

DiCoEnviro, a Multilingual Terminological Resource on the Environment: The Brazilian Portuguese Experience

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Abstract

DiCoEnviro is a multilingual terminological resource that contains terms in the field of the environment in different languages, i.e. French, English, Spanish, Portuguese, Italian and more recently Chinese. The present paper focuses on the Portuguese version of the resource in order to show how the terminological work has been developed particularly with the use of a Brazilian Portuguese corpus. More specifically the paper presents how DiCoEnviro i) represents the specialized meaning of the terms, ii) represents terminological structures within the environmental domain, and iii) uses lexical functions to establish connections between the terms within a lexical relation. The results show a selection of terms that belong to the environmental domain in Portuguese, particularly to deforestation, their analysis, linguistic description and representation of the most preferred lexical relations the terms establish among themselves. Terms and terminological relations for Portuguese in DiCoEnviro are under construction and our purpose is to increase the number of entries and relations that represent deforestation, as well as to expand the corpus to include other topics associated with the environment.

Keywords: environment; terminology; lexical-semantic approach

1. Introduction

DiCoEnviro is a multilingual terminological resource that contains terms from the subject field of the environment in different languages, i.e. French, English, Spanish, Portuguese, Italian and more recently Chinese. The research in Portuguese was initiated by Botta (2013) with the compilation of the Brazilian Portuguese corpus, selection and analysis of terms and preparation of entries.

The objectives sought by the development of a Portuguese version are: i) to investigate the field of the environment in Portuguese by means of the study of terms; ii) to identify the terms and their specialized meaning; iii) to reveal the terminological relations of the field and to represent them, iv) to establish interlinguistic relations among these languages; and v) to discover semantic frames by describing the linguistic property of terms.

The terminological work is based on the lexico-semantic approach to terminology (L’Homme, 2004a; 2004b; 2012; 2016; 2018). The approach is based on the following principles:

- i) the specialized domain is investigated based on the analysis of terms as lexical units;
- ii) terms are investigated based on the description of their specialized meaning;
- iii) terms are structured, i.e. they establish terminological structures that include two types of relations, the paradigmatic relations and syntagmatic relations.

This paper concentrates on explaining how the Portuguese version of DiCoEnviro describes the specialized meaning of the terms and their terminological structures within the environmental domain. This study refers to the first level of description provided by the resource¹. The paper is structured as follows. Section 2 provides information on the characteristics of the text corpus compiled in Portuguese by Botta (2013) and on the extraction of terms to develop the research. Section 3 focuses on the criteria used to identify the specialized meaning of lexical units. Section 4 concentrates on the linguistic description of terms, particularly the description of i) the lexical meaning and ii) the terminological structures. Section 5 provides details on the use of lexical functions as a model to describe the lexical relations. Finally, Section 6 draws some conclusions and mentions aspects that we wish to explore in the future.

2. Linguistic data

DiCoEnviro is a specialized dictionary which presents terms that belong to the environmental domain in different languages. The description of lexical units is heavily derived from a corpus, more specifically a specialized corpus containing environmental texts mainly from the subdomain of deforestation.

The Brazilian Portuguese corpus is composed of scientific and journalistic texts in the period between 1981 and 2012. The corpus was compiled by Botta (2013) and contains 136,910 words (types of words) in the scientific corpus and 139,943 in the journalistic one (Botta, 2013). The texts are stored in Intercorpus², an online concordancer, from which contexts are extracted. It produces KWIC (key word in contexts) concordance lines which are accessed in plain text by clicking on the keyword.

The Portuguese specialized lexical units on the subdomain of deforestation represent a distinct terminology. By applying automatic term extraction software called TermoStat, created by Drouin (2003), we can extract several lexical units that give us access to a

¹ The resource has three levels of description: i) a lexical resource, composed of lexical relations based on Melčuk et al. (1995); ii) contextual annotations and iii) semantic frames module.

² Chièze, E.; Polguère, A. (no date) available at <http://olst.ling.umontreal.ca/intercorpus/>.

selection of candidate terms in our specialized corpus³. Table 1 shows the list containing the first group of lexical units extracted by the software.

Candidate terms	Frequency	Score of specificity	Orthographic variants
floresta	1514	127.86	floresta____florestas
área	2880	118.91	área____áreas
solo	1406	115.16	solo____solos
atividade	1012	114.48	atividade____atividades
desmatamento	965	111.72	desmatamento____desmatamentos
manejo	865	105.34	manejo____manejos
espécie	1568	102.21	espécie____espécies
uso	1164	96.31	uso____usos
a	768	96.09	a____as
amazônia	695	94.84	amazônia
projeto	664	92.7	projeto____projetos
mata	688	83.34	mata____matas
plantio	539	82.72	plantio____plantios
ação	463	77.38	ação____ações
fator	454	76.62	fator____fatores
desenvolvimento	1304	72.79	desenvolvimento____desenvolvimentos
recurso	1032	70.2	recurso____recursos
pecuária	400	70.12	pecuária
vegetação	426	69.96	vegetação____vegetações
setor	369	69.06	setor____setores
carbono	435	68.72	carbono____carbonos
custo	926	66.62	custo____custos
sustentabilidade	341	65.29	sustentabilidade

Table 1: Automatic extraction of terms by TermoStat (Drouin, 2003) from the corpus compiled by Botta (2003).

Based on a reference corpus, which is a non-technical corpus, the software compares the behaviour of lexical units in both corpora and identifies the lexical items that are specific to the specialized corpus. The results are provided based on frequency and on the score of specificity (Drouin, 2003).

The list is further analysed manually by researchers in order to select true terms based on criteria to identify terms (L’Homme, 2004a: 64-66). The first criterion establishes

³ TermoStat may extract single-word and/or multi-word entries. However, the criteria applied to identify terms requires selection of single-word entries. The analysis may then identify compositional and non-compositional sequences as having a specialized meaning. A non-compositional sequence (a sequence whose meaning bears no relation to its parts or to some of its parts) is accepted as an entry; a compositional one is not for its components are regarded as entries themselves.

that we have a term when the lexical unit is closely related to the specialized domain. The list above presented by TermoStat offers us a list of lexical units that can be related specifically to the environment, such as *floresta*, *solo*, *desmatamento*, *espécie*, *amazônia*, *mata*, *vegetação*, *sustentabilidade*. Other criteria are applied when the link is not easily or clearly established. They are particularly applied to predicative units, such as verbs and activity nouns (e.g. *desmatar* and *desmatamento*) and adjectives, which are described in more detail in the next section.

3. Lexical units with a specialized meaning

In the lexico-semantic approach to terminology, terms are considered lexical units with a specialized meaning. This approach aims at investigating the terms with a specific focus on the description of their linguistic properties. Some lexical units are unanimously considered attached to a specialized domain (e.g. *floresta*, *solo* above). However other lexical units may not be directly associated with a specialized domain, particularly verbs, activity nouns, adjectives and adverbs (named predicative units).

In these cases, we may apply the second criterion proposed by L’Homme (2004a: 64), namely the analysis of the nature of the semantic arguments that interact linguistically with the lexical unit in focus. If the arguments are terms validated by the first criterion (i.e. they are related to a specialized domain), the lexical unit in focus is also a term. For example, the meaning of the verb *preservar* 1 requires two other arguments: 1. Someone (e.g. *homem*) or something (e.g. *sistema*) that preserves; 2. The thing that is preserved (e.g. *meio ambiente*, *floresta*). If the arguments are validated as terms by the first criterion, the predicative unit is also considered a term. *Preservar* is considered a term because *homem*, *sistema*, *meio ambiente*, and *floresta* are recognized as terms.

Other criteria were proposed by L’Homme (2004a: 64-66), namely i) a morphological relationship with a term, particularly those derived from word-formation processes. For example: the derivatives of *floresta*, such as verbs like *florestar*, *desflorestar*, *reflorestar*, and their nominal counterparts, *florestamento*, *desflorestamento*, *reflorestamento*, respectively; and ii) a paradigmatic relationship with the term. For example: a semantic relationship of quasi-synonym between *desmatamento* and *desflorestamento*, and an opposite relationship between, for example, *florestamento* and *desflorestamento*, a relationship of opposition in which both units represent a different perspective on a situation, ‘with trees’, and ‘without trees’ (Gagner; L’Homme, 2015).

Next, we show how DicoEnviro represents the linguistic description of the different kinds of terms mentioned above.

4. Linguistic description

DiCoEnviro includes different kinds of terms in contrast with typical terminological resources. It includes not only entities, usually denoted by concrete and physical things

(e.g. *biomassa, água*), but also verbs (*preservar, conservar, proteger*), nouns that denote activities (*preservação, conservação, proteção*) and adjectives (*degradado, desmatado, manejado*).

The linguistic descriptions of terms are placed in a terminological file which is divided in three main sections: i) a section that describes the specialized meaning of the term, ii) a section that presents the contexts; and iii) a section, named Lexical Relations, that describes the terminological structures established by the entry with other terms. The term to be described is extracted from contexts of occurrences; by default, three contexts are shown in the file. Next we present how the specialized meaning is represented and the types of terminological structures under attention in the resource.

4.1 Description of the specialized lexical meaning

Entities and predicative units are included in the DiCoEnviro. Entities, named in the literature semantic nouns (*noms sémantique* in Polguère, 2016: 164), are physical entities such as water, air, planet, plant, tree, etc. Their meaning is not a connecting one, and therefore no participants are expressed. We show below how DiCoEnviro represents this type of meaning taking as example the entry *água 1* (Portuguese):

<p>água 1 , n. f. a água</p> <p>Definição:</p>	<p>status: 2</p>
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Table 2: Meaning representation taken from the entry ÁGUA in the DicoEnviro.

The meaning of entities is to be expressed in a specific field for the definition (Definição in the terminological file). The specialized lexical meaning of a predicative unit is described based on the expression of its argument structure. A predicative unit is called a semantic predicate (*prédicats sémantiques*) in the literature (Mel'čuk et al., 1995: 76; Polguère, 2016: 162-163). Mel'čuk et al. (1995: 76) defines a semantic predicate as a:

“...connecting” meaning – it gathers other meanings in a semantic configuration arranged like a connecting tube that links the poles of a shelter in order to form the structure that supports the shelter. The semantic predicates designate actions, events, processes, states, properties, relations, etc in one word; this behaviour necessarily entails participants.⁴

Below we show how DiCoEnviro represents the meaning of a semantic predicate, the term *preservar 1* selected from DiCoEnviro:

⁴ “...sens ‘liant’ - il réunit d’autres sens en des configurations sémantiques tout comme un tube de jonction réunit les pôles d’une tente pour former le squelette porteur de la tente. Les prédicats sémantiques désignent des actions, des événements, des processus, des états, des propriétés, des relations, etc, - en un mot, des faits qui impliquent nécessairement des participants” (Mel'čuk et al., 1995: 76).

preservar 1 v. tr.	status: 2
preservar: homem  ou sistema ~ meio ambiente, floresta 1	

Table 3: Argument structure extracted from the headword *preservar* 1 in the DicoEnviro.

Two typical participants are established in the argument structure of *preservar*: 1. The agent *homem* and the cause *sistema*; 2. The patient *meio ambiente* and *floresta*. Other contexts may reveal other arguments, other agentive participants such as *agricultor*, *fazendeiro*, *proprietário*; and other participants that are affected by the action of the verb, such as *bioma*, *espécie*, *fauna*, *flora*. However, the typical terms, i.e. the terms that seem to be more natural and frequent cooccurring with the term in focus, are the ones that are expressed first in the argument structure (L’Homme & Laneville, 2009).

4.2 Terminological structures

This section provides details on the types of lexical relations established between terms that are semantically related to the entry and how these relations are represented in the DiCoEnviro. This is based on the consideration that the lexical system of a language is not simply a list of lexical units, but a “vast lexical network: an extremely rich and complex system of lexical units connected to one another” (Polguère, 2016: 130). In this system each lexical unit has a value by means of which multiple types of relations are established. For this reason, the terms are thought to be structured within a system of relations established with other terms that belong to the specialized domain.

There are two major types of relations established by lexical units, as observed by Polguère (2016: 130):

1. Paradigmatic relations: they connect lexical units by means of semantic relations, which can eventually be accompanied by morphological ones. For example, the verbs *preservar* and *conservar* are quasi-synonyms; *preservar* and *proteger* are related meanings.
2. Syntagmatic relations: they link lexical units based on the most preferred combinations established in the syntactic axis of a language. For example, *preservar a área*, *~ a vegetação*, *~ a fauna*, *~ a flora*.

In the lexico-semantic approach the research focuses on the different types of paradigmatic and syntagmatic relations the terms establish among themselves. L’Homme (2004a: 83-118) names these *terminological structures* because they are identified within a specialized domain. Two types of terminological structures are envisaged: i) the classical lexico-semantic relations, composed of different types: taxonomic relations, synonymy and near synonymy, antonymy, meronymy; ii) other lexico-semantic relations particularly composed of combinations, such as collocations.

In DiCoEnviro the terminological structures are represented in the terminological file in a field named *Lexical Relations*. A list of terms that are semantically related to the entry is provided along with a short explanation of the relation. Terms that are available online are hyperlinked, allowing users to access their entries directly.

The *Lexical Relations* are composed of the following families: related meanings, opposites, types of, parts of speech and derivatives, combinations and others, as described below.

The family *Related Meanings* (*Voisins* in French; *Significados Relacionados* in Portuguese) includes the following relationships: near synonyms, related meaning and generic relation. For example, the entries *preservar* 1 and *conservar* 1 are analysed as ‘near synonyms’ because the data analysis shows that they may be interchanged in some contexts. On the other hand, *preservar* 1 and *proteger* 1 are analysed as related meaning (*sentido vizinho*) because they may not be interchanged and their argument structure displays a different configuration, as it is shown below:

preservar 1 , v. tr. status: 2
 preservar: homem  ou sistema ~ meio ambiente, floresta 1 
 Contexto(s)
 Relações lexicais

Explicação	Termos relacionados
Significados relacionados	
Quase sinônimo	conservar 1
Sentido vizinho	proteger 1

Table 4: Lexical relations extracted from the entry *preservar* 1 in DiCoEnviro.

proteger 1 , v. tr. status: 2
 homem  ~ recurso, espécie  contra degradação 1 
 Context(s)
 Lexical relations

Explanation	Termos relacionados
Significados relacionados	
Sentido vizinho	preservar 1 conservar 1

Table 5: Lexical relations extracted from the entry *proteger* 1 in DiCoEnviro.

The family *Opposites* (*Contraires* in French and *Opostos* in Portuguese) includes four main categories of opposite relationships: *antonym* (complementary and reversive),

opposite (near gradable, near reversible), *conversive* and *contrastive*⁵ (Gagné & L’Homme, 2016). DiCoEnviro considers, for example, that pairs such as *florestamento* and *desflorestamento* (English *afforestation* and *deforestation*) do not establish a canonical type of opposition (meaning the negation of one member of the pair necessarily entails the assertion of the other); they are considered, on the other hand, a type of reversible, a reversible 1.

florestamento 1 , n. m. status: 2
 florestamento: ~ da área ⊕ pelo homem para colocar árvore ⊕
 Contexto(s)
 Relações lexicais

Explicação	Termos relacionados
Opostos	
Antônimo	desflorestamento 1 desmatamento 1

Table 6: Lexical relations extracted from the entry *florestamento* 1 in DiCoEnviro

desflorestamento 1 , n. m. status: 2
 desflorestamento: ~ de região ⊕ por homem para retirar árvore
 Contexto(s)
 Relações lexicais

Explicação	Termos relacionados
Significados relacionados	
	desmatamento 1
Opostos	
Antônimo	florestamento 1
Oposto	reflorestamento 1

Table 7: Lexical relations extracted from the entry *desflorestamento* 1 in DiCoEnviro

⁵ Gagné & L’Homme (2016) identified these different types of categories in a research based on data extracted from DiCoEnviro.

According to Gagné and L’Homme (2016: 16), “reversives 1 consist in a change of direction applied to an entity between two absolute states (...). Therefore, the initial state of the first member corresponds to the final state of the second member and vice versa, so both members represent a different perspective on a situation”.

Some lexical units establish an atypical type of opposition. In these cases, we add ‘near’ to the pairs. The terms *desflorestamento* 1 and *reflorestamento* 1 are considered ‘opposite’ (*oposto*) and not pure reversives (*antônimos*) because the change of direction, implied in a reversible case, is not an absolute state, i.e. *desflorestamento* 1 does not entail necessarily *reflorestamento*. The entries mentioned above are presented in Tables 6 and 7.

The family *Other Parts of Speech and Derivatives* (*Autres parties du discours et dérivés* in French and *Outras partes do discurso e derivados* in Portuguese) accounts for the morphological relations a term shares with the entry. For example: same meaning but different parts of speech: e.g. *desflorestar* (verb) → *desflorestamento* (noun); *desflorestar* (verb) → *desflorestado* (adjective). Table 8 shows the relationships represented in the DiCoEnviro.

desflorestar 1 , v. tr.

desflorestar: homem ~ mata ☕ para retirar árvore

ContextsLexical relations

Explanation	Related term
Other Parts of Speech and Derivatives	
Nome	desflorestamento 1
Uma mata que foi d.	desflorestado 1

Table 8: Lexical relations extracted from the entry *desflorestar* 1 in DiCoEnviro

The family *Types of* (*Sortes de* in French and *Tipos de* in Portuguese) accounts either for paradigmatic relations or syntagmatic relations (combinations). The paradigmatic relations contain single-word terms that represent, for example, a generic-specific relationship, i.e. the hyponyms related to the entry are represented (e.g. *floresta* is a ‘type of’ *ecossistema* – the generic). The syntagmatic relations involve properties and are expressed linguistically by the collocates of an entry. In the DiCoEnviro, the way the collocate combines with the entry is specified: e.g. *ecossistema* → ~ *aquático*; ~ *florestal*.

The family *Combinations* (*Combinatoire* in French and *Combinações* in Portuguese), on the other hand, accounts for syntagmatic relations that involve activities. The relations are also expressed linguistically by the collocates of an entry. The specification of the combination is represented as follows: *ecossistema* → *ameaçar o ~*; or the nominalization: *ecossistema* → *ameaça ao ~*. Below we show the representation of these relationships in the entry *ecossistema*:

ecossistema 1 , n. m.

um ecossistema: ~ de floresta 1 ⊕

Contexts

Lexical relations

Explanation	Related term
Types of	
Que é relativo a uma área específica	~ aquático ~ florestal 1 (...)
Combinations	
Alguém ou algo pode apresentar um risco ao e.	ameaçar 1 o ~
Nome para alguém ou algo pode apresentar um risco ao e.	ameaça 1 ao ~ (...)

Table 9: Lexical relations (‘Types of’ and ‘Combinations’) extracted from the entry *Ecossistema 1* in DiCoEnviro

5. Lexical functions

In the DiCoEnviro, the paradigmatic and syntagmatic relations are encoded in the database using lexical functions, LF, (Melčuk et al., 1995; Polguère, 2016). This system allows the encoding of the syntactic and semantic properties of paradigmatic relations and syntagmatic relations (i.e. collocations). For example: assuming that *desflorestar 1* has the following argument structure:

DESFLORESTAR 1 : AGENTE {homem} ~ ORIGEM {mata} para retirar PACIENTE {árvore}

and that DESFLORESTAMENTO 1 and DESFLORESTADO 1 are related semantically, each relation will be defined based on lexical function, as follows:

S0 (DESFLORESTAR 1) = DESFLORESTAMENTO 1 (noun that conveys the same meaning)

A2 (DESFLORESTAR 1) = DESFLORESTADO 1 (the adjective that applies to the second argument of DESFLORESTAR)

If we were to encode the related term DESFLORESTADO to the entry DESFLORESTAR, the lexical relation would be assigned to “Other parts of speech and derivatives” due to the morphological and semantic relation between the terms: *desflorestado* is the adjective form of the verb *desflorestar*. The information that is inserted is shown below⁶:

```
<famille nom="Autres parties du discours et dérivés">
<lien-lexical>
<explication-ra>Uma <role-ref nom="Origem"/> que foi <lexie-ref/> </explication-ra>
<explication-tt>Uma <role-ref nom="Origem" lemme="mata"/> que foi <lexie-ref/>
</explication-tt>
<fonction-lexicale>A2Perf</fonction-lexicale>
<lien identificateur="desflorestado" numero-acceptation="1" xlink:type="simple"
xlink:show="replace" xlink:actuate="onRequest"
xlink:href="desflorestado.xml#_desflorestado1">desflorestado 1</lien>
</lien-lexical>
</famille>
```

Table 10: Encoding of the related term *desflorestado* 1 in the entry DESFLORESTADO 1

In the database of DiCoEnviro, three levels of explanation are provided for each relation: the first two are divided into two systems (L’Homme, 2012: 384-385): the first one (explication-ra) explains the relation in terms of semantic roles (e.g. Uma Origem que foi “entry”); the second one (explication-tt) refers to the typical term (e.g. Uma mata que foi d.). Then the lexical function (A2Perf) is indicated. Finally, a pointer to the related term is given (DESFLORESTADO1).

Each relation is encoded with the use of an LF based on the type of relation established with another term. Although the LFs are formally codified, the Web version of DiCoEnviro displays only explanations in natural language. Table 11 shows the relationships listed in Section 4 represented by means of LFs in English and Portuguese provided with a short explanation on the left.

⁶ An XML editor (Oxygen) is used to add entries to the database.

RELATION	EXAMPLE	LF
SIGNIFICADOS RELACIONADOS (RELATED MEANINGS)		
Quase-sinônimo (near synonym)	Preservar → conservar, maintain	QSyn
Sentido vizinho (related meaning) or	Preservar → proteger	Cf
OPOSTOS (OPPOSITES)		
Antônimo (Antonym)	Florestamento → desflorestamento, desmatamento	Rev1
Oposto (Opposite)	Desflorestamento → reflorestamento	QRev1
OUTRAS PARTES DO DISCURSO E DERIVADOS (OTHER PARTS OF SPEECH AND DERIVATIVES)		
Nome (Noun)	Desflorestar → desflorestamento	S0
Uma mata que foi d. (A forest that was deforested)	Desflorestar → desflorestado	A2Perf
TIPOS DE (TYPES OF)		
Tipo de (Type of)	Ecosistema → floresta	[Spec]
Que é relativo a uma área específica. (That concerns a specific location)	Ecosistema → ~ aquático, ~ florestal	Hypo - Lieu
COMBINAÇÕES (COMBINATIONS)		
Alguém ou algo pode apresentar um risco ao e. (Someone or something may cause the e. to be in a worse state)	Ecosistema → ameaçar o ~	Caus@AbleDegrad
Nome para alguém ou algo pode apresentar um risco ao e. (Someone or something may cause the e. to be in a worse state)	Ecosistema → ameaça ao ~	S0Caus@AbleDegrad

Table 11: Examples of terminological relations and lexical functions encoded in the DiCoEnviro

6. Concluding remarks

The paper presented the Portuguese version of DiCoEnviro referring particularly to its first level of description, the lexical resource. In this level, the resource concentrates on

the description of the specialized meaning of lexical units and on the description of the terminological structures established among the terms.

The lexical units include entities and predicative units. The meaning of predicative units is described in the argument structure section in which the core participants are stated. Subsequently, two types of terminological structures are described, one based on paradigmatic relations and the other on syntagmatic relations established among the terms. The lexical functions are the formal mechanism to encode the paradigmatic and syntagmatic relations in the database (Oxygen XML editor).

The coverage in Portuguese differs quite drastically from that in French and English. Data taken into account as of February 2018 (L’Homme, 2018) show French, English and Portuguese have the following number of entries and relations: English (982 entries, 11,942 relations), French (1,309 entries, 16,723 relations), and Portuguese (37 entries, 563 relations).

Terms and terminological relations for Portuguese in the DiCoEnviro are under construction and our purpose is to increase the number of entries and relations that represent deforestation, as well as to expand the corpus to include other topics (e.g. climate change, endangered species, recycling, sustainable development), associated with the environment.

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