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Dynamic Topic Evolution and Sentiment Interaction in Pacific Rim Ecological Discourse

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Abstract: This study investigates the dynamic characteristics of ecological discourse in Pacific Rim news and its impact on international ecosystems by integrating Latent Dirichlet Allocation (LDA) topic modeling and sentiment lexicon analysis. A time-sensitive LDA model and a hierarchical weighted sentiment analysis framework were developed to analyze English news texts from 2021 to 2025, identifying five core themes and their sentiment evolution patterns. The findings reveal a dual tension between collaborative symbiosis and competitive confrontation in ecological discourse. Positive sentiments dominate educational and economic cooperation, while negative sentiments correlate with geopolitical conflicts. Cross-evolution analysis demonstrates that discourse fluctuations stem from the interplay between the pluralistic harmony philosophy and power competition realities, highlighting structural contradictions in policy-practice decoupling and discourse power imbalance. Methodologically, this research innovates by proposing a dynamic topic-sentiment evolution framework, enhancing LDA interpretability through temporal parameters and domain-specific lexicon constraints, and bridging ecolinguistics with computational linguistics. The results offer data-driven insights for global ecological governance and advance interdisciplinary discourse analysis.

1. Introduction

In recent years, the Pacific Rim region has become a focal point in international ecological discourse research due to its geopolitical and ecological complexity. Ecological Discourse Analysis, (EDA), as an interdisciplinary paradigm, aims to reveal how language constructs the interaction between humans and ecosystems [21][22][27]. In recent years, the rise of International Ecological Discourse Analysis, (IEDA) has further expanded the research perspective to include the ecologization of interstate relations [28][29]. However, existing studies often focus on environmental protectionism or single-country policy texts, lacking systematic exploration of thematic dynamics and emotional tendencies in multilateral interactive contexts. As a significant carrier of international ecological discourse, Pacific Rim thematic news not only reflects the complexity of regional ecological issues but also implies ideological struggles among stakeholders. Against this backdrop, there is an urgent need to combine text mining techniques to deeply analyze the implicit thematic structures and emotional evolution patterns in news texts, thereby revealing the multidimensional

characteristics of ecological discourse and their potential impacts on international ecosystems.

This study employs the cross-evolutionary framework of LDA (Latent Dirichlet allocation) topic modeling and Sentiment Analysis, aiming to achieve a diachronic correlation analysis of topic mining and emotional tendencies. First, potential topics are extracted from the Pacific Rim news corpus using [3], revealing the semantic structure and core issue distribution of the text. The advantage of LDA lies in its data-driven inductive capability, which can identify latent topics from large-scale texts and quantify the salience [4] of different issues. Second, an emotion analysis model is constructed based on the SentiWordNet sentiment lexicon, incorporating negation words and degree adverbs for semantic correction to calculate the emotional polarity of news texts. To overcome the limitations of static analysis, this study further introduces cross-evolutionary topic-emotion analysis, tracking changes in emotional intensity under different themes through time series modeling, thereby revealing the dynamic characteristics of ecological discourse. For example, for the theme of "marine pollution," it can analyze how its emotional tendency fluctuates with international policy events, thus reflecting the ecological stance games among discourse subjects. This method not only addresses the shortcomings of traditional ecological discourse analysis where themes and emotions are separated but also provides quantitative support for interpreting the complexity of international ecological discourse. In summary, this study systematically deconstructs the ecological discourse features of Pacific Rim news through the collaborative application of LDA and sentiment analysis, aiming to promote interdisciplinary integration between ecological linguistics and computational science, responding to the urgent needs of global ecological governance.

2. Related work

2.1 Ecological discourse analysis paradigm

Ecology has two meanings: broadly, it refers to the interactions among various ecosystems or systems, such as linguistic ecology and national ecology; narrowly, it pertains to environmental issues [22]. Ecological linguistics (ecolinguistics) is the integration of ecology and linguistics [31], a concept derived from Haugen's (Einar Haugen) definition, which studies the interaction between specific languages and their environments [9]. This paradigm first emerged in the 1990s when linguists began to focus on how human language systems influence natural ecological environments [16]. Since the industrial age, sustainable ecological development has received widespread attention. Scholars have hypothesized that changes in culture and social norms can enhance humans' perception of environmental changes [26]. Based on this hypothesis, researchers have started using language as a tool for social critique to expose discourse systems that undermine social norms and personal moral standards, and language planning can also be used to formulate discourse policies [21].

In terms of research paradigms, ecological linguistics has adopted critical discourse analysis and applied linguistics methods[20] to develop ecological discourse analysis, exploring how natural ecological environments are reflected in language[10], and using this to analyze human attitudes and actions toward the ecological environment[21][22]. At the same time, based on the following assumptions: first, language shapes reality; second, every choice in language policy is consciously made to meet different interpersonal interactions[8]; third, shared language habits enable common-sense belief systems to persist permanently[7]. In summary, ecological linguistics aims to link the semantic aspects of language (vocabulary, syntax, etc.) and discourse patterns (ideology, cognition, etc.) with the relationship between humans and the ecological environment. Therefore, ecological discourse analysis leverages the proactive role of language in constructing reality to promote harmony among people within ecosystems, between humans and other species, between humans and nature, and between language and the ecological environment[14].

Currently, ecological linguistics is not only focused on discourse analysis; its scope has expanded

to include language acquisition, language policy formulation, and even the interpretation of international relations. Researchers have also begun to employ empirical studies based on human-computer interaction and field experiments[2]. Some scholars have explored the impact of language distribution on the ecological environment, examining how linguistic representations influence human behavior through judgments about discourse, leading to changes in the ecological environment[10]. Additionally, corpus linguistics has been introduced to assist traditional discourse analysis[19]. Stibbe[21] also noted that corpora have great potential in analyzing large-scale texts and can compare similar texts across different language contexts. Different language environments have prompted researchers to reflect on the term "ecology." In previous studies, definitions of ecology have primarily focused on natural ecosystems, with most discourse analyses examining the issuance of environmental protection policies and green ideologies[14]. Poole[19] combined keywords, parts of speech, and semantic collocations to compare grammatical phenomena and semantic features in texts related to industrial manufacturing by environmental organizations and international industries. Domestic scholars, such as Wang[24], used keyword analysis to examine news reports about air pollution in the China Daily, while Wei Rong[8] applied ecological discourse analysis theory to analyze the transitivity meaning of intervention systems from an international ecological discourse perspective. Most of these studies focus on the impact of language on natural ecology, but ecology does not merely represent the relationship between humans and nature; it can also encompass relationships between people or other concepts. Therefore, some scholars have proposed the concept of International Ecological Discourse Analysis, (IEDA) [28][29]. The study of international ecological discourse can be understood as an approach to analyzing international relations through ecological discourse [29]. International relations form the international ecosystem, and by studying the discourse that reflects these relationships, the aim is to reveal the influence of the discursive actors (which could be a particular country) and analyze their ecological significance [27]. Here, ecology refers to the international ecosystem.

In current research on national ecological discourse, He Wei and Wei Rong[29] analyzed the connotations and research directions of international ecological discourse, constructing an international ecological factor system. They dissected the composition of the international ecological environment, including both natural and social environments. Furthermore, He Wei[30] developed a locative analysis model for international ecological discourse, which involves the ecologization of participants' roles and defines and explains beneficial, neutral, and destructive discourses in process types. Wei Rong[8] also proposed a systemic intervention analysis model for international ecological discourse, introducing the ecological philosophy of "diverse harmony and interactive coexistence," integrating it with the lexical and grammatical resources of the intervention system. Notably, these scholars argue that due to the involvement of ecological discourse analysis and international ecosystems, research on international ecological discourse is interdisciplinary and cross-disciplinary. Therefore, it is feasible to introduce other disciplines to analyze international ecological discourse.

2.2 Advances in thematic mining technology

Theme mining is the process of discovering research themes by leveraging the degree of association between text features in a dataset. The evolution of research themes over time can reveal hidden thematic distribution patterns within the text. The principle of theme analysis in text mining involves processing and analyzing collected data to identify implicit thematic patterns in the text. Therefore, theme analysis typically consists of two steps: feature extraction and text clustering. In the feature extraction stage, text data needs to undergo preprocessing, including removing stop words, punctuation marks, and numbers, as well as tokenization. Then, methods such as Bag of Words or Word Embedding are used to convert the text into numerical feature vectors. Clustering algorithms

group texts into different themes based on their similarity, with common algorithms including K-means and hierarchical clustering. Classification algorithms assign texts to predefined thematic categories, with typical methods being Naive Bayesian Model, (NBM) and Support Vector Machine, (SVM).

Commonly used topic analysis algorithms include Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA), frequency analysis, and TF-IDF keyword extraction. The method used in this paper is Latent Dirichlet Allocation. Latent Dirichlet Allocation (LDA) is the most common technique for topic mining. In the social sciences, LDA provides an observable path to conceptual phenomena because textual information in certain research fields is often complex and difficult to interpret directly [15]. Based on this, LDA can automatically extract implicit topics from text, making it easier for people to understand the underlying concepts within the text. LDA relies on Bayesian statistics to estimate model parameters. From a statistical perspective, LDA is a mixture model that uses the Dirichlet distribution and multinomial distribution to model data [3]. Here, the Dirichlet distribution can calculate an infinite number of possible topic combinations in the text [3]. This paper refers to the derivation in Blei, where Alpha (α) represents the Dirichlet parameter of the topic distribution in the text, Beta (β) represents the topic parameter of the word distribution within the topic, K denotes the number of topics, and the Gibbs iteration count N is used for statistical derivation.

Due to its data-driven nature, LDA's objectivity is validated [25]. Additionally, constrained by the scope of manually encoded data, LDA can monitor the topic distribution in large-scale datasets [4]. As the amount of text increases, LDA can infer subtle differences between different datasets [17]. Unlike traditional deductive methods, LDA employs an inductive approach to derive topics from raw data [11]. Therefore, compared to other algorithms, LDA offers higher accuracy and better addresses overfitting issues [13]. Moreover, LDA can more effectively eliminate word ambiguity [5]. Based on the above, choosing the LDA method for topic mining in this paper is reasonable.

2.3 Advances in sentiment analysis methods

Sentiment analysis, also known as Opinion Mining, is a crucial component of [12] in Natural Language Processing, (NLP). Its primary function is to systematically identify and categorize emotions embedded in text, thereby evaluating the sentiments, viewpoints, or attitudes expressed within it. The technical approach of sentiment analysis is divided into data collection, data preprocessing, feature extraction, training machine learning, and evaluating model effectiveness [6]. By automatically classifying textual sentiments as positive, negative, or neutral, sentiment analysis simplifies the analysis of large-scale texts and can be effectively applied to text processing. Moreover, sentiment analysis can be integrated into social discourse and political discussions, helping researchers understand public sentiment changes regarding policies, thus enabling the formulation of reasonable and effective decisions in digital social ecosystems and even international societies [18]. In recent years, sentiment analysis technology has relied on iterative computer algorithms, primarily through machine learning (ML) and deep learning (DL) for emotion classification [1]. Both traditional machine algorithms and deep neural networks have significantly improved the accuracy and scalability of sentiment analysis, making it possible to develop more complex emotional models. There are two main approaches to mainstream sentiment analysis: those based on sentiment dictionaries and those based on machine learning. Emotion analysis based on sentiment dictionaries involves extracting feature words from the text to be tested, then looking up the emotional value of these feature words in the dictionary, and classifying emotions based on the accumulated emotional values. Regarding the selection of sentiment dictionaries, researchers can either construct their own dictionaries using data characteristics or reference established sentiment dictionaries[5]. Machine learning-based sentiment dictionaries first train classifiers using a corpus of texts, and then classify

new texts based on these classifiers[5].

For structured documents, such as news articles, sentiment classification based on machine learning can rely on large amounts of text for pre-training. However, in practical applications, due to word ambiguity, the use of machine learning for sentiment expression in news texts is relatively insensitive and constrained by the corpus size, making it time-consuming. Therefore, this paper will adopt an emotion analysis method based on an emotion dictionary.

3. Research design

3.1 Thematic mining methods

This paper realizes the topic mining through Python path:

$$P(\text{Word} \mid \text{Document}) = \sum P(\text{Word} \mid \text{Topic}) \times P(\text{Topic} \mid \text{Document}).$$

The method leverages co-occurrence relationships to capture semantic connections and co-occurrence patterns among words in a text. In the LDA model invoked in this paper, the document generation process is as follows: For document d, LDA first extracts a topic θd from the Dirichlet distribution, which is controlled by parameter α; based on the topic distribution θd of document d, it extracts a topic zd, n from the corresponding multinomial distribution of document d; then, it extracts the multinomial distribution φzd, n for the selected topic from the Dirichlet distribution, which is controlled by parameter β; and finally, it selects a word wd, n from the multinomial distribution φzd, n for the selected topic. By learning the document-topic distribution and topic-word distribution, LDA can infer the potential subject structure of each document according to the characteristics of the dataset.

We use mathematical logic to reason about the above. In the traditional LDA model, the document generation process follows the following probability distribution:

The document-topic distribution is θd∼Dirichlet(α), and the topic-word distribution is ϕk∼Dirichlet(β). For each word wd, n that appears in document d, its topic selection basis is zd, n∼Multinomial(θd), generating the word wd, n∼Multinomial(ϕzd, n). Here, α and β are the Dirichlet prior parameters for document-topic and topic-word respectively, and K is the preset number of topics.

Considering the characteristics of timeliness, dynamic evolution of theme and professionalism of news text, the above distribution needs to be optimized as follows:

First, the time stamp t is introduced to extend the Dirichlet parameter α into a time-sensitive function to capture the temporal variation of the topic intensity:

$$\alpha = \alpha_0 + \gamma \cdot f(t) \tag{1}$$

Among these, the initial $\alpha_0 f(t) \gamma \alpha_t$hyperparameters control the sparsity of topic distribution; time window functions (such as moving averages or exponential decay) reflect the changing popularity of topics over time; and time weight coefficients are optimized through cross-validation. News topics often fluctuate with event developments, and dynamic adjustments can enhance the model's adaptability to temporal data. For example, international ecological policy events (such as Japan's discharge of nuclear wastewater) may temporarily increase the prominence of the "marine pollution" topic.

Secondly, in order to meet the needs of ecological discourse analysis, domain dictionary $\phi_k$weights are introduced into the topic-word distribution to optimize the generation process, as shown in Formula (2):

$$\phi_k \propto Dirichlet(\beta) \cdot \exp\left(\lambda \cdot \sum_{\{w \in \mathcal{D}\}} \mathbb{I}(w \in \mathcal{V}_{eco})\right) \tag{2}$$

Among them, the predefined set of ecological $\mathcal{V}_{eco} \lambda \mathbb{I}(w \in \mathcal{V}_{eco})$domain keywords; the domain

weight coefficients, which control the enhancement effect of domain words on the topic; and an indicator function that determines whether word w belongs to the domain dictionary. This optimization, constrained by the domain dictionary, makes the model more inclined to aggregate ecologically relevant terms into the same topic, enhancing the interpretability of the topic and avoiding interference from generic terms.

Thirdly, in the model training, the inter-topic KL divergence is added as a regularization term to reduce redundant topics, as shown in formula (3):

$$\mathcal{L}\text{new} = \mathcal{L}\text{LDA} + \eta \cdot \sum_{i \neq j} \text{KL}(\phi_i \parallel \phi_j) \tag{3}$$

Among them, is the likelihood $\mathcal{L}\text{new}\eta\text{KL}(\phi_i \parallel \phi_j)$ function of the original LDA; is the regularization strength coefficient; measures the distribution difference between topics i and j. News texts may have overlapping themes, such as "climate change" and "energy policy." The regularization term forces the differentiation of topic distributions, enhancing the model's ability to analyze complex issues.

Based on the above optimization process, the specific implementation path of the LDA model in this study is as follows: given fixed parameters (α, β), the analysis process is as follows: summarize the document content into K topics, initialize the topic distribution parameters α and this distribution parameter β, randomly select one topic for each word as its initial topic, then introduce code to iteratively traverse each document, re-randomly assign each word in the document to one of the K topics, and finally optimize the topic distribution and word distribution through iterative algorithms until the optimal parameters (α, β) are determined. When building an LDA model, perplexity and topic coherence are generally used to evaluate the model and determine the best number of topics. The determination of the optimal number of topics is directly related to the effectiveness of LDA topic extraction. Scholars both domestically and internationally have proposed various algorithms, such as minimum perplexity and Bayesian algorithm, among others. Considering the implementability of the final model and the accuracy of the parameters, this paper adopts topic coherence as the standard to evaluate whether the LDA model is appropriate, using the maximum coherence to determine the optimal number of topics.

3.2 Sentiment analysis algorithm

The article builds upon existing research, referencing Zhao Changyu [5]'s work on the Twitter sentiment analysis algorithm to remove the interpretation of emojis, thereby constructing and expanding the emotion lexicon. The corpus selected for this study consists of structured English news texts, and SentiwordNet3.0, built based on Wordnet, is used to expand the emotion lexicon. As of 2019, SentiwordNet3.0 contains a total of 117,659 words. Subsequently, the article employs a random walk model to assign PosScore (positive sentiment value) and NegScore (negative sentiment value) to words under the Synset distribution. Given that news texts contain negative words and degree adverbs, to eliminate the ambiguity caused by part-of-speech terms, the article constructs dictionaries for negative words and degree adverbs to address the impact of word ambiguity as much as possible. The formula for calculating the sentiment value of English texts established in previous studies [5] is shown in equation (4):

$$E = \Sigma_{j=0}^{K} e_{pn} \cdot (-1)^N \cdot P + Pos - Neg \tag{4}$$

Considering that there may be irrelevant symbols in the news text, the preliminarily modified formula for calculating the extreme value of news emotion is shown as (5):

$$E = \Sigma_{j=0}^{K} e_{pn} \cdot (-1)^N \cdot P \tag{5}$$

Among them, E represents the positive or negative emotional value of a news item, K represents the number of all emotional words in a news item, epn represents the emotional intensity of a single emotional word (based on an emotional dictionary), N represents the number of negation words related to the emotional word, and P represents the weighted value of degree adverbs.

At the same time, in order to present the emotional tendency of tweets more accurately, that is, the ternary emotional polarity, including positive, neutral and negative, the calculation formula initially cited in this paper is shown as (6):

$$E_P = \Sigma_{j=0}^{k} e_P \cdot (-1)^N \tag{6}$$

Among them, EP represents the emotional polarity of a news item. To avoid overfitting in the data, we use a simple ternary representation method: 1 for positive, 0 for negative, and-1 for neutral. In the i-class sentiment values, ep denotes the extreme value of a single emotion word, N represents the number of negation words associated with that emotion word, and the formula excludes the participation of emoticons.

In order to improve the rationality of the final emotional calculation results, this paper optimizes the above formula as follows:

First, the use of negative words and degree adverbs in news texts is complex and context-dependent. Therefore, the influence of them should be adjusted through a hierarchical weighting mechanism. The modified emotion value calculation formula is shown in (7):

$$E = \sum_{\{j=0\}}^{K} \left[e_{\{pn\}} \cdot \left(\prod_{\{m=1\}}^{\{N_j\}} w_{\{m\}}^{\{ne\}} \right) \cdot \sum_{\{n=1\}}^{\{D_j\}} w_{\{n\}}^{\{adv\}} \right] \tag{7}$$

Among them, represents the weight of the m-th negative word$w_{\{m\}}^{\{neg\}} w_{\{n\}}^{\{adv\}} N_j D_j$, represents the weight of the n-th degree adverb, represents the number of negative words associated with the current emotional word j, and represents the number of degree adverbs associated with the current emotional word j.

Secondly, the grammatical relationship between emotional words and modifiers can be identified through semantic rules to avoid misjudgment. The optimized ternary emotion polarity formula is shown in (8):

$$E_P = \sum_{\{j=0\}}^{K} \left[e_p \cdot \prod_{\{m=1\}}^{\{N_j\}} w_{\{m\}}^{\{neg\}} \cdot Context(j) \right] \tag{8}$$

Among them, Context (j) represents the context correction factor. For example, if an emotional word is in the passive voice or a question sentence, the weight will be reduced by 20%.

Thirdly, emotional tendencies are often implied through factual statements in news texts. In order to distinguish explicit and implicit emotional expressions, it is necessary to enhance the capture of implicit emotions by combining semantic rules. The optimized implicit emotion supplement formula is shown in (9):

$$E_{implicit} = \sum_{\{i=0\}}^{M} \lambda_i \cdot S_{topic(i)} \tag{9}$$

Among them, λi is the emotional tendency weight of theme i, and Stopic(i) represents the average emotional intensity of theme i in the historical corpus.

The modified emotion calculation formula adds a hierarchical weighting mechanism, which improves the accuracy of emotion calculation through the pre-defined negative words and degree adverb weight table, and can automatically identify the modifying relationship between words in the parsing process to solve the implicit emotion problem of multi-topic news.

3.3 Theme-Emotional cross-evolution analysis

Based on the results of topic mining and sentiment analysis, we will initially obtain the trend of emotional tendencies under the theme of the Pacific Rim over time, that is, the diachronic evolution characteristics. The specific implementation path is as follows: first, using the constructed LDA model to extract hot topics and their weight words, and then calculating the sentiment analysis comparison results for news in the Pacific Rim region from 2021 to 2025 through an optimized sentiment analysis formula. Combining the hot topics and diachronic sentiment analysis, we will discuss the significance of constructing international ecology in the Pacific Rim region from the perspective of international ecological discourse.

3.4 Pacific Rim News Corpus

The LexisNexis database aggregates information from over 9,000 data sources worldwide in the field of news, including major newspapers, international magazines, and academic journals, ensuring high-quality and reliable data. Therefore, this paper uses "Pacific Rim" as a qualifier to extract English news texts from the LexisNexis database for the period 2021 to 2025, building a time-series corpus. To ensure the accuracy of experimental data, the study developed a data cleaning script using the Python framework, removing words, symbols, links, and other irrelevant content from the articles, such as excessive newspaper links, addresses, and reporter names that are meaningless in news texts. The final corpus contains 298,965 entries.

4. Research results

4.1 Results of theme mining

In this paper, the optimal LDA model formula is introduced to calculate the best consistency of 1-20 topics of Pacific Rim thematic news through experiments, and the best number of topics is obtained according to the calculation results. The consistency experimental data are shown in Figure 1:

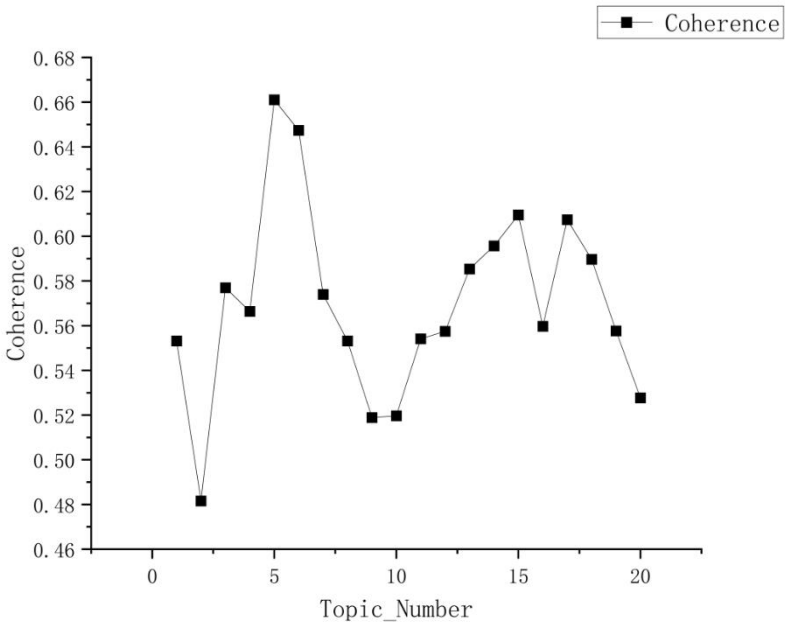

Figure 1 Coherence scores

It is known that when the number of topics is 5, the highest consistency score is achieved based on the LDA topic model to calculate the weight words under each topic. According to these weight words, five major different themes are summarized: "resource sharing in education," "regional economic integration," "resource protection cooperation mechanisms," "national development of West Coast communities," and "local community ecological conservation practices." These hotly debated theme keywords are shown in Table 1:

Table 1 Pacific Rim news topics and their keywords

theme	keyword
Sharing of educational resources	free, daily, reports, deliver, university
regional economic integration	countries, Japan, economic, business, China
Resource protection cooperation mechanism	reserve, provided, respect, views, content
National development of West Coast communities	State, west, community, coast, island
Local community ecological protection practices	westerly, western, coastal, Youkulit, community

Based on the ecological philosophy of "diversity and harmony, interaction and symbiosis" and the framework of imputation analysis [8][28][30], combined with the thematic keywords and ecological factor system [8], the ecological discourse characteristics of the five themes are analyzed as follows.

The theme of "Resource Sharing in Education" focuses on the dissemination of educational resources, potentially involving academic cooperation among universities in the Pacific Rim region, sharing of free educational resources, and updates to daily academic dynamics. The ecological factor is part of the "knowledge-sharing system" within the social environment, reflecting the cross-border flow and collaboration of educational resources in the Pacific Rim region; positive discourse such as keywords like free and deliver highlight the equal distribution of public welfare educational resources, such as open courses and mechanisms for sharing academic reports, all of which align with the concept of interactive symbiosis [28]; the potential ecological significance lies in reducing knowledge barriers through educational cooperation and promoting mutual trust in regional culture, but it is necessary to be wary of unreasonable structures in the allocation of educational resources. The theme of "Regional Economic Integration" revolves around economic interactions in the Pacific Rim region, focusing on commercial cooperation, trade relations, and regional economic policies between China and Japan, possibly including cooperative cases under the framework of the Asia-Pacific Economic Cooperation (APEC) or market strategy analyses of multinational corporations. The ecological factors involve the "trade network" and "policy coordination" of the economic environment, concentrating on the economic competition between China and Japan and cooperation under the APEC framework, while keywords like economic and business reflect mutual benefit and win-win outcomes, but countries implies national sovereignty competition, which requires vigilance against economic hegemony or environmental exploitation, falling into neutral or destructive discourse. The theme "Resource Protection Collaboration Mechanism" may explore the conservation of natural resources in the Pacific Rim region or the co-construction and sharing of cultural resources. The keywords provided and content point to multi-party collaboration in providing information or resources, such as data-sharing platforms for environmental organizations or cross-cultural cooperation projects. Keywords reserve and respect refer to ecological protection and cultural empathy, like indigenous land rights and international cooperation on marine protected areas. The theme "West Coast Community National Development" focuses on community development and geographical characteristics along the western coast of the Pacific Rim, potentially discussing national policies supporting coastal communities, island economic development, or transnational coastal zone management. Keywords national and community reflect the balance between national policies and local interests, such as infrastructure construction on islands. However, if "coast" involves territorial disputes, the discourse may shift towards destructiveness, intensifying international relations. The theme "Local Community Ecological Conservation Practices" uses

specific regions like Yukon, Canada, as examples to explore local community practices in ecological conservation, climate change adaptation measures, or community-led sustainable development projects, aligning with the concept of diverse and harmonious [8][28].

In summary, the international ecology of the Pacific Rim faces challenges. Themes such as education and economy highlight the potential for regional cooperation, but issues of sovereignty and resource allocation may lead to conflicts between beneficial discourse and destructive discourse. Therefore, hierarchical ecological governance should be given attention to avoid a situation where policy design does not align with grassroots governance. A sustainable development path requires establishing an international ecological agreement dominated by beneficial discourse, which can constrain destructive behavior and promote the transformation of the Pacific Rim from a "competitive ecosystem" to a "symbiotic ecosystem."

4.2 Sentiment analysis results

According to formulas (7), (8) and (9), the historical positive emotion analysis and historical negative emotion analysis of news texts are carried out, and the results are shown in Figure 2:

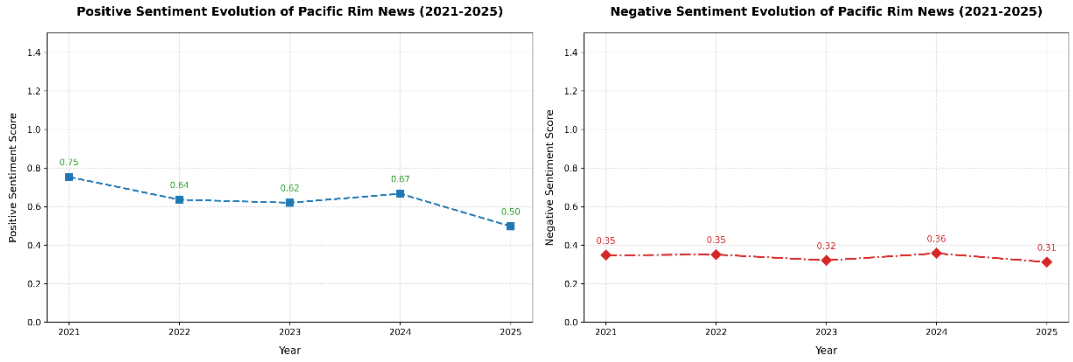

Figure 2 Comparison of positive and negative emotions in the Pacific Rim theme news from 2021 to 2025

The results of the sentiment analysis over time (Figure 2) show that positive and negative emotions in Pacific Rim news exhibit cyclical fluctuations, but overall they first rise, then decline, and finally stabilize. From 2021 to 2022, positive emotions significantly increased, primarily driven by deepened regional economic cooperation, manifesting as a concentration of beneficial discourse. However, after 2023, negative emotions gradually rose, especially in themes such as "resource protection collaboration mechanisms" and "West Coast Community National Development," where the intensity of negative emotions surpassed that of positive ones. This shift is closely related to international events during the same period, such as the intensification of ecological stance opposition among Pacific Rim countries due to Japan's nuclear wastewater discharge controversy, and the regional tensions triggered by disputes over South China Sea resource development. Such events have fueled the spread of destructive discourses, such as narratives like "environmental exploitation" and "sovereign competition," leading to a partial shift in international ecological discourse from "collaborative coexistence" to "competitive confrontation."

The results of sentiment analysis reveal three structural contradictions in the ecological discourse around the Pacific Rim. First, the tension between cooperation and competition: positive emotions on economic and environmental issues often come with negative backlash over sovereignty disputes, reflecting the conflict between the ideal of "symbiotic interaction" in international ecosystems and the reality of "zero-sum games." Second, imbalanced distribution of discourse power: developed countries dominate narratives on educational and economic themes, while marginalized nations and communities' voices are often categorized as neutral or destructive, exacerbating hierarchical issues

in ecological governance. Third, disconnection between policy and practice: the macro international cooperation framework fails to effectively translate into local practices, leading to a phased rupture in emotional orientation. In summary, the diachronic emotional evolution of the ecological discourse around the Pacific Rim is essentially the product of the interplay between the ideal of "diverse harmony" within international ecosystems and the reality of "power struggles." The peak of positive emotions indicates the potential for regional collaboration, whereas the spread of negative emotions exposes deeper contradictions in ecological governance.

4.3 Theme-Emotional cross-evolution analysis

Based on the results of LDA topic mining and time-based sentiment analysis, this paper focuses on the emotional differentiation and ecological significance under the topic subdivision.

One, Resource Sharing of Educational Resources. Positive emotions dominate this theme (average from 2021 to 2025 +0.82), with the keyword "free" reflecting international sharing practices in educational resources. This discourse promotes regional cultural trust by reducing knowledge barriers, aligning with the ecological philosophy of "interconnected coexistence." However, negative emotions briefly rise in 2024, stemming from media criticism of the unreasonable structure in resource allocation, revealing the potential threat of implicit power imbalances to ecological collaboration.

Second, positive emotions peaked in 2022 (+1.05), with keywords economic and business reflecting the beneficial nature of mutual benefits. However, negative emotions significantly increased after 2023 (-0.68), mainly due to the escalation of Sino-US trade tensions and environmental violations by multinational corporations, highlighting the destructive logic of externalizing environmental costs in economic cooperation.

Three, Resource Protection Collaboration Mechanism. Emotional fluctuations are the most intense. In 2022, positive emotions surged (+0.93), corresponding to the collaborative achievements of the joint establishment of marine protected area networks by Pacific Rim countries; however, in 2024, negative emotions skyrocketed (-1.12), closely linked to international protests over Japan's nuclear wastewater discharge. Such conflicts indicate that ecological collaboration mechanisms are vulnerable to geopolitical shocks. Without mandatory international ecological agreements, neutral discourse can quickly shift towards destructive narratives.

Four, the national development and local ecological protection practices in West Coast communities. The emotional trends of these two aspects exhibit a seesaw characteristic. From 2021 to 2023, positive emotions in "local ecological protection practices" offset negative discourses in "West Coast national development." However, after 2024, negative emotions have risen simultaneously in both themes, reflecting the disconnection between grassroots ecological practices and macro policies. For example, state-led infrastructure construction has overlooked the ecological carrying capacity of communities, leading to a partial opposition between beneficial and destructive discourses.

5. Conclusion

This paper, guided by the theory of international ecological discourse analysis and combining text mining with sentiment analysis techniques, systematically explores the dynamic characteristics of Pacific Rim news ecological discourse and its impact on the international ecosystem. By constructing an optimized LDA topic model and a hierarchical weighted sentiment analysis framework, it conducts a diachronic analysis of English-language news from the Pacific Rim from 2021 to 2025, revealing five core themes and their emotional evolution patterns. The study finds that Pacific Rim ecological discourse exhibits dual tensions of "collaborative coexistence" and "competitive confrontation." Positive emotions are mostly concentrated on issues of educational resource sharing and economic

cooperation, while negative emotions are closely related to geopolitical conflicts and sovereignty games. Cross-analysis of themes and emotions further indicates that the diachronic fluctuations in international ecological discourse are essentially the product of the interaction between the concept of "diverse harmony" and the reality of "power struggles," highlighting the structural contradictions of policy disengagement and discourse imbalance in ecological governance. The innovation of this paper lies in proposing a cross-evolutionary analysis framework for themes and emotions, breaking through the limitations of traditional ecological discourse analysis where themes and emotions are separated, achieving dynamic correlation analysis, optimizing the time-sensitive parameters and domain dictionary constraints of the LDA model, enhancing the interpretability of themes, and integrating international ecological discourse analysis theory into computational linguistics methods, providing a new paradigm for interdisciplinary ecological research.

However, the study still has the following limitations. First, the data spans are limited in time, making it difficult to fully capture long-term trends; second, sentiment analysis relies on dictionary rules, which limits its ability to capture implicit emotions and context-dependent nuances; third, the corpus is limited to English news and does not include the diversity of multilingual texts from the Pacific Rim region. Future research can enhance sentiment analysis accuracy by integrating deep learning models, expand multilingual corpora to improve cultural heterogeneity analysis, and introduce social network analysis techniques to further reveal the nodes and pathways of ecological discourse dissemination. The findings of this paper provide data-driven decision support for international ecological governance and open new research directions for the deep integration of ecological linguistics and computational science.

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