Writing Environmental Sciences at University

GUIDES FOR WRITING IN SPECIFIC DISCIPLINES

Universitat Autònoma de Barcelona
Universitat de Barcelona
Universitat Politècnica de Catalunya BarcelonaTech
Universitat de Girona
Universitat de Lleida
Universitat de Vic Universitat Central de Catalunya

1 What are the Environmental Sciences?

The environmental sciences are a number of interrelated scientific disciplines that deal with the study of the environment in a comprehensive and systemic way.

Professionals from many scientific disciplines have participated in the development of the environmental sciences. For example, chemists, microbiologists, ecologists, and chemical and civil engineers have studied water quality management; physicists, chemists and chemical engineers have addressed air pollution; and geologists and industrial engineers have worked on solid waste management.

Efforts to align these disciplines to study the environment are relatively recent (second half of the 20th century). The environmental sciences are an amalgam, the result of the combination and interaction of numerous disciplines to achieve scientific objectives. This interdisciplinary approach stems from the need to understand complex environmental problems and to address them from different but complementary perspectives.

Environmental sciences and environmental engineering are separate but closely related fields. Environmental sciences focus on the diagnosis and understanding of environmental problems, while environmental engineering aims to solve those problems with engineering tools.

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Environmental engineering has developed along lines similar to those of the environmental sciences. It is also an amalgam of disciplines, an engineering specialisation focused on protecting and improving the environment and the health and wellbeing of people. It integrates scientific knowledge, technical principles and management practices related to natural resources and the interaction of living beings with the environment.

In addition to being interdisciplinary, environmental sciences and engineering depend on the participation of stakeholders, such as politicians, neighbours, associations, companies, NGOs, to carry out studies and projects. Comprehensive training in environmental sciences also involves social sciences like economics and sociology. Environmental scientists and engineers study and asses the sustainability of products and processes from four perspectives – environmental, technical, economic and social – and contribute very actively to sustainable development.

2 General characteristics of writing in Environmental Sciences and Engineering

Environmental science texts can have a variety of linguistic features. This depends on the document type (reports, construction projects, popular science articles, etc.) and the target readership, both of which generally determine the formal aspects and the specific content of those texts. Despite their variability, they have a number of features in common.

Clarity
Ideas should be explained in an orderly, coherent and clear manner, without unnecessary details, and in short and simple sentences that avoid excessive subordinate clauses. Paragraphs should have important ideas at the beginning, precise vocabulary and discourse markers that contribute to the cohesion of the text.

Popular science texts can be made easier to understand by adding explanatory paragraphs, providing examples from everyday life to demonstrate and observe concepts and ideas, or including simple experiments to show the effects of a phenomenon.

Objectivity
Generally, environmental sciences and engineering texts present information in a neutral and objective way. They are organised into sections and sub-sections, with clear headings and information presented in a logical order. That rigour and objectivity is maintained by providing specific data with numerical values and their units.

Formal features include presenting information more objectively by using impersonal constructions (The test was conducted...), referring to the task (The test demonstrates that...) or using the first person plural to avoid the excessive subjectivity that the first person singular would suggest (With this test, we confirm...).

In research articles and final degree projects, it is often useful to compare and relate one's own results to the work of other researchers (called "literature"), and to properly reference it. Contrasting the contributions of the text with other research in the same field also contributes to objectivity. This is key to a good discussion of the results and to highlighting their relevance in the wider context of the research or study carried out.

Precise terminology
Many terms from the specialised vocabulary of the environmental sciences have been incorporated into general language through the media and environmental legislation. The result is that, in some cases, the same concept may have several names (some more colloquial, others more technical). In fact, synonyms are very common and often a source of confusion, so texts need to be written in precise and accurate language. The writer of the text, for example, must be able to choose between words such as *filter*, *biofilter*, *green filter* and *constructed wetland*, which can be used to designate very similar realities.

Generally, it is recommended to avoid using synonyms so as not to create ambiguity or confusion. Also, check the terminology used by standardisation bodies, especially if conventions such as the international system for units of measurement exist. Finally, use the terminology of the language of the text whenever possible or, failing that, use italics for names in other languages.

In general, define the key concepts of the text when you first introduce them if you think the reader may not be familiar with them or if there is no single agreed-upon definition in the literature of the field. In popular science texts, terminology can be accompanied by simple definitions and examples that can be understood by non-specialists.

Finally, consider how to treat the acronyms used in the text. Often, long terms (made up of several words) are shortened in the form of an acronym or abbreviation, which in some cases almost replaces the use of the actual term. To avoid any misinterpretations among readers who are not familiar with these acronyms or abbreviations, use them in parentheses the first time they appear in the text. Depending on the type of document, if there are many acronyms, it may be useful to add an appendix with a table containing all the acronyms and their corresponding terms.

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3 Typical written texts in Environmental Sciences and Engineering

Reports

Reports are probably the most common written texts in the environmental sciences and engineering. Frequently, they include a summary of about 200 words at the beginning to present the scope and main findings of the work. In long reports, the summary may include as many as 800 or 1000 words, and is then often referred to as an "executive summary". Reports always have direct and concise language but, depending on each case, they can vary in length: from several pages to hundreds.

Reports usually have a standardised structure that includes the following sections: introduction, objectives, methodology, results, conclusions and appendices. The introduction presents the motivation for the work carried out and may be called "Background". The objectives section is usually the shortest and defines very clearly and directly the scope of the work. The methodology section explains how the work has been done, and the results section usually includes data tables and graphs to enhance understanding of the text. There may be a discussion of the results, for example by comparing the results of the project with those of other studies. In this case, the section can be entitled "Results and discussion".

At the end of the report, the section presenting conclusions should be very clear and, as a general rule, respond to and be drafted on the basis of the stated objectives. Appendices vary; they may include data, formulas, complementary methodologies, etc. Finally, the reports may include a section thanking individuals or institutions that have provided support or information.

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Construction project documentation

In the case of construction projects, written documents are required to establish the work, equipment, services and measures to build and operate facilities such as drinking water plants, wastewater treatment plants, gas treatment systems and waste management plants. These documents can have various levels of detail. Texts for so-called *basic projects* set out general aspects of and justifications for what is to be done, and include an approximate budget. However, they do not meet the requirements to carry out a construction project, so more detailed texts – *executive projects* – are necessary. These have a well-defined structure with the following sections: report, plans, specifications, budget and appendices. They also present the project's motivation and objectives. Arguably, many parts of these texts are comparable to those of a basic project, but the plans are usually numerous and specify in detail everything that must be completed to carry out the project: from sections and elevations to electrical and hydraulic installations.

The specifications set out the materials to be used to ensure and preserve the long-term functionality of the system to be built. They also include strict quality controls over the materials and may even define the obligations of the different actors involved during the construction phase of the project (the contractor, the owner, the project manager, etc.).

The budget usually includes the amount or number and unit prices for all the materials and pieces of equipment required for the project, presented in line items or chapters and followed by the total amount of the budget.

The appendices are a very important part of the project, in terms of their number, content and length, as they provide the details that justify the report. There are well-defined appendices of calculations: hydraulic, structural, geotechnical, electrical, biotechnological, etc. There can also be installation, safety operation and maintenance appendices. Their number and content can vary widely depending on each project.

Environmental impact statements (EIS)

These documents identify and anticipate the impact of an action on both the environment and the health and wellbeing of people. They also interpret and communicate information on potential impacts, identifying measures to reduce or avoid negative effects. Within the fields of environmental impact assessment (EIA), an action is any project or intervention that may have environmental implications. The actions can be varied. They include the study of the construction of a large infrastructure, a road or port, or of any industrial activity. Therefore, each environmental impact assessment is always very specific. Environmental impact statements are often included as appendices to construction project reports and they usually have a structure determined by regulations (such as Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment).

Typically, they include a description of the action and a study of alternatives (including the option of not carrying out the action). Most also include an environmental inventory (the elements of the environment that are likely to be affected, such as fauna, flora, soil structure, etc.), an impact assessment, measures to prevent, minimise and/or avoid impacts, and a mechanism to monitor the measures.

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Life cycle assessment studies

Life cycle assessment (LCA) is a standardised technique to objectively assess environmental impacts of objects or processes in different scenarios during their entire life cycle (from manufacture or implementation to becoming waste). LCA is a particular example of environmental impact assessment. For example, an LCA study might compare the environmental impact of using a glass or plastic bottle for water. These studies follow ISO standards, which require a strict division into sections. They include the scope, which defines the objectives, scenarios, reference unit (in our example it could be the bottle) and system boundaries; an inventory analysis, which collects data and refers them to the reference unit; an impact assessment, which calculates environmental effects; and the interpretation of the results.

Scientific and technical papers

Scientific papers are the main way the scientific community communicates new knowledge and discoveries. The findings they present are clearly limited to activity carried out in research centres, universities and other research institutions. They are very formal documents with a well-defined structure that includes the following sections: introduction, materials and methods, results and discussion, and conclusions. They also have an abstract and often an acknowledgements section, in which researchers thank funding institutions for their support, for example.

Before scientific papers are published as articles, specialists in the field review them, and inform journal editors about the novelty of the work and recommend or advise against their publication. Before publishing them, editors very often ask authors to revise articles following the reviewers' recommendations.

Technical articles are similar to scientific articles except they are not subjected to the rigour of peer review. It is usually the editors themselves who decide whether to publish a technical article or not. Technical articles are the main way to communicate practical issues in the field of environmental sciences and engineering, such as the commissioning of a new wastewater treatment plant and the challenges that entails. They are very useful for professional practice, often even more so than scientific articles.

Popular science articles

These relatively short texts aim to bring knowledge of environmental sciences and engineering closer to the general public. They usually follow a journalistic style, with an attractive title and an approach to the subject that is more understandable, avoiding too much specialised terminology. If specialised terms are introduced, they can be accompanied by simple definitions to make them easier to understand.

Bachelor's and master's degree final projects

Bachelor's and master's degree final projects are very important for the academic development of any university student. They usually study very specific topics in a particularly detailed way and can cover a wide range of topics, from research questions to literature reviews on a specific theme. Generally, they receive high marks when they are relevant to the syllabus and, in an interdisciplinary way, deal with a subject studied in the degree programme from a complementary perspective.

In research projects, students can carry out their own experiments, evaluate the results and draw conclusions. In these cases, it is best if students work in a laboratory as part of a research team with much broader objectives than their own work, so they can take a wider view. In some research projects, students analyse data from experiments carried out by other researchers. These works often include statistical analysis or detailed numerical simulation.

Literature reviews are projects in which students use databases to compile, identify, read and analyse literature. What is most valued in a review of this kind is the ability to notice discrepancies, find concordances and establish future lines of research to increase knowledge. Finally, some final projects simulate construction projects at a level of depth arranged with advisors.

4 Writing conventions in Environmental Sciences and Engineering

Given the multidisciplinary nature of environmental sciences, it should be no surprise that many writing conventions come from the fields of physics, chemistry and biology, and even from scientific and technical writing in general.

Equations and formulas

In general, treat equations as textual elements; therefore, punctuation rules specific to the language of the text apply. Write the equation centred and on a separate line from the text, with a blank line left before and after it.

The equations are numbered consecutively using parentheses or square brackets aligned to the right. For example, to calculate the hydraulic retention time of a reactor would use

$$T_H = \frac{V}{Q}, \tag{1}$$

where

T_H is the hydraulic retention time, in h.

V is the reactor volume, in m^3.

Q is the flow rate entering the reactor, in m^3/h.

Resume the sentence after the equation with a lowercase letter, as it continues the sentence containing the equation. Then define each of the variables or parameters on separate lines, indicating their units. By numbering the equations, it is possible to refer to the main body of the text in a very simple way. For example, "In this work, the hydraulic residence time has been calculated with Equation 1." Note that the word equation begins with a capital letter. When using in-text references to equations, tables, figures, etc., capitalise these words.

When specifying numerical values of variables or parameters, include the units if they have not been mentioned before or have been mentioned much earlier in the document:

$$T_H = \frac{5600\ m^3}{800\ m^3/h} = 7\ h \qquad (2)$$

Another way of describing an equation is the one below, which is the mass balance of a substance in a reactor:

$$V\frac{dC_1}{dt} = QC_{in} - QC_1 \pm rV, \qquad (3)$$

where C_{in} and C_1 are the concentrations of the substance at the reactor inlet and outlet, respectively, [M L^{-3}]; *V* is the reactor volume, [L^3]; Q is the incoming (and outgoing, which in this equation is the same) flow rate, [L^3 T^{-1}]; and *r* is the reaction rate, [M T^{-1} L^{-3}].

In the example above, the units correspond to the dimensions: M (mass), L^3 (volume), etc. If these equations are used later to show numerical calculations, specify the units, as in Equation (2). Semicolons separate variable descriptions because, internally, the descriptions already have elements separated by commas.

Symbols

With regard to symbols, use the mathematical, physical, chemical and biological symbols established by international and national standardisation institutions, and apply the writing criteria they set (italics, roman type, upper and lower case, etc.). Note that symbols are never plural because they are invariable, and they never have a full stop after them. In the international system, other separators are used in expressions, such as the slash (kg/cm2) or the overhanging point (Pa·s). The latter is not compulsory and is used, above all, in cases where there may be confusion: Pa·s is clearer than Pa s. Negative exponents can also be used to indicate division (m^3 h^{-1}), thereby omitting the need for separators.

Write the names of units of measurement in lower case and in roman letters, except in cases where the symbol comes from a proper name. For example, the initial *p* of *Pa* is written with a capital letter because it corresponds to the surname Pascal.

When numeric values of variables or parameters are given, leave a space between the quantity and the unit symbol (11 %, 13 km, 22 °C). In word processing programs, insert a non-breaking space so that, if it coincides with the end of a line, the amount and the symbol are not separated (Ctrl + Shift + space bar in Word and LibreOffice Writer). Only in the case of the degrees, minutes and seconds of angles is there not a space between the unit and the symbol (24° 30’ 12”).

As for the symbols of the arithmetic and relational operators (+, −, ×, =, <, etc.), when they are part of an operation, leave a blank space between the operators and the operands (64 - 52 = 12), except for the slash (/), which is written without spaces (a/b). In cases where the operator precedes a figure, and is not part of an equation, it is also written without spaces (-3 °C).

Numbers

When writing numbers, follow the international convention and leave a thin space to separate the thousands (in groups of three digits starting from the decimal separator). In English, separate decimals with a full stop: 1 763.14 mg, for example.

Terminology

The distinction between upper and lower case is a grammatical convention used to differentiate common nouns from proper nouns. For this reason, you cannot arbitrarily use initial capital letters to indicate the relevance of a term in the text. Other graphic resources, such as bold type, serve this function. Similarly, although the acronym of a term is capitalised by graphic convention, the developed term is not capitalised if it is a common name (LCA, life cycle assessment, for example).

Write the names of formulas, theories, principles and laws in lower case, except for proper names that are part of the name (for example, the Chick-Watson law of disinfection, the Monod model of microbial growth, the Stokes equation of discrete sedimentation, Hazen's postulates and the double layer theory of colloids).

Use lower case as well for the names of generic chemicals (polypropylene, benzene and methanol) or any accessories, unless they are registered trademarks (Tanfloc® flocculant, Multiflo® decanter). The Latin scientific names of organisms begin with a capital letter and are written in italics (for example, *Escherichia coli*). If the name is mentioned successively in the text, the first item may abbreviated, such as *E. coli*, but the first time it is mentioned, the full name should be used.

When you use terms in a language other than that of the text, write them in italics. In the field of environmental sciences and engineering, though, many terms come from English. That said, always check unfamiliar terminology in reference sources. The Consortium of the Centre for Terminology TERMCAT has various online dictionaries (of environmental management, of the climate emergency, of civil engineering) providing translations of terms in Catalan, Spanish, Occitan and English (see Section 5). It is best not to rely on automatic translation tools to confirm terminology, as they can give false equivalents.

In environmental sciences and engineering, you will find clear terminological references in laws (see Section 5). Particularly interesting are in laws or regulations in which terms are not only used but also defined, in some cases with the establishment of basic concepts and in others with a prescriptive intent, in which the use of a given term is established.

Many public environmental agencies also provide useful online portals for this purpose. For example, the European Environment Agency, the U.S. Environmental Protection Agency's Report on the Environment (ROE), and the Australian Department of Climate Change, Energy, the Environment and Water all have glossaries of terms in the environmental sciences (see section 5).

Visual representations: figures, graphs, charts, tables, diagrams and plans
In environmental sciences and engineering documents, it is very common to use tables and figures to present numerical or non-numerical data visually and allow for quick comparison. Accompany them with a title (including a number that allows clear identification), a brief description of the content and information indicating their source of origin. In addition, place them as close as possible to the paragraphs containing the reference and leave a line space between them and the text before and after them.

In your text, first refer to a table or figure, and then add this element, preferably centred. In the reference, the first letter of the word *table* or *figure* is capitalised. See the following example:

The possible impacts of low-cost wastewater treatment systems are described in Table 1.

Table 1. Potential environmental impacts of different low-cost wastewater treatment systems (G, good; N, normal; AP, atypical problem; FP, frequent problem; NP, no problem).

Type of treatment	Odours	Noises	Insects	Integration with the environment	Effects on soil
Green filters	FP	NP	FP	G	FP
Macrophyte beds	AP	NP	FP	G	FP
Rapid infiltration	FP	NP	FP	N	FP

If abbreviations are used in a table, describe them in the table title itself (as in the example above) or separately in a table footer. Check that the terminology used in graphs and diagrams matches the terminology used within the text.

Plans, which may be inserted in the document or be included as an appendix, contain information such as the title of the project, the promoter, the drafters, the title of the plan, the date and the graphic scale. Check these short texts to ensure that they are correct. Remember to write titles (both the project title and the plan title) in title case. That is, capitalise all major words: words other than articles (*a*, *an*, *the*), prepositions (*on*, *in*, *of*, etc.), coordinating conjunctions (*and*, *or*, *but*, etc.), and the word *to*. Write these minor words in lower case.

Lists

Vertical lists are a common resource in the descriptive sections of projects or in final degree projects. They make it easier to read the elements that make them up, especially when they are short. In these cases, moreover, do not use punctuation. If the elements of the enumeration are long, use punctuation (or numbering) instead.

Finally, although not a convention but good practice, once you have finished writing the text, read it carefully, paying attention to the different aspects discussed in this guide.

5 Resources for Environmental Science and Engineering writers

1. *Diccionari de les ciències ambientals*. Barcelona: Institut d'Estudis Catalans: Fundació puntCAT, 2008 [on line]. [https://cit.iec.cat/DCA/default.asp]

   This specialised dictionary contains entries that are typical of the language that characterises the environmental sciences and aims to offer a standardised and up-to-date Catalan, Spanish, English and French repertoire of the current terms used in a discipline that is constantly evolving.

2. *Diccionari de gestió ambiental*. Barcelona: TERMCAT, Centre de Terminologia, 2017 [on line]. [https://www.termcat.cat/en/diccionaris-en-linia/218]

   This dictionary contains more than 1,600 terms in Catalan, Spanish, English and French and is an update of the work published by TERMCAT in 1997.

3. *Diccionari de l'emergència climàtica*. Barcelona: TERMCAT, Centre de Terminologia, 2020 [on line]. [https://www.termcat.cat/en/diccionaris-en-linia/295]

   Dictionary of 230 terms related to climate change and climate transition, grouped into the following subject areas: general concepts, causes of climate change, effects of climate change, mitigation and adaptation to climate change, and agreements and reference bodies.

4. *Diccionari d'enginyeria civil*. Barcelona: TERMCAT, Centre de Terminologia, 2017 [on line]. [https://www.termcat.cat/en/diccionaris-en-linia/240]

   This dictionary brings together 3,743 terms related to civil engineering, specifically construction, geotechnical and cartographic, hydraulic, sanitary and environmental, and maritime and transport engineering.

5. *Regulation (EC) No 761/2001 of the European parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a community eco-management and audit scheme (EMAS)*. [https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32001R0761]

   European Parliament regulation containing terms and definitions of interest in the field of the environment.

6. *Environmental management systems* - Requirements with guidance for use. (ISO 14001:2015). UNE-EN ISO 14001:2015. [https://en.tienda.aenor.com/norma-une-en-iso-14001-2015-n0055418]

   UNE standard that includes terms and definitions related to environmental management organisation, planning and operations.

7. *Agència Catalana de Residus*. Generalitat de Catalunya. [https://residus.gencat.cat/ca/consultes_i_tramits_-_nou/normativa/normativa_catalana_en_materia_de_residus/#bloc3]

   Website that compiles the Catalan regulations on waste (in Catalan and Spanish only).

8. *Resources, Conservation & Recycling*. [https://www.sciencedirect.com/journal/resources-conservation-and-recycling]

   A journal that emphasises the transformation processes involved in a transition towards more sustainable production and consumption systems.

9. *The European Union's Environment and Earth Observation Terminology*. [https://termcoord.eu/2021/07/environment-and-earth-observation-terminology/]

   A website introducing the Environment Terminology project ENVI, managed by the Terminology Coordination Unit of the European Parliament (TermCoord).

Servei de Llengües (UAB), Serveis Lingüístics (UB), Servei de Llengües i Terminologia (UPC), Servei de Llengües Modernes (UdG), Institut de Llengües (UdL), Serveis Lingüístics (UVic-UCC)

Coordination: Virgínia Castillo, Enric Serra (UAB)
Author, Guide in Catalan: Joan Garcia Serrano, Sílvia Llovera Duran (coordination: Montserrat Noró)
English (Adaptation and Revision): Peter Redmond

This project has received an Interlingua grant from the Generalitat de Catalunya.

Publishing date: February 2023

This guide complies with the accessibility criteria (with the assessment of Adaptabit and Mireia Ribera).