

Distinguishing polysemy from contextual variation in terminological definitions

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Abstract

In any concept-based terminological resource, polysemy, unlike contextual variation, leads to the creation of various concepts. However, the distinction between referential differences that do and do not result in separate senses must be accounted for. Our environmental knowledge base EcoLexicon, not only represents polysemy but also contextual variation. This has been achieved by reconceptualizing context-dependent propositions in semantic networks. In our approach we focus on the salience of conceptual propositions within different discipline-oriented referential settings. Accordingly, contextual variation is represented at a microstructural level by means of flexible terminological definitions.

Key words: polysemy, contextual variation, reconceptualization, terminological definitions.

Resumen

La distinción entre polisemia y variación contextual en la definición terminológica

En cualquier recurso terminológico, la polisemia, a diferencia de la variación contextual, conduce a la creación de varios conceptos. Sin embargo, es necesario dar cuenta de la distinción entre las diferencias referenciales que dan lugar a sentidos distintos y las que no. Por ello, nuestra base de conocimiento medioambiental EcoLexicon representa tanto la polisemia como la variación contextual. Ello se logró mediante la reconceptualización de proposiciones dependientes del contexto en las redes semánticas. En nuestra aproximación, nos centramos en la relevancia de las proposiciones conceptuales en diferentes marcos referenciales de acuerdo con el dominio. Asimismo, la variación contextual se representa en el nivel microestructural mediante definiciones terminológicas flexibles.

Palabras clave: polisemia, variación contextual, reconceptualización, definiciones terminológicas.

Overloaded concepts share multiple relations with many other concepts, but they rarely, if ever, activate all relations at the same time. Reconceptualization is thus based on prototypes and context. Prototype theory (Rosch, 1978) has been mainly applied to category member salience. However, in our approach we focus on the salience of conceptual propositions within different discipline-oriented settings or contextual domains (Figure 2). This means that context is regarded as a dynamic construct that triggers or restricts part of the knowledge associated with a concept.


 EcoLexicon <small>terminological knowledge base</small>	
<h2>Contextual Domains</h2>	
<p>1. ENVIRONMENTAL PROTECTION</p> <p>1.1. Environmental Law 1.2. Environmental Education 1.2.1. Sustainable Tourism 1.3. Natural resources management</p> <p>2. SCIENCE</p> <p>2.1. Geography 2.2. Biology 2.2.1. Biological Oceanography 2.2.2. Botany 2.2.3. Zoology 2.2.4. Microbiology 2.2.5. Molecular Biology 2.2.6. Biochemistry 2.3. Physics 2.3.1. Geophysics 2.3.2. Physical Oceanography 2.4. Geology 2.4.1. Hydrogeology 2.4.2. Geophysics 2.4.3. Geochemistry 2.4.4. Geological Oceanography 2.4.5. Geomorphology 2.5. Hydrology 2.5.1. Hydrogeology 2.5.2. Hydrometeorology 2.6. Chemistry 2.6.1. Geochemistry 2.6.2. Biochemistry 2.6.3. Chemical Oceanography</p>	<p>2.7. Atmospheric Sciences 2.7.1. Meteorology 2.7.1.1. Meteorological Oceanography 2.7.1.2. Hydrometeorology 2.7.2. Climatology 2.8. Ecology 2.8.1. Human Ecology 2.9. Soil Sciences 2.10 Oceanography 2.10.1. Biological Oceanography 2.10.2. Physical Oceanography 2.10.3. Meteorological Oceanography 2.10.4. Geological Oceanography 2.10.5. Chemical Oceanography</p> <p>3. ENGINEERING</p> <p>3.1. Marine Engineering 3.2. Civil Engineering 3.2.1. Transport and Infrastructure Engineering 3.2.2. Hydraulic Engineering 3.2.3. Coastal Engineering 3.2.4. Mining Engineering 3.2.5. Environmental Engineering 3.2.5.1. Waste Management 3.2.5.2. Water Treatment and Supply 3.2.5.3. Air Quality Management 3.2.5.4. Soil Quality Management 3.3. Agronomy Engineering 3.4. Chemical Engineering 3.5. Energy Engineering 3.5.1. Renewable Energy</p>

Figure 2. Contextual domains in EcoLexicon.

Given the fact that the context of a concept is the set of concepts relevant to its intended meaning (Michalski, 1991), reconceptualizing knowledge in terms of contextual domains entails constraining the relational behavior of concepts. This is done by assigning each conceptual proposition to one or more contextual domains. For example, the proposition CONCRETE *made_of* WATER is only relevant to Civil Engineering. In contrast, when WATER is described in terms of its natural interaction with the landscape, this is relevant to Hydrogeology. When domain-specific contextual restrictions are applied, the information overload disappears, as shown in Figure 3:

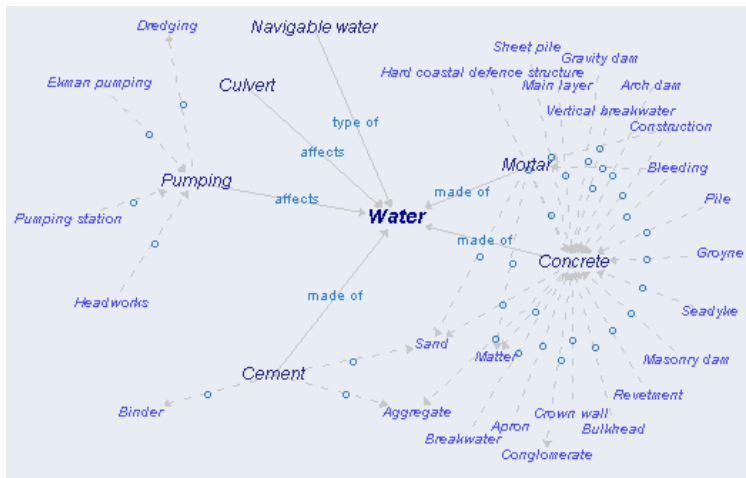


Figure 3. The semantic network of WATER in the context of Civil Engineering.

In such recontextualization, the referential extension of WATER does not change. It only behaves differently, depending on its relations with other concepts in the real world. In other words, WATER is still WATER even though it can be found in the SEA or in a WATER TREATMENT PLANT. Similarly, WATER is still WATER when it participates in CLOUD formation or in DESALINATION processes. The contextualization of concept-entries only disambiguates the situation in which the concept may occur, but this does not mean that we are dealing with different senses of a polysemic term. Consequently, any concept in EcoLexicon can be displayed from a general environmental perspective or in the context of domain-specific constraints.

In conceptual modeling, facets and contexts can be established according to different criteria. However, in EcoLexicon, a discipline-oriented approach was found to be the most appropriate since concepts may have different roles and degrees of prominence in different disciplines. Flexible definitions follow the same premises used in the reconceptualization of semantic networks since they are the prototypical reflection of such networks. However, the way that multidimensionality should be reflected in definitions has still not been resolved (Meyer *et al.*, 1992). Firstly, definitions should only include the most prototypical propositions in the semantic network of a concept. Secondly, the relevant definitional properties can only be extracted if there is a sufficiently clear boundary between polysemy and contextual variation.

Distinguishing polysemy from contextual variation: the cases of accretion and sedimentation

ACCRETION and SEDIMENTATION share meaning components since both are generally described as accumulation processes. Some general language resources define ACCRETION as a type of SEDIMENTATION (1)³¹, whereas in other resources, the two terms seem to be synonyms (2).³²

- 1) slow addition to land by deposition of water-borne sediment. [The American Heritage Dictionary of the English Language, 4th edition³]
- 2) growth or increase by the gradual accumulation of additional layers or matter. [Oxford Dictionaries Online⁴]

Nevertheless, these concepts are very different. In fact, within the environmental domain, the senses of *accretion* vary, depending on whether the term is used in Geology, Hydrometeorology, or Oceanography. Even though the specialized definitions of *accretion* all share the same nuclear meaning, they actually refer to different concepts. For instance, in Meteorology, *accretion* refers to the process by which a snowflake hits a drop and freezes with the drop, whereas in Geology *accretion* is the addition of material to a tectonic plate. Moreover, in Geology, especially in Geological Oceanography, *accretion* is the land build-up caused by sedimentation on the shoreline.

However, *A Dictionary of Environment and Conservation* (Calow, 1998) suggests that *accretion* is monosemic and attempts to include some of the above-mentioned senses in a single definition:

- 3) A process of growth by accumulation and adhesion. Examples include the build-up or accumulation of sediment, and the process by which precipitation particles grow, by the collision of an ice crystal or snowflake with a supercooled liquid droplet that freezes upon impact. On a large scale, the term is also used to describe primitive planetary growth, and to describe the addition of material at the edges of pre-existing continents.

This is a fallacious extensional definition, which is evidence of the polysemic nature of the term. By analogy, all these processes share the same nuclear meaning or genus, *growth by accumulation*, and have been given the same designation, *accretion*. However, their differentiating features or differentiae point to different senses.

³¹ <http://www.yourdictionary.com/accretion>

³² <http://oxforddictionaries.com/definition/accretion>

The reason why this dictionary has a single definition is probably that it is trying to cover all environmental terms. This is what EcoLexicon wishes to avoid since terminographers need to be attentive to intra-domain polysemy, and apply a multi-domain approach to terms (Meyer & Mackintosh, 2000: 135). In the same line as in EcoLexicon, *A Dictionary of Ecology* (Allaby, 2005) splits *accretion* into three senses:

- 4) The process by which an inorganic body grows in size by the addition of new particles to its exterior.
- 5) The addition of material to the edge of a continent, thus enlarging it.
- 6) The accumulation of sediments from any cause, representing an excess of deposition over erosion.

Nevertheless, example (4) still attempts to contextualize the nuclear meaning of *accretion* within the rather large domain of Ecology by using general definitional elements such as “an inorganic body” and “new particles”. Needless to say, this definition is not helpful to the user who wishes to understand what *accretion* means in an environmental context. This dictionary completes the entry with two senses mainly related to Geology (5, 6), but the hydrometeorological sense of the term is omitted.

The third concept designated by *accretion* (6) is often mistaken for SEDIMENTATION even though the process of SEDIMENTATION occurs previous to ACCRETION. General language dictionaries tend to define *sedimentation* as a monosemic term, either with a very general definition³³ (7, 8)³⁴ or by framing the concept in a geological scenario³⁵ (9, 10)³⁶:

- 7) the process by which a sediment is formed. [MacMillan Dictionary Online⁵]
- 8) the depositing or formation of sediment. [Webster's New World College Dictionary⁶]
- 9) the natural process by which small pieces of rock, earth etc [sic] settle at the bottom of the sea etc [sic] and form a solid layer. [Longman Dictionary of Contemporary English Advanced Learner's Dictionary⁷]
- 10) the phenomenon of sediment or gravel accumulating. [WordNet⁸]

³³ <http://www.macmillandictionary.com/dictionary/american/sedimentation>

³⁴ <http://www.yourdictionary.com/sedimentation>

³⁵ <http://www.ldoceonline.com/dictionary/sedimentation>

³⁶ <http://wordnetweb.princeton.edu/perl/webwn?s=sedimentation>

Even though specialized resources generally define SEDIMENTATION within the context of a frame, they do not consider the term to be polysemic either. The tendency is to give SEDIMENTATION a general or a Physics definition (11) or define it in the context of Geology (12) or Water Treatment (13)³⁷. Very few cases were found where both contexts were taken into account (14)³⁸.

11) the tendency of particles in a fluid to fall and settle out under the influence of gravity. [*The Encyclopedia of Ecology & Environmental Management* (Calow, 1998)]

12) the deposition of sediment from a state of suspension in water or air. Also known as siltation. [*A Dictionary of Environment and Conservation* (Park, 2008)]

13) letting solids settle out of wastewater by gravity during treatment. [*Terms of Environment: Glossary, Abbreviations and Acronyms* (U.S. Environmental Protection Agency)⁹]

14) 1. strictly, the act or process of depositing sediment from suspension in water. Broadly, all the processes whereby particles of rock material are accumulated to form sedimentary deposits.
2. (Water Quality) letting solids settle out of wastewater by gravity during treatment.
[*Museum of Natural History (University of Georgia) Glossary*¹⁰]

Example (14) is one of the few cases that were found that represented both the main contextual variants of SEDIMENTATION and the hyperonymic/Physics variant. In this case, the terminographer seems to assume that *sedimentation* is polysemic and that there is a hyperonymic sense from which only the geological sense stems, but not the Water Treatment sense. Nevertheless, there is no apparent reason for such a distinction because even if the definitional elements were more specific (i.e. *water* substituted by *wastewater*), the process described would be exactly the same.

Separate senses in lexicographic resources point to different concepts, but sense differentiation must be done systematically. This was not the case in the preceding examples. In some of the definitions, the separate senses only refer to different uses of the term, whereas other definitions are overly general. Therefore, in order to find a systematic distinction between polysemy and contextual variation, we have analyzed a corpus of definitions and classified their components in terms of the conceptual dimensions shown in Figures 4 and 5.

³⁷ <http://www.epa.gov/OCEPATERMS/sterms.html>

³⁸ http://naturalhistory.uga.edu/~gmnh/gawildlife/index.php?page=information/glossary&lang=en#S_anchor

		METEOROLOGY	GEOLOGY	GEOLOGICAL OCEANOGRAPHY
ACCRETION	Agent	Frozen particle –Frozen precipitation particle –Ice hydrometeor –Snowflake –Ice crystal	Tectonic plate –Subducting tectonic plate	Wave –Constructive wave
	Patient	Super cooled liquid –Super cooled water –Water droplets	Material –Continental material –Sediment	Deposit –Sediment –Coastal sediment
	Result	Collision Freezing	Tectonic movement	Deposition –Sedimentation
	Location	Cold cloud	Continent boundary (=Continent edge) –Convergent boundary –Transform boundary	Landform –Coastal land area –Beach –Shore –Estuary –Delta –Tombolo –Spit –Dune

Figure 4. Conceptual dimensions in *accretion* definitions.

		GEOLOGY	WATER TREATMENT AND SUPPLY
SEDIMENTATION	Agent	Gravity	Gravity
	Patient 1	Material –Solid matter –Solids –Solid particles –Particles of rock material –Particles in suspension –Suspended material –Suspended sediments	Solid particles –Suspended solids
	Patient 2	Fluid –Liquid –Water	Liquid –Solution –Water –Wastewater
	Result	Settling –Deposition	Settling
	Location	Landform –Body of water –River –Reservoir –Basin –Delta	Sedimentation tank (=clarifier; sedimentation basin)

Figure 5. Conceptual dimensions in *sedimentation* definitions.

Since both *accretion* and *sedimentation* are processes, their underlying structure is composed of the same dimensions (*agent*, *patient*, *result*, and *location*). However, their values change, depending on the perspective. On the vertical axis, each dimension shows the different values and their hierarchical organization. For instance, some definitions of *SEDIMENTATION* state that the affected entity or *patient* of this process is *SOLID MATTER*, whereas in other definitions, the patient is *PARTICLES IN SUSPENSION* or *SUSPENDED SEDIMENTS*. All of these entities belong to the same category, and only differ in their degree of specificity. However, the definitional element is still the same. On the horizontal axis, the values of certain dimensions vary across contextual domains. For example, the *agents* of *ACCRETION* may be a *FROZEN PARTICLE*, a *TECTONIC PLATE*, or a *WAVE*. These entities belong to different categories, and thus their definitions have no shared elements.

Therefore, the variability of conceptual dimensions determines the boundaries of conceptual identity. Figure 4 shows that the meanings of *accretion* have no elements in common. Only the definitions of *patient* and *location* are relatively similar in Geology and Geological Oceanography, given the close relation of the two domains. Conversely, in the case of *sedimentation*, Figure 5 shows that all elements are the same except those with the role of *location*, which is the dimension that codifies contextual variation. However, the process itself does not change since a change of location is not sufficient to generate a new concept. Thus, *SEDIMENTATION* has the same conceptual identity in all contexts.

Definitional templates in EcoLexicon: stable and flexible definitions

The definitions of all concepts in EcoLexicon follow a template according to category membership, which reflect the conceptual structure in which they are inserted (Faber *et al.*, 2007). As both *ACCRETION* and *SEDIMENTATION* show similar conceptual dimensions, they share the same template, characterized by the relations *is_a*, *affects*, *takes_place_in* and *result_of*.

Stable definitional templates: the case of ACCRETION

In EcoLexicon, according to the above-mentioned distinctions, three different concepts designated by the term *accretion* were created:

ACCRETION₁	
	Natural atmospheric process consisting of the growth of a precipitation particle by the collision of an ice crystal or a snowflake with a supercooled water droplet which freezes upon contact in a cold cloud.
<i>type_of</i>	NATURAL ATMOSPHERIC PROCESS
<i>result_of</i>	COLLISION FREEZING
<i>affects</i>	ICE CRYSTAL SNOWFLAKE SUPERCOOLED WATER
<i>takes place in</i>	COLD CLOUD

ACCRETION₂	
Endogenic geological process by which crustal fragments or accretionary wedges become welded to a continent due to tectonic movements in convergent or transform boundaries.	
<i>type of</i>	ENDOGENIC GEOLOGICAL PROCESS
<i>result of</i>	TECTONIC MOVEMENT
<i>affects</i>	CRUSTAL FRAGMENT ACCRETIONARY WEDGE
	CONTINENT
<i>takes place in</i>	CONVERGENT BOUNDARY
	TRANSFORM BOUNDARY

ACCRETION₃	
Exogenous geological process by which land builds up as a consequence of the accumulation of sediment on the shoreline of any water mass.	
<i>type of</i>	EXOGENOUS GEOLOGICAL PROCESS
<i>result of</i>	SEDIMENTATION
<i>affects</i>	SEDIMENT
	SHORELINE
<i>takes place in</i>	WATER MASS

Figure 6. Stable definitions of ACCRETION₁, ACCRETION₂ AND ACCRETION₃

ACCRETION₁ belongs to the domain of Hydrometeorology, whereas ACCRETION₂ and ACCRETION₃ are both geological concepts. They are the same across disciplines. Therefore, each has a single general environmental definition, which does not need to be further contextualized

Flexible definitional templates: the case of SEDIMENTATION

However, SEDIMENTATION is a different case. Even if it is regarded as a single concept, it requires more than one definition. Therefore, EcoLexicon provides a flexible definition restricting its meaning potential across different contextual domains. Not only do semantic relations vary by word sense, they also vary by context, regardless of sense variation (Murphy, 2003: 30). Therefore, EcoLexicon combines flexible definitions (several definitions for one concept) with stable definitions (one definition per concept).

From all of the propositions in each contextual domain, only the most relevant ones are represented in flexible definitions. These propositions are activated in a hierarchical structure similar to the hierarchy of contextual domains. In other words, the propositions activated in the general definition will also be activated in the definitions of the recontextualized concept.

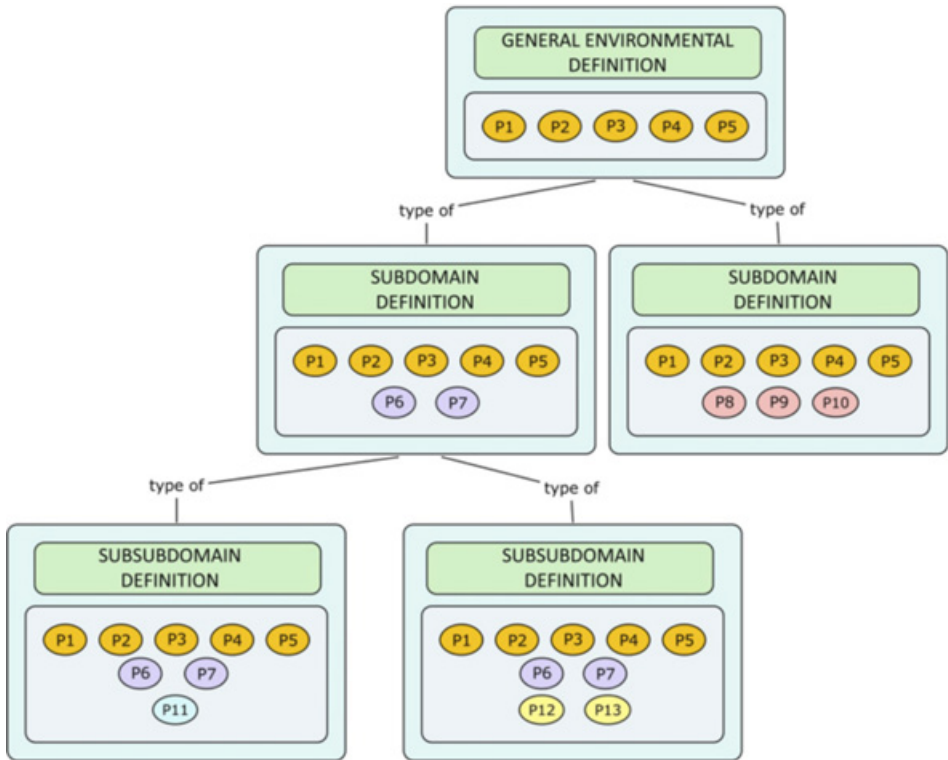


Figure 7. Hierarchical proposition inheritance in flexible definitions.

For instance, in the general environmental definition of *SEDIMENTATION*, the proposition “*SEDIMENTATION affects SUSPENDED SOLID*” is activated because it is relevant and generalized to the whole environmental domain and will be inherited in more specific definitions.

Nevertheless, there are three factors that prevent a proposition from being activated in the same way at both levels. Therefore, in certain cases, propositional inheritance does not follow the model in Figure 7:

1. *Multidimensional categorization.* Even though contextual variation does not affect concept identity, the genus of definitions does not necessarily remain unaltered. As previously mentioned, in the environmental domain, each discipline gives rise to different conceptual propositions for the same concept and that also includes hyperonymic relations. In other words, disciplines categorize the same concepts differently and this is reflected in the genus of flexible definitions. Due to multidimensional categorization, *SEDIMENTATION* is categorized as a *PHYSICAL WATER TREATMENT* in *Water Treatment and Supply* and as *EXOGENOUS GEOLOGICAL PROCESS* in *Geology*, while in the general environmental hierarchy, it is a *PHYSICAL PROCESS*. The use of different genera in each definition gives rise to the inheritance of different properties in accordance with the change of category.

2. *Contextual specification.* This occurs when a more specific proposition needs to be used instead of the corresponding proposition in the general definition. For instance, if the proposition “SEDIMENTATION *affects* FLUID” is recontextualized in Water Treatment and Supply, it becomes “SEDIMENTATION *affects* WASTEWATER”.
3. *Disjunctive generalization.* This occurs when a conceptual relation is indispensable but it produces conceptual propositions that are prototypical only in certain subdomains. In this case, all propositions will be activated in the superordinate definition and only the most relevant ones in subordinate definitions. For instance, “SEDIMENTATION *result_of* GRAVITY” and “SEDIMENTATION *result_of* CENTRIFUGATION” are both necessary to define SEDIMENTATION in the Water Treatment and Supply subdomain. However, only “SEDIMENTATION *result_of* GRAVITY” is relevant in the Geology subdomain. In this case, both propositions will be activated in the general environmental definition as a disjunction.

Prototypically, SEDIMENTATION appears in the subdomains of Geology, Water Treatment and Supply, Physics, Chemistry, and Microbiology. Nevertheless, in other contexts such as Coastal Engineering or Oceanography, SEDIMENTATION experiences contextual semantic changes as well. For instance, we only reproduce some of the flexible definitions of SEDIMENTATION, particularly those within the whole environmental domain (which also corresponds to the Physics definition), Water Treatment and Supply and Geology.

As can be observed, subordinate definitions of the general environmental definition follow the template of the latter (*type_of*, *result_of*, *affects* relations) but have different values. However, when necessary, they also activate other types of relation.

SEDIMENTATION	<i>General Environmental Definition / Physics Definition</i>
	Physical process consisting of the settling of suspended solids in a fluid due to gravitational or centrifugal force.
<i>type_of</i>	PHYSICAL PROCESS
<i>result_of</i>	GRAVITY CENTRIFUGATION
<i>affects</i>	SUSPENDED SOLID FLUID

SEDIMENTATION	<i>Water Treatment and Supply Definition</i>
	Physical water treatment process consisting of the settling of suspended solids in water due to gravity or centrifugation in a sedimentation tank for removal.
<i>type_of</i>	PHYSICAL WATER TREATMENT
<i>result_of</i>	GRAVITY CENTRIFUGATION
<i>affects</i>	SUSPENDED SOLID WATER
<i>takes place in</i>	SEDIMENTATION TANK
<i>has function</i>	REMOVAL OF SUSPENDED SOLIDS

SEDIMENTATION	<i>Geology Definition</i>
	Exogenous geological process by which sediment particles carried by transport agents are deposited due to gravity in continental environments (lakes, rivers, deserts, glaciers), shoreline environments (deltas, tidal flats, beaches) or marine environments (continental shelves, organic reefs, continental margins, continental slopes, deep sea).
<i>type of</i>	EXOGENOUS GEOLOGICAL PROCESS
<i>result of</i>	GRAVITY
<i>affects</i>	SEDIMENT PARTICLE TRANSPORT AGENT
<i>takes place in</i>	(CONTINENTAL ENVIRONMENT) LAKE RIVER DESERT GLACIER (SHORELINE ENVIRONMENT) DELTA TIDAL FLAT BEACH (MARINE ENVIRONMENT) CONTINENTAL SHELF ORGANIC REEF CONTINENTAL MARGIN CONTINENTAL SLOPE DEEP SEA

Figure 8. Flexible definitions of SEDIMENTATION.

Conclusions

Distinguishing polysemy from contextual variation in a terminological knowledge base such as EcoLexicon is necessary because it affects concept categorization. Whether a terminological unit is considered to be polysemic or contextually variant affects property inheritance including the choice of genus. Also, from a practical point of view in EcoLexicon, such a distinction determines whether a stable or a flexible definition is best to describe the meaning potential of a concept.

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