Proposal for adjusting the Flemish class boundaries according to the intercalibration exercise for river macroinvertebrates

Wim Gabriels
Flemish Environment Agency
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Summary

The present document summarises a proposal to revise the quality class boundaries for the Flemish assessment method for river macroinvertebrates, resulting from the intercalibration exercise that was conducted by the Central-Baltic Geographical Intercalibration Group (CB-GIG) for river macroinvertebrate assessment methods within the European Water Framework Directive.

First, the proposed Flemish assessment method for river macroinvertebrates, the MMIF, is summarised. Subsequently, the different steps involved in the contribution to the intercalibration exercise are discussed for Flanders. This includes data collection and subsequent calculations as well as the establishment of reference values that are necessary for comparison of boundary values. The Flemish reference values are compared to the reference values used for intercalibration by other member states, which are very similar. All regressions between the MMIF and the intercalibration index (ICMi) resulted in a R^2 value of 0.68 or higher.

The originally proposed class boundaries for the MMIF index were 0.60 for good/moderate and 0.80 for high/good. These class boundaries, when transformed into ICMi values fall outside the harmonisation band that was calculated by the CB-GIG steering group. Therefore, a new proposal is calculated, with class boundaries of 0.70 for good/moderate and 0.90 for high/good. These class boundaries result in ICMi values that fall within the harmonisation band. Therefore, it is proposed to use 0.70 and 0.90 as the new quality class boundaries for good/moderate and high/good, respectively, for the MMIF index.

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1. Introduction

The European Water Framework Directive (WFD; EU, 2000) requires that member states develop an assessment system for all types of rivers, lakes, transitional and coastal waters, based on a number of biological elements, including macroinvertebrates. In order to establish boundary values for the water quality classes that are comparable along member states, the WFD requires an intercalibration exercise for each quality element. For river macroinvertebrates in the Central-Baltic region, this intercalibration exercise is coordinated by the Central-Baltic Geographical Intercalibration Group (CB-GIG, 2006). The Flemish method for assessing biological status based on river macroinvertebrates is the Multimetric Macroinvertebrate Index Flanders (MMIF). The present document describes the Flemish contribution to this intercalibration exercise with the MMIF and examines whether the Flemish boundary values should be updated in order to be comparable to those of other member states.

2. Flemish contribution versus national contribution

Belgian contributions for the macroinvertebrate intercalibration exercise were submitted separately by Flanders and Wallonia. This splitting is due to several reasons (Gérard et al., 2006):

- The water management is under regional authority in Belgium and consequently all present implementation efforts have been conducted separately (development of typology, development of assessment methods and reporting of data to the GIGs).

- The methods for assessing macroinvertebrate communities are different. In Flanders, the MMIF is used and in Wallonia the IBGN. This difference induced a need for separate intercalibration.

- The different types of CB-GIG rivers are not equally distributed between both regions so that a preliminary internal intercalibration was practically impossible. Moreover, reference situations are rare in Belgium and absent in Flanders. This limited the implementation of a complete exercise following the boundary setting protocol.

The data submitted by Belgium to the GIG for intercalibration of the macroinvertebrate communities belongs to the types R-C1 and R-C4 for Flanders and R-C3 for Wallonia. In this paper, only the Flemish contribution is discussed.

3. Summary of the regional classification method - MMIF

The proposed regional classification method for macroinvertebrates in rivers and lakes in Flanders (Belgium) is the MMIF (Multimetric Macroinvertebrate Index Flanders). This index was developed based on experience with the Belgian Biotic Index (BBI; De Pauw & Vanhooren, 1983; Gabriels et al., 2005) method. Both methods provide a similar indication of general degradation but the MMIF tackles a number of problems regarding WFD-compliancy of the BBI. A preliminary version of the method was published in a report in Dutch (Gabriels et al., 2004); a complete account in English of the definitive version of the MMIF is currently submitted for publication (Gabriels et al., 2007). Here, a brief description of the method is provided. Details are only given for rivers, not for lakes, since this intercalibration exercise focuses on rivers only.

3.1 Typology

The MMIF is a type-specific index, this means that index calculation depends on the type of river or lake a sampling site belongs to. The typology used is based on the typology developed by Jochems et al. (2002). For rivers, one adaptation was applied to this typology: the Strahler order is not used as a criterion for river typology.

The main characteristics of the Flemish river types are summarised in Table 1.

Table 1. *Main characteristics of the different river types in Flanders, Belgium (after Jochems et al., 2002).*

Code	Type	Sub-ecoregion	Catchment area
Bk	Kleine Beek (Small stream)	Sand/sandy loam/loam	< 50 km²
BkK	Kleine Beek Kempen (Small stream Kempen)	Kempen	< 50 km²
Bg	Grote Beek (Large stream)	Sand/sandy loam/loam	50-300 km²
BgK	Grote Beek Kempen (Large stream Kempen)	Kempen	50-300 km²
Rk	Kleine Rivier (Small river)	Any	300-600 km²
Rg	Grote Rivier (Large river)	Any	600-10000 km²
Rzg	Zeer Grote Rivier (Very Large River)	Any	> 10000 km²
P	Polderwaterloop (Polder watercourse)	Polder	-

3.2 Sampling method

Macroinvertebrates are sampled using a standard handnet with 500 µm mesh size, as described for the Belgian Biotic Index (De Pauw & Vanhooren, 1983). A river stretch of about 10-20 meter is sampled during 5 minutes with kick-sampling, the sampling effort being proportionally distributed over the different subhabitats (De Pauw & Vanhooren, 1983). In addition, organisms are hand-picked from present hard materials such as stones and branches (De Pauw & Vannevel, 1991).

If a site is too deep to be sampled with a handnet, macroinvertebrates are sampled using the so-called Belgian artificial substrates as described by De Pauw et al. (1986; 1994), composed of a plastic netting filled with medium-sized pieces of brick. This was however not the case for any of the sampling sites within the intercalibration dataset.

3.3 Identification

All macroinvertebrates are identified according to the levels defined for the Belgian Biotic Index (De Pauw & Vanhooren, 1983). This means family, genus or an intermediate level for all taxa (except for watermites, which are treated as a single taxon).

The identification levels are (De Pauw & Vanhooren, 1983; Gabriels et al., 2005):

Plathelminthes: genus

Polychaeta : family
Oligochaeta: family
Hirudinea: genus
Mollusca: genus
Watermites: presence
Crustacea: family
Diptera: family, excl. Chironomidae (groups *thummi-plumosus* and *non-thummi-plumosus*)
Megaloptera: genus
Coleoptera: family
Hemiptera: genus
Odonata: genus
Ephemeroptera: genus
Trichoptera: family
Plecoptera: genus

A list of all taxa that are taken into account for the MMIF is provided in Appendix 1.

3.4 Index calculation

The MMIF is a multimetric index consisting of 5 metrics:

1. Total number of taxa;
2. Total number of EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa;
3. Total number of sensitive taxa (other than EPT);
4. Shannon-Wiener Index (Shannon & Weaver, 1949);
5. Mean tolerance score.

The mean tolerance score is calculated as the mean of all tolerance scores of taxa encountered in a sample, similar to the British ASPT method (Armitage et al., 1983), the tolerance scores being however different. Tolerance scores, ranging from 10 for very pollution sensitive to 1 for very pollution tolerant, were assigned to 223 macroinvertebrate taxa (at BBI/MMIF identification level). For metric 3, all taxa having a tolerance score of at least 6 are included, except the EPT taxa. All tolerance scores are listed in appendix 1.

For each national river or lake type, a target reference value was set for all 5 metrics using expert judgement (with contributions from a panel of Belgian and Dutch macroinvertebrate experts). Based on these references, a scoring system was developed for each metric, consisting of treshold values for assigning a score of 0, 1, 2, 3 and 4; 4 being assigned to the metric values that are nearest to the reference value. For rivers, these scores are summarised in Appendix 2. The MMIF is subsequently calculated as the sum of the 5 scores divided by 20, hence a score ranging from 0 to 1.

3.5 Compliance to normative definitions

Because the MMIF is a combination of five metrics, each related to one or more of the boundary setting criteria, the high/good and good/moderate boundaries are not explicitly related to values of corresponding metrics. Rather, they are based on treshold values of the EQR (MMIF) value, reflecting general degradation, and are therefore based on all metrics simultaneously (and hence the boundary setting criteria).

The boundary setting criterion “taxonomic composition and abundance” is related to the following metrics:

Total number of taxa;
Total number of EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa;
Total number of sensitive taxa (other than EPT);
Shannon-Wiener Index.

The boundary setting criterion “ratio of disturbance sensitive to insensitive taxa” is related to the following metrics:

Total number of EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa;

Total number of sensitive taxa (other than EPT);
Mean Tolerance Score.

The boundary setting criterion “level of diversity” is related to the following metrics:
Total number of taxa;
Total number of EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa;
Total number of sensitive taxa (other than EPT);
Shannon-Wiener Index.

The high/good boundary is set at an EQR value of 0.80. The good/moderate boundary is set at an EQR value of 0.60.

3.6 Ecological Quality Ratio

As described above, the MMIF is calculated as the sum of the 5 scores divided by 20, resulting in a final index ranging from 0.00 to 1.00. This means that the maximum MMIF value of 1.00 can only be attained when all metric values are near the type-specific reference value for that metric. For this reason, the range of the MMIF index is considered as an EQR scale.

3.7 Quality class boundaries

The quality class boundary values were developed by equally dividing the total range of index values [0.00 - 1.00] into five quality classes. The five quality classes and the boundary values are summarised in Table 2. This table shows that the high/good boundary is set at 0.80 and the good/moderate boundary at 0.60.

Table 2. *Boundary values for the five water quality classes based on the MMIF index for assessing Flemish rivers and lakes based on macroinvertebrates.*

MMIF range	Quality class	Colour code
[0.80 - 1.00]	High quality	Blue
[0.60 - 0.75]	Good quality	Green
[0.40 - 0.55]	Moderate quality	Yellow
[0.20 - 0.35]	Poor quality	Orange
[0.00 - 0.15]	Bad quality	Red

4. Overview of data and calculations

4.1 Relevant types

The types that are currently included in the intercalibration exercise for river macroinvertebrates in the Central-Baltic region are R-C1 and R-C4, as defined by ECOSTAT WG 2.A (2004).

Within R-C1, two Flemish types are included:

- Bk: “Kleine Beek” (“Small Stream”):
  catchment area < 50 km²;
  region "sand/sandy loam/loam".
- BkK: “Kleine Beek Kempen” (“Small Stream in the Kempen region”):
  catchment area < 50 km²;
  region "Kempen".

The most closely matching national river type for R-C1 is Bk (“Small Stream”).

Within R-C4, three Flemish types are included:

- Bg: “Grote Beek” (“Large Stream”):
  catchment area ≥ 50 – 300 km²;
  region "sand/sandy loam/loam".
- BgK: “Grote Beek Kempen” (“Large Stream in the Kempen region”):
  catchment area ≥ 50 – 300 km²;
  region "Kempen".
- Rk: “Kleine Rivier” (“Small River”):
  catchment area ≥ 300 – 600 km²;
  region "sand/sandy loam/loam" or "Kempen".

The most closely matching national river type for R-C4 is Bg (“Large Stream”).

4.2 Data source

All data were obtained from the Flemish Environment Agency (VMM) monitoring database. Initially, a representative number of samples was extracted randomly from the database for both R-C1 and R-C4.

To the initial R-C4 dataset, 19 sampling sites were added, more specifically data for the regional river type BgK (“large stream in the Kempen region”), because this type was slightly under-represented in the R-C4 dataset. Furthermore, 26 sites from the R-C4 dataset and 15 sites from the R-C1 dataset were characterised by an ASPT score below 2. This would result in negative values when subtracting 2 prior to normalisation (see further, section 6.1). In order to comply to all data requirements, it was decided to exclude these sites from the dataset.

4.3 Total numbers of samples

The dataset submitted for R-C1 comprised 193 samples, including 90 samples from the regional type Bk (“Small Stream”) and 103 from the regional type BkK (“Small Stream in the Kempen Region”). For R-C4, the dataset comprised 185 samples, including 130 samples from the regional type Bg (“Large Stream”), 24 from the regional type BgK (“Large Stream in the Kempen Region”) and 31 from the regional type Rk (“Small River”). Table 3 summarises the numbers of samples within each quality class according to the MMIF for both European river types.

As can be seen in Table 3, both datasets comply to the criterion of having at least four samples within the quality classes high, good and moderate.

Table 3. *Number of samples within each quality class according to the regional classification method, for the dataset submitted by Flanders for the intercalibration exercise for river types R-C1 and R-C4.*

National classification	R-C1	R-C4	Total
High	11	4	15
Good	27	14	41
Moderate	56	39	95
Poor	84	104	188
Bad	15	24	39
Total	**193**	**185**	**378**

4.4 Abundances

Usually absolute abundances were recorded but in some cases abundance classes were recorded (especially for higher abundances). These were transformed into absolute values as follows:

class A (1): 1
class B (2-10): 2
class C (11-50): 11
class D (51-100): 51
class E (101-1000): 101
class F (1001-10000): 1001
class G (10001 and more): 10001

4.5 Taxonomic adjustments

For MMIF calculation, no further adjustments were necessary. For calculation of the ICMi (Murray-Bligh et al., 2006), some adjustments were made. Data were all available at MMIF/BBI identification levels. Consequently, taxa were merged to family level where necessary in order to calculate ICMi. Watermites were removed from the dataset. All families from the resulting dataset could be allocated to the ASTERICS taxa list.

5. Metric reference values

For Flanders, no reference sites are available, as was previously communicated to the CB-GIG steering group (Gérard et al., 2006; Gabriels, 2006a, 2006b, 2006c). Therefore, a different approach was necessary to develop reference values for the intercalibration exercise.

5.1 MMIF

As already discussed in the previous section, the MMIF is considered as an EQR scale. Consequently, the maximum value (1.00) can be used as a "surrogate" for the reference value (Gabriels et al., 2004; Gabriels, 2006a, 2006b, 2006c). Note that the metric target reference values (and hence the scoring systems) are type-specific, so the reference value of 1.00 can be considered as type-specific although the range of MMIF values is identical for all national types.

5.2 ICMi metrics

Because actual reference sites do not exist in Flanders, reference data for ICMi metrics could not be extracted from field data. However, since not the actual biological data (taxalists) of reference sites are required for calculation of the ICMi, but only the corresponding metric values, this problem can be overcome by defining reference values for each ICMi metric.

In earlier contributions to the CB-GIG intercalibration exercise, Flanders has tested a variety of methods for deriving these reference values (see Gabriels, 2006a, 2006b, 2006c). At present, none of these methods were approved yet by the CB-GIG steering group. An alternative method that was proposed by the Netherlands, using the 75th percentile of high class sites (van Riel, 2006), was recently approved by the steering group. It was therefore investigated whether this method could also be applied for the Flemish data.

Due to the limited number of sites in the dataset that are in high status class according to the MMIF, the 75th percentile values were taken of the sites in high status class for the types R-C1 and R-C4 combined (15 in total; see Table 3). The obtained values are presented in Table 4.

Table 4. *Proposed reference values for ICMi metrics for the Flemish river types, based on the 75th percentile of high status samples calculcated for each metric separately.*

ICMi metric	Proposed reference value for Flanders
ASPT	4.798
Shannon-Wiener Index	2.886
EPT families	6.000
Total family richness	27.000
Portuguese GOLD-index	0.703
Sel EPTD	0.943

5.3 Evaluation of proposed ICMi reference values

When evaluating these resulting values for ICMi metrics, a number of considerations should be taken into account:

- First, actual reference sites are absent in Flanders. Actual data on taxonomic composition are therefore not available. This alternative method however takes into account the 75th percentile of the metric values of sites that are in highest class, and this for each individual metric separately. The resulting values therefore represent values that are the best available for each metric while avoiding possible outliers.
- The predefined reference values for similar MMIF metrics can be compared to the proposed ICMi reference values. This is however difficult due to differences in identification levels between MMIF and ICMi.

- The proposed ICMi reference values can be compared to the reference values of other member states. However, differences of biological data among member states due to biogeographical differences and differences in sampling methods and laboratory processing, such a comparison may lead to erroneous conclusions. In particular, the typical lowland conditions in Flanders, predominantly characterised by relatively low current velocities, should be kept in mind, which limits the geographical comparison, which can be assumed to be most significant for the Netherlands.

Table 5 shows the 75th percentile values of the ICMi metrics in high class samples in the data from the Netherlands for R-C1 and R-C4 (from the CIRCA website for CB river GIG macroinvertebrate intercalibration - july 2006). These were used as reference values by the Netherlands (and reportedly accepted by the CB-GIG steering group).

Table 5. *75th percentile values of ICMi metrics in high class samples in the data from the Netherlands within R-C1 and R-C4.*

European type	R-C1	R-C4
ASPT	5.357	5.227
Shannon-Wiener Index	1.488	2.144
EPT families	5.000	5.000
Total family richness	19.000	26.000
Portuguese GOLD-index	0.986	0.887
Sel EPTD	1.699	1.342

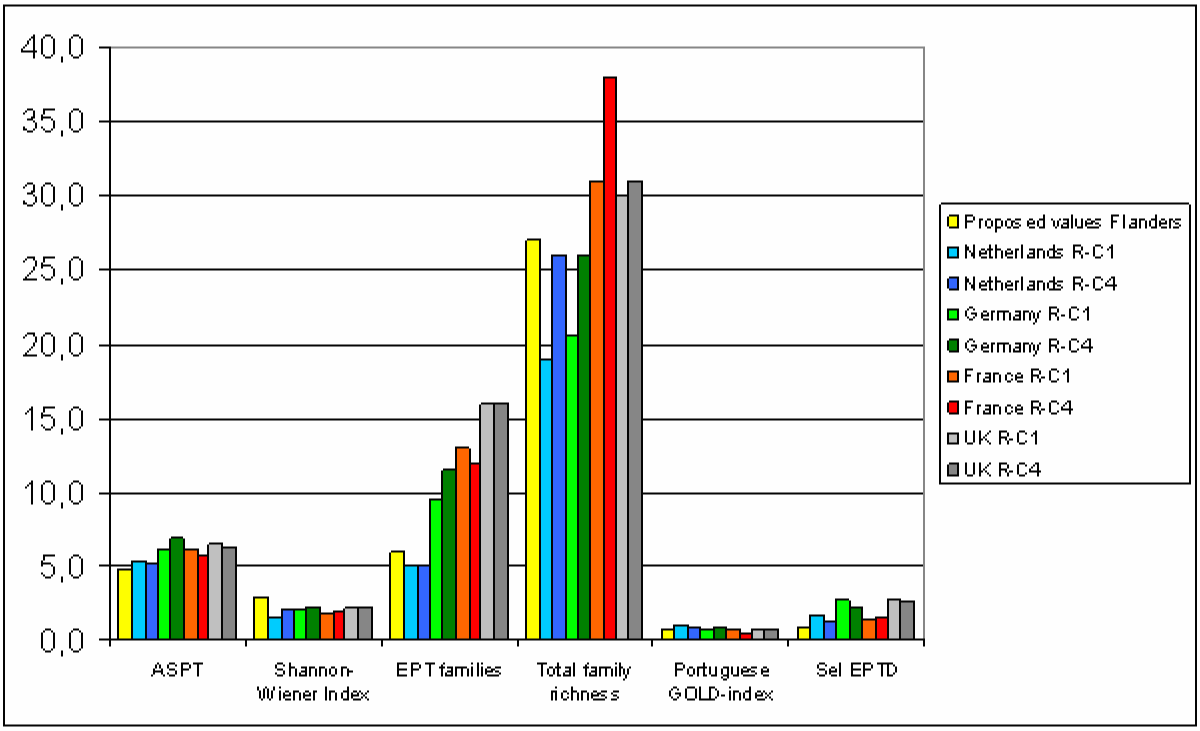

Figure 1. *Graphical comparison of metric reference values of Flanders (combined) and all neighbouring countries that contributed to the R-C1 or R-C4 intercalibration.*

In Figure 1, the proposed reference values for Flanders are graphically compared to the reference values reported by those neighbouring countries that contributed to the intercalibration for R-C1 and/or R-C4. These countries are the Netherlands, Germany, France and the UK. For the UK, these values are not the ones actually used for ICMi calculation because type-specific reference values were used instead.

These values were taken from the CIRCA website (http://forum.europa.eu.int/Members/irc/jrc/jrc_eewai/library), where they are available in the calculation sheets of the individual countries, located in the map Rivers - Central/Baltic GIG restricted → Macro-invertebrate intercalibration → MACROINVERTEBRATE DATA - JULY 2006.

It can be seen in Figure 1 that, although differences exist between metric values for all countries, the Flemish values are not systematically higher or lower in comparison to the other countries. The metric values that are relatively low for Flanders are ASPT, EPT families and Sel EPTD. These metrics are known to be highly associated with EPT taxa richness. In the Netherlands, EPT taxa are naturally rare (Van Riel, 2006). Among the cited countries, the Netherlands are most similar to Flanders from an ecological and a biogeographical point of view. The Flemish and Dutch lowland conditions result in predominantly low current velocities. It is therefore reasonable to assume that the situation in Flanders is very similar to the Netherlands for these three metrics. Among all countries compared in Figure 1, the Dutch data are most similar to the Flemish data for these metrics. For the other three metrics, no dramatic differences exist between Flanders and the other countries, except for the Shannon-Wiener index, which is slightly higher for Flanders. Furthermore, differences among metric reference values (in some cases higher, in some cases lower) between countries become less important when all metrics are combined into a single index. With all these considerations in mind, the proposed values can be considered as representative for reference status for the included national types.

6. Calculation of regression between MMIF and ICMi

6.1 Data processing

The ASPT values were subtracted by 2 prior to normalisation. Normalisation was carried out by dividing the metric values by the reference value for this metric. Subsequently, the ICMi (Murray-Bligh et al., 2006) was calculated and compared to the MMIF, for R-C1 and R-C4 separately and also for both types combined.

6.2 Data correlations

Regression lines between MMIF and ICMi were calculated. Regressions were calculated for R-C1 (Figure 2), R-C4 (Figure 3) and for all data combined (Figure 4). The R² values were in all three cases above 0.60: 0.685 for R-C1, 0.829 for R-C4 and 0.738 for the combined regression.

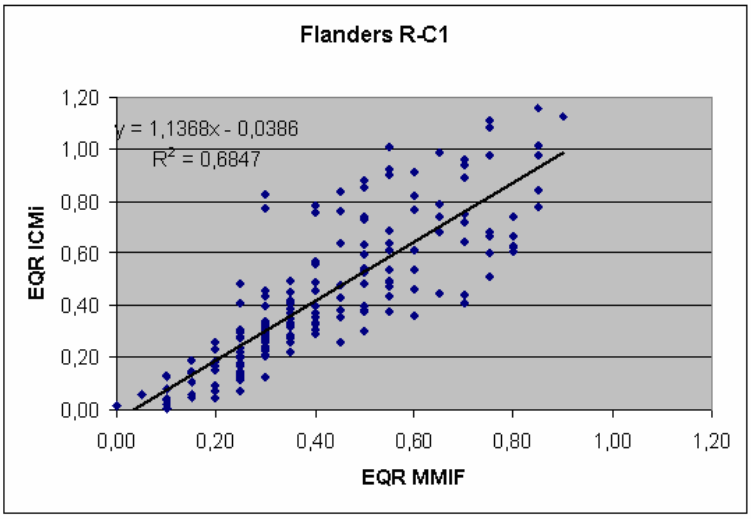

Figure 2. *Regression line for ICMi versus MMIF applied to Flemish data for R-C1.*

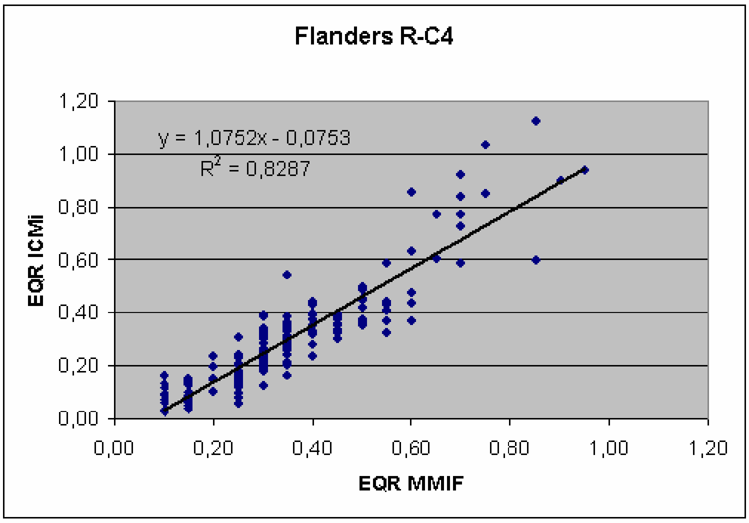

Figure 3. *Regression line for ICMi versus MMIF applied to Flemish data for R-C4.*

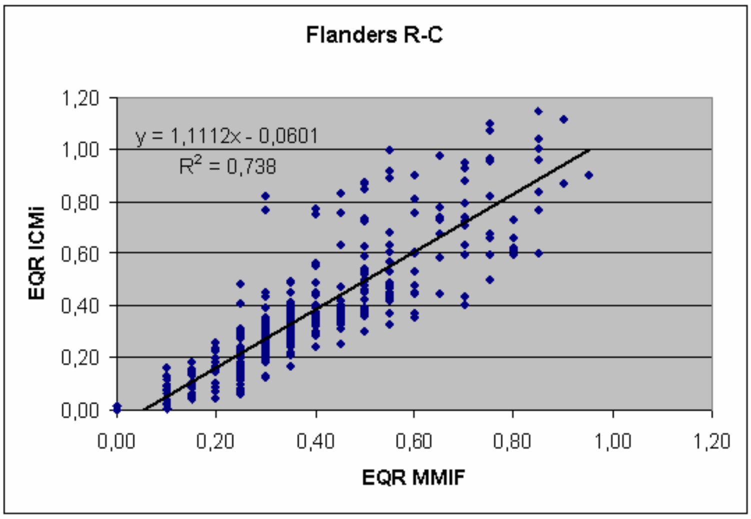

Figure 4. *Regression line for ICMi versus MMIF applied to Flemish data for R-C1 and R-C4 combined.*

6.3 Transformation of boundary values

The MMIF boundary values were transformed into ICMi values for the overall intercalibration (R-C1 and R-C4 combined) using the obtained regression equation. The results of this transformations are presented in Table 6.

Table 6. *Transformation of MMIF class boundary values into ICMi values for the combined intercalibration (including R-C1 and R-C4) using the Flemish reference values for ICMi metrics.*

Boundary	MMIF	EQR ICMi
high-good	0.80	0.829
good-moderate	0.60	0.607
moderate-poor	0.40	0.384
poor-bad	0.20	0.162

7. Alternative class boundaries for MMIF

7.1 Compliance with harmonisation band

For comparison of the class boundaries of different member states, the CB-GIG steering group calculated a harmonisation band. The national boundaries, when transformed into ICMi values, should be included in this band in order to be considered comparable to those of the other member states. For the high/good boundary, this interval is [0.88 – 0.98] and for the good/moderate boundary the interval is [0.71 - 0.81]. The originally proposed class boundaries for the MMIF index are 0.60 for good/moderate and 0.80 for high/good. These class boundaries, when transformed into ICMi values (Table 6), are below the harmonisation band for both high/good and good/moderate.

7.2 Distribution of MMIF values

Due to its calculation method using metric scores, the range of values of the MMIF is not continuous but takes a number of discrete values with an interval step of 0.05. For instance, the MMIF can be equal to 0.75 or 0.80 but not 0.77. This should be taken into account when establishing the boundary values.

7.3 Proposal to adjust MMIF class boundaries

In order to obtain boundary values that are comparable to the other boundary values, an alternative proposal is calculated. When the MMIF values of 0.70 and 0.90 are transformed according to the previously obtained regression calculation (for all types combined), the obtained values were 0.718 and 0.940, respectively. Both values fall within the respective harmonisation bands (Fig. 5).

In conclusion, if the Flemish boundary values for both high/good and good/moderate are raised with 0.10, these class boundaries result in ICMi values that are included in the CB-GIG harmonisation band. It is therefore proposed to set the boundary values for MMIF to 0.70 for good/moderate and to 0.90 for high/good.

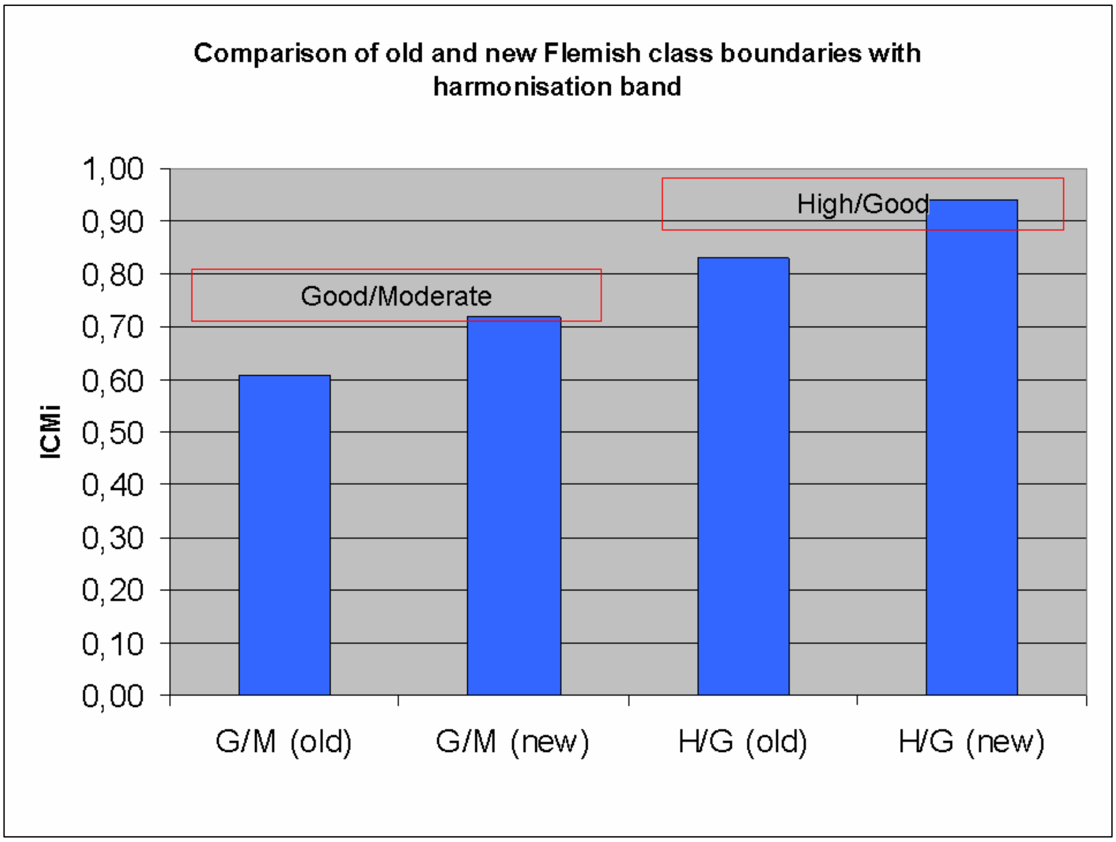

Figure 5. *Comparison of old and new MMIF boundary values transformed into ICMi values, with the CB-GIG harmonisation band for good/moderate (G/M) and high/good (H/G).*

8. Conclusion

This document describes the Flemish contribution to the CB-GIG intercalibration exercise for river macroinvertebrates. All required data, calculations and additional information are provided. The Flemish index, the MMIF, correlates well with the intercalibration index. The only difficulty was the lack of reference values, because Flanders does not have rivers representing reference conditions. This was overcome by using for each metric the 75th percentile of values from sites that are in high class according to the regional assessment method (MMIF) and subsequent evaluation and comparison to reference values of other member states. It is concluded that these values are an acceptable alternative to be used for calculating ICMi metrics. The proposed reference values can therefore be considered as suitable for comparing and harmonising class boundaries. After calculation of the regression between MMIF and ICMi, transformation of the originally proposed boundary values were below the harmonisation band. When adjusting the MMIF boundary values to 0.70 for good/moderate and to 0.90 for high/good, the regression results in ICMi values that are included within the CB-GIG harmonisation band. In conclusion, it is recommended to include these boundary values for the MMIF in the intercalibration decision.

9. References

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Appendix 1. List of macroinvertebrate taxa taken into account for the MMIF and their respective tolerance scores.

Taxon	TS
Plathelminthes	
Bdellocephala	5
Crenobia	7
Dendrocoelum	5
Dugesia	5
Phagocata	5
Planaria	6
Polycelis	6
Polychaeta	
Ampharetidae	3
Oligochaeta	
Aelosomatidae	2
Branchiobdellidae	2
Enchytraeidae	2
Haplotaxidae	4
Lumbricidae	2
Lumbriculidae	2
Naididae	5
Tubificidae	1
Hirudinea	
Cystobranchus	4
Dina	4
Erpobdella	3
Glossiphonia	4
Haementeria	4
Haemopis	4
Helobdella	4
Hemiclepsis	4
Hirudo	4
Piscicola	5
Theromyzon	4
Trocheta	4
Mollusca	
Acroloxus	6
Ancylus	7
Anisus	5
Anodonta	6
Aplexa	6
Armiger	6
Bathyomphalus	5
Bithynia	5
Bythinella	8
Corbicula	5
Dreissena	5
Ferrissia	7
Gyraulus	6
Hippeutis	6
Lithoglyphus	6
Lymnaea s.l.	5
Margaritifera	10
Marstoniopsis	5
Myxas	7
Physa s.s.	5
Physella	3
Pisidium	4
Planorbarius	5
Planorbis	6
Potamopyrgus	6
Pseudamnicola s.l.	5
Pseudanodonta	6
Segmentina	6
Sphaerium	4
Theodoxus	7
Unio	6
Valvata	6
Viviparus	6
Acari	
Hydracarina s.l.	5
Crustacea	
Argulidae	5
Asellidae	4
Astacidae	8
Atyidae	7
Cambaridae	6
Chirocephalidae	6
Corophiidae	5
Crangonyctidae	4
Gammaridae	5
Janiridae	5
Leptestheriidae	6
Limnadiidae	6
Mysidae	5
Palaemonidae	5
Sphaeromatidae	4
Talitridae	5
Triopsidae	6
Varunidae	4
Diptera	
Athericidae	7
Blephariceridae	7
Ceratopogonidae	3
Chaoboridae	3
Chironomidae:	
-non *thummi-plumosus*	3
-thummi-plumosus	2
Culicidae	3
Cylindrotomidae	3
Dixidae	6
Dolichopodidae	3
Empididae	3
Ephydridae	3
Limoniidae	4
Muscidae	3
Psychodidae	3
Ptychopteridae	3
Rhagionidae	3
Scatophagidae	3
Sciomyzidae	3
Simuliidae	5
Stratiomyidae	4
Syrphidae	1
Tabanidae	3
Thaumaleidae	3
Tipulidae	3
Megaloptera	
Sialis	5
Coleoptera	
Dryopidae	6
Dytiscidae	5
Elminthidae	7
Gyrinidae	7
Haliplidae	6
Hydraenidae	6
Hydrophilidae	5
Hygrobiidae	5
Noteridae	5
Psephenidae	6
Scirtidae	7
Hemiptera	
Aphelocheirus	8
Arctocorisa	5
Callicorixa	5
Corixa	5
Cymatia	6
Gerris s.l.	6
Glaenocorisa	5
Hebrus	6
Hesperocorixa	5
Hydrometra	6
Ilyocoris	5
Mesovelia	6
Micronecta	6
Microvelia	7
Naucoris	6
Nepa	6
Notonecta	5
Paracorixa	5
Plea	6
Ranatra	6
Sigara	5
Velia	7
Odonata	
Aeshna	6
Anax	6
Brachytron	7
Calopteryx	8
Cercion	7
Ceriagrion	7
Coenagrion	6
Cordulegaster	9
Cordulia	7
Crocothemis	7
Enallagma	7
Epitheca	7
Erythromma	7
Gomphus	7
Ischnura	6
Lestes	7
Leucorrhinia	7
Libellula	7
Nehalennia	7
Onychogomphus	7
Ophiogomphus	7
Orthetrum	7
Oxygastra	7
Platycnemis	7
Pyrrhosoma	7
Somatochlora	7
Sympecma	7
Sympetrum	7
Ephemeroptera	
Baetis	6
Brachycercus	7
Caenis	6
Centroptilum	7
Cloeon	6
Ecdyonurus	9
Epeorus	10
Ephemera	8
Ephemerella	8
Ephoron	9
Habroleptoides	8
Habrophlebia	8
Heptagenia	10
Isonychia	7
Leptophlebia	8
Metreletus	7
Oligoneuriella	7
Paraleptophlebia	8
Potamanthus	8
Procloeon	7
Rhitrogena	10
Siphlonurus	7
Trichoptera	
Beraeidae	9
Brachycentridae	9
Ecnomidae	6
Glossosomatidae	9
Goeridae	9
Hydropsychidae	6
Hydroptilidae	8
Lepidostomatidae	9
Leptoceridae	8
Limnephilidae	8
Molannidae	9
Odontoceridae	9
Philopotamidae	6
Phryganeidae	9
Polycentropodidae	6
Psychomyidae	7
Rhyacophilidae	8
Sericostomatidae	8
Plecoptera	
Amphinemura	9
Brachyptera	10
Capnia	10
Chloroperla	10
Dinocras	10
Isogenus	10
Isoperla	10
Leuctra	9
Marthamea	10
Nemoura	8
Nemurella	8
Perla	10
Perlodes	10
Protonemura	9
Rhabdiopteryx	10
Taeniopteryx	10

Appendix 2. Scoring criteria for MMIF calculation for Flemish rivers.

Type	Bk	BkK	Bg	BgK	Rk	Rg	Rzg	P
Score	**Total number of taxa**							
0	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5	≤ 5
1	≤ 12.25	≤ 12.25	≤ 13.25	≤ 13.25	≤ 13.75	≤ 14.25	≤ 14.75	≤ 13
2	≤ 19.5	≤ 19.5	≤ 21.5	≤ 21.5	≤ 22.5	≤ 23.5	≤ 24.5	≤ 21
3	≤ 26.75	≤ 26.75	≤ 29.75	≤ 29.75	≤ 31.25	≤ 32.75	≤ 34.25	≤ 29
4	> 26.75	> 26.75	> 29.75	> 29.75	> 31.25	> 32.75	> 34.25	> 29
Score	**Number of EPT taxa**							
0	0	0	0	0	0	0	0	0
1	≤ 1.75	≤ 2	≤ 2	≤ 2.25	≤ 2.25	≤ 2.25	≤ 2.5	≤ 2
2	≤ 3.5	≤ 4	≤ 4	≤ 4.5	≤ 4.5	≤ 4.5	≤ 5	≤ 4
3	≤ 5.25	≤ 6	≤ 6	≤ 6.75	≤ 6.75	≤ 6.75	≤ 7.5	≤ 6
4	> 5.25	> 6	> 6	> 6.75	> 6.75	> 6.75	> 7.5	> 6
Score	**Number of sensitive taxa (other than EPT)**							
0	0	0	0	0	0	0	0	0
1	≤ 2.25	≤ 2.25	≤ 2.5	≤ 2.5	≤ 3	≤ 3	≤ 3	≤ 2.5
2	≤ 4.5	≤ 4.5	≤ 5	≤ 5	≤ 6	≤ 6	≤ 6	≤ 5
3	≤ 6.75	≤ 6.75	≤ 7.5	≤ 7.5	≤ 9	≤ 9	≤ 9	≤ 7.5
4	> 6.75	> 6.75	> 7.5	> 7.5	> 9	> 9	> 9	> 7.5
Score	**Shannon-Wiener Index**							
0	≤ 0.2	≤ 0.2	≤ 0.2	≤ 0.2	≤ 0.2	≤ 0.2	≤ 0.2	≤ 0.2
1	≤ 1.025	≤ 1.025	≤ 1.025	≤ 1.025	≤ 1.025	≤ 1.025	≤ 1.025	≤ 1.025
2	≤ 1.85	≤ 1.85	≤ 1.85	≤ 1.85	≤ 1.85	≤ 1.85	≤ 1.85	≤ 1.85
3	≤ 2.675	≤ 2.675	≤ 2.675	≤ 2.675	≤ 2.675	≤ 2.675	≤ 2.675	≤ 2.675
4	> 2.675	> 2.675	> 2.675	> 2.675	> 2.675	> 2.675	> 2.675	> 2.675
Score	**Mean tolerance score**							
0	≤ 2	≤ 2	≤ 2	≤ 2	≤ 2	≤ 2	≤ 2	≤ 2
1	≤ 3.125	≤ 3.125	≤ 3.125	≤ 3.125	≤ 3.125	≤ 3.125	≤ 3.125	≤ 3.075
2	≤ 4.25	≤ 4.25	≤ 4.25	≤ 4.25	≤ 4.25	≤ 4.25	≤ 4.25	≤ 4.15
3	≤ 5.375	≤ 5.375	≤ 5.375	≤ 5.375	≤ 5.375	≤ 5.375	≤ 5.375	≤ 5.225
4	> 5.375	> 5.375	> 5.375	> 5.375	> 5.375	> 5.375	> 5.375	> 5.225