

Article

The ‘Carbon Capture’ Metaphor: An English-Arabic Terminological Case Study

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Abstract: The study of metaphorization processes in scientific texts is essential in terminological studies and the conceptual representation of specialized knowledge. It is considered to be a prolific tool in the creation of neologisms. Many cognitive models tried to study metaphorisation processes by drawing on metaphor and metonymy based on linguistic evidence. However, recent studies have highlighted the necessity of carrying out empirical tests in order to provide refined results that go beyond the traditional theories of conceptual metaphor and metonymy. This paper analyzes the underlying metaphor in the ‘carbon capture and sequestration’ event in both English and Arabic. It also discusses the influence of English, the *lingua franca*, in the transfer of the neologism ‘carbon capture and sequestration’, via translation processes, and its role in the so-called domain loss in the target language. Results were obtained through a corpus-based contrastive terminological analysis, extracted from specialized texts in English and Arabic in the subdomain of climate change. Data analysis was approached from the perspective of Frame-Based Terminology and Conceptual Complexes.

Keywords: translation; corpus analysis; domain loss; frame-based terminology; conceptual complexes

1. Introduction

According to Lakoff’s (1993) Conceptual Metaphor Theory (CMT), metaphor is considered as the mapping between two conceptual domains. At the linguistic level, these mappings reflect how our thoughts are structured metaphorically (Lakoff and Johnson 2003), and how metaphor is deeply engrained in the human cognitive system (Shuttleworth 2016), as it yields common crosslinguistic conceptualization patterns (Ureña Gómez-Moreno 2015, p. 258). Additionally, Ruiz de Mendoza (2017, p. 302) defined metaphor as a mapping of conceptual structure from a source to a target domain.

Interesting research on the use of metaphor in scientific discourse has been carried out by Ureña Gómez-Moreno (2012) in marine biology; Boquera Matarredona (2005) in civil engineering, Huang (2005) in medical texts related to AIDS, and Merakchi and Rogers (2013) in the Arabic scientific discourse. On the basis of CMT, Merakchi and Rogers (2013) confirmed that conceptual metaphors are used to add coherence to scientific discourse, as they “evoke the knowledge space of a particular source domain or sets of source domains” (Merakchi and Rogers 2013, p. 345). Bordet (2016) also highlighted the fact that conceptual construction of scientific neologisms varies across languages, but metaphors are frequently used. In the context of specialized translation, Merakchi and Rogers (2013) found that the translation of metaphor in scientific texts is crucial in the intercultural and communicative act. Translators frequently use them when they insert new and complex concepts in the target language. However, in an English-Arabic corpus based study in the domain of astronomy and astrophysics, Merakchi (2017) argued that metaphorical translation is controversial. Sometimes, the original texts try to facilitate the comprehension of science to laypersons by using shared author-reader experiences. Nevertheless, these experiences are not necessarily shared with the new target culture audience. In this case, unless translations are adapted, they may potentially lead to the misunderstanding of

scientific concepts and endanger cross-linguistic communication (Merakchi 2017, p. 3). However, this is not an easy situation for translators when they deal with pairs of languages that have not developed specialized terminologies equally. For instance, Abdullah and Shuttleworth (2013), in their English-Malay case study, concluded that specialized translation becomes more difficult when it involves original texts that have new and innovative scientific and technology terms. They also observed that translating specialized metaphors did pose some challenges in terms of the translation strategies available in Malay, the target language (Abdullah and Shuttleworth 2013, p. 617). In this scenario, sometimes translation processes may lead to the standardization of the underlying conceptual constructions from the source specialized domains, and to domain loss or “epistemicide” in target languages and cultures (Bordet 2016). In other words, according to Hultgren (2013, p.166), this is the failing to develop adequate scientific terminology in a national language, especially at conceptual level.

One of the modern approaches that studies the conceptual constructions of specialized texts is the theory of Frame-Based Terminology (FBT) (Faber 2012). The FBT represents specialized knowledge by means of hierarchically organized terminological definitions, where each concept is delimited within a referential conceptual frame that delineates the entities, relations and actions within their specialized domains. All of this information is extracted with the help of terminological analysis tools (López-Rodríguez et al. 2010). Ureña Gómez-Moreno et al. (2013, p. 176) showed that the FBT is also appropriate to reveal the metaphorical relation between domains. Meaning is the result of a dynamic process, which can be explained by using frames (Ureña Gómez-Moreno et al. 2013, p. 178). Frames are built by abstracting away conceptual structure from multiple experiences (Ruiz de Mendoza 2017, p. 302). They are particularly useful to analyze the conceptualization of metaphor at a cognitive level, as the way we store frame elements (Fes) in our mind is schematic; consequently, when we are faced with instances of frames, we adapt them to our schematic notions (Ruiz de Mendoza 2017, p. 302). Ruiz de Mendoza (2017) further indicated that in order to study cognitive models such as metaphor, it is necessary to refine the linguistic analysis through the study of conceptual complexes, which are defined as “combinations of cognitive models whose existence can be detected from a careful examination of the meaning effects of some linguistic expressions” (Ruiz de Mendoza 2017, p. 298).

In this research, an approximation towards the processes of metaphorization in the subdomain of CLIMATE CHANGE was carried out, with a special focus on the conceptual metaphors and the effects in domain loss of translation processes from English into Arabic. This case study focused on the CARBON CAPTURE AND SEQUESTRATION (CCS) event, a knowledge structure created originally in English on a metaphorical basis, and introduced into the Arabic language via translation processes. It is a corpus-based case study which applies the principles of FBT in the extraction and codification of information from specialized texts (Faber 2015), and the notion of conceptual complexes. Reality is represented through cognitive frames which result from top-down and bottom-up processes. The aim was to categorize reality at a multidimensional level that facilitates the analysis of semantic and conceptual information from the corpus of study.

2. Materials and Methods

2.1. EcoLexicon and the Environmental Event

The multilingual terminological knowledge base Eco Lexicon (http://ecolexicon.ugr.es/visual/index_es.html) was developed by the research group Lexicon at the University of Granada. Based on the FBT, the specialized (sub-) domains of the environment are conceptually represented in the form of a visual thesaurus, in which each concept is located within a specialized frame that outlines its relation with other concepts. All related entities and processes in the domain of the environment are delimited within a general event-frame called the ENVIRONMENTAL EVENT (Figure 1). This macro-template is conceived as a “dynamic process initiated by a natural or human agent, which affects a patient and produces a result” (Ureña Gómez-Moreno et al. 2013, p. 177). All sub events taking place in the environment are specifications of this general macrostructure.

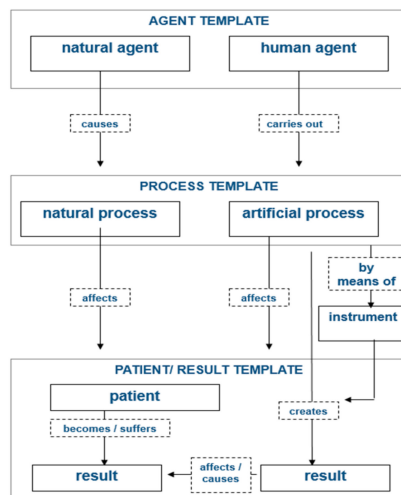


Figure 1. The ENVIRONMENTAL EVENT (<http://ecolexicon.ugr.es/en/aboutecolexicon.htm>).

For instance, the process of CLIMATE CHANGE responds to the dynamics found in Figure 1. A NATURAL AGENT (like the sun) or a HUMAN AGENT causes a NATURAL or ARTIFICIAL PROCESS of warming, such as the combustion of the fossil fuels which emit heat-trapping gases, which affect STATES and ENTITIES (climate, atmosphere of the Earth). These states and entities have the semantic role of PATIENT and, at the same time, provoke different PROCESSES/RESULTS in ENTITIES such as the sea, glaciers, etc. CLIMATE CHANGE is characterized by a series of attributes like long-term change (DURATION) and is fought by means of precautionary measures, such as the use of renewable energy sources. The specific representation of the CLIMATE CHANGE sub event is found in Figure 2, a conceptual structure that codifies knowledge at a basic level (Montero-Martínez 2008, p. 4).

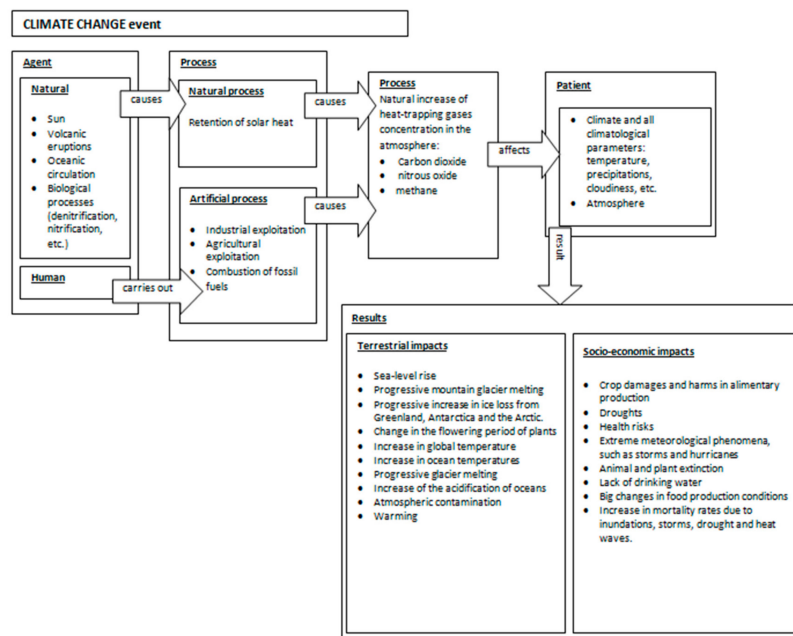


Figure 2. The CLIMATE CHANGE event.

For this study, a bottom-up process was complemented with a top-down perspective, where information was extracted from dictionaries and relevant texts in the concrete specialized subdomain. With respect to the bottom-up process, lexical constructions that evoke the concept CLIMATE CHANGE were identified, as they are considered access points towards knowledge related to this subdomain in the corpus of study.

2.2. Corpus Selection and Description

The selection criteria for the corpus of study coincides with the adequacy criteria established by Buendía Castro and Gómez-Moreno (2010), related to authority, content and design. Special emphasis was placed on the following parameters: (1) text authority, the identification of the author or the entity publishing a text is crucial as the internet contains many resources that are not always reliable; (2) topic, which in this case study must be related to the subject of climate change; (3) title of the text, which is indicative of the topic and helps in the searching criteria; (4) availability of full articles and texts, in order to adequately compile and cite the corpus; (5) impact factor, as it is especially important to choose journals with scientific quality. The corpora of the study contain specialized, semi-specialized, and informative texts. For this reason, parameters such as topic, availability of the complete text, and title were applicable in the selection of the entire corpus; however, the impact factor was taken into account in the case of specialized texts, and authority was especially important for informative texts. Following these criteria, three different corpora were compiled: (i) an English comparable corpus, (ii) an Arabic comparable corpus, (iii) a parallel English-Arabic corpus.

With respect to the English comparable corpus, it was compiled out of the Lexicon English corpus on the environment, available online in Sketch Engine. A selection of texts concerning climate change was used (with a total of 240,795 tokens) in order to obtain metaphorically based neologisms in this domain. Items in this corpus are obtained from academic articles, journals, books, and informative texts published in online newspapers or magazines. The informative texts were especially useful for their didactic function and simplified language, since they try to explain complicated scientific research to laypersons, sometimes through analogy and metaphor.

In relation to the Arabic comparable corpus (160,437 tokens), it was compiled with original texts in Arabic. However, this was not an easy task because of the scarcity of Arabic resources in comparison with the English ones, and the fact that it has not always been easy to evaluate the adequacy of the Arabic texts. For instance, in spite of being extracted from prestigious websites such as universities and national ministries, some of the texts in the Arabic corpus lack an exact bibliographic description, and vital elements such as type of text, name of the event in which it was presented, etc. For this reason, in general, it has not been possible to fulfill the criterion of impact factor in the case of texts originally written in Arabic. Additionally, in spite of the availability of the full texts, it was not possible to obtain a machine readable format for Sketch Engine, the corpus analysis tool. Consequently, the Arabic comparable corpus posed a challenge.

Finally, a parallel corpus was also created with original texts in English (29,430 tokens) and their translations into Arabic (36,326 tokens). It was adequately aligned by means of the tool Align documents, founding TRADOS Studio 2015. Texts were extracted from the journal *Nature* (<http://www.nature.com/>), together with their Arabic version; and from *Scientific American* (<https://www.scientificamerican.com/>), and their translation into Arabic available in *Al-Oloom Magazine* (<http://www.ooloommagazine.com/Home/Default.aspx>). Both publications have an elevated *h index* according to SJR (Scimago Journal and Country Report) (<http://www.scimagojr.com/index.php>). A book on climate change edited by the UNESCO was also included, together with some articles from *Permaculture Research Institute*. Finally, relevant texts from the *Integrated Regional Information Networks (IRIN)* and their Arabic official translation are found in the corpus.

The complete list of references in the corpus can be found in the following link: https://www.dropbox.com/s/x8p8uobk1jaermr/Appendixes_Carbon%20Capture%20and%20Sequestration%20An%20English%20Arabic%20Terminological%20Case%20Study.pdf?dl=0.

2.3. Candidate Metaphorical Terms and the CARBON CAPTURE and SEQUESTRATION Event

In order to extract useful information related to metaphorization processes, the framework described in Montero-Martínez (2008) was implemented. It was based on the FBT and allows the precise identification and characterization of the lexical constructions which form part of an event. The process was divided into: (a) identification of constructions evoking the frame; (b) description

of the frame lexical and conceptual profile; (c) specification of the frame relations and attributes; (d) representation of the frame definitional template. First, the corpus was analyzed in order to obtain candidate metaphorical terms and the Arabic equivalents. A word list, ordered by frequency, was generated with the help of Sketch Engine. Afterwards, it was manually analyzed to obtain a series of metaphorical candidate terms. One of the candidate terms is the lexeme ‘capture’ which appears in the corpus 52 times, as seen in Table 1.

Table 1. List of words and frequency.

	Word	Frequency
1.	capture	43
2.	captured	9

The lexical unit ‘capture’ is defined in the *Cambridge Online Dictionary* (<https://dictionary.cambridge.org/es/>) as “to take someone as a prisoner, or to take something into your possession, especially by force”. Therefore, it was selected as a metaphorical candidate to study whether, in fact, it entailed a metaphorization process or not. The contextual analysis showed that ‘capture’ frequently co-appears with the lexical units ‘sequestration’, ‘storage’, and ‘carbon’, resulting in the term ‘carbon capture and sequestration’ or ‘carbon capture and storage’(CSS), as shown in Example (1.a), (1.b), (1.c) and (1.d.) extracted from the English corpus. The fact that the argument carbon is not an animated or material object indicates that the predicate CAPTURE is used metaphorically in such examples. In other words, the argument selection carried out by the predicate in this specialized context differs from the selection described by the *Cambridge Dictionary* for the predicate CAPTURE in general language. Additionally, the fact that the lexeme “capture” frequently co-occurs in the corpus with ‘sequestration’ activates a semantic area within the realm of criminal acts and police action. Further evidence is also found in concordance (1.c.), where CSS is described as a type of “sequestration technique”.

1. Examples (1.a), (1.b), (1.c) and (1.d.) show how the CCS appears in context as ‘carbon capture and sequestration’ or ‘carbon capture and storage’.
 - a. “ ... is one step in the process of carbon capture and sequestration (CCS), and involves ... ”
 - b. “ ... Carbon Capture and Sequestration (CCS) is a set of ... ”
 - c. “ ... sequestration techniques such as carbon capture and storage (CCS) will be able to reduce the ... ”
 - d. “ ... systems or bioenergy coupled with carbon capture and sequestration setups. This poses an ... ”

The lexical constructions related to the term CCS represent the lexical formalization of the CARBON CAPTURE AND SEQUESTRATION event. These related units help in the identification of the conceptual profile of the frame, as they represent the concepts which are part of it. For example, some of the contexts retrieved from the corpus in relation to the lexical profile of the event are (2), (3), and (4). They show some key lexical constructions in italics which were further analyzed in order to understand the conceptual dynamics of the CCS event.

2. Carbon capture and sequestration (CCS) is a set of technologies that can greatly reduce carbon dioxide emissions from new and existing coal- and gas-fired power plants, industrial processes, and other stationary sources of carbon dioxide.
3. Carbon Capture and Storage (CCS). A suite of technologies exists that allows for CO₂ from the combustion or gasification of coal and other fossil fuels to be captured rather than released to the atmosphere. Once captured, CO₂ from fossil fuel use can be injected into and permanently sequestered in underground geologic formations.

- It is a *three-step* process that includes the capture of carbon dioxide from power plants or industrial sources; transport of the captured and compressed carbon dioxide (usually in pipelines); and underground injection and geologic sequestration, or permanent storage, of that carbon dioxide in rock formations that contain tiny openings or pores that trap and hold the carbon dioxide.

This information was also enriched with a top-down approach, where some units were extracted from specialized resources, such as dictionaries, encyclopedias, etc. For instance, The Intergovernmental Panel on Climate Change report of 2005 (Bert et al. 2005, p. 3) defines the terminological variant carbon capture and storage (CCS) as “a process consisting of the separation of CO₂ from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere. This report considers CCS as an option in the portfolio of mitigation actions for stabilization of atmospheric greenhouse gas concentrations” [sic]. Thus, Figure 3 shows the conceptual representation of the CCS event, defined as the process (PROCESS) to capture (PROCESS) the carbon dioxide (PATIENT) produced by the human activity (AGENT) of combustion of fossil fuel (PROCESS); to transport (PROCESS) and, finally, to storage it (PROCESS) permanently (DURATION), in geological formations or in deep sea-beds (ENTITY), in order to prevent it from reaching the atmosphere (PATIENT), and, consequently, mitigate climate change (PROCESS). The event presents its own specificity in terms of the entities and processes that take part in CCS (for instance, transportation of CO₂ to a storage place); however, it can be seen that the scheme of the event also responds to the more general conceptual configuration found in Figures 1 and 2, the CLIMATE CHANGE and the ENVIRONMENTAL EVENT, correspondingly. This way, definitional templates are established and systematically applied in FBT to all concepts related to a common area of meaning.

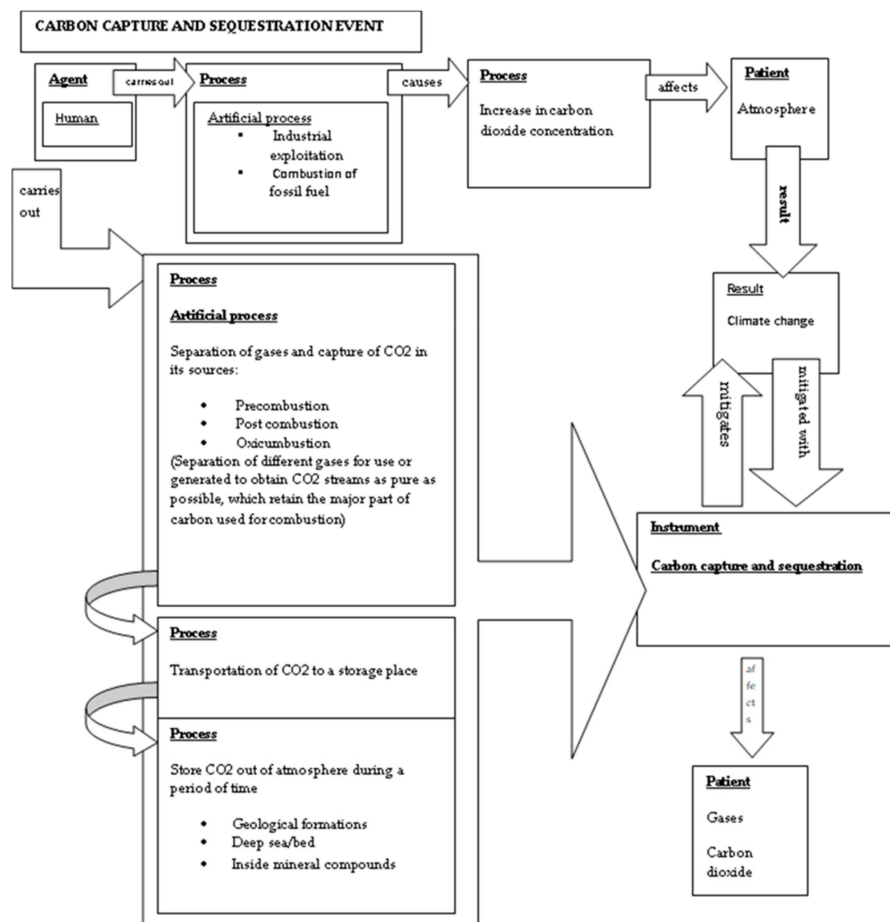


Figure 3. The CARBON CAPTURE AND SEQUESTRATION event.

3. Results and Discussion

3.1. Metaphorical Projection of CARBON CAPTURE AND SEQUESTRATION in English

The contextual analysis of the lexical units which formalize the concept CARBON CAPTURE AND SEQUESTRATION in the English corpus reflects how this process is conceptualized in discourse. For instance, examples (5) and (6) give the following information:

5. (. . .) we would employ a method that is receiving increasing attention: capturing carbon dioxide and storing, or sequestering, it underground rather than releasing it into the atmosphere. Nothing says that CO₂ must be emitted into the air (Socolow 2005a, p. 50).
6. Carbon Capture and Storage (CCS), a suite of technologies exists that allows for CO₂ from the combustion or gasification of coal and other fossil fuels to be captured rather than released to the atmosphere (Smith 2011, p. 28).

In this case, the CARBON CAPTURE AND SEQUESTRATION process is described as an action of police seizure and capture of a criminal, to judge them properly and decide whether they are guilty or not; and if declared guilty, imprison them for a determined period of time. This police action can be conceptualized as a frame, in which we find elements such as those in Table 2.

Table 2. Frame elements of POLICE SEIZURE frame.

POLICE SEIZURE Frame
Capture (PROCESS)
Imprisonment (PROCESS)
Transportation (PROCESS)
Liberation (PROCESS)
Police (ENTITY) (AGENT)
Criminal (ENTITY) (PATIENT)
Judge (ENTITY) (AGENT)
Crime (PROCESS)
Duration (ATTRIBUTE: TIME)
Prison (ENTITY) (LOCATION)
Victim(ENTITY) (PATIENT)
Police Car (ENTITY) (INSTRUMENT)

Some of the Frame Elements (FEs) that appear in Table 3 are used metaphorically in discourse to conceptualize the CARBON CAPTURE AND STORAGE phenomenon, resulting in a metaphorical frame, as can be seen in Table 3. The structure and logic of the CCS target frame determines the nature of the source (POLICE SEIZURE), which needs to have elements that correspond to the target in a significant way (Ruiz de Mendoza 2017, p. 302). For example, the mapping between the FEs in Table 3 shows that CO₂ is conceptualized as a CRIMINAL agent who harms the Atmosphere/Earth-System (VICTIM) by provoking Global Warming/Climate-Change (CRIMES). Therefore, Carbon Capture (CAPTURE) and Transportation (TRANSPORT) are carried out by scientists (POLICE), taking CO₂ (CRIMINAL) to deep sea-beds or underground (PRISON), by means of pipelines (POLICE CARS).

However, to refine the results of this analysis, it is important to go a step further and analyze how frame complexes are exploited metaphorically and metonymically. For instance, example 7 shows that two FEs of POLICE SEIZURE (i.e., PRISON and CRIMINAL) have been metaphorically used in the CCS frame. In the common frame of police seizure, we usually see the police chasing the criminal and putting them in jail where there are usually many security measures to prevent the prisoners from escaping. However, in example 7, there is an unusual development of the frame POLICE SEIZURE, that is, a different development from what is usual or expected. Here, the imprisonment of the criminal requires special measures to prevent him/her from escaping from prison (prevent it from migrating upward), and harm society. This scenario happens when the criminal tries to break out of jail using

unusual escaping techniques. For this reason, when the criminal shows any signs of disobedience, special measures are taken to prevent them from escaping from prison. One of these measures is keeping the location of prison away from society (a mile or more beneath the surface), or isolating the criminal in special cells with enhanced security (porous rock; impermeable, non-porous layers of rock). Such description leads to think of a very dangerous prisoner (CO₂) in case of escaping. Furthermore, at the same time, it entails a metonymic shift from these elements to the quality of DANGEROUSNESS of the CRIMINAL. More specifically, the allusion to special measures to prevent the criminal from escaping activates the quality of dangerousness. A case of target-in-source metonymy is found in which the whole stands for the part; the CRIMINAL (CO₂) stands for the quality of its dangerousness.

Table 3. Mapping between the frames POLICE SEIZURE and CARBON CAPTURE AND SEQUESTRATION.

	FEs of POLICE SEIZURE	FEs of CARBON CAPTURE AND SEQUESTRATION
1.	Capture (PROCESS)	Carbon Capture
2.	Imprisonment (PROCESS)	Storage/Sequestration
3.	Transportation (PROCESS)	Transportation
4.	Liberation (PROCESS)	Release
5.	Police (ENTITY) (AGENT)	Scientist
6.	Criminal (ENTITY) (PATIENT)	Carbon-Dioxide
7.	Crime (PROCESS)	Global Warming/Climate-Change
8.	Duration (ATTRIBUTE: TIME)	Duration (Temporary/Permanent)
9.	Prison (ENTITY) (LOCATION)	Underground/Sea-Bed
10.	Victim(ENTITY) (PATIENT)	Atmosphere/Earth-System
11.	Police Car (ENTITY) INSTRUMENT)	Pipelines
12.	Criminal (AGENT)	CO ₂

7. Underground injection and geologic sequestration (also referred to as storage) of the CO₂ into deep underground rock formations. These formations are often *a mile or more beneath the surface* and consist of *porous rock* that holds the CO₂. Overlying these formations are *impermeable, non-porous layers of rock* that trap the CO₂ and prevent it from migrating upward (Socolow 2005a, p. 50).

3.2. Metaphorical Projection of CARBON CAPTURE AND SEQUESTRATION in Arabic

In order to analyze whether the CARBON CAPTURE AND SEQUESTRATION process is metaphorically projected in Arabic as well, the first step was to identify the terms used to make reference to this concept. The parallel corpus showed that carbon capture is equivalent to 'احتباس الكربون' [*ih̄tibas al-karbwn*]¹ [carbon imprisonment]² and 'تخزين الكربون' [*takhzi:n al-karbwn*] [carbon storage]. Meanwhile, the comparable corpus led to the identification of the terms 'احتجاز ثنائي أكسيد الكربون' [*ih̄tija:z thuna:?i: ?uksi:d al-karbwn*] [carbon dioxide imprisonment] and 'احتجاز الكربون' [*ih̄tija:z al-karbwn*] [carbon imprisonment], with a frequency of 58 for 'احتجاز ثنائي أكسيد الكربون' [*ih̄tija:z thuna:?i: ?uksi:d al-karbwn*] [imprisonment of carbon dioxide] and a frequency of two for 'احتجاز الكربون' [*ih̄tija:z al-karbwn*] [carbon imprisonment]. Examples such as (8) were identified in which the use of the term can be observed.

¹ Transliteration is provided in italics between square brackets. Transliteration symbols can be found in Appendix A.

² Translation into English between square brackets.

ثمة استراتيجية يمكن ان تجمع بين حجز انبعاثات ثنائي اكسيد الكربون من محطات توليد الطاقة التي تعمل بالفحم وحقنها بعد ذلك في التكوينات الجيولوجية لحزنها فترات طويلة. ويمكن ان تسهم هذه الاستراتيجية بشكل ملموس في الحد من زيادة تركيز ثنائي اكسيد الكربون في الغلاف الجوي. تعد التقانات المنخفضة الكلفة التي تستهدف الحصول على ثنائي اكسيد الكربون في محطات الطاقة وزيادة الخبرة في حقن ثنائي اكسيد الكربون لتجنب تسربها لسطح الارض من العوامل الاساسية في نجاح المشاريع الكبرى لحجز ثنائي اكسيد الكربون وخرزته.

(Socolow 2005b)

8. [thammata istra:ti:jya yumkin an tajmac bayn inbica:tha:t thuna:ʔi: ʔuksi:d al karbwn min mahata:t tawli:d atta:qa allati: ta^cmal bilfahm waḥaqniha: ba^cd dha:likfi: attakwi:na:t al-jiywlwjiyya likhazniha: fatara:t tawi:la. Wayumkin an tus'him ha:dhih al-istra:tyjiyya bishakl malmu:s fi: alhadd min zya:dat thuna:ʔi: ʔuksi:d al karbwn fi: al-ghila:f al-jawwy. Tu^cadd al-taqa:na:t al-munkhafidat al-kulfaallati: tastahdif al-ḥuṣu:l^c ala: thuna:ʔi: ʔuksi:d al karbwn fi: mahatta:t al-ṭa:qa wa zya:dat al-khibra fi: ḥaḥn thuna:ʔi: ʔuksi:d al karbwn litajannub tasarrubihi li:sat'h al-ard min al-^cawa:mil al-asa:syya fi: naja:h al-masha:ri:^c al-kubra: lihajz thuna:ʔi: ʔuksi:d al karbwn wakhaznih] [There is a strategy that consists of the imprisonment of carbon dioxide emissions from coal power plants and its injection afterwards in geological formations to store it for a long period of time. This strategy may noticeably help in the reduction of the concentration of carbon dioxide in the atmosphere. It is a low cost technology which aims at obtaining carbon dioxide from energy generation stations. It also aims at increasing the expertise in carbon dioxide injection to avoid infiltrations. These two objectives are considered the main elements for the success of big projects to imprison and storage carbon dioxide].

In fragment 8, it can be observed that CCS is also described in terms of an anthropomorphic activity, which has the act of police seizure and capture of a criminal as a source domain (i.e., 'imprisonments of carbon dioxide emissions', 'to imprison carbon dioxide and storage it'). Examples in Table 4 show some of the similarities found in the lexical constructions of CCS in English and Arabic in relation to the FEs of POLICE SEIZURE listed in Tables 2 and 3. For instance, in example 1, the FEs Capture, Criminal and Imprisonment are evoked by expressions such as 'احتجاز ثنائي اكسيد الكربون وتخزينه' [iḥtija:z thuna:ʔi: ʔuksi:d al-karbwn watakhzi:nih] [capture and sequestration of carbon dioxide], and 'اسر ثنائي اكسيد الكربون وفصله' [asr thuna:ʔi: ʔuksi:d al-karbwn wafasluh] [imprisonment of carbon dioxide and its separation]. Additionally, in example 3, expressions such as 'امتصاص الغاز الكربوني وحجزه في تلك الصخور' [imtisā:s al-ga:z al-karbwny wahajzih fi: tilka al-sukhu:r] [the absorption of the carbonic gas and its imprisonment in those rocks] activate FEs such as Imprisonment, Capture, Criminal, and Prison; while example 4 shows expressions such as 'تنحية الكربون' [tanhiyat al-karbwn] [the isolation of carbon] and 'عزل الكربون' [ʔazl al-karbwn] [the insulation of carbon], evoking FEs such as Imprisonment and Criminal, etc.

Table 4. Metaphoriclexical projection of CARBON CAPTURE AND SEQUESTRATION in English and Arabic.

	Lexical Constructions in English and Arabic	Fes Police Seizure
1.	<p>‘capture and sequestration of carbon dioxide’ ‘احتجاز ثنائي أكسيد الكربون وتخزينه’؛ ‘إسْرْ ثنائي أكسيد الكربون وفصله’ [asrthuna:ʔi: ʔuksi:d al-karbwnwafasluh]; [ihtija:zthuna:ʔi: ʔuksi:d al-karbwnwatakhzi:nih] [imprisonment of carbon dioxide and its separation; imprisonment of carbon dioxide and its storage]</p>	Capture—Criminal—Imprisonment
2.	<p>‘the sequestration of greenhouse gases such as carbondioxide’ ‘احتباس غازات الدفيئة ولاسيما ثاني أكسيد الكربون’ [ihtiba:s gha:za:t al-dafyʔa wala:siyama: thuna:ʔi: ʔuksi:d al-karbwn] [the confinement of global greenhouse gases, above all, carbon dioxide]</p>	Criminal—Imprisonment
3.	<p>‘storing captured carbon dioxide underground’ ‘امتصاص الغاز الكربوني وحجْزه في تلك الصخور’ [imtiʃa:s al-ga:z al-karbwny wahajzih fi: tilka al-sukhu:r] [the absorption of the carbonic gas and its imprisonment in those rocks]</p>	Imprisonment—Capture—Criminal-Prison
4.	<p>‘carbon sequestration’ ‘تنحية الكربون’؛ ‘عزل الكربون’ [tanhiyat al-karbwn]; [ʔazl al-karbwn] [the isolation of carbon]; [the insulation of carbon]</p>	Imprisonment—Criminal

In sum, the implementation of the methodology described in [Montero-Martínez \(2008\)](#) helped in the creation of the CARBON CAPTURE AND SEQUESTRATION event, defining it as a technique or method of climate change mitigation, which consists of capturing the emitted carbon dioxide and storing it underground, instead of leaving it in the atmosphere. Corpus and manual analysis allowed the identification of the metaphorical term ‘Carbon capture and sequestration’ and its Arabic equivalent ‘احتجاز الكربون’ [ihtija:z al-karbwn] [imprisonment of Carbon]. Such methodology implies that a mapping between the conceptual categories (entities, processes, and attributes) in the CCS frame and the FEs found in POLICE SEIZURE has been established. Consequently, the principles of frame-based analysis were applied in order to identify the frame elements, and establish the correspondence between them. The results of the analysis suggest that the English term ‘carbon capture and sequestration’ was created on a metaphorical basis, and that the Arabic term ‘احتجاز الكربون’ [ihtija:z al-karbwn] [imprisonment of carbon] was created as a result of the transfer from English into Arabic via translation processes.

Frequency searches with Google operators “site: .edu”, filtering documents in websites of universities and research institutions, and exact matches for the English terms ‘carbon capture and sequestration’ (freq. 16700) and ‘carbon capture and storage’ (freq. 37,100) were carried out. In Arabic, the same operators retrieved only a frequency of five for each of the variants studied, ‘احتجاز ثنائي أكسيد الكربون’ [ihtija:z thuna:ʔi: ʔuksi:d al-karbwn] [imprisonment of carbon dioxide] and ‘احتجاز الكربون’ [ihtija:z al-karbwn] [imprisonment of carbon]. However, queries for only exact matches of these Arabic terms gave frequencies of 4300 and 6540, respectively. The enormous difference between the frequencies obtained in Arabic, with and without site filter.edu, is due to several factors. The first is that university and research institutions in Arab countries have hardly any presence in the domain .edu on the Internet. The second is that there is a lack of indexation of documents written in Arabic language, something already noted in the description of the comparable corpus in Arabic. Therefore, to see the presence of these metaphorical terms, it was necessary to make less demanding searches with regards to the sites hosting the reference documents. In short, it can be concluded that both the original English terms and their Arabic translations have a significant presence in specialized and semi-specialized discourse, judging by the frequency figures obtained.

4. Conclusions

In this study, the principles and methodology of the FBT have been applied in order to analyze metaphorization processes in the subdomain of CLIMATE CHANGE, in both English and Arabic. The results of the analysis suggest that metaphorization is a useful method in the creation of new terms in the field of climate change (Haddad and Montero-Martínez 2019). Very frequently, terms and concepts are borrowed from English in order to create terminological neologisms in many languages, Arabic amongst them. In this case study, the frame-based analysis demonstrates that the term ‘carbon capture and sequestration’ is originally constructed on a metaphorical basis. As a matter of fact, the creation of the term ‘احتجاز الكربون’ [*ih̄tija:z al-karbwn*] [imprisonment of carbon] in Arabic results from the transmission of the metaphorical frame originally used in English. The analysis showed similarities in the lexical formalizations of the concept CARBON CAPTURE AND SEQUESTRATION in both English and Arabic, and the metaphorical projection of the frame POLICE SEIZURE was found in both languages. Additionally, the analysis of conceptual complexes showed how frame complexes were exploited metaphorically and metonymically.

The direct influence of English in the conceptualization of this phenomenon led to the standardization in Arabic of the conceptual constructions found in the English metaphorical source domain. Some authors have argued that this results from the failing to create new terms and concepts in a national language (Hultgren 2013), something that impoverishes conceptual systems and prevents the growth of scientific languages at cultural and conceptual levels (Bordet 2016). When domain loss in the target language and culture occurs (Bordet 2016), some give a negative assessment of the solutions applied in the process of transferring knowledge from one language to another, either by the translators or by the experts themselves. Nevertheless, Montero-Martínez et al. (2001, p. 692) argued that, in the case of scientific and technical translation, the use of loans in the transfer of terms may also act as a fertilizer of communication techniques in other languages and, in many cases, it is more adequate than the creation of artificial and new terminology in the native language. In the current stage of development of the scientific Arabic language, this is probably the case. Experts in all fields of knowledge, especially in science and technology, learn about new concepts and terminology in specialized journals and conferences, where English is most of the times the language of communication. Thus, in order to facilitate the common understanding of scientific concepts, they frequently tend to use common cross-linguistic conceptualization patterns found in metaphorical and metonymic terms (Ureña Gómez-Moreno 2015), a fact that was also observed in the comparable Arabic corpus with original texts written by experts. In the case of the parallel corpus, translators also used the same metaphorical patterns found in the original English texts. Many times the translator’s choice was determined by the resources used for terminological documentation, which very frequently included the specialized papers, conference proceedings and reports published by the experts in the field. As seen in the frequency searches carried out with Google operators to refine document quality, the terms carbon capture and sequestration, carbon capture and storage, and the Arabic loans ‘احتباس الكربون’ [*ih̄tiba:s al-karbwn*] [carbon imprisonment] and ‘تخزين الكربون’ [*takhzi:n al-karbwn*] [carbon storage] are considerably used in discourse. Therefore, it seems that the use of conceptualization patterns and conceptual metaphors shared by English and Arabic helps climate change experts in the Arabic world to communicate and illustrate specialized concepts (Haddad and Montero-Martínez 2019) to diverse audiences.

Consequently, this case study showed that the analysis carried out within the framework of FBT and the notion of conceptual complexes is an adequate approach to the study of metaphor-based neologisms in scientific discourse. On the one hand, it allowed identifying the conceptual structure underlying the carbon capture and sequestration event, as well as the identification of the lexical profile of the frame and the establishment of the definitional template for the concepts formalizing the CCS event. All this information is essential to further process the lexical profile of CCS, identified in the study. To describe the terms in Eco Lexicon, where the subdomains of the environment are conceptually represented in the form of a visual thesaurus, each concept is located within a specialized

frame that outlines its relation with other concepts. On the other hand, the observation that the climate change discourse in Arabic borrows from the conceptual patterns found in English seems to confirm that languages lagging behind in the production of scientific texts, which is the case of Arabic, also use this strategy instead of creating pure neologisms, that is, terms not based on previous patterns coming from a source language. However, these preliminary results obtained from this case study need to be tested with a larger quantitative and qualitative study in order to determine if pure neologisms are coexisting with “borrowed” ones. This would have implications in the field of translation training in the Arabic language.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used “conceptualization, A.H. and S.M.; methodology, A.H. and S.M.; software, A.H. and S.M.; validation, A.H. and S.M.; formal analysis, A.H. and S.M.; investigation, A.H. and S.M.; resources, A.H. and S.M.; data curation, A.H. and S.M.; writing—original draft preparation, A.H. and S.M.; writing—review and editing, A.H. and S.M.; visualization, A.H. and S.M.; supervision, S.M.; project administration, A.H. and S.M.; funding acquisition, A.H. and S.M.”, please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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Appendix A

Table A1 provides the transliteration symbols for Arabic vowels and consonants.

Table A1. Arabic transliteration symbols.

Arabic Alphabet	Symbol
ء	ʔ
ث	th
ج	j
ح	h
خ	kh
ذ	dh
ز	z
ش	sh
ص	s
ض	d
ط	t
ظ	TH
ع	c
غ	gh
ق	q
و	w
ي	y
(فتحة)	a
(ضمة)	u
(كسرة)	i
مد طويل ا/ى	a:
ضمة طويلة و	u:
كسرة طويلة ي	i:
Diphthongs	aw
(أصوات علة مركبة)	ay

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