER  
Vice Director  
Bundesamt für Wasserwirtschaft  
Institut für Kulturtechnik und Bodenwasserhaushalt  
Pollnbergstrasse 1  
A-3252 Petzenkirchen  
Tel.: +43 7 416 52 108-0 Fax: +43 7 416 52 108-3  
E-mail: ikt@baw.bmlf.gv.at

### ■ Belgium

Willy BAUWENS  
Chair of Hydrology & Hydraulic Engineering  
IUPWARE - VUB  
Pleinlaan 2  
B-1050 Brussels  
Tel: +32 2 629 30 21 - Fax: +32 2 629 30 22  
E-mail: wbauwens@vub.ac.be

### ■ Denmark

Joern RASMUSSEN  
Director  
Water Quality Institute, VKI  
Agern Alle, 11  
Forskningscentret DK-2970 Horsholm  
Tel: +45 45 16 92 00 - Fax: +45 45 16 92 92  
E-mail: jar@vki.dk

### ■ Finland

Lea KAUPPI  
Director General  
Finnish Environment Institute  
PO Box 140  
FIN-00251 Helsinki  
Tel: +358 9 40 3000 - Fax: +358 9 40 300 789  
E-mail: lea.kauppi@vyh.fi

### ■ France

Patrick LAVARDE  
Director General  
CEMAGREF  
Parc de Tourvoie P.O. Box 22  
F-92162 Antony Cedex  
Tel: +33 1 40 96 62 80 - Fax: +33 1 40 96 61 42  
E-mail: jean-michel.male@cemagref.fr

### ■ Germany

Volkhard WETZEL  
Director General, Federal Institute of Hydrology  
Bundesanstalt für Gewässerkunde, BfG Kaiserin  
Augusta Anlagen 15-17  
D-56068 Koblenz  
Tel: +49 261 1306 5300 - Fax: +49 261 1306 5302  
E-mail: wetzela@bafg.de

### ■ Greece

M.A. MIMIKOU  
Head of Department of Water Resources,  
Hydraulic and Maritime Engineering  
National Technical University of Athens 5,  
Heron Polytechniou  
GR-15780 Athens  
Tel: +30 1 772 2878 - Fax: +30 1 772 2879  
E-mail: Mimikou@central.ntua.gr

### ■ Italy

Roberto PASSINO  
Director Istituto di Ricerca sulle Acque - IRSA  
Via Reno, 1  
I-00198 Roma  
Tel: +390 6 884 14 51 - Fax: +390 6 841 78 61  
E-mail: blundo@irsa1.irsa.rm.cnr.it

### ■ Norway

Odd SKOGHEIM  
Director  
N IVA - Norwegian Institute for Water Research  
PO Box 173 Kjelsås N-0411 Oslo  
Tel: +47 22 18 51 00 - Fax: +47 22 18 52 00  
E-mail: odd.skogheim@niva.no

### ■ Portugal

Rui M. CORREIRA  
Director General  
National Laboratory of Civil Engineering, LNEC  
Avenida do Brasil, 101  
POR-1799 Lisboa Codex  
Tel: +351 1 848 21 31 - Fax: +351 1 847 3845  
E-mail: jrocha@lnec.pt

### ■ Republic of Ireland

Marie SHERWOOD  
Environmental Protection Agency, EPA  
Ardcavan Wexford  
Tel: +353 1 660 2511 - Fax: +353 1 660 5848  
E-mail: M.Sherwood@epa.ie

### ■ Spain

Manuel Martín ANTON  
Director General  
CEDEX Alfonso XII, 3 y 5  
E-28014 Madrid  
Tel: +34 91 539 72 51 - Fax: +34 91 528 03 54  
E-mail: manuel.menendez@cedex

### ■ Sweden

Björn LUNDBERG  
Director  
IVL - Swedish Environmental Research Institute  
PO Box 21060  
S-10031 Stockholm  
Tel: +46 8 729 15 00 - Fax: +46 8 31 85 16  
E-mail: bjorn.lundberg@ivl.se

### ■ Switzerland

Alexander J.B. ZEHNDER  
Director General  
EAWAG: Swiss Federal Institute for Environmental  
Science and Technology  
Ueberlandstrasse, 133  
CH-8600 Dübendorf  
Tel: +41 1 823 50 01 - Fax: +41 1 823 53 75  
E-mail: zehnder@eawag.ch

### ■ The Netherlands

André R. VAN BENNEKOM  
General Director  
Institute for Inland Water Management and  
Waste Water Treatment, RIZA PO Box 17  
NL-8200 Lelystad  
Tel: +31 320 298 411 - Fax: +31 320 249 218  
E-mail: r.uyterlinde@riza.rws.minvenw.nl

### ■ United Kingdom

Jim WALLACE  
Deputy Director of Hydrology  
CEH-Wallingford  
Crowmarsh Gifford Wallingford  
Oxon OX10 8BB  
United Kingdom  
Tel: +44 1491 838 800, Fax +44 1491 692 216  
E-mail: jsw@ceh.ac.uk