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Writing Research Articles for Climate Change Impacts on Coffee Areas. A Metadiscourse Analytical Survey

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Abstract

It is widely known that climate change significantly affects biodiversity, human health, and the sustainability of crop yields. Among these, coffee stands out as a pivotal commodity in the global agri-food chain, with coffee-related climate and environmental issues also inevitably threatening production and economic stability (United Nations 1992; Gallenti *et al.* 2016; Bezner *et al.* 2022). This study draws on the qualitative and quantitative analysis of a small corpus-based approach, using the metadiscourse analytical tool (Hyland 2005) to see how coffee-related climate and environmental issues are dealt with in academic research articles. By conducting a systematic exploration of "interactive metadiscourse" and "interactional metadiscourse" devices in a corpus of nine research articles, this research examines how these devices are employed to structure arguments, engage readers, and disseminate knowledge in this form of academic writing.

Keywords: Coffee, Environmental Issues, Metadiscourse, Research Articles

Introduction

Climate change, as defined by the United Nations Framework Convention on Climate Change, "means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere […]", affecting human health, natural ecosystems, agriculture, yields, and their sustainability (United Nations 1992, 7; G7 Italia 2024). Among these, coffee is pivotal in the agri-food chain, since it is a commodity produced in developing countries and mainly exported to developed countries (Gallenti *et al.* 2016).

The global coffee value chain extends across 50 countries, covering approximately 11 million hectares, and involves over 25 million small-scale farmers. However, many of these farmers struggle to attain a fair livelihood. The sector also faces significant environmental challenges, which are exacerbated by climate change and biodiversity loss. These factors impact coffee quality, yield, and long-term sustainability, posing socio-economic and developmental risks (G7 Italia 2024, 32).

Climate change poses significant threats to supply chains and economic stability. One illustrative example is the coffee sector, with coffee crops and production, for instance, being expected to undergo significant environmental impacts by 2050, as projected in various studies (Baca *et al*. 2014; Bunn *et al*. 2014; Bezner *et al*. 2022; Vizuete *et al*. 2024). These projected changes include, as follows, shifts in climate variables, such as temperature and precipitation, that will cause farms situated in highly vulnerable coffee-producing areas to face unsuitable conditions for producing high-quality coffee. This environmental transformation is likely to further increase migration in certain communities and exacerbate infrastructural challenges. Vulnerability in this context is shaped by the interplay of three factors: exposure to climatic changes, sensitivity, and adaptive capacity (Baca *et al*. 2014, 1, 9).

The altitudinal shift in coffee cultivation is among the most critical consequences of climate change, with optimal elevations for coffee cultivation being projected to rise significantly (1). Recognising this susceptibility is essential for formulating effective mitigation and adaptation strategies to enhance the resilience of regional agriculture against the impacts of environmental change (Vizuete *et al*. 2024, 57). In Ecuador, for instance, coffee-producing areas may experience significant losses in suitable land by 2040 due to extreme climate scenarios (49, 56). Effective adaptation measures, such as shade tree management, are essential to sustaining coffee production in order to mitigate environmental risks and foster resilience (1, 56-57).

Climate change impacts extend beyond production losses, affecting the livelihoods of small-scale farmers in developing countries, who are particularly at risk (ICO Press Release 2024) since their vulnerability to the climate crisis can be exacerbated by cultural and socioeconomic inequalities, poverty and marginalisation (Bezner *et al*. 2022).

The Mesoamerican region, for instance, home to many coffee producers, is among the most susceptible to the effects of climate change (Baca *et al*. 2014, 1). Millions of people, particularly in Mexico and Central America, rely on coffee production for their livelihoods, including farmers and those involved in processing and exportation activities (*ibidem*). Similarly, Arabica coffee in Ecuador is particularly vulnerable to climatic changes because of its reliance on stable temperatures and rainfall patterns (Vizuete *et al*. 2024, 49). Given that, the variability in coffee production constitutes 50% to 65% households income, climate change threatens food security, healthcare, and education (Baca *et al*. 2014, 9).

Addressing climate change requires a coordinated global response, with governments, environmental organisations, and trade associations working together to tackle its challenges (Halkos 2016, 22). A key aspect of this effort is ensuring financial resources to support climate adaptation measures, which is crucial for building resilience. This requires contributions from both public and private sectors at all levels to effectively implement solutions. In particular, funding should prioritise the needs of vulnerable populations (G7 Italia 2024, 2, 19) while supporting sustainable, climate-resilient, environmentally responsible, and economically equitable coffee production (32).

Global efforts are necessary to address climate change, with a key goal being the achievement of net-zero greenhouse gas emissions by 2050, which is essential for limiting global warming to 1.5°C and preventing severe climate impacts (1). As part of these efforts, companies both influence climate-change dynamics and are directly affected by its physical impacts (Halkos 2016, 22).

In light of sustainable solutions to reduce environmental impacts, companies like Illy are committed to developing assessment models to analyse the effects of different supply chains. The findings of these models will provide a strategic approach to minimising emissions during

the agricultural phase of production. A key aspect of this strategy is the adoption of regenerative farming methods to emphasise soil health, biodiversity, and the sustainable management of natural resources. Furthermore, the implementation of water conservation strategies, such as rainwater management, plays a key role in preventing soil erosion and improving moisture retention. These practices are especially significant in areas vulnerable to extreme weather events, including heavy rainfall and prolonged droughts, which are becoming increasingly frequent (Illy 2023, 5-6).

These challenges represent an issue worthy of research, and a linguistic focus on the way researchers disseminate their findings is crucial to investigating how such global issues are addressed in scholarly discourse, and how researchers engage their readers. Typically, research articles are the mainstay of scientific communication. The academic research article genre is characterised by formality, technicality, objectivity, descriptiveness, and logicality (Tessuto 2024a, 2024b), albeit being dynamic in nature. As stated by Bhatia, only by appropriating "generic resources" is it possible "to manipulate and exploit genre conventions and lexico-grammatical and rhetorical resources to create new and hybrid forms" (2004, 112), and *metadiscourse* devices (see par. 2) are key features in research articles.

Through research articles, then, scholars can present the findings of their original studies and effectively negotiate the credibility of their research.

1. Aims

This study positions itself within the existing body of literature by extending previous research on metadiscourse, particularly by applying it to a niche area: coffee-related research and its intersection with environmental issues. In doing so, it offers insights into a focused analysis of metadiscourse in the scholarly communication of a specific academic genre.

More precisely, the study is guided by two research questions:

Q1. How do academic authors writing about coffee-related research and climate change issues use *interactive metadiscourse* to structure their arguments and guide readers through the text?

Q2. How do authors use *interactional metadiscourse* to express their stance and engage readers in their arguments?

To address these questions, the research method will be outlined first, followed by an analysis and discussion of the data findings. Finally, the paper concludes by summarising the key findings and their implications.

2. Methodological Background

In this framework, metadiscourse comes through as a crucial element of persuasive writing that relates to interpersonal dynamics. Hyland defines metadiscourse as "the cover term for the self-reflective expressions used to negotiate interactional meanings in a text, assisting the writer (or speaker) to express a viewpoint and engage with readers as members of a particular community" (2005a, 37). This framework categorises linguistic and discursive features realised by the categories of *interactive metadiscourse* and *interactional metadiscourse*. *Interactive metadiscourse* guides readers through the text, organises discourse in a coherent and persuasive way, and involves the writers' recognition of an active audience, focusing on their possible knowledge, interests, expectations and needs. *Interactional metadiscourse*, on the other hand, involves the reader in the text and concerns the way writers engage and interact with their audience, convey judgements, and are recognised within the community (Hyland 2005a, 49-50).

Studies by Hyland (1998, 2005a, 2005b) and Tessuto (2024a, 2024b) have extensively analysed metadiscourse in academic writings. The findings of a research article corpus by Hyland (1998, 2005a) shows that interactive discourse is more prevalent than interactional discourse, and that the most frequent markers are hedges and transitions, followed by code glosses and evidentials. A separate study by Hyland (2005b) on stance and engagement in a research article corpus shows that stance markers, particularly hedges, are commonly used. Tessuto (2024b) gives an overview of metadiscourse in the medical research article genre for instructional purposes, and analyses stance and engagement at the interpersonal level with a focus on hedges and the *stance*-taking alongside reader pronouns and directives, aiming to engage the audience (Tessuto 2024a). Mauranen focuses on a contrastive study of rhetorical differences observed in the academic writing of economics researchers from diverse cultural backgrounds where the primary focus is on the use of "metatext, or text about text" (1993, 4) to guide readers and foster a writer-reader dialogue. From her perspective, the genre of academic writing "constitutes a meaningful whole, at a level of generality which is similar to the activity of scientific inquiry in general" (4-5). Ädel proposes reflexive metadiscourse based on *metalinguistic*, *expressive* and *directive* Jakobsonian functions of language, referring to the reflexivity of the text/code, the writer and the reader as "the reflexive triangle" (2006, 182). Following this, Toumi investigates reflexive metadiscourse in research articles, and follows a functional approach to metadiscourse, defined as "the cover term for the self-reflexive expressions used by the writer to negotiate meaning in a text. It is the writer's explicit commentary on his/her own ongoing text" (2009, 66).

From this perspective, this paper aims to explore metadiscourse devices in research articles on coffee-related research and environmental issues. The current state of the art of linguistic studies in this domain reveals a growing interest in metadiscourse analysis, particularly within the context of academic writing related to climate change. However, there remains a gap in understanding how these devices are specifically employed in research articles that focus on coffee-related environmental concerns. Given the centrality of coffee in the agri-food sector, its relevance to climate change and sustainability discourse fosters a closer examination of the specific rhetorical features in this field.

Actually, prior studies have examined metadiscourse in various climate-related genres, shedding light on how rhetorical devices influence the presentation of climate change narratives. For instance, Gulzar *et al.* (2024) explore metadiscourse strategies in Pakistani print media discourse on climate change, emphasising how hedges and boosters shape narratives of urgency and responsibility. In particular, hedges are used to express caution and skepticism, while boosters intensify statements on climate change. Additionally, boosters serve as rhetorical devices that reinforce certainty, emphasise responsibility, and enhance credibility (54, 59). Similarly, Kapranov (2016) investigates discourse markers in corporate climate discourse, revealing how multinational corporations use metadiscursive strategies through discourse markers (DMs) to frame their stance on climate issues.

3. Materials and Method

3.1 Corpus Data

The data for this study came from a corpus of 9 research articles published in the period between 2016 and 2024 (tab. 1). These articles were identified ensuring both relevance to the study objectives and methodological rigour. The articles were retrieved from different academic search engines (ResearchGate, ScienceDirect-ELSEVIER, National Library of Medicine) through

a targeted search. Seed words, such as *coffee*, *climate change*, *sustainability*, were chosen to locate relevant articles, and were defined according to a qualitative and quantitative approach. Following the initial search, the retrieved articles were subsequently filtered based on selection criteria which focused on their relevance to coffee research and climate change, including both their scientific and socio-economic dimensions, and publication in peer-reviewed journals. The selection criteria ensured that the research articles concerned different aspects of the coffee world, ranging from the effects of climate change on coffee cultivation to the ethical and sustainable consumption patterns of coffee consumers in the Italian coffee market. In particular, some papers explored agricultural practices and land suitability, including the role of agroforestry in the fight against climate change, the vulnerability of wild coffee species to extinction, and soil improvement through coffee waste.

An overview of the selected research articles was presented in table 1, comprising three columns: the article number (corresponding to the order in which the articles were retrieved), the title of each research article, and the year of publication. This format allowed for a clear visual representation of the sources underpinning the analysis.

The corpus, although limited in number (71,015 tokens as shown in tab. 2), reflected the specific focus on coffee-related environmental issues, providing insights into the linguistic strategies employed in this domain. According to Aston (1997), small corpora range from approximately 20,000 to 200,000 words and are generally distinguished not only by their size but also by their greater degree of specialisation, often focusing on specific topics and genres.

The temporal gaps in the corpus were due to the limited availability of articles meeting the selection criteria within the timeframe of data collection. These criteria were primarily based on the articles' relevance to the intersection of climate change and coffee research. The inclusion of papers spanning different time periods was therefore justified by the diversity of the topics addressed across the selected studies.

Article number	Title of Research Articles	Date
1	Bacterial community structure of two Mediterranean agricultural soils amended with spent coffee grounds	2019
2	Chemical composition and anti-radical properties of coffee cherry cultivated in Mediterranean climate	2023
3	Exploring the cooling effect of shading for climate change adaptation in coffee areas	2023
4	Ethical and sustainable consumption in the Italian coffee market: a choice experiment to analyse consumers' willingness to pay	2016
5	The potential of agroforestry to buffer climate change impacts on suitability of coffee and banana in Uganda	2024
6	Coffee farmers' knowledge construction about climate change	2024
7	Land suitability of coffee cultivation under climate change influence in the Ecuadorian Amazon	2024
8	High extinction risk for wild coffee species and implications for coffee sector sustainability	2019
9	A Systematic Review on the Impacts of Climate Change on Coffee Agrosystems	2023

Tab. 1 – List of research articles collected in the *ClimateCoffee* corpus

The sampled papers were first converted into MS Word, then removed of irrelevant data (e.g. notes, URLs, etc.). The corpus was subsequently uploaded to the *Sketch Engine* platform, a corpus analysis tool widely used in linguistic research (Kilgarriff *et al.* 2014), to compile the *ClimateCoffee* corpus which amounted to a total of 71,015 running tokens (tab. 2).

Tokens	Words	Sentences
71,015	58,223	2,417

Tab. 2 – *ClimateCoffee* corpus counts

3.2 Analytical Procedure and Findings

In order to address the two research questions, this study employed a qualitative and quantitative approach to examine the metadiscourse markers in the *ClimateCoffee* corpus. Concordance analyses and frequency counts of the collected data focused on the metadiscourse markers that were identified following Hyland's metadiscourse taxonomy (2005a). The Sketch Engine concordance tool facilitated the identification of metadiscourse markers within the corpus. Kilgarriff *et al.* define the concordance as "the basic tool for anyone working with a corpus. It shows you what is in your corpus" (2014, 10). The analysis was carried out to investigate how the authors of the nine academic papers structured their arguments in writer-reader interaction and framed coffee-related climate and environmental issues, by addressing global challenges in this written form of academic communication.

Interactive metadiscourse is discursively expressed by Hyland (2005a):

1. *transitions*: they express relations between main clauses, and comprise conjunctions and adverbial phrases that help readers understand additive, causative, and contrastive relationships between steps in the writer's arguments: *addition* (e.g., *in addition*, *and*, *furthermore*, *moreover*), *comparison* (e.g., *similarly*, *equally*, *in contrast*, *however*, *but*, *on the contrary*, *on the other hand*), and *consequence* (e.g., *thus*, *therefore, consequently*, *in conclusion*, *nevertheless*);
2. *frame markers*: they refer to discourse acts, sequences, or stages (e.g., *finally*, *to conclude*, *my purpose is*);
3. *endophoric markers*: they refer to information in other parts of the text (e.g., *noted above*, *see Fig*, *in section 2*);
4. *evidentials*: they refer to information from other texts (e.g., *according to*, *X*, *Z states*);
5. *code glosses*: they elaborate propositional meanings (e.g., *namely*, *e.g.*, *such as*, *in other words*).

Interactional metadiscourse (Hyland 2005a), on the other hand comprises the two discursive categories of *stance* and *engagement*.

According to Hyland (2005b, 177), *stance* refers to an attitudinal dimension, reflecting how writers present themselves and convey their judgments, opinions, and commitments. The definitions of stance markers (Hyland 2005a) are provided below:

1. *hedges*: they withhold commitment and open dialogue (e.g., *might*, *perhaps*, *possible*, *about*);
2. *boosters*: they emphasise certainty or close dialogue (e.g., *in fact*, *definitely*, *it is clear that*, *obviously*, *demonstrate*);

3. *attitude markers*: they express writers' affective, rather than epistemic, attitude to propositions, conveying features, such as quality; interest; novelty; validity; efficacy; significance/importance; necessity; strength (Mur Dueñas 2010, 63) (e.g., *agree*, *prefer*, *unfortunately*, a*ppropriate*, *remarkable*);
4. *self-mentions*: explicit references to the author(s) (e.g., *I*, exclusive *we*, *me*, *my*, *our*); less-explicit devices for author reference (e.g., *this study*, *this paper*) (Tessuto 2024b, 76).

As regards *engagement markers*, they explicitly build a relationship with readers, signal an alignment with them, recognise them, focus their attention, so as to include them as discourse participants, and anticipate any objections (Hyland 2005a, 2005b).

3.2.1 Quantitative Findings

On the other hand, the quantitative analysis was conducted using Sketch Engine, which was employed for corpus storage and for verifying the frequency of metadiscourse markers across the corpus, complementing the manual identification of the devices. To ensure a comprehensive understanding of data patterns, the analysis involved the extraction of the occurrences of linguistic and discursive features (tab. 3 and 3.1). These features shaped the scientific arguments advanced by the authors to address readers potentially concerned about global issues. The number of occurrences of the metadiscourse items were reported in the table and subtable (3 and 13.4) under the column labelled *N*. As noted by Tognini-Bonelli (2001, 4), the frequency of occurrence reflects the frequency of use, providing a reliable foundation for assessing the profile of a specific word, structure, or expression in relation to a norm. The counts of the metadiscourse markers in the corpus provided a numerical basis for understanding the relative prominence of different metadiscourse categories and sub-categories in the corpus. To this end, some examples of *interactive* and *interactional metadiscourse* were drawn from the corpus and provided in the *Results and Discussion* section. These examples showed how these markers were used by the authors to address readers potentially concerned with the issues raised by the research.

Brezina (2018) provided two frequency measures for the items analysed in corpora: *absolute frequency* and *relative frequency*. He defined *absolute (or raw) frequency* as the "count of all tokens in the text or corpus that belong to a particular word type" (42-43) which can be employed to organise a wordlist, placing the most frequently occurring items at the top. *Relative (or normalized) frequency*, on the other hand, ensures comparability across texts and is relevant when analysing corpora of varying lengths. However, the present study was based on a small corpus focused on affectual language. It did not involve comparisons with a reference corpus since such a comparison would not be pertinent to the study focus on metadiscourse markers. As noted by Tognini-Bonelli, corpus-based linguistics is characterised by a "confident" approach to the relationship between theory and data (2001, 66). Pre-existing models and descriptive frameworks, considered to be broadly reliable, are applied to the corpus, guiding the perception, analysis, and categorisation of the data.

While a comparison with other research domains could provide additional insights, the metadiscursive features identified in this study could be particularly relevant to the field of coffee-related climate change research, contributing uniquely to this domain. The specific use of metadiscourse markers in this context is driven by the unique challenges presented by these issues, which require clear, persuasive, and credible communication to a broad audience.

Category	Sub-category	Item	N.
Interactive metadiscourse	Transitions	and, furthermore, however, but, therefore, etc.	2.509
	Frame markers	first, then, next, finally, etc.	146
	Endophoric markers	figure / fig. X, table X, (is/are) described / shown / in Fig. / Table X, etc.	194
	Evidentials	According to (X + year), Y argues(d) that / stated, etc.	697
	Code glosses	such as, e.g., for example, etc.	216
Total			3.762

Tab. 3 – Occurrences of interactive metadiscourse categories and sub-categories across the corpus texts of research articles

Category	Sub-category	Item	N.
Interactional metadiscourse			
Stance	Hedges	could (not), may, would (not), possible, probably, etc.	405
	Boosters	especially, in particular, notably, it is evident that, etc.	396
	Attitude markers	significant, very, difficult, etc.	254
	Self-mentions	(exclusive) we, our, (in) this study, us, the current study, etc.	210
Engagement markers	Reader pronouns	(inclusive) we	4
	Directives	should (not), must, it is important to (note that), etc.	70
	Questions	What are the…?	5

	Personal asides	(optimal for…), -…-, […]	13
	Appeals & References to shared knowledge	(to be) known, poorly known, unknown, etc.	19
Total			1.376

Sub-tab. 3.1 – Occurrences of interactional metadiscourse category and sub-categories across the corpus texts of research articles

4 Results and Discussion

In the following sections, the interactive and interactional metadiscourse markers that appeared in the corpus were categorised in a systematic format with the corresponding occurrences and excerpts which were provided in the tables, where the numbers in square brackets refer to the order of the research article numbers listed in table 1. This would allow readers to easily reference the original source of the examples.

4.1 Interactive Metadiscourse

Transitions (tab. 4) are linguistically realised by conjunctions and adverbial phrases. They help readers understand relations between clauses in the writer's reasoning. For instance, transitions signal addition as in example (1). Contextualised information is added to the topic being discussed about climate change impacts on coffee cultivation through the phrase *in addition* in (2), while the adverb *moreover* adds new arguments to the previous ones to focus on the role played by coffee in both trade and sustainability in (3). Some transition devices help readers understand contrastive relations (4). They also signal conclusions (5), or negative consequences, highlighting the detrimental effects of certain actions as in (6):

Example	Transition marker	Sub-category	N.	Excerpt from the article	Article number
(1)	and	Addition	2,110	Spent coffee grounds can increase […], *and* improve soil structure […].	[1]
(2)	in addition	Addition	43	*In addition*, climate change has become a major risk that is expected to lead to a decrease in […] coffee production […].	[3]

(3)	moreover	Addition	23	*Moreover* coffee is one of the world's most valuably traded commodities and a pioneering food for sustainability […].	[4]
(4)	but	Comparison	84	[…] *but* so far, these methods are largely restricted to the main coffee crop species.	[8]
(5)	therefore	Consequence	47	*Therefore*, the use of SCG […] may well have "Triple Bottom Line" advantages, having social, environmental/ecological and financial benefits.	[1]
(6)	consequently	Consequence	13	Destruction of natural coffee habitats *consequently* impacts coffee genetic resources and livelihoods.	[9]

Tab. 4 – Transitions: occurrences and excerpts from the analysed research articles

Furthermore, in the collected data, the adverb *however* (sub-tab. 4.1) often signals contrasts with previous ideas, particularly making readers aware of Arabica coffee sensitivity to climate change in (7). This device also expresses objective views of the problem (Tessuto 2024b, 20), by introducing a more balanced perspective (8). Finally, it is employed in example (9) to draw attention to the gaps in the existing literature, signalling the need for further research:

Example	Transition marker	Sub-category	N.	Excerpt from the article	Article number
(7)	however	Comparison	92	[…] *however*, the heightened sensitivity of Arabica coffee to climatic variables renders it susceptible to […] climate change.	[7]
(8)				*However*, the shade levels for coffee plantations need to be adjusted […].	[3]
(9)				*However*, few studies have attempted to look at the cooling effect of shading.	[3]

Sub-tab. 4.1 – Transitions: occurrences and excerpts from the analysed research articles

Frame markers (tab. 5) are metadiscourse devices which frame the disciplinary argument of the research. We can see this in example (1) where the use of *then* demonstrates how recalculated variables contribute to determining the suitability of coffee species under climate change conditions. Frame markers sequence parts of the text to clarify the argument through *first* and *then* as in (2). Similarly, they label text stages, signalling a summary of key findings (3). Moreover, writers employed phrases, such as *this study aims to*, to share goals and create a context with readers, thereby ensuring that the study purpose is clearly communicated as in (4):

Example	Frame markers	N.	Excerpt from the article	Article number
(1)	Then	44	The recalculated variables were *then* used to […] derive the current suitability of growing the two coffee species […] due to climate change	[5]
(2)	First	26	[…] values above or below this temperature *first* become suboptimal and *then* unsuitable for coffee	[3]

(3)	Summarize	5	[..] can be *summarized* as follows […]	[8]
(4)	This study aims to	2	Therefore, *this study aims to* analyze the coffee farmers' knowledge […] regarding climate change	[6]

Tab. 5 – Frame markers: occurrences and excerpts from the analysed research articles

Writers use *endophoric markers* (tab. 6) to add accessible material providing readers with detailed data (1) as well as to combine supplementary and visual resources, serving as a kind of verbal information (2). In example (3), they guide readers to interpretations relying on their processing skills. Additionally, these devices help readers understand and support their arguments referring to earlier material (4) or to other parts of the text (5):

Example	Endophoric markers	N.	Excerpt from the article	Article number
(1)	Can be seen in Figure / Table X	8	The distribution of the community coffee plantations *can be seen in Figure 1*	[6]
(2)	See (the) supplementary material(s)	6	A projected upward altitudinal shift of coffee species, threatens fragile ecosystems (*see supplementary material*, Fig. SI4) […]	[5]
(3)	Model (was developed / created)	2	A *model was developed* to estimate the required shade levels for Coffea arabica L. […]	[3]
(4)	See above	2	[…] (*see* "Climate and environmental data" *above*)	[5]
(5)	See methods	2	[…] (framework 2, *see methods*)	[5]

Tab. 6 – Endophoric markers: occurrences and excerpts from the analysed research articles

Evidentials (tab. 7), which signal *citations*, provide writers with devices to orient readers in the knowledge-making process in order to highlight different viewpoints on the complexity of climate change affecting coffee. They are also employed to refer to prior literature to guide the reader's awareness of the negative effects of climate change on coffee. We can see this in examples (1) and (2). Moreover, they relate the current study to community-based works to support arguments and provide context for the current findings (3):

Example	Evidentials	N.	Excerpt from the article	Article number
(1)	(the) Available literature / Literature available / The … indicate	5	*The available literature* reports contrasting results on the effect of increasing temperature on the quality of coffee […];	[2]
(2)			[…] *the Intergovernmental Panel on Climate Change (IPCC) reports indicate* that climate change (CC) will […] decrease coffee-suitable land by 2050	[9]
(3)	(various/these) Work(s) / Literature work	3	The antioxidant and anti-radical activity of coffee husks have been researched in *various works*	[2]

Tab. 7 – Evidentials: occurrences and excerpts from the analysed research articles

However, citations can be (sub-tab. 7.1):

- *integral*, with the name of the cited author in subject position (4);
- *non-integral*, with the name of the cited author either in parenthesis (5);
- in *impersonal format*, where the name of the cited author is replaced by a number which appears in parentheses, or square brackets, and refers to the full reference given in the list of references (6) (Hyland 2005a, 157-61; Tessuto 2024b, 76):

Example	Evidentials	N.	Excerpt from the article	Article number
(4)	Integral citations: Author's name (year)	54	*Bunn et al. (2019) argues that* to sustain coffee production in Uganda […]	[5]
(5)	Non-integral citations: (Author's name + year)	379	Coffee […] provides livelihoods for farmers and communities in producer countries *(Eakin et al., 2012)*	[3]
(6)	Impersonal format: (Number) / [Number]	232	C. arabica has the most thorough extinction risk assessment […] *(37)*, due to […] inclusion of climate change projections *(5, 16)*	[8]

Sub-tab. 7.1 – Evidentials: occurrences and excerpts from the analysed research articles

Passive structures may be used, too, as we can see in the following example, drawn from research article [1] (which refers to the article number listed in Table 1): "In Cervera-Mata *et al.* (2017), 2 Mediterranean agricultural soils […] were amended with different concentrations of SCG […]". The analysis (sub-tab. 7.2) has also revealed instances of a semi-impersonal format in which the name of the cited author is reported in the sentence and is followed by the number in parenthesis as in example (7). Moreover, when referring to previous research, writers can use the possessive form to cite their sources in order to gain the readers' support for their arguments (8) as well as noun phrases (9):

Example	Evidentials	N.	Excerpt from the article	Article number
(7)	Semi-impersonal format: Author's name + (Number)	9	*Moat et al. (37)* show that when climate change projections are incorporated in the extinction risk assessment […]	[8]
(8)	According to / In (X + possessive forms)	4	*According to Bicho's study* performed on C. arabica of Brazilian origin […]	[2]
(9)	According to (noun phrases)	3	*According to the Akerlof theorem* (1970) […]	[4]

Sub-tab. 7.2 – Evidentials: occurrences and excerpts from the analysed research articles

In the corpus, *code glosses* (tab. 8) have been found to serve the following functions:

- adding information by providing examples as in (1);
- providing explanation to encourage readers' comprehension (2);
- using the verb *to include* to add information through exemplification (3) (Gülich 2003);
- providing definitions of unknown words which are introduced to connect them to concepts readers are familiar with (4) (Calsamiglia and van Dijk 2004, 370, 379);
- clarifying the argument being discussed (5):

Example	Code glosses	N.	Excerpt from the article	Article number
(1)	Such as	102	As a result of climate change, tropical and subtropical crops *such as* mango, […] and others have recently been introduced in Sicily […]	[2]
(2)	Which is / are	25	The model […] includes a suitability function for mean air temperature (S), *which is* an ecological response curve […]	[3]
(3)	Include (Including / Included)	11	Key bioactive compounds found in coffee *include* polyphenols, chlorogenic acids, caffeine, […] and the variability of these chemical constituents affects the price of coffee commodities […]	[2]
(4)	Defined (as)	7	Ethical consumption *can be defined as* purchase decisions by people concerned with […] environmental consequences of their purchases	[4]
(5)	Namely	6	The construction of the farmers' knowledge can be seen from several dimensions, *namely* their substance of knowledge	[6]

Tab. 8 – Code glosses: occurrences and excerpts from the analysed research articles

Code glosses also serve further metadiscursive functions, such as reformulating technical concepts (Gülich 2003, 238-240) by providing their acronyms, which are marked off by parentheses and which are used from then on throughout the text as we can see in the following example, drawn from research article [1]: "Two kg of wet spent coffee grounds *(SCG)* are produced from every kg of coffee".

4.2 Interactional Metadiscourse

Hedges (tab. 9) are devices which are employed to recognise alternative viewpoints and multiple explanations as well as to avoid writers' complete commitment to a proposition by means of modals of possibility as we can see in examples (1) and (2). Moreover, these markers claim protection in case the writer's assertion is overthrown (3), in particular when there is a gap in the existing knowledge (4). Hedges express potential outcomes in (5), and signal a certain degree of confidence in (6):

Example	Hedges	N.	Excerpt from the article	Article number
(1)	Could (Not)	51	[…] and this *could* be explained in different ways	[1]
(2)	Might (not)	28	In the case of coffee, however, better solutions *might* be found where there is the potential for human engagement that benefits both livelihoods and biodiversity […]	[8]
(3)	Whether	12	[…] on the other hand it is doubtful *whether* consumers […] choose a food in a rational way based on the effective attributes communicated by labels […]	[4]
(4)	It is possible to	2	[…] *it is possible to* compare tropical green coffee with Sicilian green coffee, even if the literature in this regard is very poor	[2]
(5)	Expect	31	Most of the temperature changes *are expected* to occur in the middle of the century	[3]
(6)	Estimate	29	*We estimated* […] the air temperature suitability […] for coffee areas […]	[3]

Tab. 9 – Hedges: occurrences and excerpts from the analysed research articles

Hedges (sub-tab. 9.1) also provide writers with linguistic strategies to mitigate full commitment to their assertions (Tessuto 2020, 246, 2024b, 76) through the use of verb + complement *that*-clause as in example (7), verbs (8), adjectives (9), and adverbs (10):

Example	Hedges	N.	Excerpt from the article	Article number
(7)	Suggest (that)	19	The results of research […] *suggest that* farmers can protect their coffee plantations from climate variability […]	[6]
(8)	Seem	9	This *seems* to be the main reason that the temperature suitability […] is lower in 2050 than in 2000	[3]
(9)	Possible	22	[…] studies have shown a *possible* reduction in the area suitable for coffee growing on a global scale	[5]
(10)	Likely	18	[…] coffee farmers are *likely* to increase the intensity of their care they give to their crop	[6]

Sub-tab. 9.1 – Hedges: occurrences and excerpts from the analysed research articles

Boosters play a significant role in fostering the certainty and reliability of authors' arguments (Hyland 2005a, 52-53). In the ClimateCoffee corpus, *boosters* (tab. 10) may express future outcomes through future with *will* and the verb *to predict* as in examples (1) and (2). Additionally, boosters give assurance to readers by providing them with reliable information in (3), and exclude different positions in (4):

Example	Boosters	N.	Excerpt from the article	Article number
(1)	Will	78	The shading *will* be more beneficial to coffee areas at medium and high altitudes […]	[3]
(2)	Predict	13	Many studies *predict* that suitability will shift to higher altitudes where temperatures are cooler, but these zones will likely adversely affect the ecosystem	[9]

(3)	Reveal	16	The study *revealed that* in coffee cherry cultivated in the Mediterranean climate, similar amounts of chemical constituents […] *were found* concerning coffee grown in the equatorial regions	[2]
(4)	It is evident that	3	*It is evident that* ethical consumption is strongly connected with the concept of sustainability, which also involves environmental, social and economic dimensions of production […]	[4]

Tab. 10 – Boosters: occurrences and excerpts from the analysed research articles

Additionally, the verb *to show* (sub-tab. 10.1) has been found, in different forms and tenses, to express assurance of coffee beneficial effects as in (5), and reliability of information (6). Moreover, it undermines alternatives, emphasising the relationship between claims and results in (7). Among the adverbs, writers employ *especially* and *in particular*, which register a higher incidence, to draw readers' attention to relevant and specific aspects of their arguments alongside *notably*, although the latter shows a lower incidence.

Example	Boosters	N.	Excerpt from the article	Article number
(5)	Show	69	[…] coffee seeds *showed* good value of scavenging activity […]	[2]
(6)			The world coffee market *shows* that coffee is a widespread consumption product […]	[4]
(7)			The results *showed* very low values of B1 (Thiamine) and B5 (Pantothenic acid) […]	[2]

Sub-tab. 10.1 – Boosters: occurrences and excerpts from the analysed research articles

In this study, *attitude markers* (tab. 11) highlight writers' perspectives on environmental challenges which represent an issue worthy of research. These devices allow writers to emphasise the relevance of their arguments by means of adjectives such as *important*, *significant*, *positive*, *vital*, *difficult*, and *key* as shown in examples (1), (2) and (3). They also employ verbs and nouns, such as *need* and *concern* in (4) and (5). Moreover, attitude markers are also used in (6) and (7) to convey features such as quality (*good*/*better*/*best*, *valuable*), interest (*interesting*), novelty (*new*, *newly*), validity and efficacy (*effective*, *useful*, *reasonable*), significance (*important*, *relevant*, *essential*, *critical*), necessity (*need*, *necessary*), strength (*strong*, *strongly*) (Mur Dueñas 2010, 63):

Example	Attitude markers	N.	Excerpt from the article	Article number
(1)	Important	16	Coffee, an *important* global commodity, is threatened by climate change	[5]
(2)	Vital	9	In coffee systems, agroforestry can play a *vital* role by the modification of microclimate	[5]
(3)	Key	7	Robusta coffee has therefore been responsible for overcoming most of the *key* issues for coffee sector sustainability, either by direct replacement or through use in breeding new cultivars	[8]
(4)	Need	15	More research *is needed* on the direct and indirect effects of climate change on coffee yield […]	[9]
(5)	Concern	10	Such climate-related risks pose a *significant concern* for the future supply of coffee, given the ever-increasing demand partly driven by a rising population and higher incomes	[5]

(6)	Good	12	Spent coffee grounds are a *good* soil conditioner due to their contribution in increasing essential macronutrients.	[1]
(7)	Essential	8	However, for Robusta coffee, both precipitation and temperature-related variables are *essential* for its suitability	[5]

Tab. 11 – Attitude markers: occurrences and excerpts from the analysed research articles

Writers use *self-mentions* (tab. 12) to signal their presence and stance in relation to their arguments, research studies and findings. The first-person plural pronoun *we* is employed to refer to narratives concerning research processes and scientific methods in example (1), decision-making processes in (2) as well as proposals and future perspectives in (3). Moreover, *we* is employed to address the whole community, emphasising its active role in facing global issues (4).

Another recurrent metadiscursive marker is the first-person plural possessive adjective *our*, which, similarly to the pronoun *we*, displays research processes and findings of the researchers, who represent a working group which holds a collective identity (5):

Example	Self-mentions	N.	Excerpt from the article	Article number
(1)	(exclusive) we	90	*We conducted* a face-to-face questionnaire survey among Italian consumers […]	[4]
(2)			*We only considered* literature published in English for filtering	[9]
(3)			[…] *we propose* that coffee species are extinction sensitive	[8]
(4)			[…] *we can build* theories regarding the essential issues in people's lives	[6]
(5)	Our	45	[…] *our* results on required shade levels are based on mean annual air temperature only	[3]

Tab. 12 – Self-mentions: Occurrences and excerpts from the analysed research articles

Although some writers resort to a less personal style and a less explicit reference, they give an impression of themselves and of their involvement in the research process through some devices (sub-tab. 12.1) such as *researchers* in example (6), *authors* (7), *this study*/*article*/*paper* (Tessuto 2024b, 76). In this way, they can explain scientific methods and problem solving in the conducting study as in (8), scope and goals (9), or express future perspective (10).

As regards the singular pronoun *I* and the possessive adjective *my,* these were only used by coffee farmers interviewed to analyse their knowledge construction process about climate change, as shown in the following example, drawn from research article [6]: "*I* gained this knowledge by asking him", so they were not included among the counted markers.

Example	Self-mentions	N.	Excerpt from the article	Article number
(6)	(The) researcher(s)	9	[…] *the researcher* chose the grounded theory […] to investigate critical issues about the coffee farmers' knowledge of climate change	[6]
(7)	(The) author(s)	4	[…] *the authors* formulated the primary research question […]	[9]
(8)	(In) this study	35	*This study* uses a choice experiment (CE) to investigate the attitudes […] among Italian consumers	[4]
(9)			*This study* aims to understand how coffee farmers construct knowledge about climate change […]	[6]
(10)	This/The article	6	*The article* concludes by offering some perspectives on future research on the topic […]	[4]

Sub-tab. 12.1 – Self-mentions: occurrences and excerpts from the analysed research articles

The quantitative query of the corpus concerned the occurrence of engagement markers, such as reader pronouns, directives, questions, personal asides, and appeals and references to shared knowledge.

One of the main functions of *reader pronouns* (tab. 13) is to satisfy readers' expectations of inclusion. The inclusive *we* sends a sign of membership to both writers and readers since they share similar academic understanding and goals (Hyland 2005a, 151-152, 2005b, 183). In the example (1), the inclusive *we* aligns the readers with the writers' commitment to achieve their goals.

Moreover, this engagement marker signals the need for collaborative action and shared responsibility, which goes beyond the academic community and addresses all actors involved in the conservation of wild coffee species, engaging the society as a whole. The need to raise awareness, alongside climate change events, highlights how global concern issues can affect biodiversity, ecosystems, and the public at large (2).

The second-person pronoun *you* was only employed by coffee farmers interviewed to analyse their knowledge about climate change so was not included among the counted markers.

Example	Reader pronouns	N.	Excerpt from the article	Article number
(1)	(inclusive) We	4	[…] *we* need to improve the quantity and quality of coffee germplasm inventories […]	[8]
(2)			[…] *we need to* conserve existing wild coffee species in situ […]. This objective necessitates a major commitment and would require input by multiple stakeholders […]. Large, protected areas under strict control have lower human impact […] but are not immune to […] climate change and natural events	[8].

Tab. 13 – Reader pronouns: occurrences and excerpts from the analysed research articles

Writers also achieve engagement by resorting to *directives* (sub-tab. 13.1), which are devices frequently used to initiate reader participation and to position them within the academic writing (Hyland 2002, 33, 37). They are mainly expressed by modals of obligation and imperatives. They often instruct readers on how to carry out research processes or effectively act in the outside world (physical acts) (Hyland 2005a, 154; 2005b, 185). For instance, the modal *should* fulfils the necessity of comparative analysis involving readers in the experimentation in example (1). It raises awareness among exporters, due to the increasing demand for ethical and sustainable products which can influence business success, meeting consumers' needs in (2) as well as among

stakeholders who can improve their decision-making process to prioritise sustainable coffee systems so that society can benefit from them in (3). The modal *should* is also employed to give strong advice to call to action (4). Other devices are modal verbs, such as *must* (5).

Moreover, *directives* signal necessity and importance by means of the constructions with *It is important/interesting/useful to* + verb + *that*-clause, so as to guide readers to understand a point in a way determined by writers (cognitive acts) (Hyland 2002, 37; 2005a, 154; 2005b, 185) as shown in example (6).

Directives are also used to guide readers through the discussion by means of tables and figures (textual acts) (Hyland 2002, 37; 2005b, 185) alongside the use of imperatives. The examples used to analyse directives through imperatives are the same as those employed in the analysis of endophoric markers, since imperatives serve the dual purpose of referring readers to information in other parts of the texts, acting as endophoric markers, as well as directing readers to engagement, acting as directives:

Example	Directives	N.	Excerpt from the article	Article number
(1)	Should (not)	26	To classify the coffee deriving from Sicilian experimental crops, it *should be compared* with the chemical-nutritional characteristics of tropical coffee deriving from the equatorial countries that fall into the so-called "Coffee Belt" […]	[2]
(2)			Exporters *should be aware of* the increasing market segmentation for the distinct needs of individual consumers […]	[4]
(3)			Moreover, stakeholders *should be made aware of* the importance of assessing coffee-related ecosystem services […] to increase the sustainability and resilience of coffee systems worldwide	[9]
(4)			Therefore, agroforestry design and recommendation *should consider* […] altitude, regional climate, and water availability	[5]

(5)	Must	12	To ensure the provision of vital ecosystem services, ecosystem functions *must* be supported and maintained, and biodiversity *must* be protected	[9]
(6)	It is/was interesting to (note that)	5	*It is interesting to note that* ethical consumption combines the role of consumer with that of citizen […]	[4]

Sub-tab. 13.1 – Directives: occurrences and excerpts from the analysed research articles

The analysis has provided a few examples of *questions* (sub-tab. 13.2) tagged as research questions. Writers use this kind of rhetorical device to appeal to readers as peers and encourage them to follow their arguments by drawing their interest and curiosity to the topic of their paper (Hyland 2002, 39, 2005a, 153-154) as we can see in example (1). The analysis has registered only one occurrence of a question asked by a farmer in an interview to analyse coffee farmers' knowledge about climate change, drawn from research article [6]: "[…] the wind is already uncharacteristically strong, and do I know why it is like this?".

Example	Questions	N.	Excerpt from the article	Article number
(1)		5	What are the impacts of climate change on ecosystem services of coffee production?	[9]

Sub-tab. 13.2 – Questions: occurrences and excerpts from the analysed research articles

The analysis has also provided some examples of *personal asides* (sub-tab. 13.3), that is clauses used by writers to comment on some aspects of their argument by briefly interrupting it as in example (1). These devices are also employed to emphasise a point which is important to the overall argument by providing additional clarification in (2):

Example	Personal asides	N.	Excerpt from the article	Article number
(1)		13	At mid-level altitudes with temperatures from 20 to 21 ◦C *(optimal for coffee plants)*, farmers have more freedom in the shade usage	[3].
(2)			[…] another benefit of shading coffee plants under higher temperatures – *and even temperatures closer to the optimal temperature* – is that the physical and organoleptic coffee quality is improved […]	[3]

Sub-tab. 13.3 – Personal asides: occurrences and excerpts from the analysed research articles

Finally, *appeals and references to shared knowledge* (sub-tab. 13.4) are another way of engaging readers with the existing recognised and accepted disciplinary knowledge (Hyland 2002, 38-39; Tessuto 2024a) in coffee-related research and climate change issues as shown in example (1). They are also employed when referring to scientific techniques (2), regular patterns of the coffee sector (3), benefits (4), recognised legislation (5), and poor knowledge (6):

Example	Appeals to shared knowledge	N.	Excerpt from the article	Article number
(1)		17	These compounds *are known* to have several beneficial health effects	[2]
(2)			Free phenolic compounds *are known* to be easily extractable with aqueous/organic solvent	[2]
(3)			It is well *known* that the coffee sector has been the testing ground for many of the sustainability initiatives operating across commodity sectors today	[4]

(4)			The addition of SCG not only increases nutrient value but enhances PGPBs, which *are known* to aid plant growth	[1]
(5)			*As is well known*, the EU rules that regulate the traceability system were established by several EC Regulation […]	[4]
(6)			Robusta coffee has been transformed from *a poorly known* minor African crop to a major global commodity in just c. 150 years	[8]

Sub-tab. 13.4 – Appeals to shared knowledge: occurrences and excerpts from the analysed research articles

Conclusions

This study focused on a small sample of research articles in the attempt to shed light on the specific ways in which language is used to communicate the urgency and complexity of climate change impacts in coffee areas. More specifically, the study investigated how academic authors employed metadiscourse to disseminate their research. It also examined how they structured their arguments, created a reader-shared context, and addressed global issues and challenges.

Furthermore, a detailed examination of the metadiscourse strategies that help shape the discourse surrounding coffee and climate change is provided, thereby facilitating a deeper understanding of how researchers navigate the challenges of communicating environmental issues.

The findings of this study may contribute to the field by revealing how metadiscourse markers in research articles reflect both disciplinary conventions and the specificity of this research domain. The prevalence of certain interactive and interactional markers suggests that while some characteristics are common across academic writing, others may be distinctive of this particular discourse. A comparison with a broader reference corpus could further highlight these unique features, which future research might explore.

As demonstrated in previous studies (Kapranov 2016), corporate and industry narratives on climate change frame the issue through strategic discourse. Illy's *Impact Report* (2023) similarly highlights corporate strategies to mitigate climate change risks within the coffee supply chain, including regenerative agricultural practices. Furthermore, the role of academia in spreading knowledge regarding sustainability is evident in initiatives such as the *Università del Caffè* (Trieste, Italy) and the *Master in Coffee Economics and Science* (Impact Report 2023). These industry collaborations illustrate how research findings are translated into practice, further validating the need for discourse studies in this domain.

The qualitative and quantitative analysis of the categories of *interactive* and *interactional metadiscourse* made it possible to tackle the research questions at the root of this study, which led to the following conclusions.

Q1. How do academic authors writing about coffee-related research and climate change issues use *interactive metadiscourse* to structure their arguments and guide readers through the text?

One key contribution of this study is the identification of certain linguistic patterns characteristic of research articles in this domain. The frequency counts of metadiscourse markers have revealed the significant prevalence of the *interactive* category, foregrounding the authors' intention to guide readers through their texts and arguments about coffee-related climate change issues, and recognising them as an active audience. This reflects a strong emphasis on establishing a clear framework for understanding the multifaceted impacts of climate change on coffee production. Here, the prevailing interactive sub-category was that of *transitions*, suggesting how writers focus on expressing relations between main clauses to structure persuasive propositional information, thus ensuring a coherent and cohesive flow of their ideas.

The noteworthy presence of *evidentials*, expressed by citations, provided intertextuality as well as raised readers' awareness, highlighting different viewpoints on the complexity of climate change affecting coffee. In this context, writers gave credit to other researchers (Tessuto 2024b, 76) so as to support their arguments as well as to signal their alignment with the academic community.

Code glosses supported writers in adding information and clarifying propositional meanings by rephrasing them, and by means of examples, explanations, and definitions to make their research more comprehensible to their readers.

Although *endophoric markers* and *frame markers* registered a lower frequency, they played a crucial role in effectively linking different parts of the texts and clarifying the discourse to guide readers through the structures of their writing.

Q2. How do authors use *interactional metadiscourse* to express their stance and engage readers in their arguments?

Although *interactional metadiscourse* resources registered lower frequency counts, stance and engagement markers remain important features of academic writing (Hyland 2005b, 193) since they provide insights into how writers shape coffee and climate change-related discourse, persuading readers of their claims. As shown in the data, authors used *stance* devices more frequently than *engagement markers*. In particular, on the *stance*-taking side, the higher use of *hedges* signalled the authors' need to create an argument, distinguishing facts from opinions, and to situate themselves within the academic community, so as to present their claims with caution and regard to readers' views (Hyland 2005b, 187-88; Tessuto 2015, 102), acknowledging the complexity of the issues. Hedging lexical devices were mainly expressed by modal verbs of possibility. Indeed, the analysis suggests that the prevalence of hedges signals that this text genre focuses on future perspectives and hypotheses, expressing uncertainty inherent in predicting the long-term effects of climate change while informing readers about possible future research and scenarios.

These features are consistent with the characteristics of academic writing in environmental research, but they also reveal how authors in this field strive to make their work accessible while addressing the inherent complexities of climate change. The analysis further underscores that coffee-related climate change research often deals with interdisciplinary issues that require a careful balancing act between certainty and speculation, especially when discussing predictions and possible outcomes.

Writers used *boosters* and *attitude markers* to further convey their stance on the issues discussed. In particular, boosters ranged from the use of future with *will* and the verb *to predict*, to highlight future outcomes of scientific research on coffee-related climate change issues, to locutions as *It is evident that*, to express authors' certainty of their arguments. In particular, verbs such as *to show*, *to find*, *to reveal* provided reliable information and closed down alternatives. On the other hand, writers used attitude markers, including *important*, *concern*, *vital*, to

convey their perspectives on coffee-related environmental challenges and persuade readers by engaging them within issues worthy of research.

Finally, despite their lower occurrence, *self-mentions* were used to signal writers' explicit presence and stance in relation to their arguments, establishing a direct connection with their readers. Writers mainly used the exclusive first-person plural pronoun *we* and the first-person plural possessive adjective *our* to fulfil those different functions as well as to refer to researchers as a working group which holds a collective identity within the academic community, emphasising its active role in facing global issues. Moreover, some writers gave an impression of themselves in the narrative by resorting to a less personal style by means of devices, such as *researcher*, *author*, *study*.

As regards *engagement markers*, *directives* were the most frequent markers, mainly expressed by modals of obligation. Writers resorted to these features to initiate reader participation and to position them within the academic writing, signalling necessity and importance by means of the constructions with *it is important/ interesting/ useful to* + verb + *that*-clause. Even when using directives, authors mainly used the modal *should,* which does not express a strong obligation but instead suggests a general need, reflecting a cautious stance and a general feeling of uncertainty.

Writers used *appeals to shared knowledge* to engage readers with the existing recognised disciplinary knowledge in coffee-related research and climate change issues. *Personal asides* signalled brief interruptions allowing writers to comment on some aspects of their arguments.

The least used engagement categories were *questions*, mainly tagged as research questions, and *reader pronouns*. Despite the low incidence of *reader pronouns*, when they were employed, the inclusive *we* was mainly used to emphasise shared academic understanding, responsibilities and goals, including within the arguments.

Research in metadiscourse might improve writer-reader interaction in academic writing on coffee-related environmental issues, making scientific communication more accessible and persuasive. Given the growing focus on climate change impact on coffee production, this research may have implications not only for academic writing but also for the broader communication of climate science in the context of agricultural and environmental studies. A deeper understanding of metadiscourse strategies may help authors in structuring more engaging and coherent research articles. This, in turn, can facilitate the dissemination of interdisciplinary knowledge across disciplines. Additionally, fostering collaboration between environmental science, economics, and the academic community could help address future coffee-related environmental challenges, while also raising climate awareness and informing consumer demand for sustainable coffee.

By examining the linguistic tools used by scholars to engage with a complex and interdisciplinary topic, this study aimed to provide insights into the role of language in fostering awareness and dialogue about one of the most pressing global challenges of our time. Although a comparative analysis with a reference corpus may be a useful future avenue for research, the findings of this study contribute significantly to understanding how metadiscourse functions within the specific context of coffee-related climate change research.

Further investigations could explore whether the metadiscursive features identified here are consistent across other agricultural or environmental domains, potentially revealing broader patterns in scientific discourse.

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