Protocol for Water Quality Criteria Derivation for the protection of Aquatic Life in Brazil

Water Quality Criteria (WQC)

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Background information

This document was produced during the workshop “Strategies to define environmental criteria for the protection of human health and the ecosystem”[3], satellite activity of the IX Congresso Brasileiro de Mutagênese, Carcinogênese e Teratogênese Ambiental, promoted by the Sociedade Brasileira de Mutagênese, Carcinogênese e Teratogênese Ambiental (SBMCTA), supported by scientific societies[4], universities[5] and governmental agencies[6] and sponsored by scientific societies[7] and companies[8].

It is a proposal of a method to establish water quality criteria for the protection of aquatic life. The authors worked in one of the three working groups formed in the workshop. The other groups discussed method to define water quality criteria for human consumption and how to prioritize substances to be regulated.

The foreign researchers[9] presented and discussed experiences and methodologies adopted by its home institutes. Brazilian researchers[10] presented how the national criteria have been defined. After the presentations the workshop promoted a debate among the participants where national studies were discussed. It culminated on the proposal of a specific derivation method for Brazil and eventually for other countries of Latin America.

In Brazil it is common to use criteria or standards defined by developed countries in North America or Europe, or those from international agencies. There is a lack regarding methods to define standards used in Brazilian laws. In most of the cases the existing criteria are copied from different organizations or countries, with differences of climate, temperature, type of water and soil, besides of the differences in technological treatment and analytical capacities and in public management policies.

[3] The workshop was performed during the period of November, 16 to 20 2009, in Jundiaí, São Paulo, Brazil.
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Among several agencies that define their own criteria we can observe great differences for the same substances. Among the parameters used to define those criteria, there are variations between: the calculation algorithm, how the priority substance is defined, how are quantitative risks estimated, the criteria used for their carcinogenic classification or other hazard identification, which uncertainty factors are considered, the exposure scenarios, the acceptable risk levels and others. The use of different variables and calculations may generate, consequently, different numbers with the same initial goal of protection of the human health or biota[11]. The adoption of a list of substances and criteria from different countries and their use in our legal system can lead to conflicts and inconsistency in norms. For example, a substance may be considered carcinogenic for the water regulation and not carcinogenic for soil or food regulations, depending from where the criterion was imported.

Argentina, in a pioneer effort in Latin America, defined its own list of priority substances and its own calculation algorithms for natural waters. The main uses of water were considered, taking into account the country's characteristics and needs. Even more important they have a permanent group that follows the literature and reviews constantly the adopted values. All the information is presented in a transparent way and can be assessed at the Under-Secretariat of Water Resources website[12].

The derivation of criteria is a continuous process because toxicological values, the parameters used in algorithms, as well as the algorithms themselves, change with the advance of science. So, it seems clear that Brazil needs to develop its own rules for the derivation of environmental and occupational criteria. Therefore, a scientific discussion with the stakeholders of this process might be extremely important to generate rules to criteria establishment.

[11] Stouten et al. Reassessment of Occupational Exposure Limits. **American Journal of Industrial Medicine** 51:407-418 (2008)

[12] Secretaria de Obras Públicas. Subsecretaria de Recursos Hídricos. ***Calidad del Agua***. Disponível em: <http://www.hidricosargentina.gov.ar/CalidadAgua.html>. Acesso em: 30/07/2008.

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LIST OF ABBREVIATIONS

AF - Assessment Factor

BLM – Biotic Ligant Model

EC - European Community

EC_{10} - Effect Concentration for 10% of the individuals in a toxicity test

EC_{50} - Effect Concentration for 50% of the individuals in a toxicity test

EQS - Environmental Quality Standard

HC_5 - Hazardous Concentration for 5% of the species

IC_{50} - Inhibition Concentration to 50% of the species

IC_{25} - Inhibition Concentration to 25% of test organisms

LC - Lethal Concentration

LC_{50} - Lethal Concentration for 50% of the individuals in a toxicity test

LOEC - Lowest Observed Effect Concentration

NOEC - No Observed Effect Concentration in a toxicity test

PNEC - Predicted No-Effect Concentration

PWQC - Preliminary Water Quality Criterion

PSQG - Preliminary Sediment Quality Criterion

QSAR - Quantitative Structure Activity Relationship

SQC - Sediment Quality Criteria

WQC - Water Quality Criteria

Glossary

Acute effect: deleterious effect caused by toxic agents on test organisms after a brief exposure to the toxic agent.

Assessment factor: numerical value applied to the ecotoxicological data obtained in a bioassay in order to decrease the uncertainty of the value set to protect the aquatic life.

Benthic community: a community of organisms associated to the bottom of a water body.

Bioaccumulation: a process by which chemical substances are ingested and retained by organisms, either from the water or through consumption of food containing the substances.

Bioassay: laboratory test used to detect and determine the inherent capacity of a toxic agent to cause deleterious effects on living organisms.

Chronic effect: deleterious effect caused by toxic agents on test organisms after an exposure period that could occur over the whole life cycle of the organism or over a part of it.

EC_{50} or LC_{50}: half maximum effective or lethal concentration; nominal concentration at the beginning of an essay of a toxic agent that evokes an acute effect or response (lethality or immobility) in 50% of the test organisms during a defined exposure period.

Lowest Observed Effect Concentration (LOEC): the lowest nominal concentration of a chemical stressor that causes a statistically significant deleterious effect on organisms during the period of exposure under the test conditions.

Non-observed effect concentration (NOEC): the highest nominal concentration of a chemical stressor that does not cause a statistically significant deleterious effect on organisms during the period of exposure under the test conditions.

Pelagic organisms: a community of organisms which swims freely in the liquid medium.

Quality Criteria: value fixed for a certain variable that will render a body of water suitable for its designated use with a certain confidence level if it is maintained within the maximum limits (or minimum limits, depending of nature of the variable**).** The criteria can also be narrative.

Quality Standards: a group of parameters and their limits (e.g., concentration of contaminants) against which the results of the analysis of a sample are compared in order to evaluate the quality of the water for a specific use. These criteria are based solely on data and scientific judgments that evaluate the risk for the aquatic communities and the damage caused by exposure to a known concentration of a certain pollutant.

Quantitative structure-activity relationships (QSAR): regression equations linking chemical structure and biological (ecological, toxicological or pharmacological) activity in a quantitative manner for a series of compounds, thus making possible the prediction of the toxicity of a structurally related compound.

Toxicity: an intrinsic property of a substance capable of causing adverse effects on living organisms.

Trophic Level: position of an organism within a food chain or food web.

1. Introduction

As Brazil does not have an established methodology to derive water quality criteria, this protocol provides a first insight on the development of a methodology for the derivation of water quality criteria for the protection of aquatic life.

The criteria are numerical or narrative values of a quality parameter based on scientific information and are aimed at protecting the biotic components involved in the different uses of a water body.

The criteria are not legally enforceable values. They are the basis to decision makers to establish water quality standards or regulations. They are intended to be applicable to all water bodies in Brazil, but their application to a particular water body should consider the natural water body characteristics. They can also be used (adopted or modified) to establish water quality objectives to protect a particular water body within specific management plans.

The derivation protocol must be considered a continuous process that should be revised if new data are available, especially for compounds with limited data.

It is important to point out that the suggested methodology considers endpoints or effects on the aquatic community such as survival, light emission inhibition, growth, embryo-larvae development, fertilization and reproduction. Bioaccumulation, alterations of the endocrine system or genotoxicity still need to be considered in the future.

2. Objective of water quality criteria

The proposed Water Quality Criteria (WQC) intends to protect all forms of aquatic life regarding freshwater or marine ecosystems from adverse effects of chemicals. To achieve that, a minimum data set requirement has been established based on the methodology used in the EU (LEPPER, 2005).

3. Data requirements

The data base for each substance for which an environmental quality standard is to be derived should be published in peer reviewed journals using standardized protocols. Data generated with local or autochthonous species will have priority.

Table 1 describes some of the internationally accepted test criteria that could be considered to assess new or existing chemicals. Certain factors that could affect the toxicity of substances, like hardness, organic carbon content, pH should be considered in the analysis of the toxicological data, if available.

Because toxicity of some metals depends on water hardness, the effect concentrations of toxicity tests at different hardness levels can be adjusted (or normalized) to a hardness of 50mg/L prior to the derivation of the water quality criteria (STEPHAN et al., 1985). For relationships based on other water quality characteristics such as pH or dissolved organic carbon (DOC) a different approach might be used. The Biotic Ligand Model (BLM) has proved to better assess the effects of hardness, pH and DOC levels on Copper toxicity (USEPA, 2007).

Quantitative structure–activity relationships (QSARs) are useful tools for predicting acute toxicity of chemicals when little or no empirical data are available (Auer et al., 1990). The QSAR method consists of regression equations relating toxicological endpoints (e.g., LC_{50}, EC_{50}, IC_{50}, NOECs) to a physicochemical property (e.g., the octanol-water coefficient or K*o/w*) within a class of compounds. Besides that, Read-Across Models make use of empirical data for structurally similar substances. The rationale of these methodologies are based on the on the assumption that structurally compounds should behave in a toxicologically similar manner. Thus, the QSAR methods can be used to predict the toxicity of a structurally related compound.

Table1: Standardized toxicological test protocols to derive water quality criteria for pelagic and benthic organisms

Test Organism	Effect Endpoint	Exposure	Result expressed as	Classification (*)
Water column				
Microcrustacea	Survival	24 to 96 hours	LC_{50}	short term
	Reproduction	7 to 21 days	NOEC	long term
Microalgae	Biomass inhibition	96 hours	IC_{25}	long term
Bacteria	Inhibition of light emission	5 to 15 minutes	EC_{50}	long term
Equinodermata	Fertilization	24 hours	EC_{50}	short term
	Embryo-larvae development	24 hours	CENO	long term
Fish	Survival	96 hours	LC_{50}	short term
	Growth	21 days	IC_{25}	long term
Sediment				
Amphipods	Survival	4 to 7 days	LC_{50}	short term
	Survival Growth	10 or more days	LC_{50} EC_{50}	long term
Larvae of insects	Survival Growth	10 to 14 days	LC_{50}	Long term
Polichaetes	Survival Growth	20 to 28 days	LC_{50} EC_{50}	long term

(*) The definition of long-term and short-term test should be further discussed since it is not clearly stated in the European document (ECB, 2003)

4. Basis for choosing the methodology

We chose the Assessment Factor (AF) method for the derivation of quality criteria as it is a feasible and internationally applied approach. Additionally, the magnitude of the factors can be easily reduced, if new toxicological data are available. The AFs have been found particularly useful since the pool of data from which to predict ecosystem effects from most substances is very limited and only short-toxicity data are available (OECD, 1992 ; ECB, 2003). In applying such factors, the intention is to predict a concentration bellow which an unacceptable effect will most likely not occur. The magnitude of the Assessment Factor depends on the confidence with which a water quality criterion can be derived from the available data. This confidence increases as more data on the toxicity to organisms of different trophic levels, taxonomic groups and lifestyles representing various feeding strategies are available.

If the minimum data set requirements are met after literature search a criterion is derived by dividing the lowest available data by an assessment factor already defined in the methodology (Figure 1).

In the case that there is not sufficient data to do the derivation of criteria for pelagic organism, the missing data could be predicted by appropriate Quantitative Structure Activity Relationship (QSAR) predictive models. If the tested values are lower than the predicted value, a criterion can be derived using the methodology described in section 5, as there is sufficient evidence that the toxicological data available are within the most sensitive group. If the tested values are higher than the predicted value, the criterion derived is considered a Preliminary Water Quality Criterion (PWQC). If no data is available concerning the toxicity of certain substance, those values can be predicted by the QSAR model (fish, invertebrates, algae). The lowest predicted value divided by an assessment factor of 1000 for freshwater or a factor of 10,000 for marine species is also considered as a preliminary value (PWQC).

Nevertheless, it must be emphasized that QSAR prediction is quite developed for organic compounds, but not for other toxics such as metals, and therefore toxicity data for metals cannot be predicted for the moment.

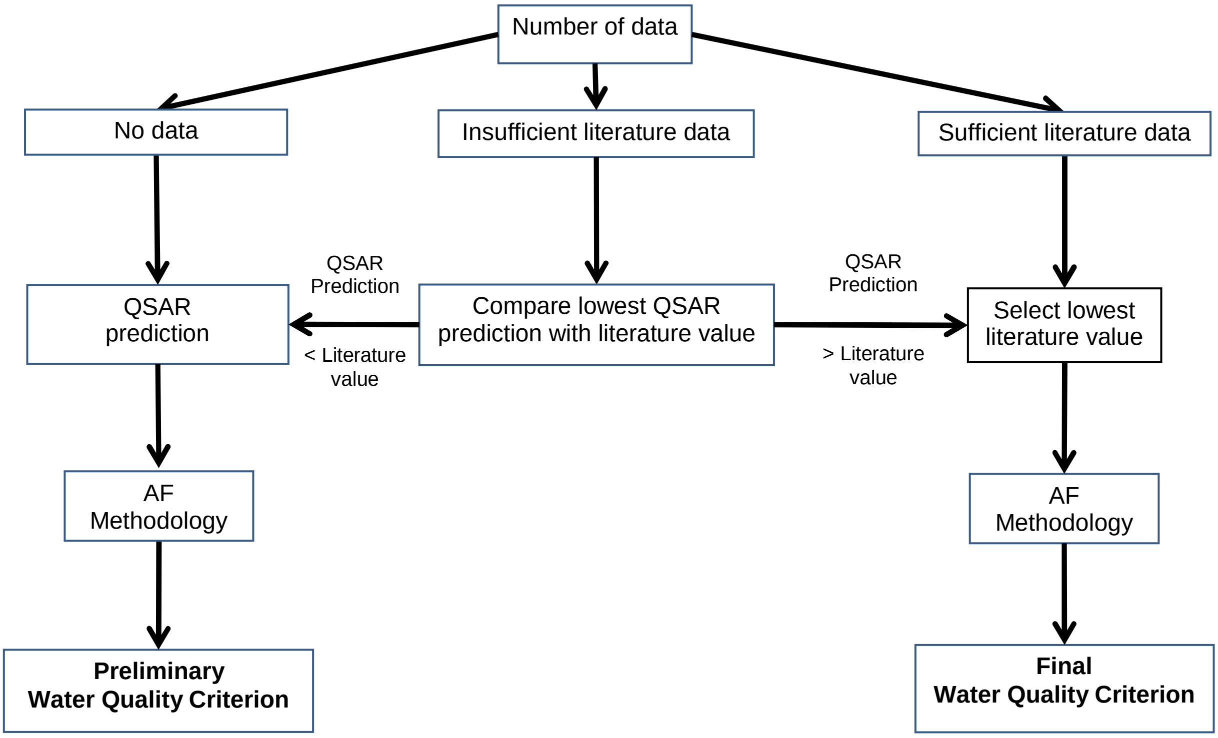

Figure 1: Operational sequence to derive water quality criteria for the protection of aquatic life.

If enough data is available (a minimum of 8 chronic data representing three different trophic levels), a sensitive distribution could be used to estimate a hazard concentration HC_5 that is intended to protect 95% of the species. In this case, the HC_5 divided by a factor of 5 can be used as an alternative method to derive the water quality criteria.

5. Derivation of water quality criteria for the protection of aquatic life

Because fresh water and marine water environments have different physicochemical properties, criteria for these environments are derived separately. Pelagic and benthic organisms are considered separately as well, since the bioavailability of contaminants in sediments differs from that in water.

5.1. Protocol for the derivation of WQC for protection of the pelagic community

5.1.1 Protocol for the derivation of WQC for protection of the pelagic community living in freshwaters

A Criterion for fresh water is to be derived if the following data requirements are met in Table 2:

Table 2: Assessment factors to derive a quality criteria for freshwater

Data set	Assessment factor (AF)
Long-term NOECs from at least three species (fish, invertebrates, algae) representing three trophic levels	10 [(a)]
Two long-term NOECs from species representing different trophic levels (fish and/or invertebrates and/or algae)	50 [(b)]
One long-term NOECs (either fish or invertebrates)	100 [(c)]
At least one short-term $L(E)C_{50}$ from each of three trophic levels of the base set (fish, invertebrates, algae)	1000 [(d)]

Notes:

(a) AF 10 will normally only be applied when long-term toxicity NOECs are available from at least 3 species across 3 trophic levels. A factor of 10 cannot be decreased on the basis of laboratory studies. If it is possible to determine that the most sensitive species to a specific contaminant has been examined , i.e. that a further long-term NOEC from a different taxonomic group would not be lower than the data already available (particularly important if the substance does not have a potential to bioaccumulate). In those circumstances, a factor of 10 applied to the lowest NOEC from only two species would also be appropriate. If it is not possible to make this judgment, then an AF of 50 should be applied.

(b) AF 50 applies to the lowest of 2 NOECs covering different trophic levels when such NOECs have been generated covering that level showing the lowest L(E)C50. AF 50 applies also to the lowest of 3 NOECs covering different trophic levels when such NOECs have not been generated from that level showing the lowest L(E)C50. This should however not apply in cases where the acutely most sensitive species has an L(E)C50 value lower than the lowest NOEC value. In such cases the PNEC might be derived by using an assessment factor of 100 to the lowest L(E)C50 of the short-term tests.

(c) AF 100 applies to a single long-term NOEC (fish or *Daphnia*) if this NOEC was generated for the trophic level showing the lowest short-term $L(E)C_{50}$. If the available NOEC is from a species which does not have the lowest $L(E)C_{50}$, it cannot be regarded as protective of the other more sensitive species. Therefore the effects assessment is based on the short-term data with an AF of 1000. However, the resulting PNEC based on short-term data may not be higher than the PNEC based on the available NOEC.

AF 100 applies also to the lowest of 2 NOECs covering different trophic levels when such NOECs have not been generated from that showing the lowest $L(E)C_{50}$. This should however not apply in cases where the acutely most sensitive species has an $L(E)C_{50}$ value lower than the lowest NOEC value. In such cases the PNEC might be derived by using an assessment factor of 100 to the lowest $L(E)C_{50}$ of the short-term tests.

(d) The assessment factor 1000 is a conservative and protective factor. For a given substance there may be evidence that the factor 1000 is too high or too low. In these circumstances it may be necessary to vary this factor, leading to a raised or lowered assessment factor depending on the available evidence. However, variation from a factor of 1000 should not be regarded as normal and should be fully supported by accompanying evidence. Except for substances with intermitent releases, under no circumstances should a factor lower than 100 be used in deriving a PNEC from short-term toxicity data.

If there are only QSAR predictions for three trophic levels (fish, invertebrates, algae), the lowest value is divided by an assessment factor of 1000. The obtained value is considered a preliminary PWQC.

Data from field studies can be considered when defining local water quality criteria or when establishing water quality objectives.

5.1.2 Protocol for the derivation of water quality criteria for pelagic organisms living in marine and brackish water

A Criterion for marine and brackish water is to be derived if data requirements shown in Table 3 are met:

Table 3: Assessment factors to derive quality criteria for saltwater and brackish water

Data set	Assessment factor (AF)
Lowest long-term NOECs from three freshwater or saltwater species (normally algae land/or crustaceans and/or fish) representing three trophic levels plus 2 long-term NOECs from additional marine taxonomic groups (e.g., echinoderms, molluscs)	10
Two long-term NOECs from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish) plus 1 long-term NOEC from an additional marine taxonomic group (e.g., echinoderms, molluscs)	50
Lowest long-term NOECs from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels	100 [(a)]
Two long-term NOECs from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish)	500 [(b)]
One long-term NOEC (from freshwater or saltwater crustacean reproduction or fish growth studies)	1000 [(c)]
Lowest short-term $L(E)C_{50}$ from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels, plus 2 additional marine taxonomic groups (e.g. echinoderms, molluscs)	1000
Lowest short-term $L(E)C_{50}$ from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels	10000 [(d)]

Notes:

General: Evidence for varying the assessment factor should in general include a consideration of the availability of data from a wider selection of species covering additional feeding strategies/ life forms/ taxonomic groups other than those represented by the algal, crustacean and fish species (such as echinoderms or molluscs). This is especially the case, where data are available for additional taxonomic group representative of marine species.

(a) An assessment factor of 100 will be applied when longer-term toxicity NOECs are available from three freshwater or saltwater species (algae, crustaceans and fish) across three trophic levels. The assessment factor may be reduced to a minimum of 10 in the following situations:

- where short-term tests for additional taxonomic groups representing marine species (for example echinoderms or molluscs) have been carried out and indicate that these are not the most sensitive group, and it has been determined with a high probability that long-term NOECs generated for these species would not be lower than that already obtained.
- where short-term tests for additional taxonomic groups (for example echinoderms or molluscs) have indicated that one of these is the most sensitive group and a longer-term NOEC test has been carried out for that species. This will only apply when it has been determined with a high probability that additional NOECs generated from other taxa will not be lower than the NOECs already available.

A factor of 10 cannot be decreased on the basis of laboratory studies only.

(b) An assessment factor of 500 applies to the lowest of two NOECs covering two trophic levels (freshwater or saltwater algae and/or crustacean and/or fish) when such NOECs have been generated covering those trophic levels showing the lowest $L(E)C_{50}$ in the short-term tests with these species. Consideration can be given to lowering this factor in the following circumstances.

- It may sometimes be possible to determine with a high probability that the most sensitive species covering fish, crustacea and algae has been examined, that is that a further longer-term NOEC from third taxonomic group would not be lower than the data already available. In such circumstances an assessment factor of 100 would be justified. A reduced assessment factor (to 100 if only one short-term test, or to 50 if two short-term tests on marine species are available) applied to the lowest NOEC from only two species may be appropriate where:
- Short-term tests for additional species representing marine taxonomic groups (for example echinoderms or molluscs) have been carried out and indicate that these are not the most sensitive group, and;
- It has been determined with a high probability that long-term NOECs generated for these marine groups would not be lower than that already obtained. This is particularly important if the substance does not have the potential to bioaccumulate. An assessment factor of 500 also applies to the lowest of three NOECs covering three trophic levels, when such NOECs have not been generated from the taxonomic group showing the lowest $L(E)C_{50}$ in short-term tests. This should, however, not apply in the case where the acutely most sensitive species has an $L(E)C_{50}$ value lower than the lowest NOEC value. In such cases the PNEC might be derived by applying an assessment factor of 1000 to the lowest $L(E)C_{50}$ in the short-term tests.

(c) An assessment factor of 1000 applies where data from a wider selection of species are available covering additional taxonomic groups (such as echinoderms or molluscs) other than those represented by algal, crustacean and fish species; if at least data are available for two additional taxonomic groups representative of marine species.

An assessment factor of 1000 applies to a single long-term NOEC (freshwater or saltwater crustacean or fish) if this NOEC was generated for the taxonomic group showing the lowest $L(E)C_{50}$ in the short-term algae, crustacean or fish tests.

If the only available long-term NOEC is from a species which does not have the lowest $L(E)C_{50}$ in the short-term tests, it cannot be regarded as protective of other more sensitive species using the assessment factors available. Thus, the effects assessment is based on the short-term data with an assessment factor of 10,000. However, normally the lowest PNEC should prevail.

An assessment factor of 1000 applies also to the lowest of the two long-term NOECs covering two trophic levels (freshwater or saltwater algae and/or crustacean and/or fish) when such NOECs have not been generated from that showing the lowest $L(E)C_{50}$ of the short-term tests. This should not apply in cases where the acutely most sensitive species has an $L(E)C_{50}$-value lower than the lowest NOEC value. In such cases the PNEC might be derived by applying an assessment factor of 1000 to the lowest $L(E)C_{50}$ of the short-term tests.

(d) The use of a factor of 10,000 on short-term toxicity data is a conservative and protective factor and is designed to ensure that substances with the potential to cause adverse effects are identified in the effects assessment. It assumes that each of the identified uncertainties described above makes a significant contribution to the overall uncertainty.

For any given substance there may be evidence that this is not so, or that one particular component of the uncertainty is more important than any other. In these circumstances it may be necessary to vary this factor.

This variation may lead to a raised or lowered assessment factor depending on the evidence available. Except for substances with intermittent release, under no circumstances should a factor lower than 1000 be used in deriving a $PNEC_{water}$ for saltwater from short-term toxicity data.

Evidence for varying the assessment factor could include one or more of the following:

- Evidence from structurally similar compounds which may demonstrate that a higher or lower factor may be appropriate;
- Knowledge of the mode of action as some substances by virtue of their structure, may be known to act in a non-specific manner. A lower factor may therefore be considered. Equally a known specific mode of action may lead to a raised factor.
- The availability of data from a variety of species covering the taxonomic groups of the base set species across at least three trophic levels. In such a case the assessment factors may only be lowered if multiple data points are available for the most sensitive taxonomic group (i.e. the group showing acute toxicity more than 10 times lower than for the other groups).

There are cases where there will not be a complete short-term data set even for freshwater algae, crustacean and fish species, for example for substances which are produced at < 1 t/yr. In these situations, the only data may be short-term $L(E)C_{50}$ data for *Daphnia*. In these exceptional cases, the PNEC should be calculated with a factor of 10,000.

If there are only QSAR predictions for three trophic levels (fish, invertebrates, algae) the lowest value is divided by an assessment factor of 10,000. The obtained value is considered a preliminary value (PWQC).

5.2 Protocol for the derivation of water quality criteria for protection of the benthic community

If three long-term toxicity tests (NOEC) with species representing different living and feeding conditions of sediment organisms are available, a quality criterion for fresh water marine or brackish sediment is calculated as follows:

Sediment Quality Criteria (SQG) [mg/kg] = lowest NOEC or EC_{10} [mg/kg] / 10

If less than three long-term toxicity tests are available, a preliminary quality criterion for fresh water sediment is calculated as follows:

Preliminary SQG [mg/kg] = lowest NOEC or EC_{10} [mg/kg] / AF

The magnitude of the assessment (AF) factors is specified in the table 4.

Table 4: Assessment factors to derive a quality criterion for benthic (sediment) living organisms.

Available sediment test result	Assessment factor
Three long term tests (NOEC or EC_{10}) with species* representing different living and feeding conditions	10
Two long term tests (NOEC or EC_{10}) with species* representing different living and feeding conditions	50
One long term test (NOEC or EC_{10})	100

*Freshwater and marine/brackish criteria should be derived separately with species belonging to each specific habitat

In case there is only a short term effect data base for benthic organisms, a preliminary SQG can be derived on the basis of both short term-effects data (applying an assessment factor of 1000 to the lowest level), and the equilibrium partitioning approach. The final value should be selected by expert judgment taking all available information into account.

If enough data is available, a sensitive distribution could be used to estimate a hazard concentration HC_5 that is intended to protect 95% of the species. In this case the HC_5 divided by a factor of 5 can be used as an alternative method to derive the sediment quality criterion.

Due to the high level of uncertainty, sediment quality criteria should be considered as indicatives.

6. Future needs

Further discussions will be necessary to address pending issues such as how to deal with emergent compounds like endocrine disruptors, pharmaceutical and cosmetic compounds.

Bioaccumulation of certain substances in living organisms must also be considered in the derivation of water and sediment quality criteria for the protection of aquatic life, as this phenomenon could pose serious adverse effects on aquatic communities.

To that end, it is very important to have a permanent working group that can keep the derivation protocol updated with new toxicity data and that can periodically review the derivation process to adequate it to the particular conditions of Latin American aquatic ecosystems.

With regard to sediments, once the Sediment Quality Criteria (SQC) has been derived, the values need to be corrected to the sediment characteristics (grain size, organic matter, TOC concentrations) of the water body where the criterion is to be applied, but further discussions will be necessary to define the methodology to do the corrections.

In Brazil there are few standard species that can be adopted to evaluate the toxicity of chemical substances in long-term tests. It will be necessary to train local laboratories to perform these tests or to increase the number of species available to be used as test organisms, especially for marine sediments.

It is also necessary to validate the available techniques for intentional contamination of sediments to evaluate the toxicity of chemicals to benthic organisms. It would also be desirable to stimulate inter-laboratory studies and to make laboratories adopt them in order to improve the quality of data obtained in Brazil. Courses about how to perform and interpret generated reports may be estimulated. .

7. New developments in Risk Assessment

Given the huge number of chemicals released into the environment and existing time and budget constraints, there is a need to prioritize chemicals for risk assessment and monitoring. Therefore, a new risk assessment procedure has been suggested recently, with regard to the specific needs of emerging substances. It has already been published and applied to an independent dataset (von der Ohe et al., 2011) and will be briefly discussed here.

Categorization into action categories

This approach considers data gaps of various kinds, by classifying compounds into different categories of action according to the assessment required (Table 5), which allows water managers to focus on the next steps (e.g. derivation of Quality Standards (QS), improvement of analytical methods, etc.). The priority within each category is evaluated based on two indicators, the *Frequency of Exceedance* and the *Extent of Exceedance* of Predicted No-Effect Concentrations. These two indictors are based on maximum environmental concentrations (MEC), rather than the commonly used statistically based averages (Predicted Environmental Concentration, PEC), and compared to the lowest acute-based (PNECacute) or chronic-based thresholds (PNECchronic).

Table 5: Overview of the requirements and actions needed for the six Categories (Cat.) used in the classification approach.

Cat.	Requirement	Action needed
1	Toxicity data is sufficient for the derivation of an EQS & Observed exposure level (MEC_{95}) indicates a potential hazard	Derivation of EQS & Inclusion in the monitoring program
2	Comprehensive hazard assessment & Few observations in the environment	Screening study to inform about the risk
3	Hazard assessment is based on predicted toxicity (P-PNEC) & More than 20 sites with analytical measurements above the LOQ	Perform a rigorous effect assessment where needed
4	Lowest PNEC based on experimental data or predictions & Mostly measured below the LOQ which exceeds the safety threshold	Improve analytical method for compounds of potential risk
5	Hazard is based on predicted toxicity (P-PNEC) & Few observations in the environment	Perform a rigorous hazard assessment and a screening study
6	Toxicity data is sufficient for the derivation of an EQS & Evidence that MEC_{95} do not pose any harm to ecosystem & human health	Monitoring efforts for these compounds could be reduced

This allows focusing on distinct actions according to the classification of the substance. A few indicators were defined that allow classification of all substances into one of these categories. For this purpose, a decision tree is used to classify compounds into one of two groups, until each chemical is classified (Fig. 2). Especially compounds in Category 1 would be of interest for the derivation of Quality Criteria. However, also category 2 (Screening monitoring) might be of interest for Brazil, in order to identify compounds of relevance for QS derivation.

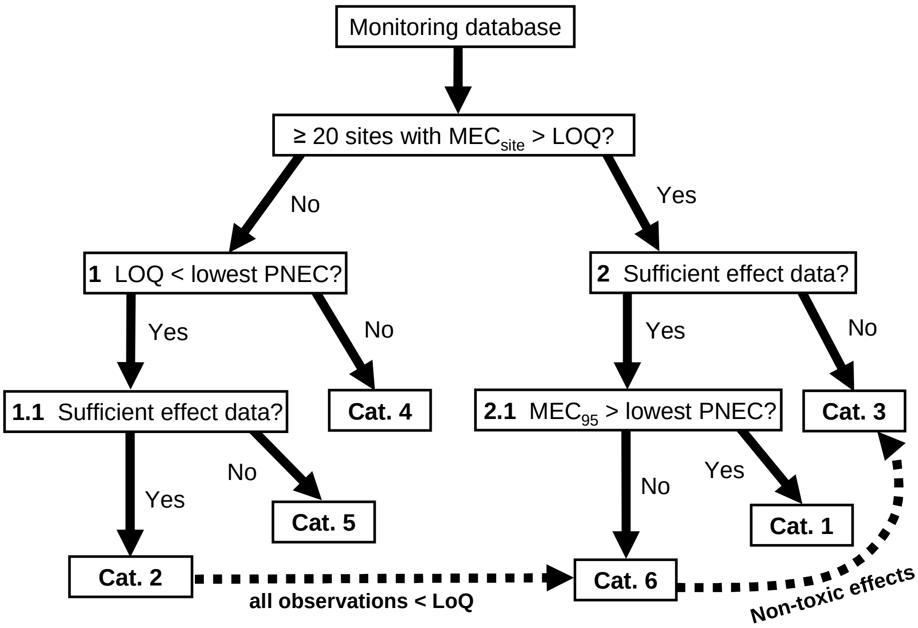

Fig. 2: Decision tree to classify emerging and classic organic pollutants into six categories of defined actions. For explanation of the categories, please see text. (MECsite = maximum environmental concentration at each site in recent years, MEC_{95} = 95th percentile of all MECsite, Cat. = Category, LOQ = Limit of quantification)

Improved hazard assessment

In chemical RAs approaches, such as described in the EQS guidelines or the TGD (Commission, 2003; Lepper, 2005), emphasis is given often to more advanced endpoints, such as Species Sensitivity Distributions (SSD) or mesocosm studies, which are expected to be more relevant, compared to acute data on single species (Lepper, 2005). However, insufficient data is rather the normal case than the exception for many compounds (Daginnus et al., 2011). Hence, a safety factor of 1000 for acute toxicity data could be assumed to be reasonable for RA. For example, even though regulators have raised concern about using mesocosm results without special concern, No Observed Effect Concentrations (NOEC) and No Observed Adverse Effect Concentrations (NOEAC) have been used for the derivation of legally binding EQSs (Lepper, 2005). Examples are the two priority substances chlorfenvinphos and chlorpyrifos, whose EQS of 0.1 and 0.03 µg/L, are within a factor of 3 and 42 of the reported acute toxicity to *Daphnia magna*, respectively (Commission, 2008). In this concentration range, community alterations would be expected (Liess and von der Ohe, 2005; Schäfer et al., 2007; von der Ohe et al., 2009) and hence, compliance with this EQS would be probably not protective. Hence, this is a good example for a need to adapt the EQS of the current list of priority substances. Interestingly, the original COMMPS study assessed the priority substances based on acute data, with substantially lower PNEC values, which probably led to their inclusion in the first list of priority substances.

Generally, assessment factors are applied to cover the whole panel of variation and uncertainty (i.e. interspecies variability, extrapolation from short-term to long-term effects, extrapolation from lab to field conditions, etc.), and ranges from 10 to 1000, depending on the quantity (number of trophic levels represented) and the quality (acute or chronic effects) of the available ecotoxicity data. However, as all the above mentioned concerns could not be considered by the commonly used higher-tier test systems, an assessment factor of 1000 on acute data is justified to ensure protection from non-specific toxic effects. It should be noted that this factor is considered a safety factor to protect wildlife from unacceptable harm, and considers both problem definition uncertainty and variability with regard to extrapolation from single species tests to the community level, according to (Ragas et al., 2009). On the contrary, it could be questioned if an assessment factor of ten on the lowest of three chronic data is protective enough, given the abovementioned considerations - let alone lower factors for mesocosm study results. Therefore, an assessment factor of 100 is strongly recommended for the lowest of three chronic data. In this way, specific effects of some compounds would be addressed by chronic endpoints, while giving similar protection from acute and chronic-based PNECs for the other substances. It was therefore concluded that the lowest of the available PNECacute and PNECchronic values would be a more conservative approach than simply using when available chronic data with the respectively low assessment factors.

If standard ecotoxicity data are not sufficient, missing toxicity data were estimated from available experimental values for similar compounds, using a kNN read-across methodology in accordance to Schüürmann et al. (Schuurmann et al., 2011). In brief, a training data set was compiled for each of the abovementioned standard test species, containing about 1000, 550 and 700 experimental toxicity values, respectively, together with the chemical structures. To estimate the toxicity of a compound which is not included in the training set, the weighted average of the experimental values for the three most similar compounds from the training data set was calculated. The similarity of compounds was evaluated employing the atom-centered fragments (ACF)-based approach (Kuhne et al., 1996). The averaged prediction error of the model ranged from 0.5 to 1.0 logarithmic units for data where experimental values were available for reasonably similar compounds (i.e. a similarity of 0.75 on a scale from 0 to 1). In case sufficiently similar compounds were not available, baseline toxicity estimated from the octanol–water partitioning coefficient ($K_{o/w}$) was used, employing established QSAR models for the three standard test organisms (USEPA, 2008; von der Ohe et al., 2005), after insuring that no enhanced toxicity because of specific effects would be expected from respective structural alerts (von der Ohe et al., 2005). Compounds with a predicted toxicity 10 times higher than the estimated water solubility (USEPA, 2008) and a melting point of more than 100 °C were excluded from the assessment, as suggested for single compound RAs (Mayer and Reichenberg, 2006).

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APPENDIX I

Common Implementation Strategy for the protection of aquatic life in South America

Water Quality Criteria (WQC)

Substance Data Sheet

Simazine

CAS-No. 122-34-9

1 Identity of substance

Name:	Simazine
CAS-Number:	122-34-9
Classification:	Water Quality Criteria

2 Proposed quality standards

ECOSYSTEM	**QUALITY CRITERION**	**QUALITY CRITERION ”ROUNDED VALUES”**	**COMMENT**
Freshwater Water-WQC	1.7 µg/L	**2 µg/L**	see 3.1
Freshwater Sediment-WQC	-	**-**	see 3.2
Marine Water-WQC	1.7 µg/L	**2 µg/L**	see 3.3
Marine Sediment-WQC	-	-	see 3.4

3 Data & Derivation of EC

3.1 EC for pelagic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute	*Brachydanio rerio*	FW	LC_{50}	4	423.300	[1]
	chronic	*Oncorhynchus mykiss*	FW	NOEC	21	700	[2]
		Oncorhynchus mykiss	FW	NOEC	28	8400	[2]
Invertebrates	acute	*Daphnia magna*	FW	EC_{50}	-	> 100.000	[1]
		Daphnia similis	FW	EC_{50}	-	457.620	[1]
	chronic	*Daphnia magna*	FW	NOEC	21	36	[2]
		Daphnia magna	FW	NOEC	21	100	[2]
Algae	acute	*Scenedesmus subspicatus*	FW	E_bC_{50}	-	42	[1]
	chronic	*Anabaena flos-aqua*	FW	NOEC	5	20	[2]
		Chlorella pyrenoidosa	FW	NOEC	5	**17**	[2]
		Navicula pelliculosa	FW	NOEC	5	33	[2]

(FW): freshwater

Calculation of WQC:

$$\textbf{WQC} = \frac{\text{Lowest of 3 chronic value of three trhopic levels}}{\text{10 AF}} = \frac{17\ \mu g/L}{10} = 1{,}7\ \mu g/L$$

3.2 EC for benthic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

(FS): freshwater sediment

Calculation of WQC:

a) $\frac{\text{Lowest of 3 chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\_\_ \ \mu\text{g/Kg}$

b) $\frac{\text{Lowest of 2 chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_ \ \mu\text{g/Kg}$

c) $\frac{\text{Lowest of 1 chronic value}}{\text{100 AF}} = \_\_\_ \ \mu\text{g/Kg}$

3.3 EC for pelagic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute	*Brachydanio rerio*	FW	LC_{50}	4	423.300	[1]
	chronic	*Oncorhynchus mykiss*	FW	NOEC	21	700	[2]
		Oncorhynchus mykiss	FW	NOEC	28	8400	[2]
Invertebrates	acute	*Daphnia magna*	FW	EC_{50}	-	> 100.000	[1]
		Daphnia similis	FW	EC_{50}	-	457.620	[1]
	chronic	*Daphnia magna*	FW	NOEC	21	36	[2]
		Daphnia magna	FW	NOEC	21	100	[2]
		Crassostrea virginica	MW	NOEC	7	1000	[2]
Algae	acute	*Scenedesmus subspicatus*	FW	E_bC_{50}	-	42	[1]
	chronic	*Anabaena flos-aqua*	FW	NOEC	5	20	[2]
		Chlorella pyrenoidosa	FW	NOEC	5	**17**	[2]
		Navicula pelliculosa	FW	NOEC	5	33	[2]
		Skeletonema costatum	MW	NOEC	5	250	[2]

(FW): freshwater; (MW): marine water

Calculation of WQC:

WQC = $$\frac{\text{Lowest of 3 chronic value of three trhopic levels + 2 marine}}{\text{10 AF}} = \frac{17\ \mu\text{g/L}}{10} = 1{,}7\ \mu\text{g/L}$$

3.4 EC for benthic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [μg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{\text{Lowest of 1 FS} + \text{2 MS chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

b) $$\frac{\text{Lowest of three chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

c) $$\frac{\text{Lowest of 1 FS} + \text{1MS chronic value of different living and feeding conditions}}{\text{100 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

d) $$\frac{\text{Lowest of 2 FS chronic value of different living and feeding conditions}}{\text{500 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

e) $$\frac{\text{Lowest of 1 FS chronic value}}{\text{1000 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

f) $$\frac{\text{Lowest of 1 FS} + \text{1 MS acute value of which marine species is more sensitive}}{\text{1000 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

g) $$\frac{\text{Lowest of 1 FS or 1 MS acute value}}{\text{10,000 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

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APPENDIX II

Common Implementation Strategy for the protection of aquatic life in South America

Water Quality Criterion (WQC)

Substance Data Sheet

Ametryne

CAS-No. 834-12-8

1 Identity of substance

Name:	Ametryne
CAS-Number:	834-12-8
Classification:	Interim Water Quality Criterion

2 Proposed quality standards

ECOSYSTEM	QUALITY CRITERION	QUALITY CRITERION ”ROUNDED VALUES”	COMMENT
Freshwater Water-WQC	0.04 µg/L	**0.04 µg/L**	see 3.1
Freshwater Sediment-WQC			see 3.2
Marine Water-WQC			see 3.3
Marine Sediment-WQC			see 3.4

3 Data & Derivation of EC

3.1 EC for pelagic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [dias]	Value [µg/L]	Reference
Fish	acute	*Pimephales promelas*	FW	LC_{50}	4	78.940	QSAR
	chronic						
Invertebrates	acute	*Daphnia magna*	FW	LC_{50}	2	34.015	[1]
	chronic						
Algae	acute	*Selenastrum capricornutum*	FW		3	4	[1]
	chronic						

(FW): freshwater

Calculation of WQC:

WQC = $$\frac{\text{lowest of 3 acute value of three trophic levels}}{100\ \text{AF}} = \frac{4\ \mu\text{g/L}}{100} = 0.04\ \mu\text{g/L}$$

*** Ametryne is a known herbicide. For this reason it is assumed that algae are the most sensitive group and a AF of 100 is protective.**

3.2 EC for benthic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [d]	Value [µg/Kg]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{\text{Lowest of 3 chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

b) $$\frac{\text{Lowest of 2 chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

c) $$\frac{\text{Lowest of 1 chronic value}}{\text{100 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

3.3 EC for pelagic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [d]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) = $$\frac{\text{Lowest of 3 chronic value of three trhopic levels + 2 marine}}{\text{10 AF}} = \_\_\_\ \mu\text{g/L}$$

b) = $$\frac{\text{Lowest of 2 chronic value of two trhopic levels + 1 marine}}{\text{50 AF}} = \_\_\_\ \mu\text{g/L}$$

c) = $$\frac{\text{Lowest of 3 chronic value of three trhopic levels}}{\text{10 - 100 AF}} = \_\_\_\ \mu\text{g/L}$$

d) = $$\frac{\text{Lowest of 2 chronic value of two trhopic levels}}{\text{500 AF}} = \_\_\_\ \mu\text{g/L}$$

e) = $$\frac{\text{Lowest of 1 chronic value of fish and invertebrates}}{\text{100 - 1000 AF}} = \_\_\_\ \mu\text{g/L}$$

f) = $$\frac{\text{Lowest of 3 acute value of three trophic level + 2 marines}}{\text{1000 AF}} = \_\_\_\ \mu\text{g/L}$$

g) = $$\frac{\text{Lowest of 3 acute value of three trophic level}}{\text{1000 - 10,000AF}} = \_\_\_\ \mu\text{g/L}$$

3.4 EC for benthic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [d]	Value [µg/Kg]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{\text{Lowest of 1 FS} + \text{2 MS chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

b) $$\frac{\text{Lowest of three chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

c) $$\frac{\text{Lowest of 1 FS} + \text{1MS chronic value of different living and feeding conditions}}{\text{100 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

d) $$\frac{\text{Lowest of 2 FS chronic value of different living and feeding conditions}}{\text{500 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

e) $$\frac{\text{Lowest of 1 FS chronic value}}{\text{1000 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

f) $$\frac{\text{Lowest of 1 FS} + \text{1 MS acute value of which marine species is more sensitive}}{\text{1000 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

g) $$\frac{\text{Lowest of 1 FS or 1 MS acute value}}{\text{10,000 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

References

1. R Kühne, R-U Ebert, PC von der Ohe, G Schüürmann. 2010. Read-Across Model to Predict the Acute Toxicity Towards Daphnia Magna. *In prep.*

APPENDIX III

Common Implementation Strategy for the protection of aquatic life in South America

Water Quality Criterion (WQC)

Substance Data Sheet

Xxx

CAS-No. ***Xxx***

1 Identity of substance

Name:	xxx
CAS-Number:	xxx
Classification:	Water Quality Criterion

2 Proposed quality standards

Ecosystem	Quality Criterion	Quality Criterion ”rounded values”	Comment
Freshwater Water-WQC			see 3.1
Freshwater Sediment-WQC			see 3.2
Marine Water-WQC			see 3.3
Marine Sediment-WQC			see 3.4

3 Data & Derivation of EC

3.1 EC for pelagic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{HC_5 \text{ of Species sensitivity distributon of three throphic levels}}{5 \text{ AF}} = \_\_ \mu g/L$$

b) $$\frac{\text{Lowest of three cronic value of three throphic levels}}{10 \text{ AF}} = \_\_\_ \mu g/L$$

c) $$\frac{\text{Lowest of two cronic value of two throphic levels}}{50-100 \text{ AF}} = \_\_ \mu g/L$$

d) $$\frac{\text{Lowest of one cronic value of fish and invertebrates}}{100 \text{ AF}} = \_\_ \mu g/L$$

e) $$\frac{\text{Lowest of three acute value of three throphic levels}}{100-10000 \text{ AF}} = \_\_ \mu g/L$$

f) $$\frac{\text{Lowest value QSARof three trophic levels}}{1000 \text{ AF}} = \_\_ \mu g/L$$

3.2 EC for benthic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/Kg]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{\text{Lowest of 3 chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

b) $$\frac{\text{Lowest of 2 chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

c) $$\frac{\text{Lowest of 1 chronic value}}{\text{100 AF}} = \_\_\_ \ \mu\text{g/Kg}$$

3.3 EC for pelagic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) = $\frac{\text{Lowest of 3 chronic value of three trhopic levels + 2 marine}}{\text{10 AF}} = \_\_\_ \ \mu g/L$

b) = $\frac{\text{Lowest of 2 chronic value of two trhopic levels + 1 marine}}{\text{50 AF}} = \_\_\_ \ \mu g/L$

c) = $\frac{\text{Lowest of 3 chronic value of three trhopic levels}}{\text{10 - 100 AF}} = \_\_\_ \ \mu g/L$

d) = $\frac{\text{Lowest of 2 chronic value of two trhopic levels}}{\text{500 AF}} = \_\_\_ \ \mu g/L$

e) = $\frac{\text{Lowest of 1 chronic value of fish and invertebrates}}{\text{100 - 1000 AF}} = \_\_\_ \ \mu g/L$

f) = $\frac{\text{Lowest of 3 acute value of three trophic level + 2 marines}}{\text{1000 AF}} = \_\_\_ \ \mu g/L$

g) = $\frac{\text{Lowest of 3 acute value of three trophic level}}{\text{1000 - 10,000AF}} = \_\_\_ \ \mu g/L$

3.4 EC for benthic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{\text{Lowest of 1 FS} + \text{2 MS chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\_\_\ \mu\text{g/Kg}$$

b) $$\frac{\text{Lowest of three chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_\ \mu\text{g/Kg}$$

c) $$\frac{\text{Lowest of 1 FS} + \text{1MS chronic value of different living and feeding conditions}}{\text{100 AF}} = \_\_\_\ \mu\text{g/Kg}$$

d) $$\frac{\text{Lowest of 2 FS chronic value of different living and feeding conditions}}{\text{500 AF}} = \_\_\_\ \mu\text{g/Kg}$$

e) $$\frac{\text{Lowest of 1 FS chronic value}}{\text{1000 AF}} = \_\_\_\ \mu\text{g/Kg}$$

f) $$\frac{\text{Lowest of 1 FS} + \text{1 MS acute value of which marine species is more sensitive}}{\text{1000 AF}} = \_\_\_\ \mu\text{g/Kg}$$

g) $$\frac{\text{Lowest of 1 FS or 1 MS acute value}}{\text{10,000 AF}} = \_\_\_\ \mu\text{g/Kg}$$

APPENDIX IV

Common Implementation Strategy for the protection of aquatic life in South America

Water Quality Criterion (WQC)

Substance Data Sheet

Fipronil

CAS-No. 120068-37-3

1 Identity of substance

Name:	Fipronil
CAS-Number:	120068-37-3
Classification:	Water Quality Criterion

2 Proposed quality standards

Ecosystem	Quality Criterion	Quality Criterion ”rounded values”	Comment
Freshwater Water-WQC			see 3.1
Freshwater Sediment-WQC	0.002 µg/Kg	**0.002 µg/Kg**	see 3.2
Marine Water-WQC			see 3.3
Marine Sediment-WQC			see 3.4

3 Data & Derivation of EC

3.1 EC for pelagic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $$\frac{HC_5 \text{ of Species sensitivity distributon of three throphic levels}}{5 \text{ AF}} = \_\_ \mu g/L$$

b) $$\frac{\text{Lowest of three cronic value of three throphic levels}}{10 \text{ AF}} = \_\_\_ \mu g/L$$

c) $$\frac{\text{Lowest of two cronic value of two throphic levels}}{50 - 100 \text{ AF}} = \_\_ \mu g/L$$

d) $$\frac{\text{Lowest of one cronic value of fish and invertebrates}}{100 \text{ AF}} = \_\_ \mu g/L$$

e) $$\frac{\text{Lowest of three acute value of three throphic levels}}{100 - 10000 \text{ AF}} = \_\_ \mu g/L$$

f) $$\frac{\text{Lowest value QSARof three trophic levels}}{1000 \text{ AF}} = \_\_ \mu g/L$$

3.2 EC for benthic freshwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/Kg]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
		Chironomus riparius	FW	NOEC	28	0.2	[1]
Algae	acute						
	chronic						

Calculation of WQC:

c) $\frac{\text{Lowest of 1 chronic value}}{\text{100 AF}} = \frac{0.2}{100} = 0.002\ \mu\text{g/Kg}$

3.3 EC for pelagic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/L]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) = $\frac{\text{Lowest of 3 chronic value of three trhopic levels + 2 marine}}{\text{10 AF}} = \_\_\_ \ \mu g/L$

b) = $\frac{\text{Lowest of 2 chronic value of two trhopic levels + 1 marine}}{\text{50 AF}} = \_\_\_ \ \mu g/L$

c) = $\frac{\text{Lowest of 3 chronic value of three trhopic levels}}{\text{10 - 100 AF}} = \_\_\_ \ \mu g/L$

d) = $\frac{\text{Lowest of 2 chronic value of two trhopic levels}}{\text{500 AF}} = \_\_\_ \ \mu g/L$

e) = $\frac{\text{Lowest of 1 chronic value of fish and invertebrates}}{\text{100 - 1000 AF}} = \_\_\_ \ \mu g/L$

f) = $\frac{\text{Lowest of 3 acute value of three trophic level + 2 marines}}{\text{1000 AF}} = \_\_\_ \ \mu g/L$

g) = $\frac{\text{Lowest of 3 acute value of three trophic level}}{\text{1000 - 10,000AF}} = \_\_\_ \ \mu g/L$

3.4 EC for benthic saltwater species

Trophic level	Test	Species	Habitat	Endpoint	Exposure [days]	Value [µg/Kg]	Reference
Fish	acute						
	chronic						
Invertebrates	acute						
	chronic						
Algae	acute						
	chronic						

Calculation of WQC:

a) $\frac{\text{Lowest of 1 FS + 2 MS chronic value of different living and feeding conditions}}{\text{10 AF}} = \_\ \mu\text{g/Kg}$

b) $\frac{\text{Lowest of three chronic value of different living and feeding conditions}}{\text{50 AF}} = \_\_\_\ \mu\text{g/Kg}$

c) $\frac{\text{Lowest of 1 FS + 1MS chronic value of different living and feeding conditions}}{\text{100 AF}} = \_\_\_\ \mu\text{g/Kg}$

d) $\frac{\text{Lowest of 2 FS chronic value of different living and feeding conditions}}{\text{500 AF}} = \_\_\_\ \mu\text{g/Kg}$

e) $\frac{\text{Lowest of 1 FS chronic value}}{\text{1000 AF}} = \_\_\_\ \mu\text{g/Kg}$

f) $\frac{\text{Lowest of 1 FS + 1 MS acute value of which marine species is more sensitive}}{\text{1000 AF}} = \_\_\_\ \mu\text{g/LKg}$

g) $\frac{\text{Lowest of 1 FS or 1 MS acute value}}{\text{10,000 AF}} = \_\_\_\ \mu\text{g/Kg}$

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