



Research on the Efficacy and Paradigm of AI-Assisted English Translation of Forestry Ecological Security Legal Texts— A Comparative Experiment Based on Zero-Shot, Few-Shot, and Chain-of-Thought Prompting Strategies

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Received: 03 Sep 2026; Received in revised form: 30 Sep 2026; Accepted: 05 Oct 2026; Available online: 10 Oct 2026

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Abstract— *The international dissemination of China's ecological rule-of-law discourse relies heavily on high-quality English translation of legal texts. However, English translation of forestry ecological security legal texts has long faced quality bottlenecks due to inconsistent species nomenclature, complex interdisciplinary semantics of ecological terms, and difficulties in restructuring complex legal sentences. The emergence of Generative Artificial Intelligence (LLMs) offers a novel path for legal translation in domain-specific contexts. Using the Forest Law and the Wetland Protection Law of the People's Republic of China as corpora, this study constructs a Chinese-English parallel dataset and designs a comparative experiment across three prompting strategies—Zero-shot, Few-shot, and Chain-of-Thought (CoT)—based on a 5-point Fluency and Adequacy scale. The results indicate that Chain-of-Thought prompting achieves the best performance in restructuring complex sentences and converting legal jurisdiction concepts; few-shot examples significantly reduce mistranslation rates; and general-purpose large language models can efficiently adapt to forestry legal translation scenarios through prompt engineering optimization. This study constructs the 'Prompt Guide for AI-Assisted Forestry Legal Translation,' providing a reusable solution for cross-border forestry law enforcement cooperation and the international dissemination of ecological rule of law.*



Keywords— *Generative AI, Forestry Ecological Security, Legal Translation, Prompt Engineering, Chain-of-Thought, Machine Translation Evaluation*

I. INTRODUCTION

With the deep evolution of the global ecological governance system, China has achieved remarkable progress in rule-of-law construction regarding forest resource protection and wetland restoration. The ecological legal system, represented by the Forest Law and the Wetland Protection Law, constitutes the core foundation of the national ecological security and legal shield. However, in cross-border forestry law enforcement cooperation, CITES compliance, and the construction of international ecological governance discourse, the English

translation of forestry legal texts faces multiple practical dilemmas.

Forestry ecological security legal texts feature both legal normativity and ecological professionalism. The pain points in their English translation manifest in three aspects: first, inconsistent nomenclature for species names and proper nouns, with a lack of strict mapping between Latin scientific names and legal terms; second, complex interdisciplinary semantics of ecological terms (such as 'non-commercial forests for ecological protection' and 'forestland use control'), which lack direct counterparts in Western legal systems and are prone to semantic drift;

third, multiple logical tiers in complex legal sentences, which easily lead to structural breakdown or omission of key information during LLM translation.

To address these bottlenecks, this study leverages the academic strengths of Northeast Forestry University to explore guiding LLMs toward precise translation via prompt engineering. By constructing a Chinese-English parallel terminology database and designing comparative experiments among zero-shot, few-shot, and chain-of-thought strategies, this study quantitatively evaluates the performance differences of various paradigms in term accuracy, sentence compliance, and logical restructuring, aiming to establish a low-cost, high-efficiency, and reusable practical paradigm.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Legal Translation and International Dissemination of Ecological Rule-of-Law Discourse

Legal translation emphasizes 'functional equivalence' and 'Skopos theory,' requiring translators to reconcile concepts across legal jurisdictions. Existing research mostly focuses on general codes, with a noticeable lack of quantitative empirical studies on the English translation of forestry ecological laws.

2.2 Generative AI and Prompt Strategy Research

As the core method for controlling LLM outputs, prompt engineering encompasses three classic paradigms: 1. Zero-shot prompting: directly providing the source text and instructions; 2. Few-shot prompting: embedding a small number of high-quality parallel corpus examples to align formatting and terminology features via in-context learning; 3. Chain-of-Thought (CoT) prompting: significantly enhancing the quality of complex sentence restructuring through explicit reasoning steps (e.g., 'extract terms — analyze structure — draft translation — conduct legal proofreading').

III. RESEARCH DESIGN AND EXPERIMENTAL METHODOLOGY

3.1 Corpus Extraction and Parallel Terminology Dataset Construction

This study selects the Forest Law and the Wetland Protection Law along with their authoritative English translations, extracting 100 core terms to construct an Excel Chinese-English parallel dataset. The corpus covers species names (e.g., Korean pine), ecological terms (e.g., peatland wetland), and legal procedure terms (e.g., timber harvesting quota).

3.2 Prompt Strategy Experimental Design

The experiment calls representative LLMs such as DeepSeek/Kimi to design three instruction comparisons: Strategy A (Zero-shot direct translation); Strategy B (Few-shot example constraint); Strategy C (Four-step CoT). Each strategy is tested 3 times on the same corpus to eliminate random generation errors.

3.3 Evaluation Metrics and Scoring Standards

A standard 5-point 'Fluency and Adequacy' scale is adopted, with double-blind scoring by 3 experts and inter-rater reliability testing (ICC) to ensure data objectivity.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

Data statistics show the scores of the three prompt strategies across Adequacy, Fluency, Term Accuracy, and Overall Average Score, as shown in Table 1:

Table 1: Comparison of Translation Performance Among Three Prompt Strategies

Prompt Strategy	Adequacy Avg	Fluency Avg	Term Accuracy	Overall Avg
Zero-shot Prompting	3.42	3.85	71.5%	3.64
Few-shot Prompting	4.28	4.30	91.2%	4.29
Chain-of-Thought (CoT)	4.75	4.68	96.8%	4.72

4.1 Term Accuracy and Conceptual Mapping Analysis

Experimental analysis shows: First, term recognition and conceptual mapping capabilities are significantly improved. Under zero-shot, the model often literal-translates '生态公益林' as 'Ecological Public Welfare Forest', whereas few-shot and CoT strategies explicitly map it to 'Non-commercial forests for ecological protection' through term constraints, raising term accuracy from 71.5% to 96.8%.

4.2 Logical Restructuring of Complex Legal Sentences

Second, the ability to restructure complex legal sentences is greatly enhanced. Legal clauses often contain complex conditional sentences. CoT prompting guides the model through grammatical analysis to automatically convert Chinese pre-conditions into standard legal English post-clauses or participial phrases, significantly improving fluency and legal rigor.

V. PRACTICAL PARADIGM AND PROMPT GUIDE DESIGN

Northeast Forestry University (Project No. 202610225537).

Based on experimental results, this study extracts a structured System Prompt Template:

[System Role] Senior expert in ecological legal translation.

[Workflow (CoT)]

1. Term Analysis: Extract species names and ecological legal terms, converting them standardly according to the [Term Bank];
2. Logical Breakdown: Deconstruct logical tiers of legal clauses (main actions, applicable conditions, exception clauses);
3. Draft Translation: Use standard legal English (prioritizing terms like "shall", "in accordance with", etc.);
4. Self-Proofreading: Verify accurate transmission of legal binding force without omission or ambiguity.

[Term Bank Example] 生态公益林 -> Non-commercial forests for ecological protection; 采伐限额 -> Timber harvesting quota.

VI. APPLICATION PROSPECTS AND SOCIAL BENEFITS

The research outcomes have clear application prospects: serving cross-border forestry law enforcement and CITES compliance; promoting high-quality translation of characteristic achievements such as 'ecological red line' and 'forest chief system' to enhance international discourse power; providing a lightweight AI application paradigm that enables general LLMs to adapt to domain-specific scenarios relying solely on prompt engineering and terminology databases without model fine-tuning.

VII. CONCLUSION AND OUTLOOK

This study addresses the pain points of forestry ecological legal English translation and verifies the efficacy of different prompt strategies. Experiments confirm that CoT and few-shot strategies effectively resolve issues such as inconsistent species nomenclature, term semantic drift, and complex sentence restructuring difficulties. The resulting prompt guide possesses high reusability. Future research can further expand corpus size and explore AI Agent applications in multilingual ecological legal translation.

VIII. FUNDING STATEMENT

This work was supported by the University-level Innovation Training Program for Undergraduates of

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