WEAVING RELATIONS: EXPLORING THE EPISTEMOLOGICAL INTERACTION BETWEEN INDIGENOUS & TRADITIONAL ECOLOGICAL KNOWLEDGE AND EURO-WESTERN PARADIGMS IN EDUCATION FOR SUSTAINABLE DEVELOPMENT-
AN UMBRELLA REVIEW

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Abstract

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Aim: This thesis aims to explore the epistemological challenges and opportunities of integrating Indigenous and Traditional Ecological Knowledge (ITEK) in Education for Sustainable Development (ESD) within the context of Euro-Western paradigms.

Theory: In considering epistemological interactions between ITEK in ESD, the theoretical framework for this study is a "weave" of the transformative paradigm as the warp; postcolonial, decolonial, and Indigenous research methodologies as the weft; and the transdisciplinary approach as the frame.

Method: This study employs an umbrella review (a review of reviews) methodology to analyze and synthesize 30 existing systematic reviews on the integration of ITEK in (E)SD. The search was conducted in the Web Of Science database, and eligibility criteria were established to maximize the relevance and quality of the included studies. PRISMA and MMAT guidelines were followed to ensure a comprehensive and transparent approach complete with adequate quality appraisal filters.

Results: The results of this study demonstrate that while there is a growing body of research on the integration of ITEK in ESD, the Euro-Western epistemological framework presents significant challenges for successful integration of other worldviews. The themes that emerged from the analysis include the importance of epistemological justice, the need for decolonization of knowledge systems, and the potential for transformative and transdisciplinary approaches to facilitate the integration of ITEK in ESD. The study also identifies gaps in the literature and proposes avenues for future research.

Foreword

I dedicate this work to all Indigenous peoples around the world, all nations that are still anchored in their ancestral ways, despite centuries of colonization, and to the ones defending the sacred web of life for the benefit of all living beings.

I bow in humble gratitude to the elders sharing their precious wisdom and I stand in unwavering alliance to the youth who are willingly and bravely carrying it forward.

I feel a deep reverence toward a past in which the knowledge of the interconnectedness of life guided and shaped our ancestors lives, reverberating these memories across the ages for us to hear and to remember.

Now, in the midst of the greatest destruction ever inflicted by humans onto this beautiful planet we call Earth, the echoes of these memories are a beacon calling us to overcome our differences, bring together our skills and abilities, and unify in service to the wellbeing of our life giving home.

It is a call which carries within it the responsibility to acknowledge that we are tomorrow's ancestors and that generations to come will be measuring our actions as their very lives and futures depend on the choices we make.

I put forth the intent that we learn to weave a new tapestry of human creativity, inventiveness, kindness, respect, responsibility, generosity, and love in such a way that we can once again earn our place in the great circle of relations we are but a small part of.

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We are ONE Living Organism.

We are ALL Related.

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Let the ones who still remember lead the way!

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List of Abbreviations

CGD - Colonialism/Globalization/Decolonization

ESD - "Education for Sustainable Development (ESD) empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while respecting cultural diversity." (UNESCO, 2002)

(E)SD - Used in text to address instances when a Sustainable Development integration or study has a direct or indirect educational component linked to it. Alternatively meaning that SD is intrinsically linked to education.

EJ - Epistemological justice

EWE or WE - (Euro) Western Epistemologies refers to the dominant knowledge systems and ways of knowing that have emerged from Western European and North American cultures and that have been historically privileged in academic and scientific discourse. E/WE are often characterized by a focus on objectivity, empiricism, and reductionism, and have been criticized for their limited perspectives and exclusion of diverse knowledge systems and worldviews.

LEK - Local ecological knowledge. Refers to the knowledge, practices, and beliefs that are developed by and transmitted through local communities, including but not limited to Indigenous communities, over generations, and that relate to the relationships between people and the natural world in a specific local area.

IK, LIK, ILK, iLK - Indigenous knowledge, Indigenous local knowledge

ITEK - Indigenous and Traditional Ecological Knowledge (ITEK) refers to the knowledge, practices, and beliefs that are developed by and transmitted through Indigenous and local communities over generations, and that relate to the relationships between people and the natural world.

SDG - The official definition was adopted by the United Nations General Assembly in 2015. According to the UN: "The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The 17 Goals are all interconnected, and in order to leave no one behind, it is important that we achieve them all by 2030."

SR - Systematic Review

1. Introduction

"There is no such thing as absolute knowledge, and those who claim to possess it are the greatest fools." - Socrates n.d

Despite the fact that the modern world has in recent times (particularly in the last decade) become aware of the connection and mutually beneficial relationship between Indigenous and Traditional Ecological Knowledge (ITEK)[1] and the process of Educating for Sustainable Development (ESD)[2], somehow the merger of the two remains surprisingly difficult to put in practice. Although modern sustainable development goals (SDG) reflect and are inspired by the intentions for multi-generational and multi-species well-being, also upheld by a large number of Indigenous cultures around the world, the effective integration of Indigenous knowledge systems in sustainability discourse (although attempted by governments and institutions) still seems to encounter many socio-economic and cultural challenges. Amongst these integration barriers there seem to be considerable axiological, ontological, epistemological, and methodological challenges to ITEK integrations (Denzin & Lincoln, 2008). Various sources indicate that *some* of these paradigmatic challenges are particularly linked to a pre/dominance of Western and Eurocentric worldviews (Cajete, 2000; Chilisa, 2020; Dahlstrom et al., 2021; Dei et al., 2000; Higgins, 2020), and that a possible answer to this epistemological power dynamic can be found in Western Europe's long established colonial and imperial past (Battiste, 2018; Berkes, 2008; Smith, 2012). The interesting dichotomy between the plurality-oriented and culturally inclusive theoretical aspirations of ESD and this possible hegemonic tendency, brings with it questions about this apparent contrast and its implications for successful knowledge co-production between the different worldviews. So what then are the actual conceptual obstacles in ITEK integration, do they indeed point to epistemological and ontological clashes? Are those clashes at least partly related to Euro-Western paradigms, and if so, how do these interactions impact ESD and sustainability practices as a whole?

1.1 Stating relevance

Addressing the relevance of this line of research to the field of (E)SD[3], it seems important to begin summarly establishing the importance of ITEK integrations by mentioning findings such as the fact that: "comprising less than 5% of the world's population, indigenous people protect 80% of global biodiversity" (Raygorodetsky, 2018). Such a revealing statistic is one of many supportive confirmations for the scholars and practitioners affirming that Indigenous and traditional ecological systems of knowledge can beneficially contribute to the field of ESD. This socio-cultural and academic current supports

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[1] Note. ITEK will be defined in more detail at the later in the thesis.

[2] Note. ESD is used here as a blanket term encompassing epistemological positions, curriculum design, implementation, and the practice of sustainability education.

[3] Note. (E)SD used in this way is a hybrid term that refers to Sustainable Development in general, acknowledging that this field has an inseparable educational component, regardless of the application.

the position that: as Indigenous[4] people and traditional knowledge keepers seem to be the ones currently leading by example in the struggle of protecting the Earth for future generations, they should not only be counted as stakeholders but possibly even as guides/ leaders in the development of sustainable initiatives and discourse (Breidlid & Krøvel, 2020). Even cursory research following this ideological thread shows that there is indeed a growing movement toward the practical implementation of ITEK with the purpose of enriching the epistemological and axiological nature of ESD in order to ultimately enhance the effectiveness of practical sustainability initiatives ranging from citizen education to governmental policies (Higgins, 2020). As a quantitative data point example, on the GU online library portal in February 2022, the search string "Indigenous knowledge AND sustainability" gave 85,504 results, while the more specific string "Indigenous knowledge AND education for sustainable development" gave 71,960 results. These numbers alone support the observation that an increasing number of practitioners and curriculum developers designing science and sustainability education have adopted this approach and are now seeking to integrate (or already doing so) ITEK into ESD. In the words of a group of Scandinavian scholars: "Indigenous knowledge offers rich contexts which have the potential to contribute understanding the relationship of environmental, sociocultural, and spiritual understandings of life and nature" (Zidny, Sjöström & Eilks, 2020, p. 147). The findings and approaches mentioned above are demonstrably echoed in a multitude of other resources, many of which will be referenced in the thesis, but suffice to say at this point that there is considerable literature support for arguments on the benefits of integrating ITEK in ESD, as well as for existing designs and implementations of this conceptual merger.

Furthermore, as sustainability initiatives are underway in cross-sector and transdisciplinary applications, cumulative data and subsequent observations are in turn leading scholars working in the field to direct focus on the importance of interrogating established paradigms. One such author states: "The present-day environmental crisis urges us, in fact, to critically revise the overall scheme in which our societies are rooted, and in particular the very foundation of Western culture, since it plays a predominant role in planning the future" (Mazzochi, 2020, p. 77). In addition to the overarching questioning of our society's entrenched paradigms, further investigations into epistemic justice issues have begun to emerge in recent years, particularly in the areas of integrating diverse knowledge systems (such as ITEK) under the umbrella of *sustainable* development in general and ESD in particular (Demssie, 2020). For example, researchers are highlighting that: "it is the moral and ethical responsibility of Western scientists working in and with Indigenous communities to make a concerted effort to collectively create mutually advantageous new knowledge while strengthening traditional knowledge and considering the normative impacts of Western science methods" (Chapman & Schott, 2020, p. 1).

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[4] Note. "Indigenous" as a term will be defined later in the paper.

1.3 Finding a purpose

Due to the wealth of resources on the topic, the particular focus of this research will then be _less on_ bolstering the motivations for **integration of ITEK in ESD**, and _more on_ exploring the interplay of these two worldviews **in relation to conceptual challenges this integration encounters.** The reasons for choosing the latter direction are that based on my research so far, it seems focusing on these challenges, _particularly on the relationship between Euro-Western epistemologies (EWE) and ITEK in (E)SD_, is not only complimentary to the integration efforts already underway, but it could also possibly represent an answer to the literature gap I identified. The gap points to the fact that although ITEK is known to be valuable to (E)SD and integrations are being actively conducted, the researchers applying the integrations are asking for these types of deconstructive examinations to be undertaken with the hopes of resulting in viable solutions to the Euro-Western epistemological barriers they seem to encounter. Here is an example of such a request: "In an effort to mitigate the legacy of colonial discourse in the academy, research partners of Indigenous communities have progressively called for decolonizing research by placing Indigenous voices, epistemologies, and cultural contexts at the center of the research process" (Battiste, 2000; Dickerson et al., 2020; Held et al., 2019; L. T. Smith, 2012; Swadener & Mutua, 2008; as cited in Cox, 2021, p. 465). Here is another:

> The fact that the SDGs [Sustainable Development Goals] do not refer to indigenous knowledges in the education chapter (nor in the SDGs overall document) indicates clearly that epistemological issues are not on the SDGs agenda … The lack of references to indigenous knowledges in the SDGs reflect the situation among the important institutions behind the SDGs. The problem is that there is little discussion among the International Non-Governmental Organizations (INGOs) and the national governments about potential changes in learning strategies and knowledge transmission given the status quo in learning outcomes. (Breidlid & Krøvel, 2020, p. 24)

In summary, upon exploration of previous literature and case studies with a focus on determining challenges to ITEK integration into ESD, two interlinked research directions emerged so far: 1. The relevance of mapping the challenges this integration encounters, while working to identify in which way those challenges are linked to Euro-Western/Eurocentric epistemologies in the design and/or application of ESD (Loch & Riechers, 2021); and 2. If indeed EWE can be identified as a barrier to ITEK integration, it would follow to attempt responding to the researchers' call for the design of models and tools through which these barriers can be addressed and hopefully mitigated.

This inquiry is then built on and inspired by: a. the arguably well-established relationship between ITEK & ESD; b. the considerable amount of supporting literature addressing epistemological interactions between the two (resources which will be mentioned throughout the paper); and c. the personal experiences, observations, and perspectives

resulting from my particular positionality (described in more detail in the **text box** below and in the Chapter 2).

A story of personal transformation
This a story about methodological journeys to unknown destinations.

When offered options about the research design for my thesis, and knowing already that I will write about the way Indigenous and traditional ecological knowledge integrate into ESD, conducting a systematic review was the last option I could imagine. Having the gift of being directly connected to various Indigenous nations and elders, a method such as participatory action research was not only more attractive, but also easier and more natural. Two things happened which derailed me from my clear and comfortable course: 1. A global pandemic making travel to my Indigenous relatives almost impossible; and 2. An "interesting" conversation during the ESD masters programme. The first factor has probably been the reason for many systematic reviews being written, tragicomically increasing the need for umbrella reviews to process all the data generated. In fact "[O]ne analysis of submissions to Elsevier's health & medicine journals alone found an increase in submissions of 63%" between February 2020 to February 2021 (Faulkner, 2022). The second factor on the other hand was much more decisive for my journey.

This direction-altering conversation occurred during a moment in the programme where I was presenting my intention for the thesis. As I outlined my intention to compare and contrast Western epistemology with its Indigenous and non-Western counterparts in the field of ESD, I was met by some of the course leaders with a type of resistance which at first was veiled but later became quite evident. I was asked by one professor something along the lines of: "Why do you want to attack Western epistemology and praise Indigenous knowledge, are you against science?" To this I replied: "No, but I would like the Euro-Western academic world to accept that there is a vast amount of knowledge outside its boundaries that is just as scientifically relevant, empiric and beneficial as Western science claims to be". I was then asked if this inquiry is motivated by my personal bias, to which I could not immediately reply because I was shocked to understand that the simple act of questioning Western epistemologies can so easily be seen as biased. It was both a wake-up call and a challenge. If as a White Eastern European scholar I was met with these types of reactions, what hurdles do Indigenous and non-western colleagues have to overcome when attempting to propose the inclusion of other worldviews than Euro-Western paradigms?

And so my method changed. It thus became imperative for me to conduct this inquiry much beyond the scope and design of my personal interest, in a way that could withstand such questioning, but more importantly in a way that could mitigate the bias I was being accused of and which I felt I needed to address in a manner appropriate to the scale of the issues this very conversation had just confirmed for me. On a personal level I wanted to dive deeper in understanding why questioning Western science can elicit such reactions, and most importantly I wanted to determine if Indigenous people and scholars are met with these same challenges in the realm of sustainability and the educational processes which accompany it.

It bears mentioning at this point that in order to undertake this comparative epistemological investigation, a certain amount of dichotomy had to be allowed, and perhaps even encouraged, so as to account for a thorough and pointed analysis. Firstly, this inquiry is centered *specifically* on EWE and ITEK interactions, which admittedly eliminates other worldviews and nuances from the discussion. While it could possibly be viewed as reductionist, this narrowing of the focus on *only two worldviews* — represented by Indigenous and traditional ecological knowledge on one hand and Euro-Western science and paradigms on the other — is done willingly and after careful consideration. As will be argued later in this paper, such a contrasting perspective is necessary in order to clarify the inherent power dynamics specifically present in applications of sustainability in which ITEK systems are placed alongside their Western counterparts (Kimmerer, 2012). Purposefully contrasting and to a certain degree simplifying these worldviews is akin to a "zoom out" effect that serves in achieving the globalized perspective required to determine if the calls for epistemic justice made by Indigenous and non-Western scholars are indeed warranted. With this direction and motivation in sight, the following research questions seemed like a reasonable starting place.

1.4 Research questions

Main research question:

How do Euro-Western epistemologies influence the integration of Indigenous and Traditional Ecological Knowledge (ITEK) in Sustainable Development and Education for Sustainable Development (ESD)?

Specific research questions:

1. What are the epistemological barriers and challenges faced by ITEK in its integration and application process in ESD within the Euro-Western paradigms?

2. Is there a pre/dominance of Euro-Western paradigms in ESD, and if so, what implications does it have for the integration of ITEK?

3. What are the outcomes and potential benefits of incorporating pluralistic perspectives and knowledge, such as integrating ITEK in ESD?

Research Success Criteria

The qualitative and quantitative information collected by converting literature into data through content analysis should hopefully be able to demonstrate that when attempting to implement Indigenous and local knowledge into ESD:

a. Western epistemologies and Eurocentrism are identifiable as challenges to successful ITEK integration;

b. if identified, the presence of this challenge is widespread enough to warrant notice;

c. sufficient data can be found to support categorizing EWE as predominant;

d. if the Euro-Western epistemological framework is indeed widespread and presents as a challenge and/or impediment to other worldviews (particularly ITEK) being represented in ESD, then certain models and/or frameworks for its identification and mitigation could be found/suggested and briefly discussed as future research directions.

1.5 Connecting to supportive theories

The core of the theoretical scaffolding supporting and motivating this research can be found in a mixture of *postcolonial, decolonial,* and *Indigenous research methodologies*. Core, meaning that in addition to these, the foundational principles upon which the research is done has to theoretically accommodate the constant adjustments needed in order to reckon with the *transformative learning* and *transdisciplinary orientation* implied by these critical lenses. In a sense the theoretical scaffolding can be seen as a *multi-theory weaving* which while aiming to achieve transformative results remains accountable to the just interaction between axiological, ontological, epistemological and methodological aspects in ITEK/ESD.

1.6 Outlining my methods and acknowledging my limitations

"[C]uriosity is piqued, niggling questions emerge, and literature searches are initiated based on information at hand and personal insights." (Fingfeld-Connett, 2013, p. 5)

I begin by acknowledging the contentious nature of apparently "pitting" two worldviews against each other and narrowing the focus in such a way as to seem almost intentionally combative. Such is the risk of engaging onto-axio-epistemological fulcrums in which tension is present both historically and conceptually. Such are the dangers of romanticizing and over-simplifying Indigenous and traditional ecological knowledge. Such also is the resistance of Western and modern science in being measured according to a set of parameters outside of its own canonical boundaries. Yet this discussion of questioning its knowledge claims and dominant tendencies in relation to other systems:

> should not be anathema to Western science—in fact, it is through dialogue that new insights have emerged from the ancient Greek academies to today's laboratory meetings and scientific conferences. In this sense, a dialogue can catalyse the development of shared meanings, which are key factors in binding people and societies together as vehicles of social cohabitation (Mazzochi, 2006, p. 3)

This is all to say there are no simple means through which such an analysis can be conducted, neither is it possible for it to address all the philosophical, theoretical, and even cultural aspects present. It is virtually inevitable when entering such dialogue to not omit, obfuscate, offend, or even be drawn into the mirage of personal predilections. I am prepared to have the reader be challenged and even outraged by my inquiry and by its design. I am also prepared to be continually transformed by this research, to find its flaws even as I conduct it, but most importantly to possibly reveal that regardless of its complexity and difficulties, such a dialogue is worthy, timely, and necessary both for (E)SD and society at large.

Having thus hopefully determined the relevance of this research, and considering the delicate balance required in working with possible biases (including my own) while deconstructing complex sociocultural and eco-political power dynamics (Moreno-Tabarez, 2020), I then opted for a study design which could hopefully provide an evaluative framework that was as broad, impartial, and balanced as possible. I found the method of an *umbrella review* **conducted through the systematic review process** to be most appropriate for this endeavor in that: "Systematic reviews … provide a redress to the natural tendency of readers and researchers to be swayed by [such] biases, and they can fulfill an essential role as gyroscope, with an in-built self-righting mechanism." (Petticrew & Roberts, 2005, p. 6). Simply described, umbrella reviews are overviews of reviews which do not draw on primary research but use instead other systematic reviews as data units (Grant & Booth, 2009). The other reason I chose this design was the fact that I found remarkably large amounts of literature on the topic — some of which included systematic reviews of ITEK integrations, and even a few systematic reviews of systematic reviews. As a further example of supportive

statistics, in late 2022 the search string: "indigenous knowledge AND western epistemology AND sustainability" in Göthenburg University's Library yielded 5,130 results. Thus because the sheer amount of resources I uncovered was well beyond my abilities to properly analyze as a single researcher, I was motivated to aggregate the findings of other reviews in an attempt to reach a wider scope through the framework and methodology of an umbrella review.

Another limitation to mention at the onset is related to the scope of a master's thesis in relation to such a gargantuan task[5]. I acknowledge that a suggested limit of 20,000 words was given for this undertaking. While I attempted to be as concise as possible, I state here that *I decided to opt for a longer format of around 30,000 words including references* due to: the topic and its complex nature; the systematic review method and its rigorous requirements for protocol transparency; and the need of repeatedly integrating references from 30 authors. With this is mind, I have done my best to spare the reader by: creating useful tables; utilizing the Appendices as a repository of deeper detail; using footnotes and including links between sections; and finally by summarizing every chapter and sub-section as necessary.

1.7 Opening the umbrella - an overview of each chapter

Offering here an orientational guide of each section in this review, **Chapter 2** focuses on "**Researcher Positionality,**" acknowledging my background as a researcher, and the influence of my socio-cultural beliefs, upbringing, and personal experiences on the study. By critically examining my own positionality, this chapter hopes to enhance transparency and ensure accountability is present in the investigation. **Chapter 3**, "**Related Literature & Themes,**" introduces the main literature sources and outlines the key themes that underpin my exploration of epistemological interactions between ITEK and EWE during integrations into ESD. Moving to **Chapter 4**, "**Theoretical Frameworks: Weaving a Theoretical Design**," a unique theoretical weave is created by intertwining the transformative paradigm, postcolonial, decolonial, and Indigenous research methodologies, and the transdisciplinary approach. This framework is intended to provide a solid foundation for investigating the epistemological interactions between ITEK and Euro-Western paradigms in ESD.

Continuing with **Chapter 5**, "**Methods,**" the umbrella review methodology is described, encompassing the search strategy, inclusion and exclusion criteria, and the utilization of PRISMA and MMAT guidelines for data analysis and quality assessment. **Chapter 6**, "**Results,**" presents the findings of the umbrella review, showcasing visualizations and offering a narrative commentary by synthesizing the systematic reviews. The discussion of how the studies answer the research questions takes place in **Chapter 7** where also a conceptual tool is offered for how to approach this type of research in the future. Lastly,

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[5] Note. After undertaking this task, I truly salute any researcher attempting a systematic review of this kind on their own. Do not be discouraged, but be forewarned: it is possible, yet it is nonetheless daunting.

Chapter 8, "**Conclusion and Recommendations**," closes with the study's main conclusions, proposes avenues for future research, and provides recommendations based on the identified gaps in the literature. Overall, this comprehensive exploration seeks to shed light on the epistemological complexities and implications of integrating ITEK in ESD, paving the way for more transformative and inclusive sustainability practices.

2. Researcher Positionality

When approaching inter-cultural and transdisciplinary work, particularly one in which colonial power dynamics still exist, it is becoming increasingly necessary (and hopefully one day mandatory) to begin by clarifying the positionality of the researcher(s) involved. For example, authors Herndl and Nahrwold (2000) support the view that researchers must evaluate their practices in connection to their access to institutional and cultural forms of power. According to them, it is this access, and not their inner paradigms which heavily influence the role of researchers as social actors in knowledge co-production, as they function within structures built on asymmetric power dynamics, socio-economic and political contexts, embedded prejudice, dominating discourses, varied traditions, etc.

The discussion of positionality is carried widely across multiple forms of research, yet rarely is it more relevant than in instances where Indigenous knowledge is being approached by non-Indigenous researchers in order to produce an academic body of work based on the modern scientific paradigm (Maclean et al., 2022). Such instances can carry resonance of colonial pasts, of cultural appropriation, tokenization of Indigenous peoples and their ancestral knowledge, of perpetuating the dominance of Western cultures, science, and epistemologies, all very strong reasons for which I believe having a clear statement of positionality would be the minimum requirement in engaging with these topics. While such interactions will be treated in considerably more depth below, I now take the time to bring this personal note in order to model the implementation of the necessary reflexivity required when undertaking cross-cultural and boundary blurring research.

To that extent, I state here that I am a female researcher born and raised in Romania, (an Eastern European land with a long history of being colonized by larger empires), a country whose recent history was dominated by communism and the totalitarian regime it engendered. This is relevant insofar as it places my positioning at the intersection of presenting as a white European and benefiting from racial privilege, yet being one who has lived and still experiences the effects of dominant cultures and the discrimination (often times covert) which they exert on the colonized, or the dominated. This socio-political binary upbringing continued throughout my life, as two decades ago my family moved from the "Eastern Block" to Canada, a country where upon arrival we became settler-colonialists by simple virtue of utilizing the Euro-colonial structure that made Canada as a country possible.

My time in so-called North America (many Indigenous people prefer to call it Turtle Island) has brought me close to Indigenous elders and nations, by some of whom I have had the privilege to be adopted (a term known as the "making of relations") and whom I since fully consider family. I am of course still in close contact with my relatives, whose ways and ceremonies I am actively learning from and practicing alongside my ancestor's traditions.

After 10 years of living on the ancestral unceded territories of the Squamish, Salish, Stó:lō, and Kootenai First Nations, I returned to Europe where I now live in Ellada (known as Greece), a land whose ancient lineages are related to my own direct Thracian lineage. All this to say that I have personally experienced various zones on the spectrum of these socio-political and cultural power dynamics (Herndl & Nahrwold, 2000), and it is this experience which informs my inner posture as well as my academic work, the latter which I firmly place in service of utilizing my privilege as a white European to center Indigenous and marginalized voices, support decolonization initiatives, and participate in accountability-fostering reconciliatory protocols. In addition to standing alongside Indigenous people in their struggle for liberation, decolonization, and autonomous selfhood (Tuck & Yang, 2012), I am also actively involved in connecting to the ancestral ways of my own lineage, while working toward bringing awareness of colonial power imbalances to my fellow Europeans and encouraging all of us from these lineages to once again become responsible members of the human family. It is from this personal work of deconstructing and learning about my own preconceived and limited views on indigeneity, colonialism, whiteness, cultural appreciation versus cultural appropriation, I have begun to understand that such biases are not only common but rather ubiquitous. When questioning my own inner paradigm as a White presenting Eastern European I have come to realize that it is so deeply intertwined with my education as to be almost indistinguishable. This then led me to further investigate the knowledge claims upon which I was basing my whole understanding of reality, of nature, of the constructs of race, of environmental preservation, etc. Through this personal quest I have found the Western paradigm, which had been the main lens of my educational journey until that point, to be severely lacking in equipping me with the complexity tolerance required for interacting with other worldviews, particularly in such instances where European colonialism was brought up in relation to Western science. It was thus not a distant reach to ask if other European origin fellows and researchers are afflicted by the same limiting lens and in doing so, to notice that Indigenous and non-Western people and scholars have long been discussing this issue.

I make clear this position as a pre-requisite for the type of work which I will undertake in my review, yet because I remain aware of potential biases which this positioning can bring, I have constructed a theoretical framework and methodology which can hopefully mitigate and navigate this delicate interaction.

3. Related Literature & Themes

"Sustainability is not just about environmental conservation, but also about social justice and economic equity. Indigenous knowledge can help to address these broader dimensions of sustainability." (Breidlid & Krøvel, 2019, p. 6)

In keeping with the methods and layout of this type of study, I begin by introducing here a selection of relevant literature which acts both as background for the inquiry, source for the themes outlined next and as support for theoretical scaffolding in [Chapter 4](#).

3.1 Introducing literature support

I consider it important to mention again that the amount of resources on the topic of ITEK and (E)SD is so vast, that the options from which one can choose are truly overwhelming. Due to this overabundance of resources, yet also in an effort to remain anchored in the positionality, reflexivity, and critical perspectives mentioned above, I chose to mainly work with a specific list of 10 books as my main literature support for the theories and themes which I introduce below in Chapter 3 and later in Chapter 4. That said, in order to ensure a fair inclusion of worldviews, these authors have been selected to represent both Western and non-Western perspectives, with consideration to academic, ethnic and geographic positioning. Utilizing primarily these books as literature for my thesis is directly motivated by their critical perspectives on Western epistemology and Eurocentrism, their exploration of the potential for epistemological justice issues, the reclamation of Indigenous knowledge, and the focus on integrating Indigenous and Traditional Ecological Knowledge (ITEK) into sustainable development and education. Important to note here that in discussions of minority miss-representation, such as in the case of Indigenous and colonized societies, great care has to given to center and include the otherwise marginalized and overpowered voices. In other words, this list reflects the calls from Indigenous and non-Western peoples for their rightful and equal representation in dialogues about their cultures. Thus each book offers unique insights and perspectives on these topics, drawing on diverse disciplinary approaches and frameworks. I propose that the insights and guidance contained in their pages are crucial to developing a deeper understanding of the epistemological interactions between ITEK and EWE in (E)SD integrations. In addition, these resources aptly identify challenges and opportunities for achieving epistemological justice and the decolonization of knowledge production also beyond sustainability discourse. A brief introduction of each book can be found below, with the paragraphs alphabetically introduced by author name and with a mention of each author's ethnical background (based on their self-identification and wherever available).

In *Reclaiming Indigenous Voice and Vision*, Mi'kmaq indigenous scholar Marie Battiste (2000) argues that incorporating Indigenous knowledge and ways of knowing into the education system is crucial for decolonizing education. She amply addresses the need for revitalizing Indigenous languages, cultures, and knowledge systems to empower Indigenous

communities and challenge Western-centric paradigms. This aligns with the focus of my review on incorporating Indigenous and Traditional Ecological Knowledge (ITEK) into Education for Sustainable Development (ESD) and promoting decolonization.

In a similar vein, in *Decolonizing Education: Nourishing the Learning Spirit,* Battiste (2018) provides a framework for decolonizing education and offers examples of how this can be achieved. Through revisiting instances of colonialism and racial assimilation of Indigenous people by the colonial systems imposed onto them, her book advocates for a critical re-evaluation of Western educational paradigms, including curriculum development and pedagogy. This is an important aspect to consider when examining the challenges of integrating ITEK into ESD and evaluating epistemological fairness.

Scandinavian scholars Anders Breidlid and Roy Krøvel (2020) in *Indigenous Knowledges and the Sustainable Development Agenda* provide a comprehensive overview of the role of Indigenous knowledge in sustainable development. The book examines case studies from around the world and explores the ways in which Indigenous knowledge can be integrated into policy and practice. This source supports on one hand the focus on ITEK in (E)SD and underlines the value of focusing on Indigenous knowledge in sustainability efforts, while on the other it offers insights into how IK can contribute to achieving the UN's Sustainable Development Goals. As such, this is one of the two *main literature resource* I will utilize *for integrative evaluations of ITEK & (E)SD.*

Editors Norman K. Denzin, Yvonna S. Lincoln, and Māori scholar Linda Tuhiwai Smith (2008) in their *Handbook of Critical and Indigenous Methodologies* provide a unique connective map of critical and Indigenous research methodologies, exploring the ways in which these approaches can be used to challenge dominant paradigms and empower marginalized communities. Spanning the whole world and featuring numerous reputable researchers, this handbook calls for centering Indigenous voices and perspectives in research, emphasizing the need to challenge Euro-Western epistemologies and recognize the knowledge systems of Indigenous communities. The authors provide examples of how these approaches have been successfully used in various educational contexts, and offer insights into how researchers can adopt these methodologies in their own work. This source supports the focus on epistemological justice and the need for a Euro-Western epistemological identification and mitigation tool in ESD.

Routledge Handbook of Critical Indigenous Studies - edited in 2020 by a group of all indigenous scholars - Brendan Hokowhitu (Māori), Aileen Moreton-Robinson (Quandamooka), Linda Tuhiwai Smith (Māori), Chris Andersen (Métis), Stephanie Larkin (Hawaii) offers an interdisciplinary overview of critical Indigenous studies, exploring the ways in which Indigenous scholars and activists are challenging dominant paradigms and advocating for Indigenous rights and sovereignty. The book provides insights into the

complex interplay of socio-political and cultural power dynamics between Indigenous and non-Indigenous communities and the necessity of placing Indigenous voices and perspectives at the center in research and policy in the hopes of attaining a more holistic society. This source supports the decolonial and postcolonial theoretical frameworks used in placing and analyzing my umbrella review.

Diederik A. Ludwig (Dutch), Ilkka Koskinen (Finnish), Zuziwe Mncube (Xhosa), Leandro Poliseli (Brazilian), Luis Reyes-Galindo (Mexica) wrote *Global Epistemologies and Philosophies of Science* (2022) as an exploration of the ways in which different epistemological traditions have shaped scientific inquiry around the world. They argue that acknowledging and valuing diverse epistemologies can contribute to a more pluralistic and inclusive approach to knowledge production, and offer insights into how this can be achieved. This book showcases the relevance of critically evaluating dominant Western epistemologies and the potential for alternative perspectives, which is particularly relevant to the integration of Indigenous and Traditional Ecological Knowledge into Education for Sustainable Development.

Mbah, Leal Filho, and Ajaps' book *Indigenous Methodologies, Research and Practices for Sustainable Development* (2022) explores the potential of Indigenous methodologies and practices in promoting sustainable development. Their book argues that Indigenous knowledge systems and practices have much to offer in addressing complex sustainability challenges, as they are based on long-standing relationships with the environment and foster community-based decision-making. The authors examine various case studies that demonstrate how Indigenous methodologies can be applied in research, policy development, and practice to address sustainability problems. This book connects with my theoretical framework through focusing on Indigenous Research Methodologies and Sustainable Development, aligning with the themes of ITEK in SD/ESD and decolonization. In addition, it touches on critical theory and postcolonialism in the context of challenging Western epistemologies and promoting epistemological justice. The transdisciplinary approach is also evident throughout the book, as the authors draw on insights from a wide range of disciplines, including anthropology, geography, and environmental science. This is another essential resource for my review as it spans almost all the chosen theories and themes, emphasizing the potential of Indigenous methodologies and practices in addressing sustainability challenges.

Emma A. McKinley (Cherokee Nation) and Linda Tuhiwai Smith's (Māori) *Handbook of Indigenous Education* (2019) provides an overview of Indigenous education, exploring the ways in which Indigenous knowledge and traditions can be integrated into teaching and learning to better serve Indigenous students and communities. Their book offers critical perspectives on the ways in which Western education systems have historically excluded Indigenous knowledge and ways of knowing, and it provides guidance on how to

incorporate Indigenous knowledge into the education system in a way that is respectful and meaningful. As a theoretical support this handbook places focus on ITEK in SD/ESD by underlining the necessity for education systems to be inclusive and responsive to the needs of Indigenous communities.

Portuguese scholar Boaventura de Sousa Santos' (2015) *Epistemologies of the South* explores the ways in which knowledge is produced and disseminated in the Global South, arguing that Southern epistemologies offer important insights and perspectives that are often marginalized in dominant paradigms. The book reinforces the need for a more inclusive and pluralistic approach to knowledge coproduction and dissemination that recognizes the diversity of epistemological traditions representative of other cultures outside of the Euro-Western realm. Santos' book is relevant as it supports the need for a critical re-evaluation of dominant Western epistemologies and the potential for alternative perspectives, including those from the Global South.

In her landmark book *Decolonizing Methodologies*, Linda Tuhiwai Smith (2012) challenges the dominant Western research methodologies that have historically been used to marginalize and exploit Indigenous communities. Smith offers a critical perspective on how research and education can be used to perpetuate colonialism and oppression. This quintessential book provides a roadmap and manual for decolonizing research and education by centering Indigenous knowledge systems, values, and perspectives. It also clearly and effectively underscores the necessity of building meaningful partnerships with Indigenous communities and engaging in research that is respectful of Indigenous protocols and ethical considerations. Proposing the integration Indigenous knowledge systems into research and education, Smith argues that we can create a more egalitarian and diverse approach to sustainable development that is grounded in local contexts and cultures. Connecting of course to decolonization and transdisciplinary approaches, Smith's book also has relevant applications of ITEK/ESD integrations which are all meaningful for the review.

In his seminal work *Research is Ceremony: Indigenous Research Methods* (2008), Cree scholar Shawn Wilson (Opaskwayak Cree Nation) talks about including Indigenous research methodologies and epistemologies in the research process. He underliness the significance of cultural protocols, storytelling, and the role of the researcher in Indigenous research. His book centers Indigenous voices and perspectives in research and challenge dominant research paradigms as he argues that Indigenous research methods offer a unique perspective on the world, one that is grounded in community, connection to the land, and spiritual beliefs. Wilson's work is in line with the decolonial and postcolonial theoretical frameworks used in this thesis and supports the transdisciplinary approach that aims to integrate multiple perspectives and knowledge systems. It touches on and elevates themes of epistemological justice and ITEK in SD/ESD integrations.

Needless to say that this list could be much longer and contain other valuable contributions to the field, for example Gregory Cajete's *Native Science: Natural Laws of Interdependence* (2000), Robin Wall Kimmerer's *Braiding Sweetgrass* (2013), Tuck, Smith, & Yang's *Indigenous and decolonizing studies in education : mapping the long view* (2019), or Virtanen, Keskitalo & Olsen's *Indigenous Research Methodologies in Sámi and Global Contexts* (2021) are but a few of the beautiful and valuable books written by Indigenous authors. In addition, there are myriad other books written by Euro-Western origin or orientation scholars capable of complexity tolerance and sensitivity to the topic of ITEK and its integration into sustainability and modern education. While some these authors will be cited throughout the review, many others will unfortunately be left out. Be that as it may, I motivate this selection through its collection of reputable and highly cited academics with extended expertise on these topics, and through the depth of field made possible by the literary expanse of a book as opposed to a journal article. I do not carry illusions as to the limitations and possible faults of proposing a rather concise literature list, yet for the purpose of this exercise, its relation to the topic should be hopefully satisfactory in creating the conceptual and theoretical axis necessary for successfully conducting my inquiry.

3.2 Introducing the themes

A growing awareness of the similarities of experiences of Indigenous peoples worldwide has reshaped the terminology used to define their own lives. No longer are tribally specific or local terms such as Indian, Metis, Inuit or Native (as used in Canada) or Aborigine or Aboriginal (as used in Australia) … The term Indigenous is now used to refer to that knowledge system, which is inclusive of all. Indigenous scholars are in the process of shaping, redefining and explaining their positions. They are defining the research, outlining the ethical protocols and explaining the culturally congruent methodologies that can be used at the behest of their communities. (Wilson, 2008, p. 54)

Lecture of these books has inspired me to draw conclude that the 9 authors above cover a sufficiently wide range of aspects relevant to the research questions and studies selected for review. Combined and extrapolated, the topics treated in their pages allowed me to extract *5 thematic structures* which I have been able effortlessly connect to the theoretical weave (as shown later in Table 3), while also being able to identify them in the systematic reviews which comprised the data for my analysis.

Here then are the *five* **main themes** which will be initially introduced as conceptual guidelines extracted from the literature selection[6]:

1. **Indigenous and Traditional Ecological Knowledge (ITEK);**

2. **ITEK in Sustainable Development (SD) and/or Education for Sustainable Development (ESD);**

3. **Western Epistemology/Eurocentrism;**

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[6] *Note.* The 5 themes are later utilized in Chapter 5 - Methods, as data and quality analysis criteria.

4. Colonialism/Globalization/Decolonization[7]; and

5. Epistemological Justice.

The extraction of these main themes serves several important purposes within the context of the thesis. Firstly, they align with the aim and objectives of the research to explore the epistemological challenges and opportunities of integrating ITEK in ESD within Euro-Western paradigms. By extracting these specific themes, I tried to ensure a comprehensive analysis of the relevant factors that shape the interactions between different knowledge systems. Secondly, the selected literature strongly supports this emergent thematic focus, providing rich insights into the aspects contained within, thus allowing for a deeper exploration of their interconnectedness and implications. Finally, the themes represent critical areas of inquiry that are essential for understanding and addressing the complexities, power dynamics, and potential transformations associated with the integration of ITEK in (E)SD.

Arguably arbitrary yet also self-explanatory, these themes are highlighted not only to further focus on the research questions, but most importantly to ensure that Indigenous voices are respectfully included in a genuine quest toward epistemological and ontological balance. As they emerged rather organically from the literature I propose these aspects as overarching representations of key factors affecting the integration of ITEK in ESD. In their capacity as key factors, these 5 themes will also later serve as a framework for interpreting the onto-epistemological clashes encountered in the data analysis process. The *first three themes are foundational* to the inquiry, while *the last two engage the critical perspective* necessary for constructing meaning. Following below is a brief introduction and description of each, with the mention that they will be treated again during the results and discussion part of this review.

1. Indigenous and Traditional Ecological Knowledge (ITEK)

Beginning this thematic elucidation by addressing the ever-so-contested term "i/Indigenous" as so apparently contentious is this definition that numerous texts separate it based on its first letter. For example for some authors, "indigenous" is viewed to refer to people who are indigenous to a specific land, while "Indigenous" is representative of cultures that have been or currently still remain exposed to colonial invasions (Mazzochi, 2020). While inevitably beyond the scope of this work to discuss such nuances, I will introduce here Shawn Wilson's definition of the term Indigenous as: "relating to those peoples and communities who have a historical and ancestral connection to a specific land, language, and cultural practices that are distinct from those of the dominant settler

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[7] *Note.* Decolonization appears both as a theoretical approach and as a theme because decolonization transcends theoretical confines as it is an active liberation process. In this way decolonization is a true example of a transformative element as it brings metamorphosis to all who engage with it.

society" (Wilson, 2008, p. 27). Similarly, Linda Tuhiwai Smith defines Indigenous as: "the original inhabitants of a specific territory, who have a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, and who consider themselves distinct from other sectors of the societies now prevailing on those territories" (Smith, 2012, p. 134). This subtle but important distinction is addressed in this text through the use of ITEK as a term which both differentiates the two while showing how they are deeply related.

In keeping with the rather confusing taxonomy of sustainable development terms, while some scholars separate Indigenous knowledge (IK) from Traditional Ecological Knowledge (TEK), others merge them into a unified set of systems, treating them as synonymous (Whyte, 2013). Some authors argue that IK is specific to Indigenous peoples' cultural knowledge systems, while TEK is more narrowly focused on environmental knowledge and management practices derived from local records of *indigenous* (in its small letter version) populations living in the same locations for extended periods (ie. Romanian peoples are an indigenous ancestral population that posses traditional ecological knowledge but that is not currently subjected to colonial domination). These authors stress that the two knowledge systems are interconnected but distinct, with IK being the domain of living Indigenous tribes and nations that are currently experiencing some form of colonialism (Smith, 2012). Other scholars however, see IK and TEK as essentially the same, arguing that both are embedded in a holistic worldview that focuses on the interconnectedness of all things and the importance of relationships between people and the natural world. These authors suggest that the distinction between IK and TEK is artificial and that it is more productive to focus on the commonalities and shared principles between the two knowledge systems (Cajete 2000; Battiste, 2000; Ludwig, 2022; Wilson 2008). More so, these two concepts can appear defined for example as Indigenous Ecological Knowledge (IEK), Local Indigenous Knowledge (LIK), Indigenous and Local Knowledge (ILK), Indigenous Knowledge Systems (IKS), Indigenous Ways of Knowing (IWOK), Indigenous Traditional Knowledge (ITK).

Acknowledging that the distinction between IK and TEK is a contested issue in the literature, I have chosen *a blend of both positions* by treating these terms both as separate — presenting them as Indigenous **and** Traditional Ecological Knowledge (ITEK) — as well as complementary — wherever their holistic perspective transcends their differences. In other words, instances will be respected when they appear in a text as only IK, or only TEK or Traditional Knowledge (TK), this being done to account for pluralistic treatment of the terms, resisting reductionism, while also attempting to simplify terminology for the purpose of clarity and cohesion. To that extent, I put forth that the term ITEK used in this modular way could possibly mitigate the taxonomy differences and unify the overly fragmented list of terminology currently available.

In regard to the Indigenous Knowledge aspect of ITEK, a comprehensive definition of the term is offered by prestigious Indigenous scholar Marie Battiste:

> Indigenous knowledges are diverse learning processes that come from living intimately with the land, working with the resources surrounding that land base, and the relationships that it has fostered over time and place. These are physical, social, and spiritual relationships that continue to be the foundations of its world views and ways of knowing that define their relationships with each other and others. Indigenous elders have transmitted the functions and knowledge inherent to their living on the land and made clear that what the land reveals is that all things are interconnected, it is sacred, and our people must be stewards of its continued protection. (2018, p. 46)

Sometimes complementary (even synonymous) and sometime quite different from IK, Traditional Ecological Knowledge, is a considerably more complicated concept to clarify due to its occasional separation from Indigenous Knowledge. This separation often encountered in the literature of the field, opens the door to ambiguities and confusion particularly when trying to equate TEK with a more Western empirical progression of knowledge production. Addressing this difficultly in defining the term separately from IK, Fikret Berkes in his book *Sacred Ecology* states:

> To arrive at a definition of traditional ecological knowledge [TEK] , it is necessary to sift through the various meanings and elements of the concept through the development of the fields of ethnoscience and human ecology … The study of [TEK] begins with the study of species identifications and classification (ethnobiology) and proceeds to considerations of peoples' understandings of ecological processes and their relationships with the environment (human ecology). Implied in the concept is a component of local and empirical knowledge of species and other environmental phenomena. There is also a component of practice in the way people carry out their agriculture, hunting and fishing, and other livelihood activities. Further, there is a component of belief in peoples' perceptions of their role within ecosystems and how they interact with natural processes. (2012, p. 6)

In this text ITEK as a main theme focuses on the nature of various Indigenous *and/or* Traditional Ecological knowledge systems, emphasizing their significance in the discourse of environmental protection, and the critical role they play in achieving multi-generational and multi-species well-being. Considering this noble intention, a critique can nevertheless be brought to the lack of space for proper treatment of this complex set of concepts and the risks of generalization which this umbrella term can be fraught with.

2. ITEK in Sustainable Development (SD) and/or Education for Sustainable Development (ESD)

By extension, the theme of ITEK and Sustainable Development (SD)/Education for Sustainable Development (ESD) elucidates the mutualistic relationship between ITEK and sustainability goals and focuses on processes in which these systems were integrated in SD/ESD initiatives, with the range of integrations spanning the whole spectrum of sustainability

applications. An important distinction to introduce here is the difference between SD and ESD: whereas SD is defined by the United Nations Brundtland Commission "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987); ESD is presented by UNESCO as giving "learners of all ages the knowledge, skills, values and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, and inequality" through being a "lifelong learning process and an integral part of quality education" that "enhances the cognitive, socio-emotional and behavioral dimensions of learning and encompasses learning content and outcomes, pedagogy and the learning environment itself" (UNESCO, 2023).

While both concepts and their definitions are strongly contested as being inaccurate, incomplete, and even confounding representations of their intended purpose, in the case of ESD this ambiguity becomes almost debilitating (Wals, 2015). The reason for this can be found in "the lack of conceptual and consequently methodological unity within the research and practice of ESD" as well as "the lack of researchers' and practitioner's agreement on what ESD is or what it is not" (Kopnina, 2014, p. 2). I point this out here to state that in the process of conducting this review SD and ESD became at times impossible to separate as a theme simply due to the fact that the distinction between what constitutes sustainable practices and what constitutes education for sustainable practices is often so vague (based on the official definitions) that I finally decided to use them as a pair and differentiate where they appear as clear distinctions within the resources used.

3. Western Epistemology/Eurocentrism

In the case of Western Epistemology/Eurocentrism thematics, these have been extracted in order to expose the power dynamics and potential epistemological conflicts that can occur in the integration of ITEK in ESD and the institutional and structural barriers that this integration can encounter. Again to remind the reader that the inclusion of Western epistemology and Eurocentrism as themes in this study does not seek to provide an exhaustive analysis of the entire history and breadth of Western epistemology, nor does it intend to oversimplify or generalize Europe's scientific and epistemological traditions. Rather, it aims to critically examine the dominant Western frameworks of knowledge production and their potential implications for the integration of ITEK into (E)SD. The motivation for this particular focus is on shedding light on power dynamics, biases, and cultural hegemony tendencies, with an aim to foster a deeper understanding of the challenges faced in incorporating diverse knowledge systems, along with a clear intention to promote non-discriminatory and encompassing approaches to ESD.

In addition, questioning Western epistemology and the presence of Eurocentrism is becoming an increasingly demanded practice in ESD and the academic work at large. As mentioned by Breidlid & Krøvel:

> there is a need for Western scholars to write back to the epistemological center where we are located, distance ourselves from the superiority claims of the West and the Orientalizing discourse towards Indigenous Peoples and indigenous knowledge systems and thereby strengthening the ties with the indigenous people's fight for alternative and indigenized ways of sustainability (2019, p. 2)

Following these clarifications it could be argued that as it is characterized by a focus on scientific rationality and objectivity, and often used to justify and perpetuate Western ways of knowing and doing, Western epistemology is the dominant way of understanding the world that has been mainly developed and upheld by Western European colonial societies (Ludwig et al., 2022). Because of this origin story in some instances where particularly relevant, I will use the term Euro-Western epistemology (EWE), while Western epistemology will be the more common utilization.

In the context of education for sustainable development (ESD), critiques of Western epistemology have focused on its limitations in addressing complex environmental problems and the need for more inclusive, culturally responsive approaches to knowledge production and action. Proponents of culturally inclusive and pluralistic ESD argue that Western epistemology needs to be critically examined and integrated with other knowledge systems in a context of plural epistemologies, including Indigenous and local knowledge, in order to promote the sustainable and equitable futures extolled by the SDG's (Jickling, 2008; Mbah, 2022; Santos, 2015). Considered as the dark and biased side of Western epistemology, Eurocentrism can be defined as the dominance of European culture, history, and thought over those of other cultures and regions. According to Dei, Hall & Rosenberg (2000), Eurocentrism promotes the notion of superiority of Western knowledge systems, which leads to the marginalization and devaluation of other ways of knowing, including Indigenous and traditional knowledge.

4 & 5. Colonialism/Globalization/Decolonization[8]; and Epistemological Justice

A critical perspective is applied to the interaction between ITEK and SD/ESD by adding the themes of Colonialism/Globalization/Decolonization and Epistemological Justice, both crucial in understanding the broader socio-political and historical contexts in which these power dynamics and potential clashes arise. In regard to the first thematic grouping the choice points to the various forms in which Indigenous peoples have and are encountering domination mechanisms engendered by colonial pasts and which are currently

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[8] *Note.* Decolonization appears both as a theoretical approach and as a theme because decolonization transcends theoretical confines as it is an active liberation process. In this way decolonization is a true example of a transformative element as it brings metamorphosis to all who engage with it.

inflicted through the more subversive encroachment of globalization all resulting in unsustainable environmental outcomes for the affected populations. In SD discourse particularly, decolonization comes as a response to the dominant nature of Western paradigms. Mbah et al.writes: "Fulfilling the SDGs requires transformation of our societies, including IHEs [Indigenous higher education], through the decolonization of our socio-economic paradigms, the healing of communities and relationships damaged by colonization, and local mobilization to achieve global sustainable development goals" (2022, p. 119).

Lastly, epistemic in/justice emerges as both an overarching theme (directly connected to decolonization in its theoretical approach and action-oriented process) and as a direction toward regenerative practices from which practical and applicable solutions can be suggested. Questions about epistemic injustice arose in the Global South as "a set of inquiries into the construction and validation of knowledge born in struggle, of ways of knowing developed by social groups as part of their resistance against the systematic injustices and oppressions caused by capitalism, colonialism, and patriarchy" (Santos 2014, x). No analysis of epistemological interactions between worldviews would be complete without an epistemological justice lens, more so at a time when Indigenous and non-Western peoples and scholars from around the world decry the hegemonic tendencies of the main narrative stating: "there is no global social justice without global cognitive justice" (Santos, 2015, p. 1)

In conclusion, taken together these themes attempt to provide a comprehensive and holistic epistemological analysis of the integration of ITEK in ESD, hopefully yielding the degree of plurality which is necessary for supporting the goals of education for sustainable development to be conducted in a culturally sensitive and ethical manner. Clearly outlined by the 10 books in the literature selection, I justify the use of these 5 different aspects as they allow for a deeper exploration and understanding of the epistemological complexities and challenges of integrating ITEK into ESD, which in turn point to the broader societal implications of such integration (see Appendix 1 for an outline of these relations).

Even though highlighting ITEK, ITEK in (E)SD, Western Epistemology/Eurocentrism, Colonialism/Globalization/Decolonization, and Epistemological Justice, appears relevant to the research context, there are some potential limitations to consider. Firstly, the selection of these themes may be seen as overly focused only on specific aspects of the integration of ITEK in ESD, potentially overlooking other important dimensions or perspectives, thus they may not encompass the entirety of the complexities surrounding this topic. Secondly, as mentioned above, the reliance on a specific set of literature may result in a biased representation of the field, with a possibly insufficient thematic treatment. Lastly, while the chosen themes provide a framework for analysis, there is a nevertheless a need for careful interpretation and contextualization in order to avoid oversimplification or essentialization of complex concepts such as epistemological justice and colonialism. Which points to one of

the main limitations of this thesis and its space-induced deficiency to engage in a sufficiently nuanced exploration of these themes as to avoid perpetuating limited or superficial narratives.

Moving on, **Table 1** below succinctly defines each of these concepts in order to allow their use both as conceptual guidelines, akin to the various colours of the yarns used in a weave, but also as data analysis tools (capacity in which they will be reintroduced later).

Table1

Defining the Main Themes

Theme	Definition
Indigenous & Traditional Knowledge (ITEK)	Knowledge systems developed by Indigenous and local peoples that reflect their cultures, traditions, and values
ITEK into SD and/or ESD	The incorporation of Indigenous and traditional knowledge into sustainable development and/or education for sustainable development initiatives and pedagogical designs
Western Epistemology/Eurocentrism	The dominant way of knowing and understanding the world that has emerged from Western societies and often reinforces Eurocentric perspectives
Colonialism/Globalization/Decolonization	Historical and ongoing processes through which Western powers have imposed their authority and culture on other societies, often resulting in the marginalization and oppression of Indigenous peoples. Decolonization is the process of undoing the effects of colonization and working towards the restoration of Indigenous knowledge, culture, and sovereignty. It involves challenging and dismantling the structures and systems that uphold colonialism and promoting the resurgence of Indigenous ways of life and governance.
Epistemological Justice	The recognition and valuing of diverse knowledge systems, including Indigenous and traditional knowledge, as valid and legitimate ways of knowing, and the promotion of equal access to knowledge and decision-making power for all people

Note. This is a preliminary introduction of the main themes which will be treated more in depth the methods section.

Important for the reader to know that in <u>Appendix 1</u> the 10 books described above are placed in relation to the theoretical weave and thematic analysis introduced so far.

4. Theoretical Frameworks: Weaving a Theoretical Design

To decolonize the "word" is to recognize that the dominant language that includes gesture, tone, expression, theoretical frameworks, methods of data collection, and data analysis communicates dominant cultures and is most likely to misrepresent and render silent the experiences of the majority researched relegated to the position of Other. (Chilisa & Tsheko, 2014, p. 223)

In traditional loom weaving (an ancient art shared by all peoples of this Earth) there are two essential components which create the fabric. The *warp* ⫴ is created by the longitudinal yarns that are held in tension in order to provide the structure onto which the pattern can be created. Traversing the warp is the *weft* ☰ made by the yarns which cross through, meandering above and under the warp in order to make the design visible. As for the *frame* ⊞, it is clearly the neutral yet solid structure which makes all of this possible. This imagery felt well suited in such a cross-cultural knowledge coproduction exercise where, as shown in *Figure 1,* the interaction of various epistemologies (and methodologies) is being analyzed and decoded in search of an emerging pattern.

Figure 1

Visual representation of the Warp, Weft, and Frame analogy
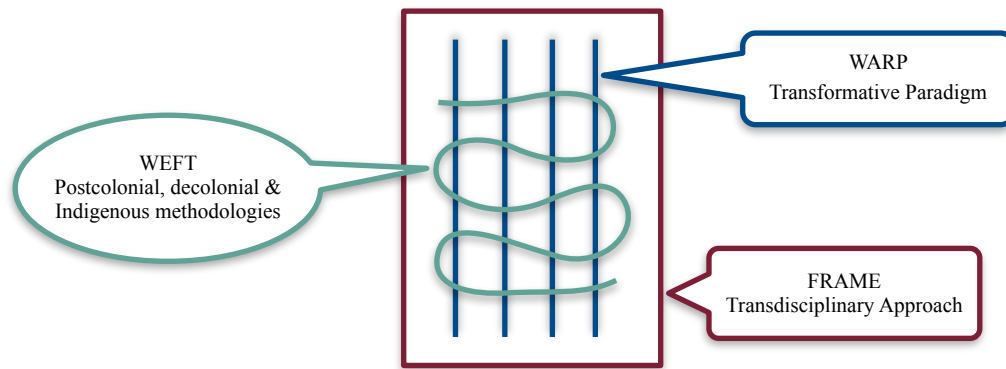
In other words, the theoretical scaffolding for the current inquiry will be presented as a *multi-theory weaving* which, aiming to achieve transformative results, remains accountable to the treatment of various axiological and ontological parameters involved in ITEK integrations in relation to Euro-Western epistemologies (Denzin, Lincoln & Smith, 2008). The reason for this decision emerged throughout the planning of the research, the identification of the research questions and further as the research itself was conducted, process through which it became quickly clear that a poly-theory approach was indeed the only reasonable way I could ever hope to tackle this evaluation at the scale implied by a review of reviews. To that extent, acknowledging here the ethically "removed" nature of conducting systematic reviews, where no direct interaction between researcher and participants occurs, it thus became of vital importance to make conscious efforts in ensuring theoretical inclusivity and epistemologically equitable multi-worldview support (Kincheloe & Steinberg, 2008). More so, as I have already mentioned the inevitable dichotomy of interweaving worldviews involved in ITEK/(E)SD interactions, while retaining a ***critical view on dominant discourses and paradigms***, is a treacherous proportion for which a complex enough selection of theories must be offered in order to mitigate the equally inevitable bias accusations. In other words, this choice of introducing a poly-theory approach was also made in respect of introducing a balanced selection of both Western and Indigenous originated theoretical orientations, in the hopes of demonstrating that this discussion can be efficiently held separately by the two worldviews, yet that the proposition which is most worth pursuing is to understand where the two can meet and how they can successfully interact. This practical and metaphoric weaving, thankfully allowed me to envision the possibility of remaining inspired while delving in the fairly sterile world of systematic reviewing, being nevertheless able to sustain the ideological and theoretical scaffolding necessary for this undertaking.

After careful consideration, study, and observation of the approaches and emerging patterns in the data, I settled on a theoretical design "weave" of the: a. *Transformative paradigm* as the **warp** ││**;** b. *postcolonial, decolonial,* and *Indigenous research methodologies* as the **weft** =**;** c. the *transdisciplinary approach* as the **frame** ⊞ holding the resulting tapestry. In other

words, as shown in **Figure 1** above, the transformative paradigm will hold the structure onto which postcolonial, decolonial and Indigenous methodologies can weave through (as it becomes necessary and relevant), while the transdisciplinary approach will mainly frame and inform the discussion and the conclusion/recommendations. That said, the reader can expect to see the above theories revealed throughout the text in any order, and woven together with or without a mention of the warp, weft, or frame aspect of each theory.

Another important mention at this time is that although there are other note-worthy approaches present in ITEK integrations into (E)SD — such as critical race theory or participatory action research — this selection covers most of the theories present both in the supportive literature and the studies chosen as research data. Justifications for inclusion and descriptions of these various methodologies follows below.

4.1 Transformative paradigm: A theory of intrinsic tensions / The Warp ⫶

"ESD is considered to have a robust transformative approach as it seeks - contrary to other instrumental approaches - to empower individuals by encouraging them to critique status-quo values and social norms and to adopt sustainable principles and ethics by addressing unsustainable practices" (Rodriguez, 2020).

Choosing to use the transformative paradigm as the *warp* or threads of support for the other theories is motivated by the nature of this comparative epistemological exercise, coupled with the reflexivity called for by researchers engaging in ITEK integrations into ESD, and the critical evaluation lens required for the topic of knowledge coproduction.

About this method, SAGE Research method encyclopedia states:

The transformative paradigm views knowledge as a social construction shaped by the knower's individual experiences, personal characteristics, and community affiliations. As a result, researchers and evaluators as well as study participants are called to reflect on their own beliefs, consider how beliefs are shaped by one's identity and life experiences, and critically examine how such beliefs may influence one's perspectives on the study topic and methods. (Frey, 2018, p. 2)

Originally introduced by Jack Mezirow in the late 1970's and solidified through his book "Transformative Dimensions of Adult Learning" in 1991, transformative paradigm theory appears under other names or conceptual frameworks such as *transformative learning / education / pedagogy / change / dialogue; critical reflection / self-reflection / self-awareness*, or *perspective transformation*[9]. Further developed by scholars such as Donna Mertens (2018, p. 216), an instrumental figure in advancing the tenets of this theory, in **Table 2** on the next page, a short breakdown of this paradigm is carried out:

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[9] Note: these terms will be used interchangeably throughout the paper.

Table 2

Basic Beliefs of the Transformative Paradigm

Ontology: There are multiple realities that are socially constructed, but it is necessary to be explicit about the social, political, cultural, economic, ethnic, racial, gender, age, and disability values that define realities.
Epistemology: To know realities, it is necessary to have an interactive link between the researcher and the participants in a study. Knowledge is socially and historically located within a complex cultural context. Respect for culture and awareness of power relations is critical.
Methodology: A researcher can choose quantitative or qualitative or mixed methods, but there should be an interactive link between the researcher and the participants in the definition of the problem, methods should be adjusted to accommodate cultural complexity, power issues should be explicitly addressed, and issues of discrimination and oppression should be recognized.
Axiology: Three basic principles underlie regulatory ethics in research: respect, beneficence, and justice. An explicit connection is made between the process and outcomes of research and furtherance of a social justice agenda.

Note. Reprinted from "Transformative Paradigm Mixed Methods and Social Justice" by Donna Mertens, Journal of Mixed Methods Research, 2010, p. 216, DOI: 10.1177/1077800410364612.

Having a rather longstanding relationship to ESD this theory was first applied in connection by scholars like Arjen Wals in the early 2000's, who in support of transformative paradigm wrote: "learning in the context of sustainability requires 'hybridity' and synergy between multiple actors in society and the blurring of formal, non-formal and informal education" (2011, p.180). In the updated and metamorphosed version suggested by Mertens, this theoretical framework becomes particularly relevant based on its emphasis on social and environmental justice, critical reflection, and action-oriented learning in education for sustainable development, and its aim to transform dominant power relations and promote more fair and sustainable ways of living. The main points of reaction between transformative practices and ESD are: 1. Their focus on promoting social and ecological sustainability by challenging dominant worldviews and power structures that contribute to unsustainable practices; 2. The call for critical reflection and action to create transformative change towards more sustainable futures; 3. The emphasis on the significance of involving diverse stakeholders in decision-making processes to create more democratic and inclusive approaches to sustainability (Rodriguez, 2020).

In addition, the relevance of a transformative paradigm approach for this specific inquiry is meaningful in the context of deconstructing paradigms, particularly because investigating intersections of relationality between Indigenous & Traditional Ecological Knowledge and Euro-Western epistemologies is a learning ground in which the comfortable distance of the objective researcher does not exist. All who engage such evaluation and the subsequent questioning of entrenched narratives, are bound to learn and be transformed, and no research participant, in any capacity, is exempt from the requirement to deeply and critically evaluate one's ideological constructs[10].

Relevant critiques to this paradigm were at the onset centered on its original form in which Merzow, although proposing a transformative process, was himself inevitably

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[10] *Note.* For me the process of choosing this very topic reflected transformative learning as I observed in academic environments a tendency to "skip over" or only superficially engage the difficult dialogue of cultural power dynamics and epistemic justice in ITEK/ESD knowledge coproduction initiatives. As such, I changed the whole direction of my thesis in order to question these dynamics and try to identify if Western thinking/paradigms are indeed "resistant" to, or even dismissive of, other forms of knowledge.

affected by over-rationalization at the expense of emotions and generalizations on the nature of education. These critiques were subsequently addressed in future iterations of this theory, with the current criticism being directed toward the risk for superficial use of its tenets, particularly in being co-opted by corporate and governmental actors looking to green-wash policies or perfunctorily address inclusivity and plurality requirements (Singer-Brodowski, 2023). Be that as it may, it does remain one of the most satisfactory and encompassing theoretical orientations for me to use as a non-Indigenous scholar looking to remain consistent to her positionality, while operating within the available paradigmatic field of my European fellows. In other words, this was the closest Western-originating common language I could find in order to provide the necessary scaffolding for the critical contributions of Indigenous and anti-colonial oriented epistemologies[11].

4.2 Postcolonial, Decolonial and Indigenous methodologies / The Weft ≡

The theoretical approach which ultimately shaped the design of my research can be found in a mixture of *postcolonial, decolonial*, and *Indigenous research methodologies*. These are the ***weft*** of the weave, meandering under and through the tension threads of transformative learning, bringing the alternating perspectives required for a multi-stakeholder dialogue, underscoring the epistemological divergences and/or injustices, and informing the data analysis protocols of the emerging patterns and themes. More so, the presence of these theories serves as an accountability indicator, ensuring that the research process does not fail to take into account the adjustments needed in order to accommodate the *transformative plurality* described at the onset. Simply put, due to the nature of the topic, which demands a balancing and meeting of world-views, Western theories have to be met in equal proportion with Indigenous generated theoretical frameworks if a balanced analysis is to be attempted.

Postcolonial Theory

Introducing first the *postcolonial theory*, a field of study that emerged primarily through the work of scholars from former European colonies in Africa, Asia, and the Caribbean, as well as scholars working in diasporic communities. Key figures in the development of postcolonial theory include Edward Said, Homi K. Bhabha, Gayatri Chakravorty Spivak, Frantz Fanon, and others. Appearing as a response to the historical and ongoing legacies of colonialism, which have had a profound impact on the economic, social, and cultural systems of colonized peoples and nations, it is not necessarily Indigenous-generated in the sense that it does not solely originate from Indigenous communities or cultures, but it does share some similarities with Indigenous perspectives and critiques of colonialism, imperialism, and globalization. Describing postcolonialism, Lyn Carter states that it:

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[11] *Note*. I underline this because one of the important aspects and tensions in reflexive exercise is to be aware of not "speaking on behalf of" which for me translates in integrating Indigenous methodologies as a guiding principle but not one that I would want to interpret myself.

redirect[s] our attention to the edge of the Western gaze enabling the deconstruction of Occidentalism, it also problematizes the categories within which much of the discussion on global culture occurs. Thus, it critiques contemporary global cultural processes unevenly restructuring world relations around the role of the economic-political, the appropriation of the Other, the spread of modernity with its liberal-humanist rhetoric of universalism, the hegemony of some forms of knowledge and delegitimization of others, and the scope for Third World agency (2004, p. 824).

In support of choosing this theory as part of the weft of the weave, is the fact that it "affirm[s] the power of education to make visible, to deconstruct, and to disrupt historical patterns of circulation of power/knowledge and problematic configurations of meaning, affect, and relationality that reproduce systemic violences" (De Oliveira Andreotti, 2014, p. 381). As far as a direct connection to ESD, a strong confirmation can be found in Arjen Wals' statement: "In recognizing that sustainable development is a political, social and cultural rather than just a technical issue, postcolonialism has brought a needed critique to the dominant discourses on sustainability that are often based on the universalism and linear thinking of the Enlightenment." (2010, p. 383). In other words, postcolonial discourse was the first meaningful theoretical current to clearly underline socio-cultural power dynamics and epistemic injustice that arise from the interaction of colonizer and colonized, focus which makes it particularly relevant to sustainability education in its pursuit for Reduced Inequalities and Quality Education as declared by the 10th and 4th Sustainable Development Goals respectively (United Nations, 2015).

Although a very useful framework for ex-colonies (particularly on the African continent) to begin liberation processes, through the contributions of prominent scholars such as Franz Fanon, the postcolonial theory has been criticized by Indigenous scholars and peoples as lacking in nuance and clarity particularly when needing to address the ongoing colonizing practices that many territories are still experiencing (Tuck, McKenzie, McCoy, 2014). Some Indigenous scholars argue that the term itself is flawed and unclear since it implies that we are inhabiting a time "after" colonialism, yet numerous Indigenous populations remain under active occupation whether politically, economically or both.

Decolonization

More directly connected to and representative of Indigenous needs and sensibilities, *decolonization,* as both a theoretical current and social action, is much more direct in addressing questions of epistemic injustice and power imbalances between the dominator and dominated. Decolonization has included political, economic, and cultural aspects since its inception, being used by colonized populations to express their dissent and resistance against deeply embedded colonial systems and matrixes of oppression (Betts, 2004). For example, for the Indigenous peoples in the Americas, decolonization is synonymous with their fight for land reclamation from settler-colonizers who have forcefully displaced

Indigenous and First Nations peoples from ancestral territories. It also extends to cultural (language and traditions) and spiritual (resisting Christianity as a colonial tool) self-determination struggles (Hall, 2010). For all these reasons and more, it has by now become a true dialectic of freedom, questioning and challenging the pervasive and ubiquitous reach of Eurocentric and colonial paradigms (Battiste, 2000).

Maori scholar Linda Tuhiwai Smith in her seminal book "Decolonizing Methodologies" (2012), deconstructs Western and Eurocentric research protocols showing that Indigenous-led alternatives are the only reasonable and fair way through which to approach endeavors such as integrating Indigenous knowledge in any level of Euro-Western educational designs. Smith states: "[R]esearch methodologies are often presented as value-free and objective. However, the fact that knowledge is socially situated and that knowledge acquisition is an active, interpretive process means that research is not a neutral activity" (2012, p. 4). In other words, the axio-onto-epistemolgical questioning of prevalent Western paradigms is one of the core applications of decolonization processes, brining to focus issues of plurality and inclusivity in knowledge coproduction that must be finally reckoned with in academic environments essentially built on colonially derived worldviews and sciences.

Therefore in the context of ESD the decolonization lens becomes almost essential. The reason for this high degree of relevance can be found in the very tenets of sustainability practices and again in the SDG's. For example: SDG 1 No Poverty; SDG 4 Quality Education; or SDG 10 Reduced Inequalities; very importantly in SDG 13 Climate Action; and SDG 16 Peace, Justice, and Strong Institution; are all directly connected with decolonial processes through their promotion of social, economic, and environmental justice. In addition, there is growing recognition that achieving the SDGs will require a decolonization of development practices and a rethinking of the dominant paradigms that have contributed to the marginalization of certain communities and the exploitation of natural resources. Decolonization in this context can be seen as a critical step towards creating a more just and sustainable world for all as it: "means embracing, although critically, indigenous worldviews, languages and cultural practices in the fight for a sustainable planet and where a decolonizing strategy against the current hegemonic epistemology which systematically is making the planet unsustainable is a must" (Krøevel, 2019, p.4).

As far as limitations to the use of it as a theory, because decolonization has been primarily developed by Indigenous scholars from North America and New Zealand, it may not reflect the diverse perspectives of Indigenous peoples from other parts of the world. This theoretical framework has occasionally been criticized for overemphasizing cultural and spiritual aspects of Indigenous knowledge, which do not consistently align to the practical realities of how ITEK is used in sustainable development practices.

Indigenous Methodologies

Arriving now to the theoretical thread holding and guiding the movement of the weft under, above, and through the warp of my theoretical weave, this is the moment to introduce *Indigenous methodologies* and their meaning for the current inquiry. In keeping with the transformative paradigm, and my previously stated reflexivity commitment of "not speaking on behalf of", I will start by listing a few quotes from Indigenous scholars describing Indigenous methodologies:

◉[Kaupapa Māori Research] - It has meant an 'Indigenous participant observation' of research, of the culture and politics of research, of how it has been institutionalized and established in the colonies, of how research has been implicated in our own colonization. But it has also been about understanding the ways in which research can provide systematic ways of understanding our own predicaments, of answering our own questions, and of helping us as communities to solve our problems and develop ourselves. Engaging in a discussion about research as an Indigenous issue has been about finding a voice, or a way of voicing concerns, fears, desires, aspirations, needs and questions as they relate to research. When Indigenous peoples become the researchers and not merely the researched, the activity of research is transformed. Questions are framed differently, priorities are ranked differently, problems are defined differently, and people participate on different terms. (Tuhiwai-Smith, 2012, p. 249-250)

◉A postcolonial indigenous paradigm is informed by a relational epistemology that values communities as knowers, and knowledge as the well-established general beliefs, concepts, and theories of any particular people that are stored in their language, practices, rituals, proverbs revered traditions, myths, and folktales. Knowing is something that is socially constructed by people who have relationships and connections with each other, the living and the nonliving, and the environment. Knowers are seen as beings with connections with other beings, the spirits of the ancestors, and the world around them that informs what they know and how they can know it. African perspectives view relational epistemology as knowledge that has a connection with the knowers. (Chilisa, 2014, p. 223)

◉[T]he colonial tax of Native [North American] scholars not only requires a renegotiation of personal identity but also an analysis of how whole nations get trans- or (dis)figured when articulated through Western frames of knowing. … By virtue of living in the Whitestream world, indigenous scholars have no choice but to negotiate the forces of colonialism, to learn, understand, and converse in the grammar of empire as well as develop the skills to contest it. … Native students and educators deserve a pedagogy that cultivates a sense of collective agency as well as a praxis that targets the dismantling of colonialism, helping them navigate the excesses of dominant power and revitalization of indigenous communities. While there is nothing inherently healing, liberatory, or revolutionary about theory, it is one of our primary responsibilities as educators to link the lived experience of theorizing to the processes of self-recovery and social transformation. (Grande, 2008, p. 4)

◉…[E]nabling and empowering Indigenous self-determination in which Sámi researchers document the histories of their own people, that is, their own stories. The aim is to test theories and find solutions to the questions of Indigenous peoples when creating a brighter world for Indigenous communities and people after a long period of cultural colonial practices. … Sámi research as a field of study is understood as research with Sámi contents from a Sámi standpoint and with the aim of producing knowledge about Sámi people using their own premises and Sámi language terminology. It can cover among other things, Sámi history, society, language, material and non-material culture, as well as environmental issues. (Virtanen, 2021, p. 23 & 30)

With these examples of Indigenous voices (Maori, Quechua, Motswana, and Sámi) describing and defining the methodologies appropriate for their respective historical and cultural contexts, it bares mentioning that this has become an ever-growing field of study looking to understand how indigenous knowledge and research methodologies challenge, counteract, inform, complete, develop or guide Euro-Western epistemologies toward a more plural methodological research scaffolding.

As for the direct connection to the field of sustainability, while an entire thesis could be written (and many have been) on the topic, Indigenous scholar Joe L. Kincheloe writes:

> Some indigenous educators and philosophers put it succinctly: We want to use indigenous knowledge to counter Western science's destruction of the Earth. Indigenous knowledge can facilitate this ambitious 21st- century project because of its tendency to focus on relationships of human beings to both one another and to their ecosystem. (2022, p. 3)

In support for this synergistic relationship between ITEK and ESD are positions such as Anders Breidlid's who states: "there is a strong need to include alternative knowledge systems, i.e. indigenous knowledges and epistemologies in literacy education if goal 4 of the SDGs is to be achieved" (2019, p.12). This is also echoed in the words of Arjen Wals and Brenton J. L. Jickling, some of the field's most prominent scholars:

> One of the key lessons from Indigenous knowledge is that sustainability is not just about resource management, but is an all-encompassing way of life. Rather than seeing nature as something to be exploited, Indigenous cultures view themselves as a part of nature, and as stewards of the land. (2008, p. 7)

Blending the insights and descriptions above, it can be safely stated that Indigenous methodologies underscore the value of connection to land, community, and spiritual values. Perceiving the world as "web of relations" results in understanding the environment as inevitably interconnected with social, cultural, and economic systems. Precisely because Indigenous peoples view the concept of sustainability as inherently intertwined with their way of life and their relationship with the land, a significant part of Indigenous methodologies revolves around protecting the natural environment for the well-being of all who inhabit it.

Critiques of Indigenous methodologies raise concerns about risks of generalizations, and questions of reliability, and validity beyond the specific cultural context in which they were developed. Some scholars argue that Indigenous methodologies may not be appropriate for research aiming to generate knowledge to be applied beyond Indigenous communities. Others argue that Indigenous methodologies may not be rigorous enough for scientific inquiry or may lack transparency and replicability.

4.3 The Transdisciplinary Approach / The Frame ⊞

Finally arriving to the wider theoretical structure framing the yarns of this weave, the transdisciplinary approach is chosen for its focus on the integration of multiple disciplines, stakeholders, and knowledge systems in order to address complex, real-world problems. Originating in the field of systems theory and developed by Jean Piaget, Erich Jantsch, and Basarab Nicolescu in the 1970s,

> Transdisciplinarity involves creating new knowledge that is grounded in academic disciplines but also informed by the needs and values of society. Thus, it requires collaboration among diverse actors across disciplinary, sectoral, and other boundaries in order to co-produce knowledge that is both scientifically sound and socially relevant. (Lang, 2012, p. 26).

Its multi-faceted and pluralistic intentions render this theoretical orientation particularly suited for holding the other theories in a setting which engenders collaboration. While transformative learning focuses on individual cognitive and behavioral change, and post/de-colonial and Indigenous methodologies focus on advancing and advocating other forms of knowledge, transdisciplinary approaches can facilitate collective action and co-creation of knowledge and solutions across multiple disciplines and sectors.

Choosing this theoretical construction for my weave can be justified thus:

1. Firstly, in relation to the transformative paradigm, the transdisciplinary approach can facilitate the integration of diverse knowledge and perspectives necessary for transformative learning and change.

2. Secondly, in the case of postcolonial, decolonial, and Indigenous research methodologies, the transdisciplinary approach can provide a framework for collaboration and knowledge co-production between different stakeholders, including academic and non-academic actors.

3. Lastly, the transdisciplinary approach can serve as a frame for the entire theoretical weave, providing a holistic and integrated perspective that will guide the discussion and recommendations.

As for its specific utilization in ESD, this method can facilitate the exploration of complex sustainability issues as it recognizes the interconnectedness of technological and social systems and the significance of considering the social, economic, and environmental impacts of technology alongside social and environmental responsibility. Furthermore, transdisciplinarity focuses on the need of engaging with local communities and promoting participatory decision-making, which is critical if ITEK/ESD integrations hope to be socially and culturally appropriate and relevant (Steelman, 2011). Perhaps most importantly for this case though is the undertaking that: "[r]ather than assuming the epistemic priority of

Western science, transdisciplinary approaches can contribute to acknowledgement of diverse forms of "situated knowledge" (Ludwig, 2022, p. 5).

While the transdisciplinary approach offers several advantages for this study, it is important to acknowledge some of its potential critiques and limitations. One critique is related to the practical challenges of implementing a transdisciplinary approach as collaborating across disciplinary boundaries and engaging diverse stakeholders can be time-consuming and resource-intensive. It requires effective coordination, communication, and consensus-building among individuals with different expertise, perspectives, and interests. Additionally, the integration of different knowledge systems and the negotiation of power dynamics between different actors can be complex and may lead to conflicts or tensions during the research process.

Another critique is that the transdisciplinary approach may risk diluting or homogenizing Indigenous and Traditional Ecological Knowledge (ITEK). The emphasis on integrating multiple knowledge systems may inadvertently prioritize Western scientific perspectives and methodologies, overshadowing the unique epistemologies, ontologies, and ways of knowing embedded in ITEK. In the same vein, transdisciplinarity may face challenges in terms of power dynamics and representation. The involvement of different stakeholders may not always guarantee sufficiently inclusive participation or influence, particularly for marginalized communities or Indigenous knowledge holders. These two points for example are some of the reasons why the previous theoretical choices of Indigenous, post and decolonial were made.

Despite these critiques, the transdisciplinary approach can still offer valuable insights and opportunities for collaboration, knowledge integration, and transformative change. By recognizing and addressing these limitations, researchers can work towards creating a more inclusive and equitable transdisciplinary framework that respects and values diverse knowledge systems, including Indigenous and Traditional Ecological Knowledge, in the context of Education for Sustainable Development.

As for a critique of the whole theoretical apparatus, the first limitation to point out is the obvious potential for theoretical bias and cherry-picking of theories to fit preconceived notions or desired outcomes. As I was aware that the selection of theories may be influenced by my personal preferences or subjective judgments, which could introduce bias into the analysis, I ensured that these were indeed the theories present both in the literature as well as in the studies, utilizing the same mindset of a systematic review in concluding that if a large enough number of resources are finding these theories relevant, it is safe to assume that they are indeed an appropriate an compatible blend.

Listing other shortcomings, my poly-theory approach may have overlooked other relevant theories and perspectives that could have contributed valuable insights to the study.

The exclusion of critical race theory and participatory action research, for example, may have limited the depth and breadth of the analysis, potentially overlooking important dimensions of power, social justice, and community engagement that the proposed theories might not address. Additionally, the use of multiple theories has arguably introduced a level of complexity in terms of terminology, concepts, and theoretical frameworks, which could make the analysis more challenging to follow and understand by readers less versed on these subjects.

In view of these limitations and critiques, I maintain that this multi-theory weaving approach nevertheless offers a unique opportunity to explore the complexities of Indigenous and Traditional Ecological Knowledge (ITEK) integrations into (Education for) Sustainable Development (E)SD). It is my hope that this weaving allows for a more nuanced understanding of the diverse theoretical perspectives and methodologies that can inform this integration. My proposition is that through critically engaging with multiple theories, it becomes possible to capture the richness and complexity of the topic, and to explore the potential synergies and tensions between different worldviews.

Summarizing the theoretical apparatus[12]

The theoretical framework for this study is a "weave" of the *transformative paradigm* as **the warp** providing the threads in tension; *postcolonial, decolonial, and Indigenous research methodologies* as **the weft** are the threads interweaving under and over the warp; and *the transdisciplinary approach* as **the frame** holding the multiple perspectives present in considering epistemological interactions between ITEK in ESD.

5. Method

"…researchers can also be influenced, consciously or otherwise, by their own pet theories, by their funders, and sometimes by the perceived need to produce positive findings in order to get published. All these make it difficult to work out where the balance of truth lies in many areas of science. Systematic reviews, however, provide a redress to the natural tendency of readers and researchers to be swayed by such biases, and they can fulfill an essential role as a sort of scientific gyroscope, with an in-built self-righting mechanism." (Petticrew, 2008, p. 5)

Utilizing the fairly novel method of the **systematic review (SR)** *process* (with a product of it being for example an umbrella review) as a master's thesis is admittedly still somewhat unusual. In support of this choice I can say: "[It] is widely acknowledged that this approach to research allows students to gain an understanding of different research methods and develop skills in identifying , appraising, aim synthesizing research findings" (Boland, 2017, p. 3) and I for one can attest to this transformative learning process. Beyond what should be the evident benefits of utilizing this process in order to effectively analyze and interpret large amounts of data, in my case this particular tool was by far the most appropriate. In keeping to my intention of answering questions on *epistemological interactions and possible epistemic*

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injustice in ITEK into (E)SD interactions, I needed a method that could encompass a wide array of examples, be as clear and reproducible as possible, and contain within it safeguards which could keep me as centered and objective as a human and a researcher can hope to be.

An important mention to make at this point is in regard to the *systematic review process* and what constitutes a systematic review. According to Grant & Booth's *A Typology of Reviews (2009)*, all types of reviews are systematic reviews as long as they use *a systematic and transparent approach* to identify, appraise, and synthesize the available evidence on a specific research question. This means that regardless of the type of review (ie. scoping review, rapid review, critical review, etc.), as long as they follow a rigorous and transparent process that includes explicit search criteria, inclusion and exclusion criteria, and a structured and replicable method of data extraction and synthesis, they are to be considered systematic reviews (Petticrew, 2001; Zawacki, et al., 2016). From here onwards, the studies included in the final selection will occasionally be referred to as systematic reviews (SR's), and where necessary, by the particular sub-category they represent.

5.1 Outlining the umbrella review protocol

"The aim of an umbrella review is not to repeat the searches, assessment of study eligibility, assessment of risk of bias or meta-analyses from the included reviews, but rather to provide an overall picture of findings for particular questions or phenomenon. For example, compared with a systematic review or meta-analysis limited to one treatment comparison, an umbrella review can provide a broader picture of many treatments. This is more useful to inform guidelines and clinical practice when all of the management options need to be considered." (Aromataris, 2015, p. 133)

Simply described, an umbrella review (meta-review, overview of reviews, or review of reviews) is a higher-level synthesis which uses <u>systematic reviews as a unit</u> in search, inclusion, and data analysis processes (Pollock et al. 2020; Faulkner, 2022). Because it is essentially a utilization of the systematic review approach, an umbrella review follows the same methodological guidelines and best-practices recommended for systematic reviews. Below in **Table 3** is a clear and concise comparison between the two approaches:

Table 3
Comparison of Methods Between Systematic Reviews and Umbrella Reviews
[adapted from Pollock et al. (2020)].

	Systematic Reviews	Umbrella Reviews
Objective	To summarize evidence from *primary studies*	To summarize evidence from *systematic reviews*
Selection criteria	Describe clinical and methodological inclusion and exclusion criteria. The study design of interest is the *primary study*.	Describe methodological inclusion and exclusion criteria. The study design of interest is the *systematic review*.
Search	Comprehensive search for relevant *primary studies*.	Comprehensive search for relevant *systematic reviews*.
Inclusion	Include all *primary studies* that fulfil eligibility criteria.	Include all *systematic reviews* that fulfil eligibility criteria.
Assessment of methodological quality/risk of bias	Assess risk of bias of included *primary studies*.	Assess methodological quality/risk of bias of included *systematic reviews*, and primary studies contained within included systematic reviews.
Data collection	From included *primary studies*.	From included *systematic reviews*.
Analysis	Synthesize results across included *primary studies* for each important outcome using meta-analyses, network meta-analyses, and/or narrative summaries.	Summarize and/or re-analyse outcome data that are contained within included *systematic reviews*.

From. Faulkner, G., Fagan, M. J., & Lee, J. (2022). Umbrella reviews (systematic review of reviews). International Review of Sport and Exercise Psychology, 15(1), 73-90. https://doi.org/10.1080/1750984x.2021.1934888

5.2 Justifying the use of the umbrella review method

"as systematic reviews become more plentiful, there is the potential for greater use of such overarching reviews as a mechanism for aggregating findings from several reviews that address specific questions." (Grant, 2009, p. 103)

In the particular case of my thesis, this method proved relevant insofar as umbrella reviews being a "response, and potential solution, to the perennial dilemma reviewers face regarding 'lumping' versus 'splitting' " (Grant, 2009, p. 103), allowing for a more comprehensive analysis to be conducted by comparison to a systematic review design for example. More so, when answering questions about Indigenous and traditional ecological knowledge, one must account for the diversity of Indigenous and traditional populations around the globe and the particular geo-socio-political and cultural context they exist in, and in which sustainability initiatives are implemented (Santos, 2015). In other words, the amount of primary studies I would have had to locate and analyze in order to derive a satisfactorily encompassing answer to my research questions was beyond my abilities as a single researcher and for this reason, likely to be much more vulnerable to research bias. In addition, an epistemologically oriented inquiry — which critically compares and contrasts paradigms seeking to reveal inherent powder dynamics — is a clearly controversial topic that could be impacted by all manner of bias, therefore requiring a method which can mitigate some of these potential pitfalls (Cant, 2022). To this dilemma I found my solution in the design of the umbrella review and its ability to generate a comprehensive research fractal that I could logistically manage on my own and that could give the widest possible research and data reach within the limitations I was placed under[13].

5.3 Research questions, search strategy, inclusion and exclusion criteria

a. Re-introducing here my **research questions** to remind the reader that my core intention for this inquiry was to answer as a main operating question:

Main research question:

How do Euro-Western epistemologies influence the integration of Indigenous and Traditional Ecological Knowledge (ITEK) in Sustainable Development and Education for Sustainable Development (ESD)?

Specific research questions:

1. What are the epistemological barriers and challenges faced by ITEK in its integration and application process in ESD within the Euro-Western paradigms?

2. Is there a pre/dominance of Euro-Western paradigms in ESD, and if so, what implications does it have for the integration of ITEK?

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[13] Note. I will further address these limitations in a subsequent paragraph in the Discussion chapter, under "Strengths and limitations of an umbrella review"

3. What are the outcomes and potential benefits of incorporating pluralistic perspectives and knowledge, such as integrating ITEK in ESD?

In order to ensure that my focus was kept on answering these questions I crafted and followed a set of **success criteria** as outlined in **Table 4**:

Table 4
Research Success Criteria

Measuring Research Success
• Western epistemologies and Eurocentrism are identifiable as challenges to successful ITEK integration;
• if identified, the presence of this challenge is widespread enough to warrant notice;
• finding sufficient data to support categorizing EWE as predominant;
• if the Euro-Western epistemological framework is indeed widespread and presents as a challenge and/or impediment to other worldviews (particularly ITEK) being represented in ESD, then certain models and/or frameworks for its identification and mitigation could be found/ suggested and briefly discussed as future research directions.

b. As for the **search strategy** I utilized in order to locate appropriate resources, after beginning my exploration of various data bases with the intention of determining which ones are the most suitable for my topic, I finally settled on **Web of Science (Clarivate)** as the *only database to work with*. The reasons for this choice were motivated in part by limitations of time, scope of research (master's thesis), and of course the fact that I was primarily working alone throughout this process. I say primarily, because the sessions with my supervisor have acted somewhat as a course-correction mechanism and secondary quality-assessment assistance, insofar as being able to consult about the choice of method and the type of resources I selected. The other important reason for choosing of Web of Science as a data base was dictated by its high standards in choosing peer-reviewed publications and the range of scientific subjects available, as well as the useful tools the platform provides in analyzing results and citations. Most specifically, one of the intentions of focusing only on Web of Science results is that I was interested in finding relevant answer to the research questions in practical and scientifically conducted integrations of ITEK in (E)SD, rather than more theoretical or philosophical positions.

With the choice of data base made, I utilized the generic search string shown in *Figure 2* below:

Figure 2

Search Criteria in Web of Science (Clarivate)

As the reader can see, the choice was made to limit the publication date to the last 5 years, after a wider search with the same terms and less filters resulted in 21,800 articles. In response to this overwhelming number, I opted for a rather conservative and restrictive search strategy allowing me to address the limitations mentioned above. To this generic search query I then applied a large number of filters in/excluding results based on:

- **Document Type** (ie. include - Article of Review Article; exclude - Book Chapters, Proceeding Papers, etc.),
- **Citation Topics Meso** (ie. include - Climate Change Adaption, Environmental Justice; exclude - Medicine, Marine Biology, Political Science, etc.)
- **Web of Science Categories** (ie. include - Environmental Sciences, Environmental Studies; exclude - Biotechnology, History of Social Sciences, etc.)

c. Moving further, with the feedback of my thesis supervisors, I crafted the following **inclusion and exclusion criteria,** shown here in **Table 5**, to help me determine which studies to include or exclude in my review:

Table 5

Inclusion & Exclusion Criteria

INCLUSION CRITERIA	EXCLUSION CRITERIA
• Clear mention of Indigenous and traditional ecological knowledge (ITEK)- in the title or in the abstract.	• ITEK does not appear in the title or abstract or in text in a meaningful or clear way
• Clearly centered on integrating ITEK in (E)SD or EfS initiatives, programs, educational designs, etc.	• ITEK & SD and/or ESD are not central to the research questions
• Western epistemology/paradigms are discussed in relation to ITEK integrations.	• Western epistemology/paradigms are not mentioned in sufficiently to warrant discussion
• Is conducted as a research study (research question, methods, results, discussion, conclusion)	• Theoretical framework and interpretation of ITEK & ESD interactions are not clear
• Is conducted through the systematic review process (rapid review, scoping review, mixed methods review, mapping review, etc.)	• Not a research study or the research is not conducted according to the commonly accepted research study design & methods
	• The systematic review design is unclear or absent

This particular set of criteria represents my effort to effectively capture the key elements and themes that are central to my investigation of integrating Indigenous and traditional ecological knowledge (ITEK) in Education for Sustainable Development (ESD). They are designed to prioritize systematic reviews (as required by the umbrella review methodology) that explicitly mention ITEK and are centered on integrating ITEK in (E)SD or EfS, while also addressing issues of epistemological interactions between EWE and ITEK. In terms of the exclusion criteria, they effectively filter out studies that may not align with the central focus of my research. For example, excluding studies that do not mention Western epistemology/paradigms or lack a clear theoretical framework and interpretation of ITEK-ESD interactions ensures that the selected studies provide valuable insights into the integration of these different knowledge systems (Aikens et al., 2016).

While the search terms and the inclusion criteria are as well-defined and appropriate for my research as I could manage, it is important to acknowledge some of their limitations. For example, by focusing exclusively on studies that explicitly mention ITEK, I may have inadvertently excluded relevant studies that explore related concepts or frameworks without using the specific terminology. Similarly, the emphasis on Western epistemology/paradigms in relation to ITEK integration may have overlooked valuable insights from non-Western or non-Eurocentric perspectives, potentially reinforcing a binary understanding of knowledge systems. In addition, perhaps limiting the results to English only is another possibly bias inducing factor that possibly further perpetuates the very colonial and epistemic injustice dynamics I am trying to avoid. More so, it bares mentioning that any and all criteria are liable for biases simply by the fact that researchers have to sometimes make partly arbitrary choices to include or exclude resources (Petticrew & Roberts, 2008). With this in view, I have further endeavored to balance these weaknesses through the use of transparent, replicable, and thorough methodological and analysis tools. For example, the query link to the full search details is offered on the previous page, under *Figure 2*.

5.4 PRISMA protocol, data extraction, data analysis, and quality assessment

a. The use of the **PRISMA protocol** in this umbrella review is justified for several reasons. Firstly, PRISMA is widely recognized as the gold standard for conducting systematic reviews, ensuring that the review is constructed in a transparent, replicable, and comprehensive manner (Moher et al., 2009). In addition, PRISMA is particularly well-suited to umbrella reviews, as it provides a clear framework for selecting and analyzing relevant studies, synthesizing results, and assessing bias and limitations (Page et al., 2021). By using the PRISMA protocol, the review will ensure that the selection and analysis of studies is as rigorous, transparent, and replicable as possible, and that the resulting synthesis of evidence provides a comprehensive and reliable overview of the literature on the epistemological

interactions between Indigenous and traditional ecological knowledge and Euro-Western paradigms in education for sustainable development. Finally the protocol has been applied in numerous reviews of indigenous and traditional ecological knowledge, including in the context of sustainable development and education for sustainable development (Breidlid & Krøvel, 2020; Mbah et al., 2022; McKinley & Smith, 2019).

Figure 3 below shows the flow diagram of my search process which is additionally detailed under it.

Figure 3.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

Identification of studies via databases and registers	
Identification	Records identified from: Web of Science Core Collection (n = 1,986) - Science Citation Index Expanded (n = 391) - Social Sciences Citation Index (n = 429) - Emerging Sources Citation Index (n = 167) - Arts & Humanities Citation Index (n = 20)	Records removed *before screening*: - Duplicate records removed (n = 2) - Records marked as ineligible by automation tools (n = 1,191) - Records removed for other reasons (n = 0)
Screening	Records screened: Title & Abstract (n = 793)	Records excluded based on Title & Abstract screening (n = 291)
	Reports sought for retrieval (n = 502)	Reports not retrieved (n = 178)
	Reports assessed for eligibility (n = 324)	Reports excluded: - No ITEK mention (n = 10) - - ITEK & ESD or EfS not central to RQ's (n = 30) - Not a Research Study (n = 60) - Not a Systematic review (n = 47) - No library access (n =18)
Included	Studies screened for the review (n = 205) Systematic Reviews screened for final analysis (n = 40) - Studies excluded through quality assessment tools (n = 10) - Studies included in the **Final Analysis (n = 30)**	

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

After establishing my initial search filtration procedure (without the specific filter for review articles[14]) the search string in *Figure 2* yielded *1,986 results*, onto which the further automated filtration of Web of Science resulted in *793 articles* that I screened by 'Title and Abstract' to further eliminate irrelevant material. The 'Title and Abstract 'screening left me with *324 retrievable results* that I then passed through my inclusion and exclusion criteria, leaving me with *205 articles* that fit most of my criteria but were not yet filtered for their systematic review design. The last *pre-selection* (complete criteria in combination with the Review Article filter) was composed *of 40 systematic reviews*, with ***a final selection of 30 studies conducted through the systematic review process*** being chosen for inclusion in my analysis. As an initial introduction to the 30 SR's, *Figure 4* depicts their distribution along the Web of Science categories after the category filters were applied to the search.

Figure 4.
Bar Graph of Web of Science Categories for the 205 Background Studies
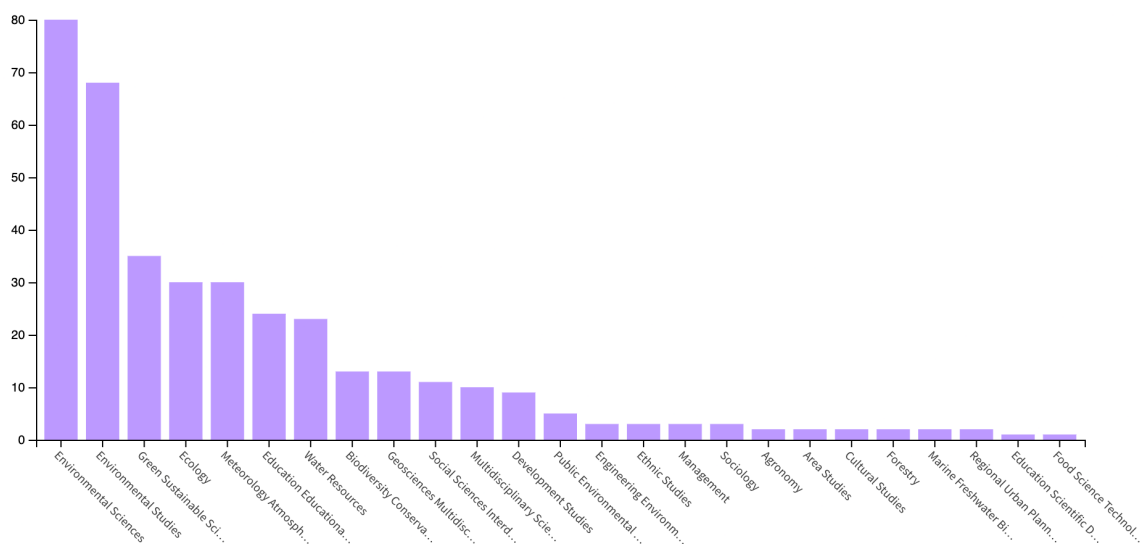
Note. These were categories of the pre-selection of 205 studies. From these once the systematic review filter and the inclusion and exclusion criteria were applied, the final selection of 30 SR's was derived. A comparison of category breadth can be made by referring to Figure 4. Web Of Science. 2023. Retrieved from https://www.webofscience.com/wos/woscc/analyze-results/886835e4-c67b-4800-a322-c92810c8c6db-8889bf00

b. As for the **data extraction** tool, in this study I used **Nvivo** to help me facilitate the analysis of the 30 included studies. Nvivo is a widely used software program for qualitative data analysis that allows researchers to analyze large datasets efficiently and systematically (Frayne & Lupton, 2016). As Braun and Clarke (2019) note, Nvivo is particularly useful for managing large amounts of data and identifying patterns and themes across different sources. This helped me identify patterns and themes across the different sources of data in

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[14] *Note.* An important mention to make here is that although Web of Science's filter for "Review Article" is effective in selecting systematic reviews which have originally been listed as such at the time of upload on the database, it can miss reviews that either have not been listed as such or do not contain the word 'review' in the title.

every study, which was particularly relevant for the umbrella review design given that across the 30 included studies there were a multitude of relevant themes and sub-themes. Although Nvivo's autocode feature was very helpful in automating the process of revealing patterns in the reviews, it extracted such a large number of codes (mostly not directly relevant to my research questions), that I finally settled for creating my own codes (which I supported when necessary with the results of the Autocode) based on the themes I identified from the literature and by reading each of the 30 studies. The use of Nvivo as a data extraction tool was therefore an important, but not singular part of the analysis process, the final analysis protocol being human generated.

Figure 5 below offers a visual comparison of the two coding styles, while **Table 7** shows the complete list of my codes:

Figure 5

Comparing Autocode Results in Nvivo to my Personal Codes

Note. The chart on top is the result of applying the Autocode function to the 30 SR's, while the chart at the bottom is my personal selection of relevant codes (themes).

Table 6

Complete List of My Codes in Nvivo

Name	Files	References
Study Design	31	366
Results(Discussion) & Conclusion	30	136
Methods	30	78
Research Questions	29	43
Amount of Studies Included	28	40
Inclusion & Exclusion Criteria	20	32
Theoretical Framework	11	22
Positionality	10	15
Epistemology	30	163
epistemic justice	29	81
transdisciplinary	8	16
western epistemology	8	14
transformative paradigm	4	9
ontology	6	7
axiology	2	2
ITEK & Western Science	29	112
ITEK in SD	29	107
ITEK in ESD	5	10
sustainable development	3	5
Indigenous Knowledge	27	73
indigenous views	5	6
LIK or LKS	5	6
Western science	26	64
eurocentric	7	9
Traditional ecological knowledge	20	51
local knowledge	9	11
Ecological Wisdom	1	5
Decolonization	13	31
colonization	17	47
power dynamics	5	11
globalization	3	5
Support for the case	6	8
LOCATIONS	3	3
Canada	9	10
World Wide	8	8
Asia	5	7
India	1	1
Africa	4	4
Global South	2	3
Americas	3	3
Arctic	2	3
Chile & Spain	1	2
Main English speaking countries	1	1
Australia	1	1
USA	1	1

Another useful data extraction mechanism was provided by the **VOS (Visualization of Similarities)** viewer which is a powerful and intuitive software tool used for creating and visualizing bibliometric networks. It is widely used to analyze scientific literature and identify patterns and relationships between publications, authors, and research topics. The software provides a range of visualization options, such as cluster maps, density maps, and overlay networks, that can help researchers identify key trends, emerging areas of research, and potential collaborations. Its use can help make sense of complex bibliometric data and provide valuable insights that can inform future research directions. In the case of this umbrella review, the use of VOS generated analysis helped improve the quality of my research by providing a clearer picture of the relationships between the different studies chosen (Neylon & Wu, 2009).

c. Lastly, when choosing a **quality assessment tool** through which to evaluate each of the 30 studies, I opted again for a dual design comprised of the MMAT tool and a classic Research Review Matrix comprised of Critical Sections and the Themes introduced above. One of the reasons for this "double checking" was to mitigate the potential research bias of being the single researcher who evaluated all the studies. *Figure 6* gives a visualization of the two methods, but the complete results for the 30 studies being evaluated through these tools can be found in the Appendix section at the end of the text. After placing each study in the Research Matrix, looking at study design, implications, connections to other research, critique and significance, and the relation to the 5 themes outlined previously, I applied an adapted MMAT tool in order to further confirm study quality[15].

Figure 6.
Quality Assessment Tool Examples

Note. Depicted here is a combination of a classic review matrix reprinted from ESD500 and the MMAT criteria from Hong et al. (2018). Mixed methods appraisal tool (MMAT), version 2018. Retrieved from http://mixedmethodsappraisaltoolpublic.pbworks.com/w/file/fetch/127914747/MMAT_2018_criteria-manual_2018-08-01_ENG.pdf

[15] Note. In the PRISMA flow chart it can be seen that 10 systematic reviews were excluded from the final selection by applying these tools.

The **Mixed Methods Appraisal Tool** (designed by Canadian researchers Hong et al. in 2018) is a tool used to assess the methodological quality of mixed-methods studies. proposing five assessment domains: (1) qualitative research, (2) quantitative research, (3) mixed-methods research, (4) other types of research, and (5) overall methodological quality. Each domain can then be evaluated based on a set of specific sub-criteria that are tailored to the type of research being evaluated and each criterion is rated as "yes," "no," or "cannot tell," and the total score is calculated by summing the number of "yes" responses. Using this rating protocol suggested, as shown in **Table 7**, I adapted the MMAT protocol by blending the list of criteria into 8 main questions to complement the findings from the Research Matrix[16]:

Table 7

Adapted MMAT Quality Assessment Criteria

Quality Assessment Criteria	Description
Was the research question or objective of the review clearly stated?	This criterion assesses whether the study has a clearly defined research question or objective that guides the search, selection, and synthesis of evidence. A clear research question or objective is important to ensure that the study is focused and provides relevant and meaningful results.
Was the search strategy comprehensive and appropriate for the research question?	This criterion assesses whether the study uses a comprehensive search strategy to identify all relevant evidence related to the research question or objective. A comprehensive search strategy is important to ensure that the study does not miss any relevant evidence and to reduce the risk of bias.
Were the inclusion and exclusion criteria for the studies used in the review clearly defined?	This criterion assesses whether the study has clearly defined inclusion and exclusion criteria that are applied consistently to identify relevant evidence. Clearly defined inclusion and exclusion criteria are important to ensure that the study only includes evidence that is relevant to the research question or objective.
Was the study selection process conducted systematically and without bias?	This criterion assesses whether the study selection process is systematic and unbiased. A systematic and unbiased study selection process is important to ensure that the study includes all relevant evidence and reduces the risk of bias.
Was the quality assessment of the included studies appropriate and clearly described?	This criterion assesses whether the study has used an appropriate quality assessment tool to evaluate the quality of included studies, and whether the quality assessment is described clearly. An appropriate and described quality assessment is important to ensure that the included studies are of sufficient quality to be included in the synthesis of evidence.
Were the characteristics and findings of the included studies appropriately synthesized and presented?	This criterion assesses whether the study has appropriately synthesized and presented the findings of the included studies, taking into account the quality and heterogeneity of the evidence. Appropriately synthesized and presented findings are important to ensure that the study provides accurate and meaningful results.
Was the overall quality of the evidence assessed using an appropriate method?	This criterion assesses whether the study has assessed the overall quality of the evidence and whether the conclusions drawn are appropriate given the quality of the evidence. Assessing the overall quality of evidence is important to ensure that the study provides reliable and accurate conclusions.
Were the limitations of the review clearly acknowledged and discussed?	This criterion assesses whether the study has acknowledged and discussed the limitations of the study, including potential sources of bias or uncertainty. Acknowledging and discussing limitations is important to ensure that the study is transparent and that the limitations of the study are taken into account when interpreting the results.

As for justifying the choice to use it, the MMAT tool has been widely recognized as a valuable approach for evaluating the methodological quality of studies in umbrella reviews and systematic reviews due to its ability to tackle diverse research methods. It has been applied in various fields such as health, social sciences, and education, and has been shown to provide a comprehensive evaluation of the quality of included studies. (Hong et al., 2018). In the case of an umbrella review looking to evaluate epistemological interactions across cultures, sustainability approaches, and the various research methods present in the 30 systematic review studies, the versatility and detail of this tool is particularly suited as an added evaluation and auto-corrective lens.

In summary:

The method chosen for conducting this umbrella review could be described as: a focused (one data base & many filters) yet wide search (generic search terms) ➢ onto which a

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[16] *Note.* Appendix 4 details the application of this process for each study

carefully designed inclusion and exclusion criteria were applied ➢ in order to result in a concise yet comprehensive list of systematic reviews ➢ which were manually and automatically coded ➢ and finally passed through two different quality appraisal tools. The results of this methodological approach are introduced in the next chapter.

6. Results

While operating at a far more subtle and sanitized manner in the contemporary era, epistemological tyranny still functions in the academy to undermine efforts to include other ways of knowing and knowledge production in the curriculum—it subverts multilogicality. ... The power struggle involves who is allowed to proclaim truth and to establish the procedures by which truth is to be established; it also involves who holds the power to determine what knowledge is of most worth and should be included in academic curricula. In this context, the notion of indigenous knowledge as a "subjugated knowledge" emerges to describe its marginalized relationship to Western epistemological and curricular power. ... Despite all the debates about what constitutes indigenous knowledge and separates it from scientific knowledge, one constant emerges: All indigenous knowledge is subjugated by Western science and its episteme (its rules for determining truth). (Kincheloe & Steinberg, 2008, p. 13)

One of the beautiful and frustrating experiences of conducting this search and sorting through the results was to uncover such a vast amount of interesting, meaningful, well crafted, forward thinking, and creative initiatives, studies, and theoretical treatments inspired by the topic of Indigenous & traditional ecological knowledge and (E)SD. More specifically, the epistemological interactions of these two worlds have generated a truly impressive body of research and accompanying literature replete with a veritable rainbow of wise and practical solutions to the challenges encountered in these integrations (Wilson, 2008). Although addressed in the recommendations section, I will also state here that the need for further analysis and research on this topic cannot be sufficiently overemphasized. It was not an easy choice to narrow the focus so drastically, yet the need to stay on task and produce a result which can be clearly transmitted, guided and supported this journey, allowing it to arrive at the moment of the weaving process where the colors and threads have been chosen and the pattern can now begin to emerge. The outcome of this "focusing procedure" can be found in the **30 studies conducted according to the systematic review process.** Although the complete bibliographic list of all 30 studies is available in <u>Appendix 2</u>, what follows below is the visual, schematic, and narrative description of the data which they yielded. That said, for ease of use and coherency, the results will be introduced in three parts:

1. **Data visualizations** - I begin by inserting a section of visual representations in order to reveal data patterns, some which were immediately visible, others which emerged after the process of manual coding started.
2. **Data analysis** - this sub-section introduces a systematic and structural presentation of the 30 SR's through further graphical and tabular synthesis accompanied where necessary by brief text clarifications.
3. **Narrative commentary** - here a brief description of the studies is offered relating

them to the Research Matrix findings and the MMAT criteria allowing the connections to be made to the data visualizations and analysis.

5.1 Data visualizations

The selection of visualizations below begins with *Figure 7* as a first set of images showing data connections in the wider selection of the 205 studies I chose the systematic reviews from, included in order to show a sample of the research background the SR's emerged from. Next, shown in *Figure 8* is a map of the main study locations the 30 SR's drew primary data from. This wider context is followed by visualizations of various data and coding patterns in the 30 SR's. *Figure 9* created in VOS viewer shows thematic and quotation connections, while *Figure 10* shows the Web of Science category distribution across the reviews. These are followed in *Figure 11, 12* and *13* by a set of Nvivo coding visualizations depicting main theme distribution as manually coded during the data analysis process.

Figure 7.
Overlay Visualization of Avg. Citations (left) and Word Frequency (right) for the 205 Background Studies
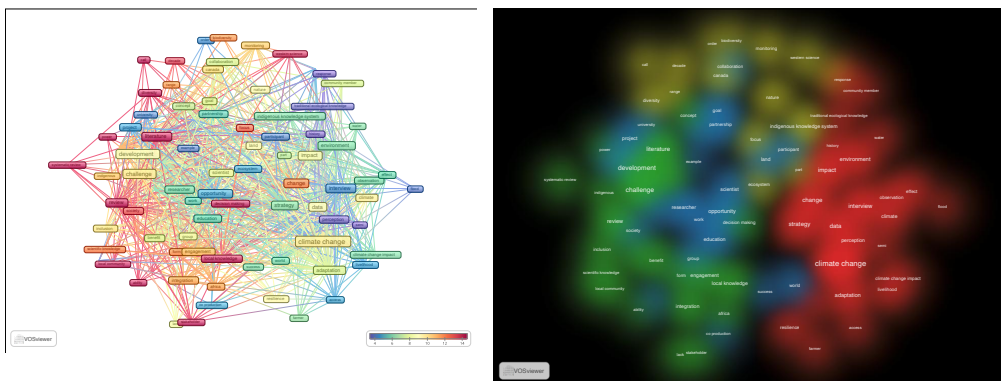
From. Visualization of the co-citation network of Indigenous and Traditional Ecological Knowledge and Education for Sustainable Development literature from Web of Science search, created with *VOSviewer 1.6.16* (Van Eck & Waltman, 2021).

Figure 8.
Map Locations from the 30 SR's
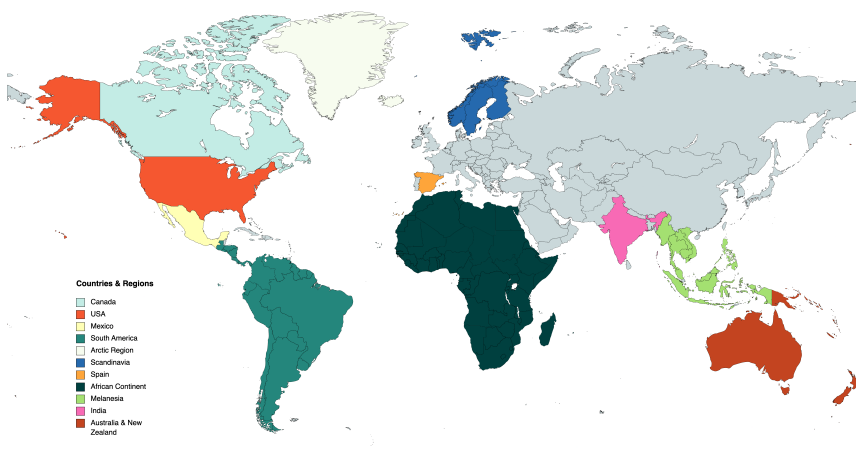
Note. Some of the studies were conducted with worldwide data, but these are outlined to show the main distribution. Created with www.mapchart.net. 2023.

Figure 9.
Visualizations of Conceptual Connections and Word Frequency in the 30 SR's
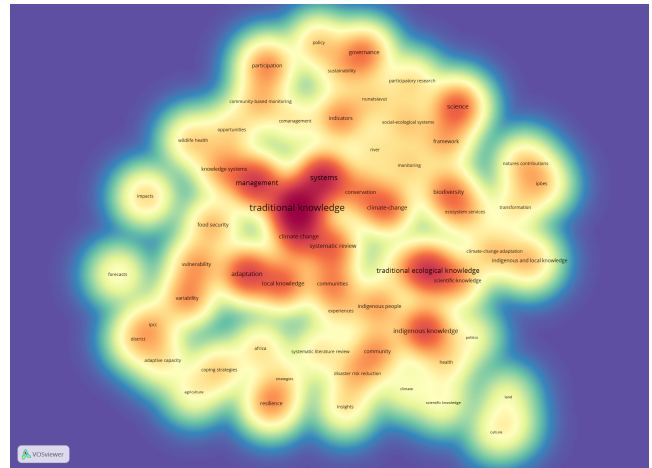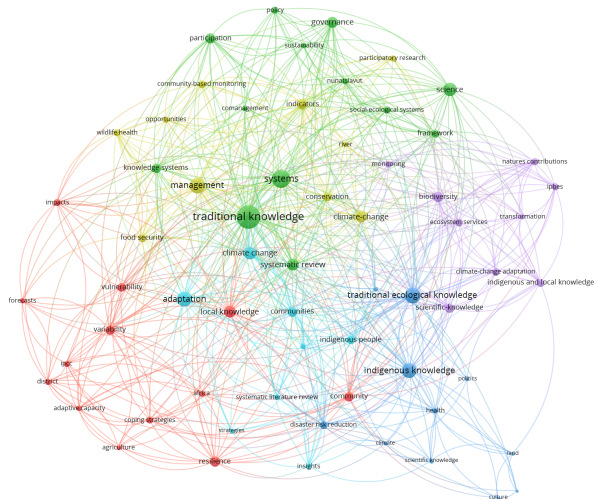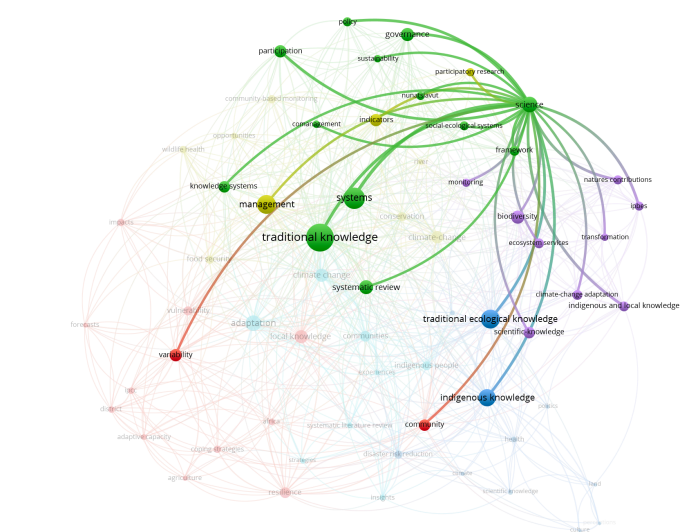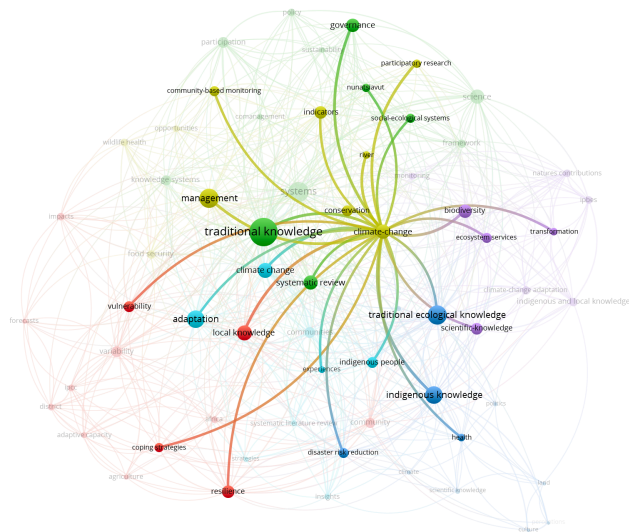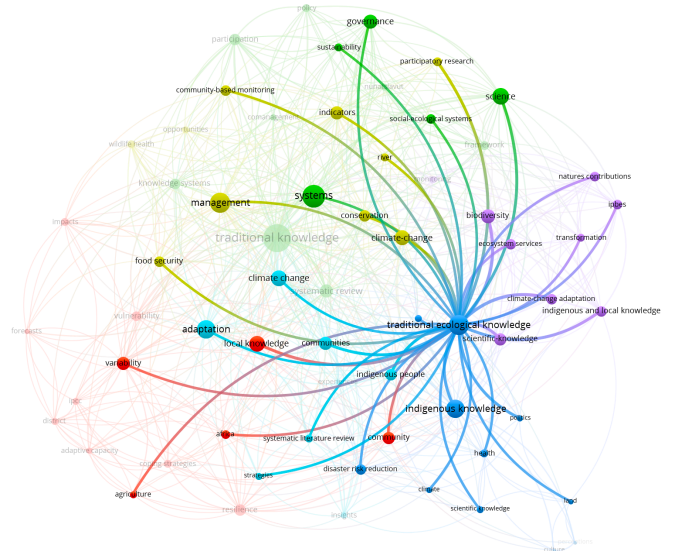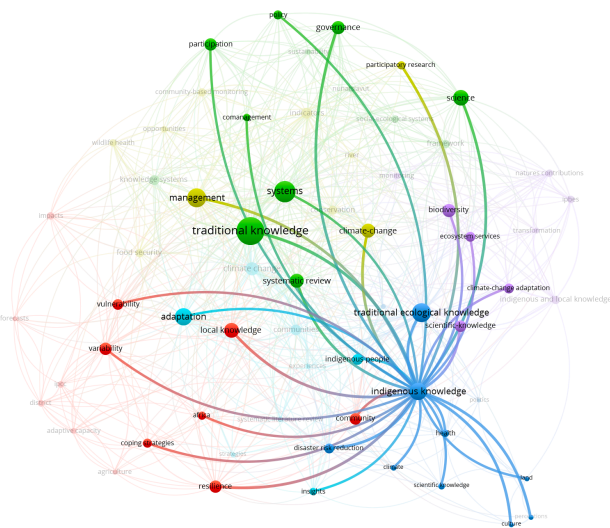
Note. Visualizations showing from top left: **1. All themes; 2. Heat map of connections; 3. IK; 4. TEK; 5. Climate change; 6.Science.**
Created with VOS Viewer. 2023

Figure 10.
Web of Science Categories Across the 30 SR's

Web of Science Categories

Percentage of distribution across the 30 Systematic Reviews

Regional Urban Planning (1.6%)
Public Environmental Occupational Health (1.6%)
Oceanography (1.6%)
Multidisciplinary Sciences (1.6%)
Engineering Environmental (1.6%)
Education Educational Research (1.6%)
Development Studies (1.6%)
Marine Freshwater Biology (3.2%)
Geosciences Multidisciplinary (3.2%)
Water Resources (4.8%)
Biodiversity Conservation (4.8%)
Meteorology Atmospheric Sciences (10%)
Ecology (10%)

Sociology (1.6%)
Environmental Sciences (22%)
Environmental Studies (19%)
Green Sustainable Science Technology (11%)

Chart: Alexandra Silvestru • Source: Web of Science • Created with Datawrapper

From. Web Of Science. 2023. Retrieved from https://www.webofscience.com/wos/woscc/analyze-results/886835e4-c67b-4800-a322-c92810c8c6db-8889bf00.

Figure 11.
Nvivo Coding Hierarchy for the 30 SR's
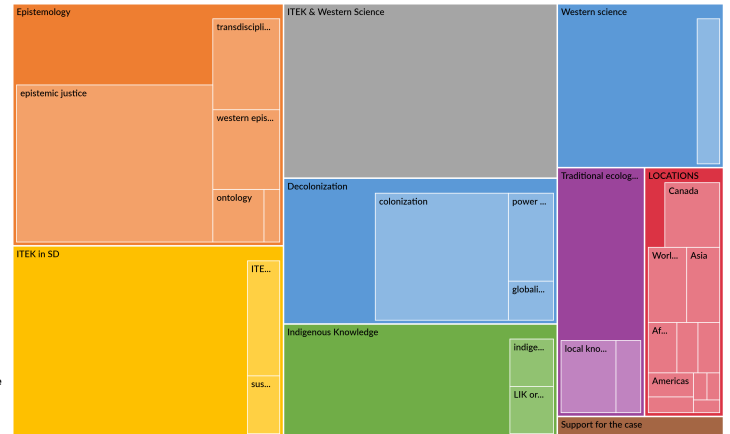
From. Nvivo software. 2023. Code selection without the Study Design coding tree, for a better visualization.

Figure 12.
Coding Matrix of the Main Themes across the 30 SR's
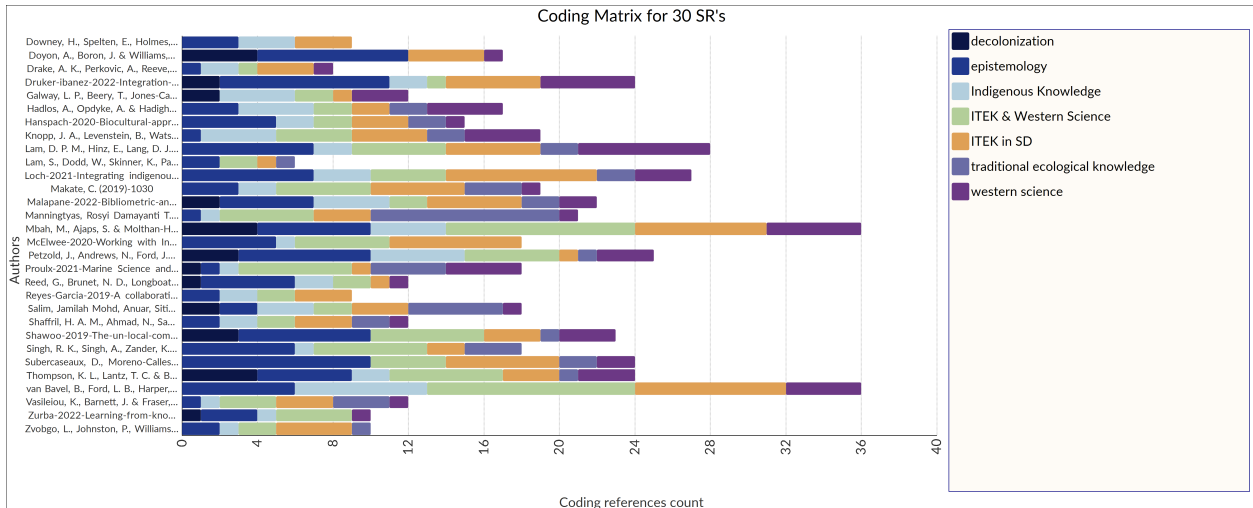
From. Nvivo software. 2023. Code selection without the Study Design coding tree, for a better visualization.

Figure 13.
Heat Map Coding Matrix - Main Themes of the 30 SR's
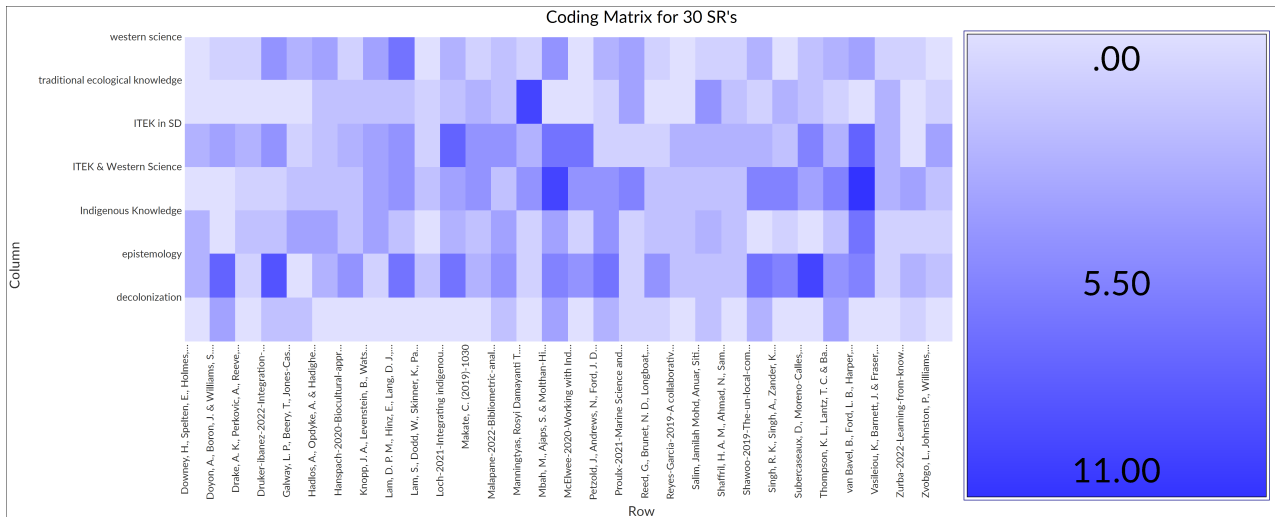
From. Nvivo software. 2023. Code selection without the Study Design coding tree, for a better visualization.

5.2 Data analysis

As shown in *Figure 12*, the 30 studies chosen for this analysis were cited according to Web of Science for a total of 562 Times (543 times without self-citations), at an average of 112.4 times per year and 18.73 citations per item. There were 4 studies with no citations (Drake et al., 2022; Downey et al., 2022; Salim et al., 2023; Vasileiou et al., 2022).

Figure 12

Citation Report for the 30 SR's (left) &
5 Year Citation Connection Visualization (right)
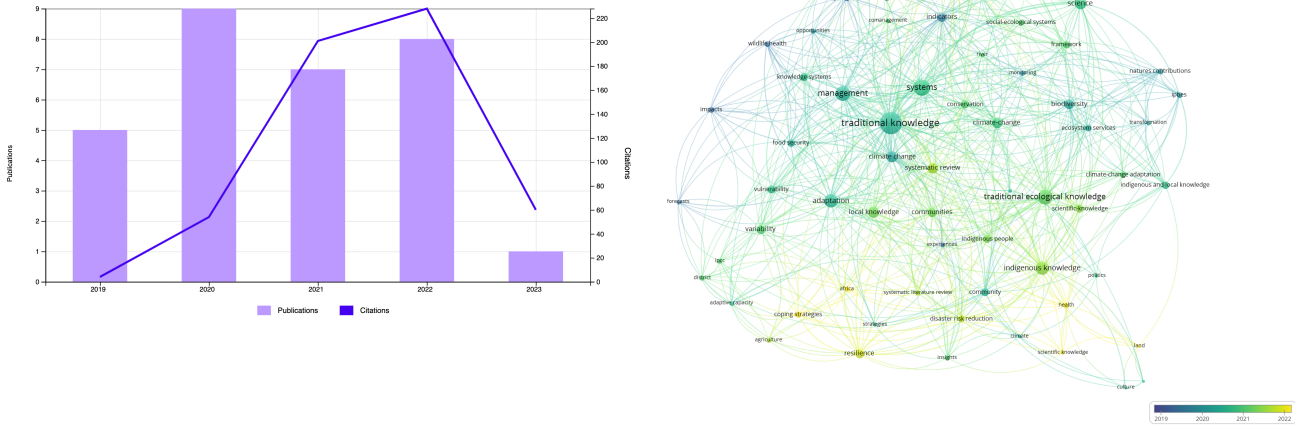
Note. On the right is the total citation report across the 30 SR's. From: Web of Science. 2023. https://www.webofscience.com/wos/woscc/citation-report/4941aa1d-dd45-46b8-acfa-5004df086e6b-89303612. On the left, a visualization of citation overlays between 2019-2023 was generated in VOS viewer. 2023.

Lastly, below in **Table 8** is a simple statistical analysis of the reviews, showing their type, the total amount of studies they drew upon, as well as the distribution of themes across the 30 reviews. Further quality assessment procedures, evaluating the way themes were used by each study as well as the MMAT criteria (study & methodological design quality) are introduced in Appendix 3 & Appendix 4 below and are not included due to space limitations.

Table 8

General Statistical Analysis

Total amount of Reviews	Reviews conducted through the systematic review process	30
Total Amount of Studies	Studies summed between all the 30 reviews	866
Types of Reviews	Systematic review	16 studies
	Scoping review	8 studies
	Rapid review	3 studies
	Meta-synthesis	2 studies
	Meta-analysis	1 study
Theme Distribution across the 30 reviews	Indigenous & Traditional Knowledge (ITEK):	92%
	ITEK & SD and/or ESD:	71%
	Western Epistemology / Eurocentrism:	52%
	Colonialism / Globalization / Decolonization:	87%
	Epistemological Justice:	68%

5.3 Narrative Commentary

For the complete bibliographic list of these studies and their quality analysis (including relevant quotes), again the reader is invited to peruse the **Appendices** section. For ease of use though, I start the narrative commentary by offering a very brief introductory description of each study in an alphabetized order of authors. This introduction is then followed by a portion relating the studies to the 5 themes and the multi-theory weave. This will conclude the results chapter, opening the way for the discussion which will place these findings in connection to the literature, while showing how and where they answer my research questions.

a. Introducing the 30 reviews

Some studies, such as the review by Downey et al. (2021), explore the meanings of water for river communities in Australia, while others, like Doyon et al. (2020), examine the representation of Indigenous peoples and knowledge in transitions research. Several studies, such as the scoping review by Drake et al. (2021), investigate community participation in coastal and marine research and monitoring in Inuit Nunangat, while others, like the systematic review by Druker-Ibanez and Caceres-Jensen (2020), explore the integration of ILK into sustainability education. Galway et al. (2021) conduct a scoping review to map the Solastalgia literature, while Hadlos et al. (2021) conduct a systematic review to identify the gaps and challenges in integrating local and Indigenous knowledge into disaster risk reduction efforts. Hanspach et al. (2021) conduct a systematic review of biocultural approaches to sustainability, while Knopp et al. (2021) conduct a systematic review of documented Indigenous Knowledge of freshwater biodiversity in the circumpolar Arctic. Lam et al. (2020) conduct a literature review on Indigenous and local knowledge in sustainability transformations research, while Lam et al. (2019) conduct a systematic review of community-based monitoring of Indigenous food security in a changing climate. Loch and Riechers (2021) conduct a literature review on the integration of ILK in management and research on coastal ecosystems in the Global South, while Makate (2019) explores the role of local institutions and Indigenous knowledge in the adoption and scaling of climate-smart agricultural innovations among sub-Saharan smallholder farmers. Malapane et al. (2022) conduct a bibliometric analysis and systematic review of Indigenous knowledge from a comparative African perspective, while Manningtyas and Furuya (2021) examine the differences between Traditional Ecological Knowledge and Ecological Wisdom in cultural landscape research.

Other studies, such as Mbah et al. (2021) and Petzold et al. (2021), focus on the deployment of Indigenous knowledge systems towards climate change adaptation and provide evidence maps of academic literature on the topic. In 2021 Proulx et al. review successful partnerships between Indigenous Traditional Ecological Knowledge and ocean

observing, while Reed et al. (2021) examine Indigenous guardians as an emerging approach to Indigenous environmental governance. Reyes-Garcia et al. (2021) describe a collaborative approach to bringing insights from local observations of climate change impacts into global climate change research, while Salim et al. (2021) conduct a systematic literature review on the impacts of Traditional Ecological Knowledge towards Indigenous peoples.

In their 2021 study, Shaffril et al. conduct a systematic literature review on adaptation towards climate change impacts among Indigenous people in the Asia Pacific regions. Meanwhile, in a 2021 evaluation, Shawoo and Thornton analyze the UN local communities and Indigenous peoples' platform using a Traditional Ecological Knowledge-based approach. Singh et al. (2020) systematically review successful processes of knowledge co-production for managing climate change and associated environmental stressors in India, with a focus on adaptation policies and practices to support farmers. Subercaseaux et al. (2018) explore emerging agro-rural complexities in Occident Mexico through a transdisciplinary sustainability science approach. Thompson et al. (2019) review the role of Indigenous knowledge and participation in environmental monitoring, while van Bavel et al. (2021) discuss the contributions of Indigenous and local inclusion in climate and health monitoring and surveillance systems at different scales. In their 2021 study, Vasileiou et al. conduct a systematic review of motivations, processes, and outcomes of integrating local and scientific knowledge in disaster risk reduction. Finally, Zurba et al. (2020) provide a review of global lessons learned from knowledge co-production research and practice, and discuss their implications for collaborative research in Nunatsiavut. Zvobgo et al. (2021) assess the role of Indigenous knowledge and local knowledge in water sector adaptation to climate change in Africa.

Before I begin inferring connections and patterns from these 30 SR's in order to then discuss these inferences, I would like to re-introduce here a mention of my **MMAT criteria** and **Research Review Matrix** data analysis methods. Through the use of these tools, the articles were analyzed and critiqued, as thoroughly as the tools and my own arbitrary view could allow. While it is beyond the scope of the following sections to discuss the strengths and weakness of *each article*, the classification conducted through the use of these two methods, in combination with manual coding has resulted in a clear statement of their degree of relevance to the research questions and this inquiry. In Appendix 3 for example, each review is rated in accordance to the MMAT criteria, while in Appendix 4, the thematic distribution and overall use of themes is rate on a scale of 1-5 for each article. This is to say that even though some detailed quality assessment mentions or critiques will not be made in text, the critical perspective has been extensively applied throughout the data analysis process. In other words, a quantitative quality score has been created through the use of the qualitative research tools, resulting in the mixed methods design which this type of study requires (Mertens, 2018).

As can be seen in the figures above, analyzing the 30 studies in relation to the literature and theories revealed several recurring themes and sub-themes grouped as: *Indigenous and Traditional Ecological Knowledge (ITEK), Education for / Sustainable Development ((E)SD), Western Epistemology (WE)*, the interconnected themes of *Colonialism/Globalization/Decolonization (CGD)*, and the *Epistemological Justice (EJ)* implications of these interactions. These 5 themes were introduced prior in the paper based as well on their presence and vital role in the literature and theoretical framing. They are now re-introduced to: facilitate the data analysis; to help understanding the potential for Indigenous methodologies to inform sustainable development (and its educational component); and because of their value as scaffolding for the epistemological investigation proposed.

1. In terms of **ITEK**, the studies by Downey et al. (2021), Doyon et al. (2017), Makate (2019), and Reyes-Garcia (2019) demonstrate the significance of utilizing Indigenous and traditional ecological knowledge and insights and incorporating them into environmental sustainability discourse. These studies stress the need to recognize the value of ITEK in sustainable land use practices and conservation efforts. Analogously, the studies by Hanspach (2020), Loch & Riechers (2022), and Salim et al. (2023) underline the necessity for recognizing the diverse worldviews and value systems around development and framing nature-society relationships within which biocultural approaches have been proposed as a potential basis for the improvement of sustainability indicators.

2. On the other hand, the studies by Lam and Dodd (2019) and Shaffril et al. (2020) discuss the challenges of incorporating ITEK into mainstream environmental policies and practices due to the perceived lack of scientific rigor and standardization. These studies directly and overtly challenge the hegemonic Western scientific knowledge production system that perpetuates this preconception. Further aspects of **ITEK integrations into SD and ESD**, are addressed by the studies of Galway et al. (2019) and Singh et al. (2021) focusing on the need to recognize the multi-faceted perspectives and experiences around SD and ESD, particularly among marginalized communities. Galway et al. (2019) show that incorporating culturally responsive pedagogies and recognizing the diverse needs and experiences of Indigenous students in higher education is crucially important at this time. Meanwhile, Singh et al. (2021) discuss the need to recognize the limitations of the SDG framework in addressing the diverse needs and experiences of different communities.

3. On the topic of **Western epistemology (WE)**, 4 studies particularly stand out. Authored by Druker-Ibanez & Caceres-Jensen (2022), Loch & Riechers (2022), Malapane et al. (2022), Shawoo (2019), these reviews critically engage with the dominant Western scientific paradigm and its historical impact on Indigenous knowledge systems.

Perhaps the most relevant example of this epistemological deconstruction comes from Druker-Ibanez & Caceres-Jensen's (2022) study looking into the intersection of Indigenous and Local Knowledge (ILK) and sustainability education, with a particular focus on the principles of environmental and epistemological justice. The study explores the potential of ILK to enhance and support education for Sustainable Development (ESD), addressing the power dynamics that perpetuate the dominance of Western scientific knowledge while excluding, marginalizing, or rejecting other knowledge systems and epistemologies. The review critically examines the prevailing epistemological and political dynamics that uphold the supremacy of Western scientific knowledge and contribute to the exclusion of alternative knowledge systems. It highlights the concept of epistemic violence, epitomized by the abysmal thinking or cognitive injustice inflicted upon non-Western knowledge systems. authors emphasizes the urgent need for democratization and the recognition of diverse knowledge systems in sustainability education.

In Loch & Riechers's (2022) study, the dominance of Western scientific logic in the integration of Indigenous and local knowledge (ILK) into management and research is underscored. The study emphasizes the importance of overcoming this dichotomy within Western science to create more inclusive approaches that value ILK. It addresses the ways in which colonialism and historical marginalization have limited the inclusion of ILK in research and management. Complementarily, Malapane et al.'s (2022) work addresses the suppression of indigenous cultural belief systems, practices, and taboos by Western scientific knowledge. These authors explore the role of colonialism in eroding knowledge systems in Third World countries and advocates for the recognition and inclusion of IK in research and policy development. The review additionally calls for the decolonization of knowledge and the development of frameworks that embrace the potential of IK in addressing ecological and socio-economic crises. In like manner, Shawoo's (2019) review critically examines the integration of Traditional Ecological Knowledge (TEK) and Western scientific knowledge. It highlights the pitfalls of an incorporationist perspective that assimilates TEK into Western frameworks, potentially eroding its holistic nature and cultural characteristics. The study advocates for a partnership approach that respects Indigenous ways of knowing and facilitates meaningful collaboration between diverse knowledge systems.

Further on this topic, the studies by Drake et al. (2018) and Lam and Hinz (2020) discuss the limitations of the Western scientific knowledge (reffed here as WE) production system in addressing complex socio-environmental issues. Drake et al. (2018) accentuate the need to recognize the diversity of knowledge systems and call for interdisciplinary and transdisciplinary approaches in addressing socio-environmental issues which can include Indigenous worldviews. Meanwhile, Lam and Hinz (2020) talk about the significance of recognizing the limitations of WE and its dominant tendencies and the necessity to

incorporate diverse voices, including ITEK and feminist knowledge, to achieve more plurality encompassing and just environmental governance.

Together, these studies alone provide a robust narrative on the challenges posed by Western epistemology, colonialism, and Eurocentrism in the recognition and inclusion of ITEK. They underscore the importance of decolonizing research practices, empowering Indigenous communities, and fostering epistemological justice to generate evermore inclusive and plurality accommodating knowledge systems.

4. The theme of **CGD** is central to many of the studies, particularly those by Lam & Dodd (2019), Loch & Riechers (2022), Malapane et al. (2022), Mbah et al.(2021), Petzold et al. (2020), Proulx et al. (2021), Reed et al. (2021), Thompson et al. (2020), and Zurba et al. (2022). These studies speak to the ongoing impacts of colonialism and globalization on Indigenous peoples and their cultures, and the urgent need to decolonize research and policy-making processes.

Lam & Dodd (2019) highlight the challenges encountered in integrating ITEK into community-based monitoring systems. They emphasize the historical background of unethical research conducted on Indigenous communities and the need to recognize Indigenous peoples' contributions and knowledge in the context of research, including climate change research. Their work critically engages with the CGD theme and explores pathways for more respectful and non-discriminatory ITEK integration. Another instance of CGD treatment can be found in Loch & Riechers' (2022) who acknowledge the historical marginalization of ILK and its severe impacts on ILK itself, as well as Indigenous peoples, and local communities. They emphasize the need for ILK-inclusive research as a means of addressing the legacies of colonialism and globalization. Their work strongly underscores the role of ILK in preserving culture and tradition and its potential to contribute to conservation efforts, as long as decolonial practices and epistemological justice are applied. Petzold et al. (2020) conduct a systematic review on the geographic and thematic distribution of evidence on Indigenous Knowledge (IK) in climate change adaptation. They critique the extractive model often used in climate studies that fail to engage with Indigenous knowledge systems. The authors emphasize the ethical sensitivities and power imbalances in collecting and using IK data and advocate for decolonizing research approaches. Petzold et al. also stress the importance of Indigenous involvement in the research process, knowledge-sharing, and the recognition of IK's contributions to sustainable development. Similarly, Malapane et al.'s (2022) study identifies the need to develop models that direct data collection and enhance the understanding of how IK benefits ecosystems and human well-being, while shedding light on the significance of IK and its recognition in the face of colonialism and globalization, emphasizing the decolonization of research practices.

Conversely, some authors (Reyes-Garcia et al., 2019; Shaffril et al., 2020; Singh et al., 2021; Subercaseaux et al., 2021) do not explicitly mention CGD. For example, Hanspach et al. (2020) discuss the relevance of biocultural diversity and acknowledges the diverse ontological, epistemological, and ethico-political dimensions of biocultural approaches. However, the study does not explicitly mention decolonization or Indigenous research methodologies. Likewise, Knopp et al. (2022) examine Indigenous knowledge of freshwater biodiversity in the Arctic, showing the necessity of rigorous qualitative interviews with knowledge holders and diverse methods of engaging with Indigenous knowledge, yet they do not explicitly make any decolonization related mentions. In another instance of minimal treatment of this theme, Lam & Hinz (2020) discuss the significance of involving Indigenous peoples and local communities in developing and implementing more effective environmental governance systems for ecosystems and biodiversity. They also acknowledge that current research approaches that apply Indigenous and local knowledge are often driven by Western research methods and political agendas, which is questionable because all knowledge is value-driven and linked to socially situated actors. However, the study does not explicitly mention decolonization or Indigenous research methodologies.

5. The theme of **epistemological justice (EJ)** is crucial in understanding the conceptual challenges of centering and integrating Indigenous and Traditional Knowledge in Sustainable Development and/or Education for Sustainable Development. Interestingly, while some reviews for example do not tackle CGD directly, ***all of them show that epistemological justice plays a critical role*** in creating just and comprehensive approaches to SD and ESD that recognize the value of ITEK systems and the diverse experiences of non-EuroWestern stakeholders. In other words, along with the general ITEK/(E)SD theme (which was a basic inclusion criteria), *issues of epistemic injustice are mentioned, even if weakly, by every single review in the list*.

For example, as was mentioned above, Druker-Ibanez & Caceres-Jensen (2019) and Proulx et al. (2021) call for dominant societies and institutions to recognize and address the power imbalances in research and policy-making processes, particularly in relation to the unequal distribution of environmental risks and benefits across communities. Thompson et al. (2020) and van Bavel et al. (2020) extends this theme by clarifying the need to employ an epistemologically balanced "two-eyed" approach when working with Indigenous systems.The authors above warn against replacing Indigenous views with the dominant Western approaches in SD integrations. These and similar studies not only recognize the interconnectedness of human and environmental well-being — emphasizing the spiritual and cultural dimensions of environmental sustainability — but as a cause of this recognition, they reinforce the demand to equitably incorporate diverse knowledge systems into environmental governance.

As in the instance in which EJ is strongly present, Lam & Hinz (2020) conduct a systematic literature review which begins by highlighting the diversity of conceptual approaches to transformations within the Western scientific knowledge system, including social-ecological transformations, sustainability transitions, transformative adaptation, and sustainability pathways. The authors primarily adopt an epistemological and epistemic justice lens, discussing the dominance of Western scientific knowledge and its influence on sustainability transformation discourse. This review raises important critical questions about the application of ILK in current research, which is often driven by Western research methods and political agendas. Emphasizing the need for transparency, Lam & Hinz call for a fair and encompassing approach to integrating ILK, recognizing that all knowledge is value-driven and linked to socially situated actors.

Summary of thematic results:

As shown above (and more critically in [Appendix 4](#)), *the 30 studies reviewed in this analysis clearly intersect and align with the 5 recurring themes which are addressed in a multitude of unique and interconnected ways by the authors*. While some focus on the meaningfulness of centering Indigenous knowledge and ways of knowing in sustainability initiatives, others emphasize the need to recognize and address power imbalances in research and policy-making processes. Additionally, several studies call specifically for the systematic and effective incorporation of diverse ITEK systems in environmental governance and sustainable development efforts as a response to various global challenges.

c. Placing the reviews in the theoretical weave

Moving onward, on a **theoretical level**, the analysis shows how these SR's cumulatively support the proposition that a *transformative paradigm*, informed by *postcolonial, decolonial, and Indigenous research methodologies*, and supported by a *transdisciplinary approach* is necessary to fully recognize and incorporate the value and significance of diverse knowledge systems and achieve more plurality embracing global knowledge production. Reconnecting to the weaving metaphor used for understanding how these themes intersect and inform one another: as the theoretical apparatus represents the warp ‖ , weft ≡, and frame ⊞ of this review; the studies themselves can be viewed as the threads and colors; while the data connections within them are part of the pattern of the weave ▦. In the particular case of this umbrella review, the transformative paradigm supports egalitarian and just social change and recognizes the need for alternative ways of knowing and learning. Postcolonial, decolonial, and Indigenous research methodologies in turn counterbalance the status quo by asking to center the voices and experiences of marginalized communities and challenging the hegemonic tendencies of Western scientific knowledge production systems. Finally, the transdisciplinary approach encourages and attempts to facilitate collaboration and

integration across the various disciplines and knowledge systems involved in ITEK/(E)SD integrations.

1. One of the main theoretical connections which could be derived from the list of studies is their link with the **transformative paradigm**, confirming its role as the warp which provides the tension threads holding together the weave. For instance, Druker-Ibanez & Caceres-Jensen (2021) explore the integration of indigenous and local knowledge into sustainability education, which can transform traditional knowledge into new forms that are more relevant and useful in the context of contemporary sustainability challenges. Analogously, the study by Hanspach et al. (2021) on biocultural approaches to sustainability showcases the transformative potential of such approaches in enhancing human well-being and environmental conservation. Other studies in the list also demonstrate various aspects of ITEK's transformative potential in specific socio-cultural and geographical contexts. In a direct example of this approach, Lam et al. (2020) review the literature on Indigenous and local knowledge in sustainability transformations research. They underscore the potential for such knowledge to inform more non-discriminatory and encompassing sustainability transformations, while also acknowledging the epistemological and ontological challenges associated with integrating these diverse forms of knowledge. Admittedly less directly, Makate (2021) discusses how local institutions and indigenous knowledge can be harnessed to scale up climate-smart agricultural innovations among smallholder farmers in sub-Saharan Africa. The study by Vasileiou et al. (2021) on disaster risk reduction similarly puts focus on the value of integrating local and scientific knowledge to transform traditional practices into more effective disaster risk reduction strategies.

Overall, these reviews directly suggest that the transformative paradigm can indeed provide a useful framework for exploring how Indigenous and traditional ecological knowledge can be equally integrated in current paradigms in order to transform contemporary methods of dealing with environmental challenges. The transformations oriented authors (and the studies they reviewed) propose that by integrating Indigenous and local knowledge into research, education, and policy, it is indeed possible to create new knowledge and practices that are more effective, just, and sustainable.

2. Employing a different approach and advocating for the immediate undertaking of plurality, reflexivity, and deconstruction of inherent beliefs, quite a few studies from the list directly explore topics which align with **postcolonial, decolonial, and indigenous research methodologies** and theories. These studies overtly aim to challenge dominant colonial histories and the Western epistemologies which they enforced on occupied populations. Some authors in particular (as shown above) promote the use of alternative research methodologies that are more inclusive and respectful of different knowledge systems as ways to address epistemic injustice caused by Euro-Western paradigms.

For example, Doyon et al. (2021) use a decolonial approach to explore how Indigenous peoples and knowledge can be represented in transitions research. As one of the strongest examples from the whole list, they argue that decolonization protocols can help to address power imbalances and promote more inclusive research practices. Another equally powerful connection with decolonization theory and practices is brought by Petzold et al. (2022) who question specifically how IK is treated in climate change literature, concluding that the way academic publications and practices treat the inclusion of ITEK needs to be urgently decolonized in response to the severe power discrepancies made evident by the lack of appropriate representation.In addition, Mbah et al. (2021) use a postcolonial lens to explore how the deployment of IK systems can challenge dominant Western epistemologies and promote more balanced and diverse climate change education. The authors evaluate how the agency of Indigenous peoples fares in the face of marginalization through colonial encounters and epistemic violence. They emphasize the necessity of integrating IKS into climate change education to empower Indigenous communities and enhance adaptive strategies and call for a holistic, participatory, and critical approach to ESD that challenges colonial legacies and fosters epistemological justice.

Likewise, Reed et al. (2021) explore the use of Indigenous guardians as an emerging approach to Indigenous environmental governance. They employ a postcolonial lens as well in order to examine how this approach can challenge dominant Western models of environmental governance and bring about more culturally sensitive and respectful ESD designs that center Indigenous knowledge stakeholders and their needs. Lastly, Vasileiou et al. (2020) examine through the postcolonial lens how local and scientific knowledge can be integrated in disaster risk reduction. The authors explore how this integration can challenge dominant Western approaches to disaster risk reduction and promote more inclusive and respectful practices that are grounded in local and traditional knowledge sources.

Akin to the CGD themes above, while there are some studies which cannot be directly connected with these three theories it is important to note that even if a study does not explicitly mention decolonization or Indigenous research methodologies, it may still incorporate principles of these approaches. For example, the acknowledgement of diverse knowledge systems and the need of involving Indigenous peoples and local communities in research can be seen as a form of decolonization and incorporation of Indigenous research methodologies. That said, there were a couple of the studies which outright avoided to discuss their findings from this perspective even though the topic they chose was arguably incomplete without this treatment. For instance, while the study by Knopp (2022) focuses on the integration of Indigenous traditional ecological knowledge (ITEK) with Western scientific knowledge (WS) for the assessment of Arctic freshwater biodiversity, it does not explicitly mention decolonial perspectives or power dynamics related to colonization. Moreover, the study mentions discrepancies between ITEK and WS, but it does not explore these

discrepancies in-depth or questions the dominance of WE in the assessment of freshwater biodiversity.

3. The use of **transdisciplinary approaches** is another key theoretical orientation that emerged from data analysis as most of the SR's explored how different disciplines can work together to create new knowledge and practices that are more effective in addressing complex environmental challenges. One such proposal came from Drake et al. (2022) who conducted a scoping review of community participation, in coastal and marine research and monitoring in Inuit Nunangat, using a transdisciplinary approach to identify ways of involving local communities in research and monitoring activities. Correspondingly, Lam et al. (2020) explored the integration of Indigenous and local knowledge in sustainability transformations research using a transdisciplinary approach, underscoring the value of collaborative and participatory approaches to research.

Shaffril et al. (2020) demonstrate a strong alignment with the transdisciplinary approach by adopting a transformative and inclusive research methodology. While not a traditional review, their study exemplifies transdisciplinarity by incorporating various sources such as gray literature, documentaries, scholarly articles, book chapters, videos, and conversations. Examining the incorporation of TEK into data systems, and considering both quantitative Western ecological science and qualitative TEK, the authors acknowledge the distinct ways of understanding the world and the value of integrating diverse knowledge systems for a more holistic approach to scientific research. This concept, often referred to as "Two-Eyed Seeing," recognizes the value of combining different knowledge systems to gain a deeper understanding of complex issues. Shaffril et al. acknowledge the misuse, decontextualization, and theft of Indigenous knowledge and property by researchers, emphasizing the need for a more respectful and equitable approach. This aligns with the transdisciplinary approach's commitment to recognizing and addressing power dynamics, colonial legacies, and the need for decolonization in knowledge production.

In another powerful display of this theory, Subercaseaux et al. (2021) demonstrate the importance of transdisciplinarity as an epistemic goal for addressing real-world problems, emphasizing the need to go beyond the exclusive domain of scientific experience. As the authors show, the complexity of societal issues necessitates collaborations between scientific disciplines and actors outside academia. By engaging with different sectors and actors, including local community authorities, peasants, academic researchers, and local consultants, the study seeks to complement various knowledge and information sources related to the research topic and problem. While the study demonstrates a strong transdisciplinary connection and discusses epistemology, it surprisingly does not explicitly engage with colonial or decolonial critical analysis.

Another of these variations, Loch and Riechers (2021) explore the integration of Indigenous and local knowledge in management and research on coastal ecosystems in the Global South using a transdisciplinary design. They argue that this approach can lead to more effective and culturally appropriate management strategies that better reflect the needs and values of local communities. Other examples include Makate (2019), Subercaseaux et al., or Vasileiou et al. (2021). In all these cases, the use of transdisciplinary approaches was crucial in bridging different knowledge systems and creating more holistic and effective solutions to complex environmental challenges.

Summary of theoretical results:

Ultimately, in regard to this theoretical weave, but also going beyond it, *the 30 SR's reveal and underline the significance of using alternative research methodologies and approaches that are more inclusive and respectful of different knowledge systems.* They also endeavor to demonstrate the potential of Indigenous and traditional ecological knowledge to inform and transform a wide range of contemporary environmental management practices and education across a worldwide setting. Most importantly though, the majority of the authors in these reviews, as well as the studies they drew upon, call for a transformation in the way other knowledge systems are introduced within Euro-Western scientific paradigms and epistemologies. Whether direct or indirect, the demand to improve or even replace knowledge co-production methods through decolonial, Indigenous and postcolonial methodologies is made clear (or at least referenced) by all authors.

d. Summarizing the results chapter

As the whole Results chapter shows, even though derived from only one database, through rather restrictive filters and criteria, the remaining 30 studies which were conducted according to the systematic review process, unveil a wealth of pertinent information for the inquiry. Aspects such as: their worldwide geographical distribution, diversity of topics and approaches (even within similar Web of Science categories), their interconnected thematics and theoretical orientations, the compatible and quite similar conclusions, and ultimately their unanimous treatment of epistemological justice issues, all form a considerable amount of data points onto which the discussion below can now safely be built.

That said, it is again important to acknowledge the varied degrees of treatment of these topics in each of the reviews, degrees which on one hand are motivated by the heterogeneous focus across all the articles, but also as an interesting data point itself in understating the importance of an epistemological justice lens being applied to any ITEK integrations into (E)SD.

7. Discussion

Indigenous and Western knowledge are not per definition opposing categories. Much rather, the respective underlying epistemological assumptions may lead both to knowing the same thing in a different manner as well as to conflicting conclusions of what constitutes valid knowledge and how such knowledge is generated…. As elaborated, holism is central in indigenous epistemologies, while this holism was undermined in Europe during the advent of modernity and the rise of modern science. Due to their place-based nature, indigenous ways of knowing have local relevance and do not claim universality, while universality claims—though not unchallenged—still stand strong within Western knowledge traditions. (Mbah, 2022, p. 52)

I would like to begin by stating clearly what this review is and what it is not. This offering is not a "demonization" and annulment of Euro-Western epistemologies and scientific paradigms. Neither is it a romanticizing of Indigenous and traditional knowledge or an attempt to tout it as an absolute panacea to the ills of this world. Mine is not a "this or that" proposition, but rather a search for genuine connection. Although conducting such an analysis, particularly with the personal motivations I laid in the introduction can understandably be seen as an epistemological "witch hunt" (as the professor in my story saw it), I am not intersted in such polarization. What motivates me intrinsically, emotionally, intellectually, and spiritually is the principle of **relationality**. This ancient future wisdom contained in the understanding of the interconnectedness of all living beings (and matter) carries within it the guiding mechanism followed by many if not all peoples who have lived before us. That is to say, at one distant (or not so distant) moment I believe all of our ancestors knew, studied, and applied the principle of All Things Are Related. I posit here that the observation, learning and application of this principle is indeed the essence of science itself. Thankfully, viewing science through this facet of reality's prism, can allow us to still approach the highly advanced technology that is our Earth with the same reverence, curiosity and open-mindedness many of our ancestors had. From that stance then, who could claim that they hold the supreme and irrefutable form of scientific methodology?

7.1 Setting the Background

There is a need for Western scholars to write back to the epistemological center where we are located, distance ourselves from the superiority claims of the West and the Orientalizing discourse towards Indigenous Peoples and indigenous knowledge systems and thereby strengthening the ties with the indigenous people's fight for alternative and indigenized ways of sustainability. (Breidlid & Krøvel, 2019, p.1)

Although an in-depth analysis of conceptual differences and/or similarities between ITEK and WE belongs in the realm of philosophies of science and is therefore beyond the scope of my review[17], this is nevertheless a discussion about epistemology which inevitably demands some level of relevant background and framing. To that extent, a brief outline of these epistemological traditions follows in an attempt to facilitate discussing their interactions. Respecting the reflexivity and decolonial practices mentioned earlier, when presenting Indigenous views on ITEK topics, I will introduce quotes from Indigenous scholars instead of paraphrasing them:

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[17] *Note.* For a multi-faceted and thorough comparison of the two, I point the reader to the selection of 10 books I proposed earlier.

- "Indigenous knowledge is not just a collection of information or data. It is a way of life that involves living in harmony with nature and recognizing that all things are connected." (Leroy Little Bear, as cited in Battiste, 2000, p. 292)

- Indigenous knowledge tradition emphasises … an epistemology of coordination. Different from crisis, coordination refers to ways of knowing the world that emphasise the importance of moral bonds – or kinship relationships – for generating the (responsible) capacity to respond to constant change in the world. Epistemologies of coordination are conducive to responding to mundane and expected change without validating harm or violence. (Whyte, in Hokowihtu et al., 2022, p. 53)

- "Indigenous epistemologies are grounded in the lived experiences of Indigenous peoples and their relationships with the natural world, ancestors, and community. These epistemologies are often oral and embodied, passed down through generations via storytelling, ceremony, and other cultural practices." (McKinley & Smith, 2019, p. 4)

- …an Indigenous epistemology has systems of knowledge built upon relationships between things, rather than on the things themselves. Indigenous epistemology is more than merely a way of knowing (Meyer, 2001)….these relationships are with the cosmos around us, as well as with concepts. They thus include interpersonal, intrapersonal, environmental and spiritual relationships, and relationships with ideas. Indigenous epistemology is our cultures, our worldviews, our times, our languages, our histories, our spiritualities and our places in the cosmos. Indigenous epistemology is our systems of knowledge in their context, or in relationship. (Wilson, 2008, p. 74)

- Indigenous academic researchers in the area of traditional knowledge have to work at a philosophical or epistemological (theory of knowledge) level to muster their arguments, as well as at very practical levels such as the provision of support for Indigenous students or the design of a course. In the academic environment they are assessed by their peers through such criteria as publication in international refereed journals of high standing. (Smith, 2012, p. 276)

- "I define science as pursuit of knowledge. The Native American mind is in constant search for meaning and reality in the constant flux, not only of the Earth, but also of the cosmos….for the Native American, even regularities are subject to change. Native Americans never claim regularities as laws, or as finalities. The only constant is change." (Cajete, 2000, p. 29)

As for the other side of this comparison, choosing as a focus of discussion the historical evolution of *the last 3 centuries* of Western/Eurocentric epistemologies, several key currents can be said to have shaped the way knowledge is constructed and understood. Before introducing these, it is essential to mention that such a quick overview does not in any way seek to create a monolithic, homogenized, and oversimplified view of epistemologies that inarguably transcend these limited confines. To this Linda Tuhiwai Smith reminds that:

Western knowledges, philosophies and definitions of human nature form what Foucault has referred to as a cultural archive and what some people might refer to as a 'storehouse' of histories, artefacts, ideas, texts and/or images, which are classified, preserved, arranged and

represented back to the West. This storehouse contains the fragments, the regions and levels of knowledge traditions, and the 'systems' which allow different and differentiated forms of knowledge to be retrieved, enunciated and represented in new contexts. (2012, p. 51)

To that extent, I begin this short overview in the 17th century, when René Descartes introduced *Cartesian Dualism*, which separated mind and body, emphasizing rational, analytical thinking and creating a clear division between humans and the natural world. Francis Bacon's *Baconian Empiricism* (or *Objectivity*) emerged around the same time, promoting empirical observation and experimentation as the foundation of scientific knowledge, considering this process superior to "primitive" forms of understanding. Moving on to the 18th century, Enlightenment brought the rise of *Universalism*, asserting a single, objective reality that can be understood universally, therefore entrenching the disregard of other cultural perspectives and ways of knowing. During the same period, Sir Isaac Newton's *Reductionism* gained prominence, bringing with it the breaking down of complex systems into their constituent parts, in a tendency to oversimplify the understanding of nature and the environment.

Finally, in the 19th century, Auguste Comte produced *Positivism*, which centered on the scientific method and empirical observation as the sole valid sources of knowledge, again reinforcing the position that only this methodology can be construed as "proper science." Alongside Auguste Comte's Positivism, another significant epistemological development emerged: Charles Darwin's theory of evolution through natural selection, often referred to as *Darwinism*. Darwin's theory, outlined in his seminal work "On the Origin of Species" published in 1859, had profound implications for the field of biology and the understanding of the natural world. Darwinism, with its focus on the pre-established scientific method and demands for empirical evidence, further reinforced the positivist approach to knowledge acquisition. The theory of evolution challenged traditional religious and creationist explanations of life's origins, positioning scientific inquiry as the primary means of understanding the natural world. This shift towards scientific explanations and empirical observation as the foundation of knowledge had implications for the recognition and inclusion of non-scientific ways of knowing, including traditional ecological knowledge (Ludwig, 2022).

In other words, the evolution of modern Western epistemologies has been shaped by a complex interplay of historical, cultural, and philosophical factors. The term "the West" inevitably refers to a broad and diverse range of societies and civilizations that have emerged primarily from Western Europe and North America. Throughout history, Western epistemologies have undergone significant transformations, influenced by various intellectual movements, social changes, and encounters with other cultures. The development of modern Western epistemology can be largely traced back to the Renaissance, where a shift towards humanism and individualism began to challenge traditional religious

and authority-based knowledge systems. This was followed by the Enlightenment, characterized by the rise of rationality, scientific inquiry, and the pursuit of knowledge through empirical evidence. The Industrial Revolution further accelerated the growth of Western epistemologies, emphasizing technological progress, positivism, and a belief in progress and linear development.

It is also important to note here that WE's were by no means developed with the explicit intention of excluding or disparaging ITEK. However, their application in Western societies, coupled with centuries of colonialism, ensured that eventually these paradigms would become the dominant perceptive discourse (Smith, 2012). In other words, I posit that the combined influence of Positivism, Objectivity, and Darwinism, within the larger context of Western epistemologies, created a framework that centered scientific observation, empirical evidence, and detachment from subjective experiences. While these developments offered immense contributions to scientific progress, they also directly or indirectly perpetuated the marginalization of "other"[18] ways of knowing, including Indigenous knowledge, which encompasses rich understandings of ecological relationships, intergenerational wisdom, and invaluable cultural perspectives. It is thus crucially important to recognize these historical connections and critically reflect on the implications of such *epistemological obstacles* in the integration of diverse knowledge systems in society at large as well as (E)SD in this case.

Colonialism, presented throughout this paper both as a theme (CGD) and as a theoretical approach (as decolonization or postcolonialism), represents just such an obstacle.

> The production of knowledge, new knowledge and transformed 'old' knowledge, ideas about the nature of knowledge and the validity of specific forms of knowledge, became as much commodities of colonial exploitation as other natural resources. Indigenous peoples were classified alongside the flora and fauna; hierarchical typologies of humanity and systems of representation were fueled by new discoveries; and cultural maps were charted and territories claimed and contested by the major European powers. Hence some Indigenous peoples were ranked above others in terms of such things as the belief that they were 'nearly human', 'almost human' or 'sub-human'. (Smith, 2012, p. 69)

I add this quote as a reminder to the reader that what we are exploring are very real histories of genocide which closer to the present gave place to a new, insidious, and equally violent form of colonization described by Boaventura de Sousa Santos (2014) as **epistemicide**, referring "to the destruction of alternative forms of knowledge and the imposition of dominant epistemologies, the consequent loss of intellectual and cultural diversity, and the undermining of individual and collective agency" (p. 17). These authors speak to the way Western scientific practices, for example classification and taxonomy, have been used to categorize and subjugate colonized people and their environments. In more

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[18] Note. I place other in quotation marks as an ironic reference to the "othering" dominant Western cultures are so fond of. (Smith, 2012)

recent times, *epistemic colonialism / violence* takes shapes which include: "interpretive marginalisation and credibility deficit" (Mbah, 2022; Breidlid, 2019), culturally insensitive testing systems and enforced Eurocentric educational design (Battiste, 2000 and 2014), or linguistic and philosophical domination (Ludwig, 2022; Wilson, 2008), to name a but a few.

In other words, the very history of Western epistemology evolution so tightly intertwined with colonialism as to be almost inseparable, points in turn to the need of investigating and deconstructing this ubiquitous and pervasive paradigm (Smith, 2012). Due to these colonial connections, in recent decades, there has been a growing recognition of the need to decolonize Western epistemologies, acknowledge alternative knowledge systems, and practice true onto-axio-epistemological inclusivity. This evolution reflects an ongoing quest to address the limitations and biases inherent in WE and create a more diverse and inclusive understanding of knowledge and reality.

Furthermore, as WE's evolved, they fostered Eurocentrism by privileging Western knowledge systems, values, and perspectives as universal and superior. Eurocentrism thus emerged from the colonial expansion of Western powers, which imposed Western ideologies, institutions, and ways of knowing on colonized societies. Eurocentric epistemologies positioned European thought as the standard by which all other knowledge systems were measured, marginalizing and devaluing Indigenous, non-Western, and local knowledge. This Eurocentric lens perpetuated a hierarchical view of knowledge, reinforcing power imbalances and eroding the cultural diversity and richness of other epistemological traditions. The consequences of Eurocentrism included the suppression and erasure of Indigenous knowledge, the distortion of historical narratives, and the perpetuation of unequal power relations in academia, governance, and development practices. The insights from scholars in Indigenous studies, decolonization, and critical methodologies have played a crucial role in challenging Eurocentrism and advocating for more inclusive and equitable approaches to knowledge production and engagement with diverse epistemologies.

Based on the above, thoroughly interrogating these apparent hegemonic tendencies, particularly in a setting in which other epistemologies are present and desired (ie. ITEK/ ESD), seems not only reasonable but rather imperative especially if the focus is on successful and plurality centered knowledge co-production. As such, this inquiry asks the question of how WE interacts with ITEK in ESD integrations, with a genuine interest to understand if epistemic injustice is indeed present in this field, and if so to explore the ways in which sustainability scholars and educators can remedy and prevent such unacceptable behaviors.

I am not without doubt that such an overview is insufficient in setting the proper framework for beginning to answer the research questions, yet I assure the reader that beyond what I could encompass in this section, the literature selection I proposed, treats this topic and comparison in sufficient depth and detail as to satisfy even the most exigent eye.

7.2 Answering the research questions

"…expertise does indeed take many forms and can be found all around the globe, and the different forms of expertise come with different epistemic strategies, ontological views, and metaphysical assumptions…" (Ludwig, 2022, p.301)

In essence, my ontological and epistemological exploration focuses on *relationships*. Starting with my own direct/indirect participation in these power dynamics, while attempting to span studies which include the simplest of human interactions all the way to the larger dimension of institutional and educational frameworks, I am intersted in how healthy relating can help us translate whole worlds to one another (Wilson, 2008). In response to this quest, the 30 reviews chosen for my analysis, through their reference to **866 other scientific studies from around the world**, hopefully fulfill the need for geographical and cultural diversity in practical examples of ITEK/ESD integrations, ensuring that when the research questions are asked, answers can be derived from a compatible and dynamic sample of relationship observations. More specifically, as an Easter European researcher, I wanted to understand who the

Let us then look for more direct answers to the main question: *How do Euro-Western epistemologies influence the integration of Indigenous and Traditional Ecological Knowledge (ITEK) in Sustainable Development and Education for Sustainable Development (ESD)?* Considering by extension as well, secondary aspects such as: 1. epistemological barriers and challenges faced by ITEK in its integration and application process in ESD; 2. asking if there is a pre/dominance of Euro-Western paradigms in ESD; and 3. identifying outcomes and potential benefits of incorporating pluralistic perspectives and knowledge, such as ITEK into ESD. Here then is a weave of relevant excerpts drawn from the 30 SR's.

There is Downey et al. stating: "…the few articles that addressed Indigenous recreational meanings of water showed how historical and contemporary colonist policies have compromised Indigenous sporting activities, culture, and skills sets, such as those of female swimmers, with ramifications for Indigenous peoples individual and community health." (2022, p. 13). Or Druker-Ibanez & Caceres-Jensen who warn: "The democratisation required by sustainability at this level faces a long-standing problem referred to as epistemic violence…, epistemic supremacy … abysmal thinking (Santos 2018) or cognitive injustice (Rodriguez 2017), depending on the theoretical framework associated with de-colonial perspectives. (2022, p. 1220)"

Moving further, Hanspach et al. argue that: "while sustainability is largely a matter of culture, neither local ecological knowledge, cultural values and alternative economic practices, nor their interrelation with biodiversity are currently mentioned by any SDG in the pathway to sustainability" (2020, p. 644). Similarly Lam & Dodd notice: "While Indigenous peoples observations of climate change are increasingly reported in the published literature, we found the inclusion of Indigenous peoples as co-authors did not appear to follow the

same trend. We found less than half (42%) of reviewed articles on CBM had a co-author with an affiliation to an Indigenous organization or community" (2019, p. 10).

Malapane et al. explain that: "Western scientific knowledge has suppressed indigenous cultural belief systems, practices, and taboos of native communities….What can be observed is that other countries outside the African continent are telling the African narratives primarily countries from the Global North" (2021, p. 14). Along the same lines, Petzold et al. have found: "The vast majority of climate studies using indigenous knowledge have been found to use an extractive model…The literature dealing with indigenous knowledge and climate change adaptation in IPCC reports is heterogeneous and mostly generic" (2020, p. 13). These findings are also echoed by McElwee et al. and their evaluation of the IBPES Global Assessment which they found: "the GA still faced a number of challenges in ensuring that different knowledge systems were engaged in a transparent, equitable and legitimate manner" (2020, p. 4). Further evidence is brought by Proulx et al. who state: "Non-Indigenous researchers have a history of undertaking extractive, Eurocentric and unethical approaches to engaging with Indigenous communities, causing an understandable lack of trust" (2021, p. 12).

Furthermore, Reyes-Garcia et al. have observed that: "ILK continues to be largely absent in climate change impacts research as epistemological, methodological, and scaling issues challenge the transferability, integration, and scalability of ILK" (2022, p. 87). In another very strong example of an epistemic justice discussion, Shawoo et al. explain: "Western science comes with a prototype for what counts as science today, meaning that Indigenous perspectives are often not considered legitimate." They then ask: "this incorporationist or integrationist perspective toward TEK has a number of political considerations which are often overlooked, such as: a) who has the privilege of integrating TEK and according to what ethical, ontological, and epistemological frameworks? and (b) how do the incorporating frameworks (i.e., science), which are necessarily selective, affect the integrity of TEK as a system of knowledge?" (2019, p. 1-3).

In another review the authors ask if policymakers "assign value to [the] plural knowledge for reducing uncertainty in process and subsequently in the outcomes" and they notice "[plurality] was lacking broadly in the results obtained at the policy level as processes were skewed towards only the formal knowledge and policy makers. This raises an important question: was TK appropriately and ethically mainstreamed with the institutional knowledge?" (Singh et al,. 2021, p. 2). Similarly, Subercaseaux et al. write: "The prevailing vision in industrial civilization rejects the traditional knowledge and practices generated during most human history" (2021, p. 7). This view is supported by Thompson et al. who talk about "the reductionism of science compared to the holism of Indigenous knowledge, and the focus of Indigenous knowledge on extremes compared to science's ability to discern averages" (2020, p. 9).

Finally, Zurba et al.'s analysis of WE in relation to ITEK gives perhaps the most relevant of all statements: "Power asymmetries in knowledge co-production often arise around the reductive but instructive binary of Western Scientific Knowledge (WSK) and ILK systems. WSK is heavily influenced by positivism and often conceptualizes knowledge as products that are packaged in categories, abstract generalizations, ordered observations, and testable hypotheses rather than in processes that incorporate actions, experiences, and relationships"(2022, p. 462).

I included these comments on one hand to introduce the authors' voices directly, but also to show that even from my admittedly small data sample, answers for the research questions are readily available. I remind the reader that as detailed in the results chapter and the appendices, **all 30 studies mentioned epistemic in/justice[19]**, regardless of how superficially they treated colonialism or decolonization for example. Based on the primary research in each review, and the secondary research of my umbrella review, it can thus be safely deduced that **Euro-Western epistemology heavily influences Indigenous and traditional ecological knowledge integrations into Sustainable Development and Education for Sustainable Development**, and that **its influence does exhibit clear hegemonic tendencies**. Furthermore, the relationship between modern sustainability science and local Indigenous communities, with their respective onto-epistemological value systems, seems skewed in favor of the Western colonial-born scientific supremacy and as such is inevitably fraught with injustice (Chilisa, 2020). In the words of the two Norwegian scholars, whose seminal book on ITEK and the SD agenda is a field-defining exercise:

> While indigenous knowledges [thus] are radically different from Western positivist knowledge they must nevertheless be seen in relation to Western epistemology and knowledge production since indigenous knowledges changed status during colonialism and were inferiorized due to the imposition of Western knowledge which claimed hegemony and superiority. (Breidlid & Krøvel, 2019, p. 27).

With these elements in place, we arrive then to the inevitable action of *decolonizing research* described by Indigenous scholars as: "the process in both research and performance of valuing, reclaiming, and foregrounding indigenous voices and epistemologies" (Swadener & Mutua, 2008). The reason for such a shift in status quo is that: "academic research on Indigenous peoples is typically based on western lenses, and emancipatory methodologies have primarily been defined by the epistemological framework of the western culture, including Eurocentric emancipatory scholarship acting to decolonise research" (Mbah, 2022, p. v).

As to how decolonial practices translate directly to (E)SD, for instance a central theme in one of the 30 SR's was the question of how the integration of (iLK) and Western scientific knowledge can contribute to decolonization and environmental and epistemological justice.

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[19] Note. For a rating of the degree of quality for their mention I invite the reader to peruse Appendix 4.

The study emphasized the importance inclusive relationships that recognize the legitimacy and agency of local and scientific actors involved in the integration process, and it shed light on the need to challenge epistemic supremacy and promote inclusive education that values and incorporates iLK. It argued that a genuine dialogue between different ways of knowing, without compromising the cultural integrity of iLK, can foster robust responses to the environmental and social challenges we face today (Druker-Ibanez & Caceres-Jensen, 2022). Another of the authors also asserts this need:

> to articulate, as well as bring to the nexus of research aimed at fostering sustainable development, a decolonising perspective in research design and practice. This would not only have the potential to overcome any form of epistemic violence perpetuated towards Indigenous communities and their knowledge systems, but also can engender the achievement of the SDGs, with a focus on supporting Indigenous groups to drive their own development agenda, based on their worldviews and priorities (Mbah, 2022, p. v).

The discussion on the importance of decolonial practices in sustainability warrants its own sub-field, yet suffice to say at this juncture that *achieving epistemic justice in ITEK/ESD integrations is by and large directly dependent on the inclusion of appropriate decolonial tools and lenses in any and every form of research which involves Indigenous or non-Western peoples*. While the reason for this should be self-explanatory, my personal experiences and the ensuing exploration of this topic have shown me that whether intentional or not, Euro-Western epistemology continues to relegate other forms of valuable and valid knowledge to the fringes of ESD (Silvestru, 2020).

To that extent I will state here that my focus with this thesis has not been to advocate on behalf of Indigenous peoples or explain why effective ITEK integrations can be indispensable to (E)SD. There are numerous scholars and researchers (some cited in this work) who have aptly done so. My deeper motivation is connected to assisting fellow Europeans (both Western and Eastern) to proceed with deconstructing the embedded colonial and Eurocentric perceptions we are plagued with and which are so cleverly disguised behind our so-called impartial and objective sciences. Most especially when we have arrived to the understanding that approaching ITEK requires we shift our stance towards true participatory, relational modalities as we abandon our obsolete top-down tactics (Breidlid, 2019, p. 194). Coming back to my previous statement, I put forth that deconstructing our inbuilt supremacy bias is the most appropriately scientific approach we could take and that **Eurocentric bias assessment tools** *should be part and parcel of any research initiative in which Euro-Western and Indigenous & non-Western peoples are involved*. More so, when even these much beloved scientific methods have confirmed that interconnectedness is the unavoidable principle which we have to built sustainability design on, it becomes then essential to finally align ourselves with the systems thinking practices Indigenous peoples beautifully describe as the **Web of Relations** (Battiste, 2000).

Summarizing the above findings and perspectives I offer the following simple list, condensing the conclusions of this part of the discussion:

- The Western scientific paradigm is often used as the basis for education for sustainable development (ESD) in many parts of the world. This paradigm emphasizes empirical observations, quantitative measurements, and the use of the scientific method to explain natural phenomena. It is based on the assumption that the natural world can be fully understood through objective observations and that knowledge gained through scientific inquiry is the most reliable and accurate form of knowledge.

- ESD programs around the world are quite commonly using Western paradigms as the foundation for their educational frameworks. Through its emphasis on empirical observations, quantitative measurements and the use of the scientific method, this paradigm is founded on the assumption the we can fully understand the world around us solely through objective observations thus gaining reliable and accurate knowledge through this manner of scientific inquiry.

- However, this paradigm is often criticized for its reductionist approach, which tends to separate humans from nature and treats nature as a resource to be exploited for human benefit. It also tends to prioritize Western knowledge systems over other knowledge systems such as ITEK. This can result in the marginalization and erasure of other ways of knowing, including Indigenous knowledge systems that have been developed over thousands of years in close relationship with the natural world.

- Critics argue that this reductionist approach to science has contributed to the environmental crises we face today, as it has encouraged the exploitation and degradation of the natural world for human gain. To address these issues, some scholars have called for a more holistic and integrative approach to ESD that incorporates multiple knowledge systems, particularly ITEK, into the scientific paradigm. This would involve acknowledging and respecting the diversity of ways of knowing and understanding the natural world and would require a shift away from the reductionist and profit oriented approach that has dominated Western science.

- Currently, *no sufficient epistemic justice discussions are being had or appropriate focus is being placed on these issues and their implications to the success of ITEK integrations into (E)SD,* although these integrations are being called for by UNESCO, the UN, the SDG's the respective international forums and platforms which represent these institutions, but most importantly by myriad non-Western and Indigenous peoples.

7.3 Offering a conceptual tool

1. the shared aspect of an Indigenous ontology and epistemology is relationality (relationships do not merely shape reality, they are reality). The shared aspect of an Indigenous axiology and methodology is accountability to relationships. 2. The shared aspects of relationality and relational accountability can be put into practice through choice of research topic, methods of data collection, form of analysis and presentation of information. (Wilson, 2008, p. 7)

I start with a warning. For too long Euro-Western oriented ESD academic (and institutional) philosophies and practices have held their onto-epistemologies, axiologies, and methods as *the only* operational standard to understand the natural world through. Ironically this solipsism and isolation have led to systemic symptoms akin to a mental illness, where the tools used to fix the problem are the very ones creating it (Kimmerer, 2012). Thankfully, there are however more beneficial utensils and methods we can learn to use and that can help us break free from this self-induced epistemological isolation. Accountability, reflexivity, ethical considerations, re-evaluation of entrenched paradigms and biases are all essential and regenerative tools and goals in the process of seeking to enter right relations. In an effort to modeling these behaviors, I propose the following protocol which could be of use to Euro-Western scholars, researchers, and policymakers when interacting with knowledge systems outside of WE.

The **RELATION** tool, an acronym consisting of: **R**eflexivity**, E**quity, **L**ineage diversity, **A**ccountability, **T**raditional wisdom, **I**nterconnectedness, **O**pen-mindedness, and **N**ature-centeredness, is a direct extension and result of applying the theoretical weave I offered at the onset[20]. I have developed **RELATION** to take into account the *transformative paradigm, postcolonial, decolonial & Indigenous research methodologies,* and *the transdisciplinary approach.* With it I aim to address the challenges and opportunities of integrating ITEK in ESD trough promoting a more inclusive, fair, and respectful approach to knowledge co-production. This tool should hopefully facilitate a more comprehensive and culturally sensitive exploration of the epistemological interactions between ITEK and ESD within the context of Euro-Western epistemologies. I hope that its use can enable a deeper understanding of the complexities involved and support the goal of fostering epistemological justice and decolonization in knowledge systems. Here then is how I can be in correct RELATION:

Reflexivity, as a key element of relating, aligns with the *transformative paradigm*. It emphasizes the importance of *self-reflection and critical awareness* in understanding the biases and assumptions that shape our knowledge and research practices. By engaging in reflexivity, I aim to critically examine my own positionality, biases, and epistemological orientations, ensuring a more nuanced and balanced approach to the integration of Indigenous and Traditional Ecological Knowledge in ESD.

Equity, another crucial aspect of RELATION, resonates with the *decolonial theory* embedded in my study. It underscores the need for *justice, fairness, and the recognition of*

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[20] *Note.* **RELATION** also implicitly refers to the 5 main themes

diverse knowledge systems. By emphasizing equity, I strive to challenge power imbalances, address historical and ongoing injustices, and create space for marginalized voices, particularly those associated with Indigenous and traditional knowledge, within the field of ESD.

Lineage diversity, reflects the recognition of multiple knowledge lineages and cultural perspectives, aligning with the *decolonial* and *Indigenous research methodologies* woven into the theoretical framework of my study. It acknowledges the importance of *valuing and incorporating diverse knowledge systems*, including those rooted in Indigenous traditions and ways of knowing. By embracing lineage diversity, I aim to foster a more inclusive and respectful approach to knowledge production, which respects and includes different genetic and cultural lineages.

Accountability is another crucial element in the RELATION tool, complementing the *transformative paradigm* and the *transdisciplinary approach*. It calls for the responsibility of *researchers to critically examine their role, power dynamics, and potential impacts on the communities they study*. By embracing accountability, I commit to ensuring ethical research practices, actively engaging with stakeholders, and acknowledging the potential consequences and implications of my work.

Traditional wisdom, in alignment with the *decolonial* and *Indigenous research methodologies,* recognizes the value and importance of Indigenous and traditional knowledge systems. It acknowledges that wisdom and knowledge exist beyond Western frameworks and can provide valuable insights for addressing sustainability challenges. By honoring traditional wisdom, I aim to center Indigenous and traditional knowledge in my study, amplifying the voices and perspectives of communities that hold this wisdom.

Interconnectedness, as reflected in the RELATION tool, resonates with the *transdisciplinary approach* in my study. It emphasizes *the understanding that all aspects of the natural world are inextricably inter/intra-dependently interconnected*. By recognizing the interdependencies between different domains of life itself, I aim to break down ontological and disciplinary boundaries and explore the complex interactions between Indigenous and Traditional Ecological Knowledge and ESD.

Open-mindedness, aligned with the *transformative paradigm* and *the transdisciplinary approach*, encourages a receptive and inclusive mindset. It involves *being open to different perspectives, valuing diverse forms of knowledge*, and *challenging established assumptions.* By cultivating open-mindedness, I aim to embrace alternative ways of knowing, critically evaluate dominant epistemologies, and foster a more inclusive and holistic understanding of ESD.

Nature-centeredness, another essential aspect of RELATION, aligns with the *transdisciplinary approach.* It emphasizes the *recognition of the intrinsic value of nature and the*

need to prioritize ecological well-being in ESD. By promoting nature-centeredness, I strive to challenge anthropocentrism, acknowledge the interdependence between humans and the natural world, and ensure that sustainability efforts prioritize the health and resilience of our ecosystems.

I can thus say that if there is one essential aspect I hope to contribute with through this tool it is to help foster more plurality in sustainability practices. RELATION encourages the practical diversification and evolution of our scientific methods through effectively and equitably integrating Indigenous and traditional ecological knowledge systems (which have proven to be efficient throughout millennia), as equal or better yet as leading paradigms in the work of rebalancing the human created crisis we are facing. Perhaps most importantly, this tool seeks to foster *complexity tolerance* and *acceptance of non-finality* in the transdisciplinary form of research required when attempting to integrate various worldviews into a cohesive whole designed to better equip humanity to care-take the present and the future of our precious Earth home.

Finally, presented here in **Table 9** is an simplified representation of the above:

Table 9

The RELATION Protocol

R	reflexivity	self-awareness and critical examination	transformative paradigm
E	equity	fair and inclusive knowledge exchange	decolonial theory
L	lineage diversity	embracing and honoring diverse cultural lineages and perspectives	decolonial & Indigenous research methodologies
A	accountability	responsible and ethical approach to conducting research	transformative paradigm & transdisciplinary approach
T	traditional wisdom	working in partnership with Indigenous and traditional knowledge systems	decolonial & Indigenous research methodologies
I	interconnectedness	understanding that all aspects of the natural world are interconnected and interdependent, requiring holistic approaches	transdisciplinary approach
O	open-mindedness	receptiveness to alternative perspectives and ways of knowing	transformative paradigm & transdisciplinary approach
N	nature-centeredness	the recognition of the intrinsic value of nature and the need to prioritize ecological well-being	transdisciplinary approach

Summarizing the discussion:

Arriving at long last to the point of evaluating how this study has achieved its purpose, in accountability to my *research success criteria* from **Table 5**, I can state that:

- Western epistemologies and Eurocentrism have indeed been identified as challenges to ITEK integrations into ESD;

- furthermore, the presence of this challenge seems to be widespread enough to warrant notice and action;

- sufficient data has been found in the 30 systematic reviews to support categorizing WE as a predominant paradigm in sustainability discourse and education;

- in response to these findings of power imbalances, the RELATION model has been offered as a tool for the identification and mitigation of WE intrinsic bias;

- lastly, the discussion of possible research directions follows in the Conclusions & Recommendations chapter.

Strengths and limitations of the umbrella review

"One of the goals of systematic literature review is to reduce reviewer bias. If not careful, such inclinations can lead to incomplete or partial collections of information or studies, and also result in erroneous (and biased) conclusions about the state of knowledge on a given topic." (Zawacki-Richter, 2020, p. 76)

In keeping with Cant et al.'s (2022) recommendations that umbrella reviews need to include mentions about strengths and limitations of this methodology, along with any ethical considerations, I then state the following:

Strengths:

- *Comprehensive approach:* The umbrella review methodology allowed for a comprehensive analysis of existing literature on Indigenous and Traditional Ecological Knowledge integrations into Sustainable Development and Education for Sustainable Development, ensuring as broad coverage of evidence as possible.

- *Transparency:* Following the PRISMA and MMAT guidelines enhanced the study's transparency, enabling clear and systematic reporting of the methodology and findings.

- *Time and resource efficiency:* The umbrella review methodology offered a more efficient and realistic approach by processing a large amount of existing literature without the need for primary data collection and analysis.

Limitations:

- *Potential bias:* Despite the comprehensive approach, there is a risk of bias in study selection due to the reliance on existing systematic reviews, which although passed through quality assessment criteria, may nevertheless be influenced by publication bias or other less observable biases. In addition, the choice of one data base and limit to English language publications have further limited the scope of the search.

- *Heterogeneity of included studies:* The umbrella review included studies with varying research design, quality, and scope, posing certain challenges in comparing and synthesizing findings and limiting generalizability.

- *Limited primary data:* The study's reliance on secondary data restricts its ability to address questions not previously explored in systematic reviews or primary studies.

- *Western bias:* by far the most important bias to mention is the fact that this whole thesis has been carried out thorough the means of Western scientific methods, thus has been confined to the particular predominant paradigm outlined throughout this exploration.

Along the course of this research my ethical practice has endeavored to align with the understanding that according to cross-cultural research principles, the research process and its outcome should benefit all participants, in this case referring particularly to the Indigenous researchers and populations directly or indirectly represented in the studies I have chosen. I also hold that this type of research should be culturally responsive, should allow for personal transformation, and should seek to offer an alternative framework to the predominant Euro-Western paradigm, ideally by generating conclusions and recommendations aligned with the guidance or feedback of Indigenous scholars, and other non-Euro-Western traditional knowledge keepers and participants (Madden, 2015).

As a White Eastern European scholar, I have given great care to conducting my research in a way that addressed the subtle (and evident) power imbalances created by the extractionist mentality of Euro-Western positivist paradigms when dealing with Indigenous peoples (Smith, 2010). My overarching aim when conducting this work was that upon successful completion of the umbrella review, Euro-Western, Indigenous and traditional stakeholders could derive meaning and be able to reflect both personally and at a collective level on the issue brought forth by the research questions. The degree to which I have achieved this is far from my personal ideal, yet in acceptance of the non-finality inherent in such work, I stand humbly to be corrected for any offense, obtuse view, avoidable bias, omissions, reductionism, generalizations, and the whole spectrum of ethical ills I am certain are represented in my work. Choosing to intentionally allow and even encourage such dichotomies is inevitably bound to result in these shortcomings, yet it is my proposal that in respect to the empiricism of the human itself, such trial and error attempts must be made.

I declare that I have no conflicts of interest to disclose regarding the research presented in this paper.

9. Conclusions and Recommendations

"The challenge for sustainable development practitioners is to find ways to integrate indigenous knowledges into policy-making processes in ways that respect their unique epistemological foundations while also recognizing their potential contributions to sustainability." (Breidlid & Krøvel, 2019, p.195)

I open the final chapter of this work with two statements from our Indigenous colleagues, noting that the grievances expressed remained unchanged throughout 4 decades:

◉ In 1993, the chairperson of the Working Group on Indigenous Populations [UNESCO], Dr. Erica-Irene Daes, prepared a report condemning the widespread and continued exploitation of traditional knowledge and culture by Euro-centric institutions and scholars. She described this as the final stage of colonialism, following the exhaustion of Indigenous peoples' tangible assets. Daes argues for the urgency of taking international action to protect the dignity, privacy, and identity of Indigenous peoples without waiting for the adoption of the declaration. The principles laid out by the working group acknowledge that

the heritage of an Indigenous people is a complete knowledge system with its own concepts of epistemology, philosophy, language, and scientific and logical validity that needs protection from Eurocentric exploitation. (Battiste, 2000, p.194)

◉ Colonial oppression that is allegedly defensible by real or perceived crises happens right now too. Today, people perpetrate colonialism in the name of responding to environmental crises – climate change being one prominent case. Responses to scientifically understand and mitigate climate change can harm or threaten Indigenous peoples. From scientific reports that provincialise Indigenous knowledge systems to wind power projects that desecrate Indigenous lands, there is no reason to believe that colonialism today is something other than an evolved practice of a familiar form of power (Hokowhitu et al., 2022, p. 52).

Essentialized in these words is both the argument derived from the answers to my research questions, and also a very direct call and inspiration for further action. As I repeatedly stated, investigating the hegemonic mechanisms of Euro-Western paradigms in ITEK/ESD integrations is but a simple exercise in critical thinking and by no means a condemnation of science itself or an accusation toward a whole section of the Earth's population. That said, these questions could be asked: what other field outside of ESD could possibly hope to be a frontrunner in deconstructing outdated modes of thinking in favor of biome-beneficial knowledge plurality? Where else would **relationality** hope to be healed if not within the realm of enacting on building sustainable futures for all of Earth's future generations? Why would ESD scholars not want to be the first to model what it means to be in correct RELATION to our Indigenous and traditional wisdom keepers?

Through the possibility of equitable and mutually beneficial onto-epistemological mergers present in ITEK/ESD integrations, the potential contained in this fairly novel field of sustainability is rather momentous. As such, the recommendations for future research on integrating diverse knowledge systems into SD and ESD are in my opinion both simple and quite obvious. Before listing some of these ideas, in keeping with my commitment to center their voices, I add here another contribution from prominent Indigenous scholars offering precious guidance into how we can attempt this important transdisciplinary work:

Cognitively empowered by these multiplex perspectives, complexity-sensitive, multilogical educators seek a multicultural dialogue between Eastern cultures and Western cultures, a conversation between the relatively wealthy Northern cultures and the impoverished Southern cultures, and an intracultural interchange among a variety of subcultures. In this way, forms of knowing, representing, and making meaning that have been excluded by the positivist West move us to new vantage points and unexplored planetary perspectives. Understandings derived from the perspective of the excluded or the "culturally different" allow for an appreciation of the nature of justice, the invisibility of the process of oppression, the power of difference, and the insight to be gained from a recognition of divergent cultural uses of long hidden knowledges that highlight both our social construction as individuals and the limitations of monocultural ways of meaning making. (Kincheloe & Steinberg, 2008, p.7)

As for my own recommendations toward next steps possible in this line of research,

1. I would encourage my colleagues to continue researching the epistemological interactions between ITEK and ESD, particularly where funding and teamwork is available, and do so both on a micro level of particular communities and on the macro level of forums such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) for example.

2. Any such research should be conducted by an equal number of Indigenous and non-indigenous researchers in order to redress the representation issues found so far.

3. Euro-Western scholars in particular would need to educate themselves or be educated in decolonial practices *prior* to undertaking any cross-cultural work. Protocols akin to the **RELATION tool** are good places to start.

4. From such collaborative research hopefully further clarifications into this epistemological dynamic could be obtained and practical tools and solutions could be put in place in order to mitigate power imbalances.

5. In partnership with Indigenous and non-Western scholars, an ESD specific set of epistemic justice standards could be created as a general guideline in any initiatives integrating ITEK into ESD. The official channels of UNESCO could be utilized to validate and disseminate such standard.

In closing this lengthy exploration of arguably one of our modern times most wicked problems, I kindly thank the reader for their patience and perseverance to have arrived here.

Exiting the academic confines of this writing, I humbly encourage them to stand tall as a good relation on this beautiful Earth, drawing strength from the roots of their ancestral tree while enacting toward a shared future in which all of humanity's collective wisdom has been put to use in service of protecting the one and only home we have. Let us take account of what stands in the way to us once again becoming worthy participants in life's grand web of relations. Let us face our gruesome histories knowing that we need not succumb to their consequences. Let us draw inspiration from the beauty of our miraculous world. Most especially, let us accept that we need to humbly and respectfully ask for guidance from our Indigenous Older Brothers and Sisters. For they are the ones who yet maintain a respectful and harmonious relationship with nature and who still stand in defense of its sacred deserts and jungles, plains and mountains, rivers and oceans, and all the living beings who us humans share these environments with.

Let the ones who still remember lead the way!

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Appendices

Appendix 1 + Placing the Main Resources in Relation to the Themes & Theories

Appendix 1. Placing the Main Resources in Relation to the Theoretical Framework and the Themes

Authors (Year) & Book Title	Description	Theoretical Framework	Theme
Battiste, M. (2000). ***Reclaiming Indigenous voice and vision***	A call for the revitalization of Indigenous languages, cultures, and knowledge systems within the education system to decolonize education.	Indigenous Research Methodologies, Decolonial Approach, Transformative Paradigm	ITEK in SD/ESD, Decolonization
Battiste, M. (2018). **Decolonizing Education: Nourishing the Learning Spirit**	Examines the ways in which colonialism has impacted education and provides a framework for decolonizing education to better serve Indigenous students and communities.	Decolonial Approach, Indigenous Research Methodologies, Transformative Paradigm	ITEK in SD/ESD, Decolonization
Breidlid, A., Krøvel, R. (2020) ***Indigenous knowledges and the sustainable development agenda***	An exploration of the intersection between Indigenous knowledge systems and the global sustainable development agenda from a critical postcolonial perspective.	Postcolonial Theory	ITEK in SD/ESD, Western Epistemology/ Eurocentrism
Denzin, N. K., Lincoln, Y. S., & Smith, L. T. (Eds.). (2018) ***Handbook of critical and Indigenous methodologies***	A comprehensive overview of critical and Indigenous research methodologies, with a critical perspective on the ways in which research has historically been used as a tool of colonialism and oppression.	Indigenous Research Methodologies, Decolonial Approach	Colonialism/ Globalization/ Decolonization
Hokowhitu, B., Moreton-Robinson, A., Tuhiwai-Smith, L., Andersen, C., & Larkin, S. (Eds.). (2022). **Routledge Handbook of Critical Indigenous Studies.**	This book offers an interdisciplinary overview of critical Indigenous studies, exploring the ways in which Indigenous scholars and activists are challenging dominant paradigms and advocating for Indigenous rights and sovereignty.	Transformative Paradigm (Critical Theory), Indigenous Research Methodologies	Epistemological Justice, Decolonization
Ludwig, D., Koskinen, I., Mncube, Z., Poliseli, L., & Reyes-Galindo, L. (2022). **Global epistemologies and philosophies of science.**	An exploration of the interplay between globalization, colonialism, and the evolution of knowledge systems, with a focus on the Global South.	Postcolonial Theory Transdisciplinary approach	Western Epistemology/ Eurocentrism, Epistemological Justice
Mbah, M. F., Leal Filho, W., & Ajaps, S. (2022). **Indigenous Methodologies, Research and Practices for Sustainable Development**	Explores the potential of Indigenous methodologies and practices in promoting sustainable development.	Indigenous Research Methodologies, Decolonization approach, Transformative Paradigm, Transdisciplinary approach	ITEK in SD/ESD, Western Epistemology/ Eurocentrism, Epistemological Justice
McKinley, E. A., & Smith, L. T. (2019). **Handbook of Indigenous Education.**	A comprehensive overview of Indigenous education systems and the challenges and opportunities associated with incorporating Indigenous knowledge into the mainstream education system.	Transdisciplinary Approach, Transformative Paradigm	ITEK in SD/ESD, Decolonization
Santos, B. D. S. (2014) ***Epistemologies of the South: Justice against epistemicide***	A critical perspective on the dominant Western epistemology and a roadmap for epistemological justice and the reclamation of knowledge systems that have been historically marginalized by the dominant discourse.	Postcolonial Theory , Decolonial Approach	Western Epistemology/ Eurocentrism, Epistemological Justice
Smith, L. T. (2012) ***Decolonizing methodologies: Research and Indigenous peoples***	A critical perspective on the ways in which research and education have historically been used as tools of colonialism and oppression and a roadmap for decolonizing research and education.	Indigenous Research Methodologies, Decolonial Approach	Colonialism/ Globalization/ Decolonization
Wilson, S. (2008). **Research is Ceremony: Indigenous Research Methods**	A detailed exploration of Indigenous research methods and revealings of the importance of engaging in research as a ceremony. Placing focus on the significance of centering Indigenous voices, perspectives, and knowledges in research to empower Indigenous communities and challenge dominant paradigms.	Indigenous Research Methodologies, Postcolonial Theory, Transdisciplinary Approach	ITEK in SD/ESD, Epistemological Justice,

Appendix 2 + Bibliographic List of The 30 Systematic Reviews

Appendix 2. Bibliographic List of The 30 Systematic Reviews - Part 1

#	Authors	Review Title	Source Title	Year	DOI
1	Downey, H; Spelten, E; Holmes, K; Van Vuuren, J	*A Rapid Review of Recreational, Cultural, and Environmental Meanings of Water for Australian River Communities*	SOCIETY & NATURAL RESOURCES	2022	http://dx.doi.org/10.1080/08941920.2022.2032894
2	Doyon, A; Boron, J; Williams, S	*Unsettling transitions: Representing Indigenous peoples and knowledge in transitions research*	ENERGY RESEARCH & SOCIAL SCIENCE	2021	http://dx.doi.org/10.1016/j.erss.2021.102255
3	Drake, AK; Perkovic, A; Reeve, C; Alexander, SM; Nguyen, VM; Dunmall, KM	*Community participation in coastal and marine research and monitoring in Inuit Nunangat: a scoping literature review*	FACETS	2022	http://dx.doi.org/10.1139/facets-2021-0067
4	Druker-Ibanez, S; Caceres-Jensen, L	*Integration of indigenous and local knowledge into sustainability education: a systematic literature review*	ENVIRONMENTAL EDUCATION RESEARCH	2022	http://dx.doi.org/10.1080/13504622.2022.2083081
5	Galway, LP; Beery, T; Jones-Casey, K; Tasala, K	*Mapping the Solastalgia Literature: A Scoping Review Study*	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	2019	http://dx.doi.org/10.3390/ijerph16152662
6	Hadlos, A; Opdyke, A; Hadigheh, SA	*Where does local and indigenous knowledge in disaster risk reduction go from here? A systematic literature review*	INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION	2022	http://dx.doi.org/10.1016/j.ijdrr.2022.103160
7	Hanspach, J; Haider, LJ; Oteros-Rozas, E; Olafsson, AS; Gulsrud, NM; Raymond, CM; Torralba, M; Martin-Lopez, B; Bieling, C; Garcia-Martin, M; Albert, C; Beery, TH; Fagerholm, N; Diaz-Reviriego, I; Drews-Shambroom, A; Plieninger, T	*Biocultural approaches to sustainability: A systematic review of the scientific literature*	PEOPLE AND NATURE	2020	http://dx.doi.org/10.1002/pan3.10120
8	Knopp, JA; Levenstein, B; Watson, A; Ivanova, I; Lento, J	*Systematic review of documented Indigenous Knowledge of freshwater biodiversity in the circumpolar Arctic*	FRESHWATER BIOLOGY	2022	http://dx.doi.org/10.1111/fwb.13570
9	Lam, DPM; Hinz, E; Lang, DJ; Tengo, M; von Wehrden, H; Martin-Lopez, B	*Indigenous and local knowledge in sustainability transformations research: a literature review*	ECOLOGY AND SOCIETY	2020	http://dx.doi.org/10.5751/ES-11305-250103
10	Lam, S; Dodd, W; Skinner, K; Papadopoulos, A; Zivot, C; Ford, J; Garcia, PJ; Harper, SL	*Community-based monitoring of Indigenous food security in a changing climate: global trends and future directions*	ENVIRONMENTAL RESEARCH LETTERS	2019	http://dx.doi.org/10.1088/1748-9326/ab13e4
11	Loch, TK; Riechers, M	*Integrating indigenous and local knowledge in management and research on coastal ecosystems in the Global South: A literature review*	OCEAN & COASTAL MANAGEMENT	2021	http://dx.doi.org/10.1016/j.ocecoaman.2021.105821
12	Makate, C	*Local institutions and indigenous knowledge in adoption and scaling of climate-smart agricultural innovations among sub-Saharan smallholder farmers*	INTERNATIONAL JOURNAL OF CLIMATE CHANGE STRATEGIES AND MANAGEMENT	2019	http://dx.doi.org/10.1108/IJCCSM-07-2018-0055
13	Malapane, OL; Musakwa, W; Chanza, N; Radinger-Peer, V	*Bibliometric Analysis and Systematic Review of Indigenous Knowledge from a Comparative African Perspective: 1990-2020*	LAND	2022	http://dx.doi.org/10.3390/land11081167
14	Manningtyas, RDT; Furuya, K	*Traditional Ecological Knowledge versus Ecological Wisdom: Are They Dissimilar in Cultural Landscape Research?*	LAND	2022	http://dx.doi.org/10.3390/land11081123
15	Mbah, M; Ajaps, S; Molthan-Hill, P	*A Systematic Review of the Deployment of Indigenous Knowledge Systems towards Climate Change Adaptation in Developing World Contexts: Implications for Climate Change Education*	SUSTAINABILITY	2021	http://dx.doi.org/10.3390/su13094811

Appendix 2. Bibliographic List of The 30 Systematic Reviews - Part 2

#	Authors	Review Title	Source Title	Year	DOI
16	McElwee, P; Fernandez-Llamazares, A; Aumeeruddy-Thomas, Y; Babai, D; Bates, P; Galvin, K; Gueze, M; Liu, JG; Molnar, Z; Ngo, HT; Reyes-Garcia, V; Chowdhury, RR; Samakov, A; Shrestha, UB; Diaz, S; Brondizio, ES	*Working with Indigenous and local knowledge (ILK) in large-scale ecological assessments: Reviewing the experience of the IPBES Global Assessment*	JOURNAL OF APPLIED ECOLOGY	2020	http://dx.doi.org/10.1111/1365-2664.13705
17	Petzold, J; Andrews, N; Ford, JD; Hedemann, C; Postigo, JC	*Indigenous knowledge on climate change adaptation: a global evidence map of academic literature*	ENVIRONMENTAL RESEARCH LETTERS	2020	http://dx.doi.org/10.1088/1748-9326/abb330
18	Proulx, M; Ross, L; Macdonald, C; Fitzsimmons, S; Smit, M	*Indigenous Traditional Ecological Knowledge and Ocean Observing: A Review of Successful Partnerships*	FRONTIERS IN MARINE SCIENCE	2021	http://dx.doi.org/10.3389/fmars.2021.703938
19	Reed, G; Brunet, ND; Longboat, S; Natcher, DC	*Indigenous guardians as an emerging approach to indigenous environmental governance*	CONSERVATION BIOLOGY	2021	http://dx.doi.org/10.1111/cobi.13532
20	Reyes-Garcia, V; Garcia-del-Amo, D; Benyei, P; Fernandez-Llamazares, A; Gravani, K; Junqueira, AB; Labeyrie, V; Li, XY; Matias, DMS; McAlvay, A; Mortyn, PG; Porcuna-Ferrer, A; Schlingmann, A; Soleymani-Fard, R	*A collaborative approach to bring insights from local observations of climate change impacts into global climate change research*	CURRENT OPINION IN ENVIRONMENTAL SUSTAINABILITY	2019	http://dx.doi.org/10.1016/j.cosust.2019.04.007
21	Salim, JM; Anuar, SN; Omar, K; Mohamad, TRT; Sanusi, NA	*The Impacts of Traditional Ecological Knowledge towards Indigenous Peoples: A Systematic Literature Review*	SUSTAINABILITY	2023	http://dx.doi.org/10.3390/su15010824
22	Shaffril, HAM; Ahmad, N; Samsuddin, SF; Abu Samah, A; Hamdan, ME	*Systematic literature review on adaptation towards climate change impacts among indigenous people in the Asia Pacific regions*	JOURNAL OF CLEANER PRODUCTION	2020	http://dx.doi.org/10.1016/j.jclepro.2020.120595
23	Shawoo, Z; Thornton, TF	*The UN local communities and Indigenous peoples' platform: A traditional ecological knowledge-based evaluation*	WILEY INTERDISCIPLINARY REVIEWS-CLIMATE CHANGE	2019	http://dx.doi.org/10.1002/wcc.575
24	Singh, RK; Singh, A; Zander, KK; Mathew, S; Kumar, A	*Measuring successful processes of knowledge co-production for managing climate change and associated environmental stressors: Adaptation policies and practices to support Indian farmers*	JOURNAL OF ENVIRONMENTAL MANAGEMENT	2021	http://dx.doi.org/10.1016/j.jenvman.2020.111679
25	Subercaseaux, D; Moreno-Calles, AI; Astier, M; Hernandez, JDL	*Emerging Agro-Rural Complexities in Occident Mexico: Approach from Sustainability Science and Transdisciplinarity*	SUSTAINABILITY	2021	http://dx.doi.org/10.3390/su13063257
26	Thompson, KL; Lantz, TC; Ban, NC	*A review of Indigenous knowledge and participation in environmental monitoring*	ECOLOGY AND SOCIETY	2020	http://dx.doi.org/10.5751/ES-11503-250210
27	van Bavel, B; Ford, LB; Harper, SL; Ford, J; Elsey, H; Lwasa, S; King, R	*Contributions of scale: what we stand to gain from Indigenous and local inclusion in climate and health monitoring and surveillance systems*	ENVIRONMENTAL RESEARCH LETTERS	2020	http://dx.doi.org/10.1088/1748-9326/ab875e
28	Vasileiou, K; Barnett, J; Fraser, DS	*Integrating local and scientific knowledge in disaster risk reduction: A systematic review of motivations, processes, and outcomes*	INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION	2022	http://dx.doi.org/10.1016/j.ijdrr.2022.103255
29	Zurba, M; Petriello, MA; Madge, C; McCarney, P; Bishop, B; McBeth, S; Denniston, M; Bodwitch, H; Bailey, M	*Learning from knowledge co-production research and practice in the twenty-first century: global lessons and what they mean for collaborative research in Nunatsiavut*	SUSTAINABILITY SCIENCE	2022	http://dx.doi.org/10.1007/s11625-021-00996-x
30	Zvobgo, L; Johnston, P; Williams, PA; Trisos, CH; Simpson, NP	*The role of indigenous knowledge and local knowledge in water sector adaptation to climate change in Africa: a structured assessment*	SUSTAINABILITY SCIENCE	2022	http://dx.doi.org/10.1007/s11625-022-01118-x

Appendix 3. Critical Sections - Page 1

Study	Research Questions	Theory/Concept	Methods/Procedures	Results	Implications	Connections to other research	Critique/Significance
Downey et al. (2021)	"What are the recreational, cultural, and environmental meanings of water for Australian river communities?"	"Water is a central element enabling human life. Across the world, every social group shares a water culture, sets of knowledge, customs, and behaviors that inform hydrosocial relations, some aspects of which are universal."	"this **rapid review** followed the methodology proposed by Khangura et al. (2012). It consisted of five discreet phases: (1) question development and refinement, (2) systematic literature search (see Supplementary file 1), (3) screening and selection of studies, (4) narrative synthesis of targeted studies, and (5) report production in the form of this review that was completed in 14 months." "**42 articles** included in the rapid review"	"The absence of literature around specific blue space sporting activities and the pleasure derived from recreational water activities (Head and Muir 2007) was surprising. Although articles identified restorative benefits of recreational activities near water for non-Indigenous people, findings suggest that non-Indigenous people do not frame these meanings in spiritual or cultural terms" (Witt et al. 2019).	"Emancipatory research that explores achievement of Indigenous objectives in water planning and management will benefit traditional owners and their partners. … future research may examine the role of rivers and water in non-Indigenous spirituality, culture, and the continuity of traditions and ways of life…some articles highlighted socio-cultural change in domestic water use in response to climate change."	Decolonial and ITEK connections. No direct crossover.	As a rapid review it is not as strong as it could be in its findings,.
Doyon et al. (2017)	"The aim of the study was to review the extent Indigenous and local understandings of transformation are represented in the scientific sustainability transformation literature…"	"Kohler et al. introduce ethical considerations of transitions as a new research direction stating there is a need for broader conceptual lens and heuristics to expand beyond Western theorists and human-centered impact…"	"we conducted an **integrative literature review**…This approach supports our aims of broadening conceptual lens and highlighting emerging themes in transitions research." "resulted in **22 relevant papers** for review"	"Emerging research directions Through our analysis, our experiences, and our positionalities, we identify several emerging research directions in the literature and discuss methodological and epistemological implications and opportunities….we discuss the phenomenon of epistemological superiority, issues with research methods, relationships to systems, justice, and governance, and connection to land."	"It is imperative we make space for Indigenous-led transitions research around the world and to develop methodologies and protocols for Indigenous-settler collaborations. We believe it is our responsibility as scholars to bring these issues to the foreground in a research community dominated by white scholars. For this community to change and become more inclusive, it is the responsibility of those with privilege to change, make space, and embody the principles of justice, decolonization, and ethical research practices we describe here"	**Strong decolonial and epistemological lens.** Connections with Linda Tuhiwai-Smith,	Perhaps the strongest review as far as decolonial practices and support for Indigenous led research methodologies.
Drake et al. (2018)	"To assess the degree and nature of community participation across the research process…"	"bridging Indigenous and Western science-based knowledges (see Table 1 for definitions) can more effectively address complex biodiversity conservation and co-management issues by enabling a holistic understanding of rapid environmental change (Berkes 2018; Reid et al. 2021)."	"A **scoping literature review** was performed on research and monitoring studies undertaken with community participation in coastal and marine environments across Inuit Nunangat" "remaining studies (n = 29 removed, n = **72 remaining**)"	"The near absence of collegial and Indigenous-led studies in our review emphasizes the need for projects in which communities have significantly more decision-making authority in aquatic research and monitoring. This absence has been echoed in other recent reviews"	"Although researchers from environmental and social sciences and other disciplines are striving to implement respectful ways to engage with Indigenous communities, our findings reveal a number of barriers and opportunities. A lack of clarity in terminologies used to describe community participation, and the inclusion of definitions not as a norm, but rather, individual decisions made by few authors, may delay, undermine, or misrepresent community participatory research as this field expands rapidly."	Berkes, Cajete, Johnson, Mazzochi, Reed, Reid, Thompson, Wilson.	No clear theoretical framework except for the definitions offered. "As calls for collaborations intensify in parallel to efforts to facilitate Indigenous self-determination in research, it is vital that researchers clearly communicate their use of terms and describe the associated participatory methods to promote transparent, robust, and reciprocal research that benefits both researchers and partner communities."
Druker-Ibanez & Cacaeres-Jensen (2019)	"To better understand how iLK has been integrated into sustainability education and the benefits and challenges associated with its incorporation,…"	"Thinking sustainability from the perspective of justice requires engagement with the distribution of positive and negative consequences of the environmental impacts associated with models of development." Theories anchored on epistemological justice foundations.	**Systematic review**: "to determine how iLK is being integrated into sustainability education research, a search was conducted in SCOPUS and wOS databases for empirical articles linking terms associated with iLK and eSD in english and Spanish published between 2015 and 2020." "the final corpus consisted of **20 empirical articles**"	"As a whole, the results of the reviewed research converge in highlighting the following aspects of iLK that could be integrated into formal education topromote sustainable development: a) the collective and collaborative nature of the learning processes that occur in the context of daily community activities; b) the dynamic and historical nature of iLK; c) iLKâ€™s holistic and integrated vision and, dependent on such vision; d) the general notion of respect for nature, other people, and spirituality that is grounded in ethical notions of solidarity and interconnectedness."	"These studies point to a general tendency to consider iLK as especially relevant to achieving epistemic transformations required by a development model orientated towards sustainability and not only economic growth."	Lam, Sumida Huaman, UNESCO frameworks, Zidny. **Strong decolonial and epistemological lens**	**The only review clearly addressing ITEK integrations into ESD.** Strong and well built arguments on the importance of framing these integrations through an epistemological justice lens.

Appendix 3. Critical sections - Page 2

Study	Research Questions	Theory/ Concept	Methods/ Procedures	Results	Implications	Connections to other research	Critique/ Significance
Galway et al. (2019)	"to characterize and synthesize the scholarly literature on solastalgia using a scoping review process"	"Solastalgia is a relatively new concept for understanding the links between human and ecosystem health, specifically, the cumulative impacts of climatic and environmental change on mental, emotional, and spiritual health."	"A **scoping review**, one of many different forms of knowledge synthesis, was identified as the most appropriate review method for mapping the solastalgia literature for several reasons." **"a total of 51 papers"**	"This scoping review has revealed that our collective understanding of the factors mediating the relationship between the lived experience of environmental change and solastalgia "such as place attachment, connectedness to nature, and sense of powerlessness is limited."	"Two-eyed seeing" is a framework that embraces both Indigenous and western ways of knowing in balance with one another and has the power to "reshape the nature of the questions we ask in the realm of Indigenous health research" "it is for Indigenous researchers and their communities to decide if the idea of solastalgia is useful to express experiences of negative environmental change or if existing concepts from Indigenous scholarship are more appropriate."	No direct overlap. **Moderate to strong decolonization references.**	Although introducing a new theoretical concept of solstagia, the review is weak in its mentions on how this Western term can affect Indigenous people and how in discussing why there is such little representation on Indigenous scholars in this literature.
Hadlos et al. (2022)	(RQ1) What forms of LIK appear in disaster literature? (RQ2) How has the research focus of LIK in disaster scholarship evolved over time? (RQ3) What are the priorities of the Sendai Framework (not) being captured in the current understanding of LIK in the DRR body of knowledge?	"The need to holistically review the literature on **LIK** stems from the phenomenon that a science-based stance still dominates the disaster discourse. Reasons include the persistent technocratic bias in disaster management and the dominant influence of scientific thinking in scholarship which favours more technical and formal means towards DRR."	"While a **systematic literature review** can serve a critical role in providing synthesis to identify research priorities and gaps, we further posit that such synthesis gains relevance if analysed against a backdrop of policy frameworks." **"remaining 325 documents"**	"With influential practitioners from global DRR organisations mostly being educated in scientific-based institutions, the mindset that science is more equipped than LIK in preventing risks continues to infiltrate DRR practice. … "key institutional structures continue to privilege discourses based on scientific and administrative expertise over locally contextualised knowledges, and to discount or dismiss social and cultural dimensions of risk …"	"we challenge future policymakers to consider crafting the position of LIK in future global frameworks as a knowledge system existing on its own right, and not just adjunct to scientific knowledge as how it is currently being represented."	Vasileiou & Petzold **Epistemological & epistemic justice lens.**	A fairly strong set of evidence of the benefit of ITEK (LIK) integrations as well as the challenges of blending the two systems of knowledge.
Hanspach et al. (2020)	"how the literature engages with the main principles of sustainability science, the inclusion of different knowledge types through interand transdisciplinarity and the attention to social justice issues and the consideration of normative goals as represented by the Sustainable Development Goals"	"participatory, transdisciplinary approaches that take into account multiple evidences in knowledge production processes and governance for sustainability"	"The **review process** was a combination of deductive and inductive and quantitative and qualitative approaches in order to gain a rich understanding of the available literature." **"a total of 178 papers"**	"this review also indicates very little implementation of the principles of transdisciplinarity in the scientific publications analysed, which can undermine the full potential of biocultural approaches in research for sustainability."	"a universal agenda for sustainability should acknowledge and accommodate diverse worldviews and value systems around the notion of 'development' and alternative ways of framing nature–society relationships, within which biocultural approaches have even been posed as potential basis for the improvement of sustainability indicators."	Ens & Kopnina **Transdisciplinary and inter-disciplinary research connections.** **Weak decolonial lens.**	Introducing bioculturality as an enhanced perception of ITEK which also includes rural and urban knowledge. Intentionally vague in avoiding to mention that power dynamics are related to colonialism.
Knopp et al. (2022)	(1) improve understanding of documented IK resources on the topic of Arctic freshwater biodiversity; (2) determine if observations from previously documented IK could contribute to mapping freshwater biodiversity across the circumpolar Arctic; (3) determine if observations from previously documented IK could support the identification of emerging trends in Arctic freshwater biodiversity and habitats; and (4) identify synergies or discrepancies between IK and WS knowledge bases, or new information or trends in Arctic freshwater biodiversity not documented through WS methods.	"The assessment focused on biodiversity data compiled from western science (WS), a term used here and throughout this paper following the definitions of Cajete (2000) and Mazzocchi (2006), including government, industry, and academic monitoring data from all Arctic countries. A high priority for this assessment was to ensure inclusion of IK, recognising its valuable contribution to characterising and monitoring freshwater biodiversity in the Arctic."	"**systematic literature review** of previously documented IK on freshwater was conducted following the methods of Kouril, Furgal, and Whillans (2015) and Breton-Honeyman, Furgal, and Hammill (2016)." **"the first 200 results"**	"this study demonstrated that IK provides valuable information towards determining Arctic freshwater biodiversity baselines and patterns of change"	"this study demonstrated that IK provides valuable information towards determining Arctic freshwater biodiversity baselines and patterns of change."	Berkes, Cajete, Mazzochi, Reid, Wilson **No mention whatsoever of power dynamics and colonization although it would be absolutely relevant.**	No mention whatsoever of power dynamics and colonization although it would be absolutely relevant. Weak mention of the discrepancies between WS & ITEK. This review is relevant as far as the integrations protocols, but weak from the critical perspective.

Appendix 3. Critical sections - Page 3

Study	Research Questions	Theory/ Concept	Methods/ Procedures	Results	Implications	Connections to other research	Critique/ Significance
Lam & Hinz (2020)	"The aim of this study is to review to what extent indigenous and local understandings of transformation are represented in the scientific sustainability transformation literature."	"the diversity of how transformations can be understood within the Western scientific knowledge system. Following Patterson et al. (2017), we briefly introduce how four prominent conceptual approaches to transformations from the global sustainability literature understand transformations: (1) socialecological transformations, (2) sustainability transitions, (3) transformative adaptation, and (4) sustainability pathways (Table 1)."	"we conducted **a systematic literature review** of ILK in contexts of transformation, transition, and change." **"final set of 81 papers"**	"Our literature review reveals that the discourse on sustainability transformations lacks understandings of transformations from ILK systems."	"future sustainability transformation research that engages with ILK should be transparent about how ILK is understood and which research designs and methodologies are applied. Research, which engages with ILK, needs to also apply different innovative methods to deal with the complexity of ILK and to make insights from local and place-specific ILK useful for other regions of the world that also undergo processes of change."	Berkes, Reid, Smith, Wilson. **Mainly epistemological & epistemic justice lens.**	Strong evidence of the need of plurality and epistemic fairness in working with ILK. Surprisingly although Western scientific and epistemological domination is amply discussed no mention is made about the colonial power dynamics involved in this skewed interaction.
Lam & Dodd (2019)	What does the published literature tell us about Indigenous CBM of food security in the context ofclimate change?	"Community-based monitoring (CBM) is often considered a promising strategy to improve monitoring of, and local adaptation to, environmental change."	"We examined the published literature using **a systematic review methodology** for climate change adaptation outlined by Berrang-Ford et al (2015) involving a stepwise process of selection, extraction, analysis, and synthesis of the literature." **"a total of 86 articles were included"**	"Multiple evidence-based (MEB) approaches offer a way forward for Indigenous and non-Indigenous collaborators to work together in developing CBM systems that respects and reflects different contributions. MEB approaches view Indigenous, local, and scientific knowledge systems as generating different manifestations of knowledge, that when viewed as complementary, can generate new insights to support decision-making	"Considering the history of unethical research conducted on and not with Indigenous communities, there is increasing demand for the recognition of Indigenous peoples' contributions and knowledge in the context of research, including climate change research."	Ens & Smith **Decolonial connections with multiple references in the bibliography.**	A good review of CBM and the challenges encountered in ITEK integrations.
Loch & Riechers (2022)	"we aim to (i) highlight the biogeographical specificities of studies on ILK by highlighting to which biophysical aspect and ecosystem the knowledge is related; (ii) summarize the challenges, as well as (iii) the benefits for management and research."	"The difficulties in approaching the knowledge from IPLC are reflected in the difficulties the literature has in describing and naming it. The current literature does not give a universal definition of ILK, instead many terms are used to establish what IPLC know. Each of the terms carries different implications: traditional and Indigenous knowledge describes a longstanding knowledge-practice-belief complex, whereby local knowledge lacks the dimension of historical and cultural continuity."	"We conducted **a systematic literature review** of English language scientific articles addressing ILK and conservation management of coastal ecosystems. The review followed the multiple step PRISMAsystem (Moher et al., 2009). Articles were identified via the SCOPUS database ( ) by using a search string comprised of multiple components (Appendix Table A1)." **"resulting in 254 papers"**	"The historical marginalization of Indigenous local knowledge (ILK) has had severe impacts on ILK itself, Indigenous peoples and local communities and overall perception of coastal social-ecological systems. Concluding, ILK helps to preserve culture and tradition and thereby benefits conservation efforts."	"ILK inclusive research is, hence, a fundament, which should not colonize and undervalue ILK. In order to strengthen the benefits of ILK, the current position of ILK in research and management of ecosystems needs to be further developed."	Berkes, Lam, Mazzochi, McElwee, Reyes-Garcia, Thompson, Wilson. **Strong anti-colonial critical lens.**	A very well conducted and large data set review of the importance of ILK integrations and how they are challenged by globalization, power dynamics and colonial side-effects. No direct mention of decolonial practices renders it incomplete.
Makate (2019)	"How can IK be useful in the adoption of climate-smart agriculture innovations in smallholder farming in SSA?"	"The study relied on the adaptations, institutions and livelihoods (AIL) framework to critically analyze the potential influence of LI and IK systems in improving the adoption of climate-smart innovations in smallholder agriculture. Figure 1 summarizes the AIL framework."	"A **review of relevant literature** from sub-Saharan Africa was used to answer the study research questions." **"81 met the inclusion criteria"**	"to get the best out of IK, research and development partners should find ways of complementing IK with scientific knowledge in climate change management works targeting rural communities. The mixture of old and new knowledge, however, should be made and controlled as far as possible by the indigenous people themselves."	"it has been found in the past that in areas characterized by modern agricultural practices, traditional practices are often disrupted and IK is abandoned."	Chanza **ITEK in SD focus, mainly on the benefits and much less on the challenges.**	One of the weakest studies as far as discussing clearly the epistemological challenges involved in ITEK integrations. Although conducted in Africa, colonially caused power imbalances are not referred to at all.
Malapane et al. (2022)	"provide an insight into the importance of IK research from a comparative African perspective from 1990 to 2020."	"IK consists of traditional local, non-scientific beliefs, customs, and methods that are normally described as informal forms of knowledge. The strengths of IK include—but are not limited to—legitimacy, credibility, prominence, and usability….IK has withstood the test of time and has been the pillar of rural communities, their livelihoods, and environmental conservation for decades."	"The paper used a combination of bibliometric analysis and the Preferred Reporting Items for **Systematic Reviews and Meta-Analysis** (PRISMA) protocol to provide a comprehensive view of IK research." **"20 top cited publications"**	"The literature provides evidence on the recognition and incorporation of IK within sustainable development research, knowledge enhancement, and the development of ecological approaches, methodologies, and frameworks….provides potential solutions and limitations of how IK has the ability to confront global change, ecological pressures, and other socio-economic and cultural changes"	"the direct linkages of IK to the ecosystem and human well-being that foster sustainability are not extensively researched in the African context; indeed, there is a need to develop models that can direct quantitative and qualitative data collection to allow enhanced predictions—including on how ecosystems benefit humans and how activities/strategies affect biodiversity and the amenities it provides."	Agrawal, Berkes, Chanza, Hill, Mazzochi, Thornton, Williams. **Strong decolonial connections.**	One of the meaningful reviews clearly addressing colonialism and its effect on the failure of proper ITEK integrations into SD. It does make helpful recommendations on solutions to address this problem and views ITEK & Western science collaborations in a positive manner.

Appendix 3. Critical sections - Page 4

Study	Research Questions	Theory/ Concept	Methods/ Procedures	Results	Implications	Connections to other research	Critique/ Significance
Manningtyas & Furuya (2022)	"The research question proposed in this study concerns the differences between TEK and EW."	"The objective of this study is to review and define the distinction between TEK and EW based on its definition, agents, sources, and research scope. We also analyze the relationship between keywords used by scholars and identify the connection and convergence of the thematic code."	"**a systematic literature review** was conducted of English articles, review papers, and book chapters in the cultural landscape context to answer the research question." "**31 TEK and 25 EW studies were included in the analysis.**"	"Both thematic cluster analysis and comparative analysis of primary studies revealed that TEK and EW are relatively similar, especially in the literature on cultural landscapes. However, they were distinct at the same time."	"Interaction and internalization between ecological knowledge, eco-practice experience, and tacit knowledge over time by involving an ethical mind and holistic approach could generate ecological wisdom at the individual level."	Atahyde, Berkes, Loch. Indigenous and local knowledge focus with **NO mention of colonial/ decolonial critical analysis.**	Relevant for the view of how ITEK coincides with modern iterations of ecological wisdom. No reflexivity was shown in the treatment of the two knowledge systems. No mention of power dynamic is made. It almost feels like the review is catering to the Western paradigm.
Mbah et al. (2021)	"What are the drivers of IKS-based climate change adaptation in the developing world? What IKS is being deployed and what are the outcomes? Who is deploying IKS and for whom? What are the implications for climate change education?"	"Postcolonial theory lens was applied to the review of the selected publications to highlight indigenous peoples agency, despite IKS marginalization through colonial encounters and the ensuing epistemic violence."	"this **systematic review** were derived from two databases Web of Science and ProQuest and other sources such as reference lists and google searches for more relevant articles and grey literature." "**the 39 articles included**"	"While the indigenous adaptation strategies derived from IKS are not perfect, their practices are characteristically sustainable and affordable as our analysis revealed, and IKS integration in climate change education is necessary to obtain the best of both worlds in the developing world."	"This integration will also preserve IKS since its erosion undermines the future adaptive capacity of indigenous communities. … create space for indigenous knowledge in educational frameworks intended to support adaptation to climate change so that current and future generations and areas with high vulnerability to climate change will have more options to implement adaptive strategies that would be relevant and effective for them. … climate change education should be holistic, participatory, place-based, and critical in its conceptualisation and application."	Petzold & Salim **Strong and clear anchor in post-colonial theory and decolonization lens.**	Perhaps the best example of decolonial lens application, this highly cited review demonstrates the importance of ITEK integrations and links the succes of these to epistemic justice practices. Very strong support for the theory.
McElwee et al. (2020)	1.What have been the contributions of ILK, practices and innovations to the sustainable use, management and conservation of nature and nature's contributions to people at regional and global scales? 2. What are the most important features, pressures and factors related to and/or enabling or constraining these contributions, as well as impacting present and future quality of life of IPLC? 3. What policy responses, measures and processes can contribute to strengthen and improve the institutions and governance of nature and its contributions to people with regard to IPLC?	"Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is charged with conducting regular policy-relevant assessments on the status, trends and future of biodiversity and ecosystems and their contributions to people."	"As authors who contributed to the GA, our goal in this paper is to critically evaluate the successes and challenges of working with ILK and the benefits of doing so. To do this, we discuss methodological steps taken for the GA and then outline key findings of the report that were enhanced by ILK." "**1,199 additional relevant documents in 16 languages**"	"The GA has shown the usefulness of a multifaceted and systematic approach to nature assessments that not only identifies where ILK can inform existing understandings of ecosystem health and human well-being, but also identifies the challenges and opportunities for engaged knowledge production in the future."	"acknowledging different value systems in decision-making has the potential for improving power asymmetries and equity issues in both science practice and policy implementation."	Agrawal, Berkes, Parsons, Reyes-Garcia, Shawoo. Indigenous and local knowledge focus with **NO mention of colonial/ decolonial critical analysis.**	While strong in its exploration of ITEK integrations including challenges, this review almost avoids discussing Western epistemologies as an issue, although it vaguely addressed power imbalances between stakeholders. This is important because it is written by the creators of the Global Assessment framework responsible for ITEK integrations into the SDG's. The tables describing the benefits of ITEK integrations are crucial in supporting the argument.
Petzold et al. (2020)	"How is evidence of indigenous knowledge on climate change adaptation geographically and thematically distributed in the peer-reviewed academic literature?"	"In order to support an adequate engagement with the existing and emerging research on indigenous knowledge in the Intergovernmental Published by IOP Publishing Ltd Panel on Climate Change (IPCC) assessments, this paper provides the first systematic global evidence map of peer-reviewed literature with evidence concerning indigenous knowledge on climate change adaptation, including a synthesis of geographic and thematic gaps and cluster."	"**a systematic scoping review methodology** to generate an evidence map that comprehensively engages with the existing and emerging research on indigenous knowledge." "**236 publications were considered for review**"	"The vast majority of climate studies using indigenous knowledge have been found to use an extractive model." "Future primary research with Indigenous peoples and about indigenous knowledge should engage with the decolonization agenda, in order to avoid an extractive approach to knowledge generation."	"There are inherent ethical sensitivities and power imbalances in collecting and using indigenous knowledge data in mainstream research contexts. To further the agenda of decolonizing research, it would therefore be useful if publications were explicit about the extent and nature of involvement of Indigenous peoples in the research process. This includes the production of new integrated knowledge as presented in the published articles, and whether a knowledge-sharing process had been agreed."	Berkes, Makondo, Reyes-Garcia, Singh & van Bavel. **Strong decolonial connections.**	One of the strongest and most meaningful reviews that articulates the direct link between colonial legacy and challenges to ITEK integrations. The fact that the map of evidence is spread globally is another strong attribute.

Study	Research Questions	Theory/Concept	Methods/Procedures	Results	Implications	Connections to other research	Critique/Significance
Proulx et al. (2021)	"(1) Locate and examine cases where TEK has been incorporated into a data system (collected, stored in digital form, and the metadata or data made open under some or all of the FAIR principles); (2) Identify and explore risks and limitations with the incorporation ofTEK into data systems; (3) Identify the important enabling factors that notably contributed to successful outcomes; and (4) Provide value- and process-based recommendations for observing systems to consider."	"The most successful relationships between western scientific institutions and Traditional Knowledge holders recognize the historical and cultural context that precede their relationships. Indigenous knowledge and property have been misused, decontextualized and even stolen by researchers. … Cochran et al. (2008) describe how "research has been a source of distress for [I]ndigenous people because of inappropriate methods and practices."	"This **review** considered a variety of sources, including gray literature, documentaries, scholarly peer-reviewed articles, book chapters, videos, and books." "Limiting the review to only literature would fail to recognize the oral nature of TEK, so various sources were considered including videos and conversations. … we did not conduct a formal scoping or systematic review." **"three successful projects"**	"Western ecological science often privileges quantitative work and instruments. TEK is often qualitative and represents a body of knowledge that is transmitted orally.These distinctions are not intended to be limiting or exclusionary, but rather to acknowledge two different ways of understanding the world, each with their own benefits. In general, these knowledge systems, while distinct from one another, can work together to create a more holistic approach to conducting scientific research. This concept is often called "Two-Eyed Seeing.""	"The most successful relationships between western scientific institutions and Traditional Knowledge holders recognize the historical and cultural context that precede their relationships. Indigenous knowledge and property have been misused, decontextualized and even stolen by researchers."	Aikenhead, Hill, Mackenzie, Mazzochi, & Singh. **Strong decolonial and critical lens.**	Although not a classic review, this is a great example of transformative, transdisciplinary approach blending different ways and methods of research in order to address. One of the stronger supports for the research questions. Important to include non-traditional approaches to ITEK & SD integrations.
Reed et al. (2021)	"How is the emergence of indigenous guardians represented in the literature? Are guardian approaches discussed in the literature representative of indigenous approaches to environmental governance?"	"Indigenous guardians are community-based environmental stewards who practice their cultural and traditional teachings on the land. These activities, although varying in design and operation, include responsibilities to monitor activities on their lands and territories; assist in the design of land and water management planning; support cultural revitalization and intergenerational knowledge sharing; and support wildlife and harvest monitoring."	"**a systematic review** of the peer-reviewed, published literature on indigenous guardians." **"83 articles for full-text review and analysis"**	"our review points to a systematic lack of local indigenous control over the funding and in some cases the design and implementation of indigenous guardian programs."	"Indigenous governments have the primary role in determining the objectives, boundaries, management plans and governance structures for IPCAs as part of their exercise of self determination (Indigenous Circle of Experts 2018:36). This approach could provide a means for local Indigenous Peoples to re-assert control over Country that was disrupted by settler colonization, by reinstituting traditional custodial and cultural responsibilities and building livelihoods based on natural and cultural resources."	Berkes, Ens, Hill, Foucault, Lam, Thompson, Tuck & Yang, Wilson. **Strong decolonial and anti-colonial critical lens.**	Important Canadian example on how to apply positionality, reflexivity, critical ad decolonial approaches. A strong support of Indigenous autonomous governance and the importance of ITEK integrations being conducted with the agency of Indigenous guardians.
Reyes-Garcia et al. (2021)	"observations of local climate change impacts to explore how it addresses ILK transferability, integration, and scalability"	"Most of this evidence comes from research in the natural sciences relying on large-scale weather records and the use of modelling techniques to describe impacts in data deficient regions."	"we **review scholarly publications** documenting first-hand IPLC observations of changes in social-ecological systems attributed to climate change." **"we reviewed 135 documents"**	"A network coordinating the scalability of place based research on climate change impacts is needed to bring Indigenous and local knowledge into global research and policy agendas." "Our search mostly captured scientist-led qualitative research, which – while facilitating place-based knowledge transferability to global research – did not include locally led efforts documenting climate change impacts."	"while the literature used illustrates ILK potential to become an alternative data source to evaluate the performance of global climate models, it also shows important geographical gaps and insufficient coordinating efforts to reach that potential. Thus, despite research increase, we still lack a community of practice (i.e. researchers, IPLC, practitioners, decision-makers) committed to upscaling ILK-based observations of climate change impacts in a coordinated way."	Parsons **Weak Indigenous and local knowledge focus with NO mention of colonial/decolonial critical analysis.**	Although having a large scope, this review is generic and weak in its description of the epistemological and power dynamic challenges involved in ITEK integrations. More so, the review is fully anchored in Western and modern science views and methods and makes no mention or gives due credit to the Indigenous methods which generate the meaningful climate data that the review is based on.
Salim et al. (2023)	"1. What are the types of traditional ecological knowledge (TEK)? 2. What are the impacts of TEK on economic activities? 3. What are the impacts of TEK on human health?"	"This research makes a contribution to the sustainable development goals by addressing the objectives of goal 1, which is to end poverty; goal 2, which aims to end world hunger; and goal 3, which aims to ensure that all people enjoy good health and wellbeing."	"this study will employ **a systematic literature review (SLR)** to identify the impacts of traditional ecological knowledge on indigenous people. … The method employed in the study is PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses);" **Final Result 19+4+23**	"traditional ecological knowledge plays an essential role in indigenous peoples' economic and physical wellbeing… Coordinated efforts between the local government and communities are needed to guarantee the preservation of crucial biodiversity knowledge that promotes both human and environmental wellbeing."	"The sustainability of biological diversity is being seriously threatened by the diminishing indigenous knowledge, which has been identified as one of the key dangers. The associated traditional knowledge may disappear if no effort is made to educate the next generation about the significance of these plants."	Agarwal, Berkes, SDG's, Shaffril, Singh, Smith. **Mild to moderate decolonial and critical lens.**	Meaningful contribution to placing focus on ITEK as its own system and set of knowledge. The review makes the case that protecting TEK is essential for the survival of Indigenous peoples since they are primarily using it for most of the basic and complex needs. De/colonial lens is mild yet its mentioned sufficiently to place it in the category of challenge to the integrations.

Appendix 3. Critical sections - Page 6

Study	Research Questions	Theory/ Concept	Methods/ Procedures	Results	Implications	Connections to other research	Critique/ Significance
Shaffril et al. (2020)	"What are the climate change adaptation strategies practiced by the indigenous people in the Asia Pacific region?"	"Based on the thematic analysis, seven themes were developed namely technology-assisted, traditional and local knowledge, social-related activities, livelihood diversity, government support, food and water securities, and physical infrastructure. Further analysis of the themes has resulted in 20 sub-themes."	"This study screened all the 200 selected articles by choosing the criteria for articles selection which is done automatically based on the sorting function available in the database…The present study was guided by **ROSES review protocol**." **"25 selected articles"**	"indigenous people still rely on environmental indicators (clouds, star, behaviour of wildlife, direction of the tide flow, snowdrifts, and direction of currents) to predict changes in the climate which are vital for their survival and lessening the impacts of the climate change	"This can narrow down the gap in available information on traditional knowledge and climate change adaptation, and to encourage respect for traditional knowledge and the role of indigenous peoples in policy development."	Shawoo Indigenous and local knowledge focus with **NO mention of colonial/ decolonial critical analysis.**	Although having a large scope, this review is generic and weak in its description of the epistemological and power dynamic challenges involved in ITEK integrations. No direct mention of epistemic justice or de/colonial lens is made.
Shawoo et al. (2019)	"This **review** evaluates the potential of the proposed local communities and Indigenous peoples' platform to effectively engage traditional ecological knowledge (TEK) for climate policy."	"As the platform is aiming primarily to foster knowledge dissemination and integration, theoretical underpinnings made by the TEK literature are essential to consult. … This paper, therefore, adopts an open-ended definition of knowledge which questions what knowledge itself is, rather than one that is subjective and distortionary."	(a) asses the literature on the role of IPs within the UNFCCC in conjunction with the scholarship on traditional ecological knowledge (TEK) and environmental management to develop a theoretical framework against which to evaluate the platform; (b) assess how well the platform addresses and fulfills the theories and recommendations presented within the literature on TEK; and (c) present recommendations for how the platform can be developed or restructured to engage IPs and their TEK.	"The analytical framework is designed around three themes: power, institutions, and colonial histories; social and cultural contexts; and participation, representation, and self-determination. Four criteria are identified for each theme against which to assess the platform."	"Indigenous scholars have argued that it is the responsibility of Western scientists themselves to find out what protocols are followed within individual communities in order to gain permission to use their cultural information. Further, Smith (1999) call for decolonising methodologies when accessing knowledge that require academics to approach research with IPs as partnerships that enable Indigenous leaders and knowledge keepers to fully drive, plan and design the process. At present, the platform does not appear to have the appropriate structures in place to account for adherence to such principles."	Berkes, Hill, Kimmerer, Parsons, Smith, Thornton. **Strong decolonial and anti-colonial critical lens.**	Very important review although not in direct way, but reviewing the literature connected to the main institutional UN body and UNFCCC platform responsible for monitoring ITEK integrations. The critical, epistemological, de/colonial lens utilized by the authors is extremely meaningful for the exploration of the epistemological dynamic between ITEK & SD.
Singh et al. (2021)	The study objectives were: (i) to assess the current state of emphasis being placed on traditional knowledge (TK), and knowledge co-production in Indian agricultural adaptation policies on climate change and associated stressors (ii) to understand the status of TK-led knowledge co-production in agriculture at the practice level using relevant examples, and (iii) to assess the successes and gaps in integrating TK in agricultural adaptation against climate change and associated environmental stressors at the policy and practice levels.	"for understanding and assessing a successful knowledge co-production using following five dimensions: knowledge gathering, sharing, integration, interpretation and application."	"Considering the research gaps in successful knowledge co- production to improve the adaptive capacity of Indian farmers to climate change and associated environmental stressors, we carried out a three step **systematic review** to critically examine the literature." **"we identified 67 documents"**	"The success of knowledge co-production was defined by the degree of active participation and as a joint venture between two (e.g. farmers and research institutions) or more stakeholders (e.g., policy makers, farmers and developmental agencies) in each dimension of the study framework."	"Based on key findings, we opine that there is a pressing need for the capacity development of stakeholders with emphasis on marginal TK holders so that issues of poor communication and distorted balance of power in co-production of adaptive knowledge are effectively addressed."	Agrawal, Aikenhead, Berkes, Hill, Reed, Williams. Indigenous and local knowledge focus with **NO mention of colonial/ decolonial critical analysis but with mild mentions of balance of power dynamics.**	Valuable analysis of ITEK knowledge co-production in India with very well built tables categorizing and visualizing ITEK integrations. No direct mention of de/colonial lens is made, but epistemic justice is linked to the importance if successful integrations.
Suberca seaux et al. (2021)	"(1) What epistemological approach, positioning, and elements, allow to comprehensively address RAMI and emerging complexities? (2) What implications do RAMI, and such emerging complexities, have for sustainability and traditional agriculture? (3) How has RAMI happened in the LPBâ€™s real case, and which complexities, implications and concrete effects have emerged?"	"Transdisciplinarity: joint problem solving between science, technology, and society referred to the approach as an epistemic goal of transdisciplinary research. The complexity of a societal problem requires to go beyond the exclusive domain of scientific experience. Therefore, research practices that focus on collaborations between scientific of different disciplines and actors from outside academia, are crucial."	"in this study we have sought to complement different knowledge and information sources, from different sectors and actors (local community authorities and peasants, academic researchers' experts, and local consultants) related to the research topic and problem, and different cases and experiences." "1) **A bibliographic search** was conducted, in order to collect antecedents on the re-search topic and problem." 275 results	"the epistemological approach and positioning developed and presented in this article allow us to perceive, and thus consider and incorporate in the analysis and reflections, the emerging complexities from the RAMI processes, corresponding to an own approach and positioning of transdisciplinary sustainability research."	"In contrast to agricultural modernization, there is evidence of alternative farming and rural developments, often leading to more sustainable farm production and rural areas. The literature describes practices that seek greater sustainability, labeled as low-input agriculture, agroforestry systems, polyculture agriculture, natural agriculture, permaculture, regenerative agriculture, agroecology."	Agrawal, Lang, Martens, Rockström, Steffen. The strongest transdisciplinary connection of the 29, as well as one of the strongest discussions of epistemology. **NO mention of colonial/ decolonial critical analysis**	The most important discussion and example of transdisciplinary research approach from the whole selection. The proposed blend of Sustainability Science and Transdisciplinarity is a meaningful example and exercise of the type of platforms needed for ITEK integrations. Surprisingly, no direct mention of de/colonial lens is made.

Study	Research Questions	Theory/Concept	Methods/Procedures	Results	Implications	Connections to other research	Critique/Significance
Thompson et al. (2020)	"How have Indigenous peoples participated in environmental monitoring, and how has their participation influenced monitoring objectives, indicators, methods, and monitoring outcomes?"	"Our work is informed by our positions as non-Indigenous scholars who conduct ecological and ethnoecological research in partnerships with Indigenous peoples in coastal British Columbia (NCB, KLT) and in the Northwest Territories (TCL) of Canada." "We also summarized how this literature discussed power, governance, and the use of both Indigenous and scientific knowledge in environmental monitoring efforts."	"This **review** was sparked by our collaborative work with the Gitga'at First Nation in coastal British Columbia, Canada to inform the design of a CBM program based on the knowledge of their harvesters." **"79 academic papers that met our selection criteria"**	"It is critical to examine and describe details of participatory monitoring initiatives, including who benefits from monitoring; otherwise, there is a risk of perpetuating projects that tokenize or coerce Indigenous communities rather than enabling transformation through the sharing of power."	"beyond encouraging governance arrangements that more closely link Indigenous monitoring to management, considering the sharing of power in monitoring initiatives early and often is essential to ensure that objectives, indicators, and methods are embedded in the values of Indigenous communities and appropriately engage Indigenous knowledge"	Berkes, Ens, Lam, Thompson, Wilson. **Strong decolonial and anti-colonial critical lens.**	One of the strongest treatments of ITEK integration and the challenges encountered being directly linked with disproportionate power dynamics and the domination of modern science.
van Bavel et al. (2020)	"We examined the inclusion of diverse knowledge systems in climate-health literature, focusing on: (1) analytical framing of integrated monitoring and surveillance system processes; (2) key contributions of Indigenous knowledge and local knowledge systems to integrated monitoring and surveillance systems processes; and (3) patterns of inclusion within these processes."	"we chose the Mixed Methods Appraisal Tool (MMAT)" "The literature search aimed to systematically and transparently identify empirical papers that: (1) documented monitoring and/or surveillance system; (2) integrated climate and health information or data; (3) included locally inclusive or participatory approaches; and (4) included multiple and diverse knowledge systems in MSS processes."	"We conducted **a systematic review**, synthesis, and confidence assessment of the published literature on integrated monitoring and surveillance systems for climate change and public health." **"24 studies met the inclusion criteria"**	"The value of our findings and this review demonstrate how neither scientific, Indigenous, nor local knowledge systems alone will be able to contribute the breadth and depth of information necessary to detect, attribute, and inform action along pathways of climate-health impact. If we are to advance our understanding of how and to what extent climate change is affecting health, then the equitable inclusion of diverse knowledge systems is paramount."	"There is intrinsic value that knowledge systems create for their own knowledge holders; far outside of the added-value to scientific research approaches, aims, and activities. Unfortunately, a majority of climate-related studies that access IKS and LKS still employ an extractive model of practice when engaging with Indigenous and local communities."	Agrawal, Battiste, Berkes, Lam, Reed. Strong treatment of Western hegemony but **NO mention of colonial/decolonial critical analysis**	Excellent discussion of Western scientific dominance in ITEK integrations and clear demands to review ideological and paradigm positionality of Western science as an obstacle to ITEK and Indigenous people. Surprisingly, no direct mention of de/colonial lens is made.
Vasileiou et al. (2022)	"This systematic review and evidence synthesis examined deliberate, researcher-initiated, efforts to integrate local and scientific knowledge within the context of DRR and EWS, exploring the motivations for knowledge integration, the processes of knowledge integration and the outcomes of these processes."	"A guiding principle underlining the Sendai framework is that local authorities and communities should be empowered through inclusive, accessible, and non-discriminatory participation. The deployment of traditional, indigenous, and local knowledge and practices, alongside scientific knowledge, in disaster risk assessment and management is strongly advocated so that policies and strategies respond to the needs of local communities and contexts."	"**A systematic review** and evidence synthesis of academic literature was designed. Empirical studies which described deliberate, researcher-initiated efforts to integrate local and scientific knowledge within the context of DRR and EWS were identified and analysed." **"twenty empirical studies were eligible for inclusion in the review."**	"Two main problems were reported in the literature that motivated researchers to attempt knowledge integration. These were, on the one hand, the non-adoption or even opposition by local communities of top-down DRR measures - though acceptance of scientific DRR measures is highly variable across the globe and appears to relate to the amount of economic resources communities hold - and on the other the limitations and insufficiency of scientific or local knowledge alone."	"The recognition of multiple forms of knowledge constitutes an important pillar of the concept of disaster justice."	Agarwal, Shaw, Smith, van Bavel. Weak treatment of the topic, superficial and incomplete, **NO mention of colonial/decolonial critical analysis.**	This is one of the weakest if not the weakest example of a superficial treatment of ITEK integrations even though it is written as a SR. There is almost no description of the epistemological and power dynamic challenges and No direct mention of epistemic justice or de/colonial lens is made.
Zurba et al. (2022)	"An increasing need for novel approaches to knowledge co-production that effectively and equitably address sustainability challenges has arisen in the twenty-first century. Calls for more representative and contextual co-production strategies have come from Indigenous communities, scientific research forums, and global environmental governance networks."	"Knowledge co-production means different things to different actors in different contexts; it encompasses science and governance philosophies, discursive frames, normative stances, relationships between science and society, organizational and institutional structures, theoretical and methodological frameworks, and research processes and outcome."	"We conducted **a systematic review** of peer-reviewed and grey literature on knowledge co-production published from 2000 to 2020." **"interpretation of 102 studies"**	"the findings from this review support the principles described by Norstrom et al. (2020), yet place greater emphasis on power dynamics. As such, the principles and approaches found here importantly show that markers of success should also include non-conventional outcomes (e.g., youth empowerment) and alternative avenues for mutual understanding (e.g., Two-Eyed Seeing), including assessments of the distribution of power amongst co-producers."	"even the most well-intentioned efforts to engage with complementary knowledge systems must be aware that they may unintentionally magnify power imbalances. Acknowledgement of the context of knowledge is one step towards balanced power relations for equitable knowledge co-production."	Berkes, Cajete, Hill, Latulippe, Johnson, Nortsröm, Reed, Reid, Singh, Wilson. **Strong epistemolgical, decolonial and anti-colonial critical lens.**	This is THE ONLY review found that directly addresses the need for knowledge co-production of ITEK and (E)SD/WKS, and the power imbalances that these create, to be clearly discussed and analyzed across the studies and literature on the topic. The strongest study in the selection and a model on how to treat this topic.
Zvobgo et al. (2022)	"we assess the influence of IK and LK for the implementation of water sector adaptation responses in Africa to better understand the relationship between responses to climate change and indigenous and local knowledge systems."	"This was based on IPCC framing of the IK and LK systems and practices for climate change adaptation in AR6."	"We conducted **a structured assessment** of the academic literature published between 2013 and 2019, aligned with the timeframe of the IPCC 6th Assessment." **"73 articles (36.5%) had evidence of the use of IK and LK"**	"Overall, there is high evidence of water adaptation responses implemented in the east, west, and southern African regions and little evidence in North and Central Africa. These results are consistent with reviews of responses to climate-related water scarcity in Africa, as well as reviews of climate change research funding for Africa."	"Most of the adaptation responses in literature are highly localised and implemented to address specific situations. Scaling up of some of the knowledge and creating platforms to advance the sharing of the knowledge is key to ensure a regional transformative adaptation process."	Chanza, Makondo, Nyong, Petzold, Singh, Williams. Weak epistemological focus with **NO mention of colonial/decolonial critical analysis.**	Another review making efforts to demonstrate ITEK integrations benefits without being willing to tackle the epistemological issues involved in ITEK interactions with Western science. Surprisingly for an African located research, no direct mention of de/colonial lens is made.

Appendix 3. MMAT Criteria Analysis for the Selected Studies - Part 1

Study	Clear Research Question	Comprehensive Search Strategy	Clearly Defined Inclusion and Exclusion Criteria	Systematic Study Selection	Appropriate Quality Assessment	Synthesis of Findings	Overall Quality of Evidence Assessed	Limitations Discussed	Total Score
Downey et al. (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Doyon et al. (2021)	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	7/8
Drake et al. (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Druker-Ibáñez & Cáceres-Jensen (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Can't tell	5/8
Galway et al. (2019)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Hadlos et al. (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Hanspach et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Knopp et al. (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Lam et al. (2020)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Lam et al. (2019)	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Can't tell	Yes	5/8
Loch and Riechers (2021)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Makate (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	7/8
Malapane et al. (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	7/8
Manningtyas and Furuya (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	No	5/8
Mbah et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8

Appendix 3. MMAT Criteria Analysis for the Selected Studies - Part 2

Study	Clear Research Question	Comprehensive Search Strategy	Clearly Defined Inclusion and Exclusion Criteria	Systematic Study Selection	Appropriate Quality Assessment	Synthesis of Findings	Overall Quality of Evidence Assessed	Limitations Discussed	Total Score
McElwee et al. (2020)	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Can't tell	6/8
Petzold et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	7/8
Proulx et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Reed et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	7/8
Reyes-Garcia et al. (2022)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Can't tell	5/8
Salim et al. (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Shaffril et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Shawoo and Thornton (2019)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Can't tell	5/8
Singh et al. (2021)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	6/8
Subercaseaux et al. (2021)	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Can't tell	5/8
Thompson et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
van Bavel et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Vasileiou et al. (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8/8
Zurba et al. (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	7/8
Zvobgo et al. (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	8/8

Appendix 4 + Critical Themes / Rating Theme Distribution

Appendix 4. Critical Themes - Page 1

STUDY	FOUNDATIONAL ELEMENTS			CRITICAL PERSPECTIVE of FOUNDATIONAL ELEMENTS		FINDINGS
(Authors & Year)	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/ or ESD	Western Epistemology / Eurocentrism	Colonialism / Globalization / Decolonization	Epistemological Justice	Critique/ Significance
1. Downey et al. (2022)	"in an Indigenous worldview, waterways are infused with spirit and holders of deep knowledge, animate entities that enable temporal ties with ancestors, Country, and culture (Barber 2018)."	"Increased water management partnerships may further nonIndigenous understandings of the importance of cultural and environmental flows to all people's."	"The result has been the perpetuation in water policy of a colonizing worldview that ignores marginalized voices (Berry and Jackson 2018; Downey and Clune 2020)."	"First, the few articles that addressed Indigenous recreational meanings of water showed how historical and contemporary colonist policies have compromised Indigenous sporting activities, culture, and skills sets, such as those of female swimmers, with ramifications for Indigenous peoples individual and community health."	"In light of the centrality of water to Indigenous health, it is a striking omission that water is not considered a social determinant of health and consequently is neglected in contemporary health and wellbeing policies."	"The absence of literature around specific blue space sporting activities and the pleasure derived from recreational water activities (Head and Muir 2007) was surprising. Although articles identified restorative benefits of recreational activities near water for non-Indigenous people, findings suggest that non-Indigenous people do not frame these meanings in spiritual or cultural terms (Witt et al. 2019)."
2. Doyon et al. (2021)	"Historical exclusion from decision-making processes, inadequate resources, and colonial biases in research and practice pose serious challenges for ensuring Indigenous peoples are fully engaged in sustainability transitions."	Krupa et al. discuss this point in relation to Indigenous participation in multilevel governance and co-management, citing Nadasdy and Coulthard when explaining that integration of TEK is impossible or undesirable, as the process effectively reproduces the inequities that the incorporation TEK was meant to address.	"Part of this work includes questioning our own (un)conscious biases when it comes to methodologies and epistemologies. What is credible knowledge, and who gets to decide? Whose stories get told, and who tells those stories? For this integrated literature review, we investigated the representation of Indigenous peoples, and knowledge within transitions scholarship."	"transitions research needs a deeper and fuller engagement with post- and decolonial thought across the social science and humanities.. In locations with settler/ colonial/Indigenous cultures, it is important for practitioners and researchers to acknowledge the complex histories and engage in recognition justice within transitions processes."	"Transitions scholars must move past the idea of representation towards recognition, and hopefully/eventually reconciliation. We need to actively engage in decolonizing our research practices. Holding the pen is not just about the stories we privilege; it is also about the things we name and the lines we draw."	"In moving forward with this call to actively engage in de-colonizing research practices, we want to bring attention to Indigenous scholars that have done important work in directing this praxis."
3. Drake et al. (2022)	"This knowledge is subjective and dynamic, and is passed down through generations in oral tradition, observation, and practice (Ingold and Kurttila 2000; Berkes 2018). Similar terms include: … traditional ecological knowledge (TEK), local knowledge, local ecological knowledge (LEK), and Inuit Qaujimajatuqangit (IQ), which encompasses Inuit values and worldviews."	"Indeed, bridging Indigenous and Western science-based knowledges (see Table 1 for definitions) can more effectively address complex biodiversity conservation and co-management issues by enabling a holistic understanding of rapid environmental change."	"The near absence of collegial and Indigenous-led studies in our review emphasizes the need for projects in which communities have significantly more decision-making authority in aquatic research and monitoring."	No direct mention. "The need for improved reporting and enhanced transparency emerged from our difficulties as settler academic, government, early career, and student researchers in grasping the nature and extent of community participation in published research and monitoring."	"There is a need to characterize participation and improve the transparency of this participation to continue to develop good practices."	"In this paper, we consciously sought to draw and build upon the work of Indigenous scholars working with and within Indigenous communities. … we hope to amplify Indigenous voices, and we gratefully acknowledge the contributions and knowledge shared by these scholars and by all those who participated in each study. We are committed to ongoing learning and unlearning and do not purport to speak for Indigenous Peoples."
4. Druker-Ibanez & Caceres-Jensen (2022)	"Indigenous and Local knowledge (iLK) encompasses the knowledge and practices contextualised in the daily local experiences that guide the society-nature relationship of indigenous and rural communities."	"This paper discusses the educative agenda of the sustainability paradigm from a framework of environmental end epistemological justice, specifically concerning the role that indigenous and Local Knowledge (iLK) have, and could have, in improving and supporting education for Sustainable Development (eSD)."	"epistemological and political dynamic based on the belief in the absolute supremacy of westernized Scientific Knowledge, which has as a direct consequence on the exclusion, invisibilisation or rejection of different knowledge systems and epistemologies"	"The extent to which this integration can effectively constitute a decolonizing move, in alignment with the approach of environmental and epistemological justice, depends on the directionality of the relationships between distribution of legitimacy and recognition of agency of local and scientific actors implicated in each integration experience."	"The democratisation required by sustainability at this level faces a long-standing problem referred to as epistemic violence…, epistemic supremacy … abysmal thinking (Santos 2018) or cognitive injustice (Rodriguez 2017), depending on the theoretical framework associated with de-colonial perspectives."	"Bidirectional relationships allow for the meanings and practices framed in iLK to effectively dialogue with those of western scientific knowledge without losing their cultural integrity, fostering a true articulation between different ways of knowledgethat could only bring forth a robust response to the environmental and social challenges we currently face."
5. Galway et al. (2019)	"Knowledge is holistic, cyclic, and dependent upon relationships and connections to living and non-living beings and entities. Second, there are many truths, and these truths are dependent upon individual experiences. Third, everything is alive. Fourth, all things are equal. Fifth, the land is sacred. Sixth, the relationship between people and the spiritual world is important. Seventh, human beings are the least important in the world."	"**solastalgia** and a call to better understand Indigenous peoples lived experiences of landscape transformation and degradation in the context of historical traumas."	"Solastalgia, preliminarily and broadly defined as the distress caused by the transformation and degradation of one's home environment [1–3], is a relatively new concept with particular relevance to the environment–health–place nexus."	"Indigenous peoples collective and layered experiences of historical trauma like land dispossession, colonization and forced assimilation, boarding/ residential schools, and broken nation-to-nation treaties may also shape experiences and responses to climatic and environmental change, or the intensity of experiences of solastalgia."	"an Indigenous scholar asserted that solastalgia is a colonized word, and using the term solastalgia (to describe Indigenous experiences) feels like trying to knock a square peg into a round hole. There are Indigenous concepts that can be used to describe solastalgia-like experiences better."	"Among the 17 empirical papers in our final sample, we found that no research was conducted by or in collaboration with Indigenous peoples." "This review highlighted that some regions of the world (e.g., global south) and specific population groups (e.g., youth, Indigenous peoples) are under-represented in the literature."

STUDY	FOUNDATIONAL ELEMENTS			CRITICAL PERSPECTIVE of FOUNDATIONAL ELEMENTS		FINDINGS
(Authors & Year)	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/or ESD	Western Epistemology / Eurocentrism	Colonialism / Globalization / Decolonization	Epistemological Justice	Critique/ Significance
11. Loch & Riechers (2022)	"Integrated, holistic, social and ecological knowledge, practices and beliefs pertaining to the relationship of living beings including people, with one another and with their environments; grounded in territory, highly diverse and continuously evolving through the interaction of experiences, innovations and various types of knowledge (written, oral, visual, tacit, gendered, practical and scientific); empirically tested, applied, contested and validated through different means in different contexts."	"Indigenous and local knowledge (ILK) is increasingly recognized as a valuable asset in sustainability science. Knowledges of Indigenous peoples and local communities is becoming a critical tool for understanding coastal social-ecological systems and coping with global changes."	"While our work aimed to highlight and promote ILK inclusion in management and research, our conducted research, the results and implications are dominated by a Western scientific logic." "Overcoming this dichotomy within western science may allow a rethinking and reorganisation of different types of knowledge and enable a more inclusive approach to ILK and therewith open the possibilities for generating novel governance, management and policy approaches."	"The most frequently mentioned challenge of partnership and collaboration was the challenge of cross-cultural work (16.1%). Building trust, power imbalances and the engagement in colonial paradigms were at the core of these challenges." "As long as colonial legacy in form of post-colonial and paternalistic attitudes remain, mutual knowledge production and research remain challenging."	"The exclusive consideration of literature which adheres to Western scientific standards may have led to a falsified representation of ILK integration in management and research." "The enforcement of new governance structures by colonial powers often weakened or even abolished customary management practices." "Inadequate inclusion of ILK in research and/or management based on historical, colonial systemic marginalization and devaluation of ILK and IPLC."	"ILK inclusive research is, hence, a fundament, which should not colonize and undervalue ILK. In order to strengthen the benefits of ILK, the current position of ILK in research and management of ecosystems needs to be further developed."
12. Makate (2019)	"IK is the institutionalized local knowledge built upon and passed on from one generation to another, usually by word of mouth."	"With impeccable evidence that IK and LI play a critical role in the adoption and scaling of climate-smart innovations, the key question will then be how to effectively embrace IK and LI for effective adoption and scaling of climate-smart innovations."	"IK is often treated as secondary in climate change adaptation debates." "IK should not be developed or harnessed as a substitute for formal scientific knowledge. The objective should be to find best ways of complementing IK and formal knowledge systems for enhanced climate resilience in smallholder farming."	"This explains why Church leaders in Kenya have joined other stakeholders in advocating for support from developed countries (who have immensely contributed to carbon emissions) in local climate change management (Nzwili, 2014). LI can also help external institutions to align their interventions with local needs, which enhance the effectiveness of such external interventions."	"The noble thing to do to get the best out of IK systems in spreading climate-smart innovations will be recognizing its existence and then incorporating it into designs, plans, and implementation frameworks for promoting innovations."	"to get the best out of IK, research and development partners should find ways of complementing IK with scientific knowledge in climate change management works targeting rural communities. The mixture of old and new knowledge, however, should be made and controlled as far as possible by the indigenous people themselves."
13. Malapane et al. (2022)	"IK consists of traditional local, non-scientific beliefs, customs, and methods that are normally described as informal forms of knowledge [32]. The strengths of IK include"but are not limited to legitimacy, credibility, prominence, and usability."	"The literature provides evidence on the recognition and incorporation of IK within sustainable development research, knowledge enhancement, and the development of ecological approaches, methodologies, and frameworks."	"Western scientific knowledge has suppressed indigenous cultural belief systems, practices, and taboos of native communities." "What can be observed is that other countries outside the African continent are telling the African narratives primarily countries from the Global North."	"Colonialism plays a key role in the disappearance of knowledge, practices, and systems in Third World countries." "Between 2015 and 2017, the world witnessed a new revolution throughout South African universities, known as #feesmustfall; this called out for the decolonization of the educational system."	Globally, countries show great collaboration, solidifying the stance of IK as a concept of interest and increasing popularity within the academic space. The African continent shows excellent collaborations between countries, …South Africa is one of the few countries within the African continent that recognizes and documents the knowledge of indigenous people (such as the Khoi and San people)."	"there is a lack of research based on the integration of IK and scientific knowledge to foster resilient communities, cater to ecological development strategies, and foster sustainable development and growth. … need for more research on how to develop strategic approaches, methodologies, and frameworks that are inclusive of IK, as it has the potential to provide solutions to the current ecological and socio-economic crises faced by the world. "
14. Manning-tyas et al. (2022)	"TEK, also called by other names including indigenous knowledge or native science, refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment."	"The study of TEK has argued for an effort to enhance environmental sustainability by learning how the indigenous population adapts to natural changes."	"EW is defined as the best expertise of pure improvisation for and from ecological practice that enables a person or community to make not only ethical judgements, but also take circumspect action on ecological practices" "EW was developed either by a person, community, or organization because it is based on the human ability to act and do well in response to environmental conditions."	No direct mention of any of the concepts.	"The convergence study between TEK and EW should be conducted within the scope of indigenous cultural capital, traditional knowledge, ecosystem services, and sustainable development."	"Interaction and internalization between ecological knowledge, eco-practice experience, and tacit knowledge over time by involving an ethical mind and holistic approach could generate ecological wisdom at the individual level."
15. Mbah et al. (2021)	"indigenous knowledge systems (IKSs), which refer to cultural, traditional, and local knowledge that is unique to a specific society or culture and encompasses skills and technology derived from systems of production and consumption. IKS is also fundamentally relational, linked to the land, language, and intergenerational transmission of songs, ceremonies, protocols, and ways of life."	"IKS is a crucial part of the solution to climate change, with respect to mitigation and adaptation." "most of the reviewed articles concluded that IKS has been helping the communities studied to adapt to climate change" "This implies that the integration of IKS with scientific knowledge in climate change education will provide more proactive strategies for climate change adaptation in the developing world."	"The validity and rationality of IKS cannot be measured by Western knowledge systems and standards, and vice versa, because both knowledge systems are rooted in the different cultures they emanate from, with differing epistemologies and values."	"Majority of the countries in the developing world were previously colonised and with the imposition of Western knowledge systems, colonialism violently disrupted relational ways, dismantled relational worldviews, and marginalised indigenous ways of knowing."	"The postcolonial theory discussed earlier also explains why engaging the voices and perspectives of indigenous people is important in their own education, especially to contest epistemic violence."	"We argue that the integration of IKS-based climate change adaptation strategies with the scientific knowledge already established in the formal education systems of developing world contexts is necessary for the decolonisation of climate change education."

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(Authors & Year)	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/or ESD	Western Epistemology / Eurocentrism	Colonialism / Globalization / Decolonization	Epistemological Justice	Critique/ Significance
6. Hadlos et al. (2022)	"When taken independently, the term local knowledge is derived from a community place-based relationship with the local environment while indigenous knowledge is gained from long-term cultural ties or traditional ownership of a place." "In the existing literature on disaster risk reduction (DRR), such strategies and practices emerge as products of what is conjunctively referred to as local and indigenous knowledge (LIK)."	"LIK alone is insufficient to reduce disaster risk, while scientific knowledge is devoid of the holistic picture to understand the local vulnerability context. Combining the two knowledge bases renders more precise information useful for decision making"	"The need to holistically review the literature on LIK stems from the phenomenon that a science-based stance still dominates the disaster discourse. Reasons include the persistent technocratic bias in disaster management and the dominant influence of scientific thinking in scholarship which favours more technical and formal means towards DRR."	"Among the contributing factors include state-sponsored or endorsed racism, historical isolation, ongoing marginalisation, and institutional inertia. This disregard for the potential use of LIK for effective DRR remains pronounced and can be explained by two broad and dominant influences: the persistence of scientific hegemony and the inherent technocracy among institutions and governing bodies."	"Along this, we challenge future policymakers to consider crafting the position of LIK in future global frameworks as a knowledge system existing on its own right, and not just adjunct to scientific knowledge as how it is currently being represented." "The perception that outside, expert-led knowledge is superior disempowers communities and may damage their local institutions"	"With influential practitioners from global DRR organisations mostly being educated in scientific-based institutions], the mindset that science is more equipped than LIK in preventing risks continues to infiltrate DRR practice. …"key institutional structures continue to privilege discourses based on scientific and administrative expertise over locally contextualised knowledges, and to discount or dismiss social and cultural dimensions of risk …"
7. Hanspach et al. (2020)	"The term biocultural diversity has partly been confined to the realm of indigenous and local people's worldviews and livelihood strategies and their effects on biodiversity."	"a universal agenda for sustainability should acknowledge and accommodate diverse worldviews and value systems around the notion of development and alternative ways of framing nature "society relationships … within which biocultural approaches have even been posed as potential basis for the improvement of sustainability indicators"	"Diverse ontological, epistemological and ethico-political dimen-sions of biocultural approaches have also been stressed by different sectors of academia, practice and global environmental policy-making"	"findings eventually reinforce Poole's (2018) idea that the SDGs still neglect fundamental qualities of cultural sovereignty, which are key in maintaining sustainable practices, values and lifestyle habits and that an 18th goal, which acknowledges biocultural heritage, should be included." **No direct mention of de/ colonization!**	"Diverse ontological, epistemological and ethico-political dimen-sions of biocultural approaches have also been stressed by different sectors of academia, practice and global environmental policy-making."	"It is argued that while sustainability is largely a matter of culture, neither local ecological knowledge, cultural values and alternative economic practices, nor their interrelation with biodiversity are currently mentioned by any SDG in the pathway to sustainability."
8. Knopp et al. (2022)	"The concept that all species are connected through food webs and, in turn, are influenced by environmental forces is well-understood by harvest-based Indigenous communities around the globe."	"The reliance of Indigenous communities on freshwater ecosystem services promotes a strong connection to the land and unique in-depth understanding of organisms and ecosystem processes."	"Arctic Indigenous Peoples have a different worldview of the natural world than what is seen in the WS paradigm, creating an awkwardness in cataloguing IK within existing scientific frameworks."	"the CBMP also recognises that it is critical to approach this in a way that is respectful to the knowledge holders and does not seek to ignore their right to ownership of their knowledge." **No direct mention of de/ colonization!**	"studies involving IK of Arctic freshwater biodiversity should include rigorous qualitative interviews with knowledge holders and diverse methods of engaging with IK such as historical research using archival and oral history, and linguistic methods since Indigenous place names can indicate former ecological conditions."	"Such information is of vital importance to provide longterm records of fish composition and abundance, especially when this information does not exist in other forms of knowledge such as WS datasets."
9. Lam & Hinz (2020)	"Indigenous and local knowledge (ILK) is "local and context-specific, transmitted orally or through imitation and demonstration, adaptive to changing environments, collectivized through a shared social memory, and situated within numerous interlinked facets of people's lives"	"Brondizio and Le Tourneau (2016) argued that involving indigenous peoples and local communities is essential to develop and implement more effective environmental governance systems for ecosystems and biodiversity."	"Diverse definitions of and approaches to transformation exist in the literature (Patterson et al. 2017, Blythe et al. 2018). They are decisively influenced by Western scientific knowledge because it is currently the dominant knowledge system that sets prevailing standards for research."	"The dominant sustainability transformation discourse aims for the normative goal of sustainability, which is primarily influenced by Western worldviews, values, and knowledge systems." **No direct mention of de/ colonization!**	"current research approaches that try to apply ILK are often driven by Western research methods and political agendas, such as predominant conservation and development approaches, which is questionable because all knowledge is value driven and linked to socially situated actors"	"future sustainability transformation research that engages with ILK should be transparent about how ILK is understood and which research designs and methodologies are applied."
10. Lam & Dodd (2019)	"Indigenous peoples can be defined as 'the assembly of those who have witnessed, been excluded from, and have survived modernity and imperialism. They are peoples who have experienced the imperialism and colonialism of the modern historical period beginning with the Enlightenment. They remain culturally distinct, some with their native languages and belief systems still alive'."	"Moreover, as many Indigenous communities have been monitoring the environment for centuries, there are opportunities to use both Indigenous and Western knowledge systems in CBM to develop a deeper understanding of pressures on the environment as they arise." "incorporating Indigenous knowledge in the design of food security and climate change metrics could help improve our understanding of how climate change impacts on food systems can be assessed over time."	"steps need to be taken to avoid risks including tokenistic inclusion, implied support for findings, and misappropriation of knowledge.	"Several factors make Indigenous food systems particular sensitive to climate change impacts. These include: histories and ongoing pressures of colonialism and land dispossession that have disconnected Indigenous peoples from their land and local knowledge of food practices."	"Considering the history of unethical research conducted on and not with Indigenous communities, there is increasing demand for the recognition of Indigenous peoples contributions and knowledge in the context of research, including climate change research."	"While Indigenous peoples observations of climate change are increasingly reported in the published literature, we found the inclusion of Indigenous peoples as co-authors did not appear to follow the same trend. We found less than half (42%) of reviewed articles on CBM had a co-author with an affiliation to an Indigenous organization or community."

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(Authors & Year)	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/or ESD	Western Epistemology	Colonialism / Decolonization/ Eurocentrism	Epistemological Justice	Critique/ Significance
16. McElwee et al. (2020)	"Indigenous and local knowledge (ILK), defined as 'knowledge and know-how accumulated across generations, which guide human societies in their innumerable interactions with their surrounding environment'."	"1.Using ILK to enrich concepts of nature and assess nature's contributions to people 2.Using ILK to assess and monitor status and trends in nature. 3.Using ILK to shape target-setting and achievements toward global goals ILK in scenarios and pathways. 4. Using ILK and IPLC involvement to generate options for decision-	"ILK emerges from very different epistemological contexts than formal science." "the GA still faced a number of challenges in ensuring that different knowledge systems were engaged in a transparent, equitable and legitimate manner."	"both ILK and science come from distinct types of knowledge systems (or the agents, practices and institutions that organize the production, transfer and use of knowledge) which are often asymmetrical in terms of power and can be incommensurable."	"ILK emerges from very different epistemological contexts than formal science." "many of the existing targets and goals do not necessarily reflect the heterogeneity of IPLC and their priorities and worldviews"	"to be effective, such participatory approaches must engage IPLC from the very beginning and throughout the process, construct scenarios that truly represent ILK and local priorities and deal with power differences among stakeholders."
17. Petzold et al. (2020)	"Indigenous knowledge refers to the understandings, skills and philosophies of Indigenous peoples, developed through long and multigenerational histories of interactions with the natural world and adapting to highly variable and changing ecological and social conditions including colonisation and	"Knowledge systems and practices of Indigenous peoples are recognised as a €major resource for climate change adaptation, but they have not been used consistently in adaptation efforts and have often been neglected in policy and research"	"The vast majority of climate studies using indigenous knowledge have been found to use an extractive model." "The literature dealing with indigenous knowledge and climate change adaptation in IPCC reports is heterogeneous and mostly generic."	"There are inherent ethical sensitivities and power imbalances in collecting and using indigenous knowledge data in mainstream research contexts. To further the agenda of decolonizing research, it would therefore be useful if publications were explicit about the extent and nature of involvement of	"lack of reflexive research practices that consider how research processes can be decolonized is an issue that must be addressed by climate researchers, academic journals, and research institutions."	"Future primary research with Indigenous peoples and about indigenous knowledge should engage with the decolonization agenda, in order to avoid an extractive approach to knowledge generation."
18. Proulx et al. (2021)	"Most common definitions emphasize that "Traditional Ecological Knowledge represents the collective knowledge of all people from a (tribal) area that has come through generations over time". Others note that TEK is a feeling of responsibility for future generations, explaining that we "owe thanks to everything that comes before us."	"The United Nations Declaration on the Rights of Indigenous Peoples begins by reminding readers that "respect for Indigenous knowledge, cultures and traditional practices contributes to sustainable and equitable development and proper management of the environment" ([UNDRIP], 2007)."	"Western ecological science often privileges quantitative work and instruments." "Non-Indigenous researchers have a history of undertaking extractive, Eurocentric and unethical approaches to engaging with Indigenous communities, causing an understandable lack of trust."	"In an earlier article, Simpson (2004) urges readers to be anti-colonial, noting that there is a colonial narrative to digitizing and documenting TEK." "A history of colonial narratives and Eurocentric research methods is the context from which we work to build respectful, meaningful relationships with Indigenous communities."	"Language like integrating, incorporating and collecting is (we hope unintentionally) colonial, assuming that western scientists have the right to take a body of knowledge and mold it into a system that was developed without the input of Indigenous peoples."	"Some of the most notable concerns with the digitization of TEK include sensitivity of data, intellectual property ownership, consultation protocols, decontextualization of Indigenous knowledge systems and the risk of reinforcing colonial narratives;"
19. Reed et al. (2021)	"Indigenous guardians are community-based environmental stewards who practice their cultural and traditional teachings on the land. These activities,…, include responsibilities to monitor activities on their lands and territories; assist in the design of land and water management planning; support cultural revitalization and intergenerational knowledge sharing; and support wildlife and harvest monitoring."	"indigenous peoples are often relegated to stakeholders or participants in decisions pertaining to environmental matters."	"local knowledge is based on a different epistemology and worldview to government science"	"This hesitancy to engage with indigenous peoples (and their knowledge systems) may entrench colonial modes of knowledge production." "the politics of recognition, use recognition (or settler co-governance) as a tool to sustain systems of domination over indigenous peoples, instead of providing greater indigenous authority and self-determination over ancestral lands."	"Critics of these programs have, however, noted that there has been inadequate consideration of indigenous nationhood in the design of community-based monitoring." "scholars call on those researchers working with indigenous peoples to respect and engage with their unique ontologies."	"we suggest that governments use their acceptance of the UN Declaration and the minimum standard of free, prior, and informed consent to catalyze domestic conversations intended to decolonize conservation policy and practice. … opportunity for current conversations …to highlight the contributions and leadership of indigenous-led conservation and, by extension, indigenous guardians."
20. Reyes-Garcia et al. (2019)	"Indigenous Peoples and Local Communities (IPLC) with a history of interaction with the environment have developed intricate and complex knowledge systems (e.g. information, management techniques, institutions) that allow them to detect changes in local weather and climatic variability."	"Attempts to bring insights from ILK into climate change research range from comparing ILK and scientific reports to validate the former to encouraging synergies between both knowledge systems to obtain an enriched understanding of local climate change impacts." "Indigenous and Local Knowledge (ILK) has an untapped potential to contribute to research on climate change impacts on local social-ecological systems."	"In response to calls to move anthropology to a cross-scale, multi-sited research design and an interdisciplinary mix of interactive and structured tools and technique so that the analytical focus is expanded to encompass local communities and their multiple action spaces as well as the higher spheres of decision-making, where policy and science are shaped, researchers have recently started to look for patterns in qualitative reports from multiple sites."	**No direct mention of either!**	"ILK continues to be largely absent in climate change impacts research as epistemological, methodological, and scaling issues challenge the transferability, integration, and scalability of ILK."	"while the literature used illustrates ILK potential to become an alternative data source to evaluate the performance of global climate models, it also shows important geographical gaps and insuficient coordinating efforts to reach that potential… despite research increase, we still lack a community of practice (i.e. researchers, IPLC, practitioners, decision-makers) committed to upscaling ILK-based observations of climate change impacts in a coordinated way.
21. Salim et al. (2023)	"indigenous peoples are groups with different cultural and social characteristics that share inherited ties to their homeland and natural resources. They are completely reliant on the land and natural resources to live their daily lives, and they are inextricably linked to personalities, beliefs, and livelihoods."	"Indigenous peoples are not only the keepers of one-of-a-kind belief systems and knowledge systems, but they also possess invaluable knowledge regarding sustainable practices for the management of natural resources."	"…increase scientists responsibility significantly, beyond knowledge production and transfer, by facilitating a dialogue between different forms of knowledge to create synergy."	TEK is …relevant to many other disciplines, including … social institutions for resource use, land use and occupancy, landscape knowledge and terminology, traditional knowledge education, oral history, indigenous ideology and worldview, decolonizing knowledge, and epistemology and knowledge systems."	"develop policies that recognize the value of traditional knowledge and practices in the local adaptation plan while encouraging benefit sharing among stakeholders."	"future applied research should concentrate on examining novel approaches to community empowerment and involvement, or on using community-based research techniques to better represent the needs of local communities and produce higher-quality research outcomes."

Appendix 4. Critical Themes - Page 5

STUDY	FOUNDATIONAL ELEMENTS			CRITICAL PERSPECTIVE of FOUNDATIONAL ELEMENTS		FINDINGS
(Authors & Year)	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/or ESD	Western Epistemology	Colonialism / Decolonization/ Eurocentrism	Epistemological Justice	Critique/ Significance
22. Shaffril et al. (2020)	"indigenous people as those who are attached to their geographically distinct traditional habitats or ancestral territories. They recognise themselves as a part of ca distinct cultural group, and the descendants from groups settled in the area prior to the existence of modern states and current borders established."	"the interested parties such as policy maker, public, researchers and environmentalist can now understand that there is a mounting need to integrate indigenous knowledge in any adaptation and natural resource management strategies in response to environmental and other forms of change."	"Future scholars can investigate the negative impacts of adaptation strategies related to technology-assisted, traditional and local knowledge, livelihood diversity, government and organizations support, food and water securities, social-related activities and physical infrastructure." **No direct mention!**	"One of the main issues faced by indigenous people is related to the status of their land. Most of them settled in areas that are partially given the recognition of officially or rightfully belong to them." **No direct mention of either!**	"a mounting need to integrate indigenous knowledge in any adaptation and natural resource management strategies in response to environmental and other forms of change….narrow down the gap in available information on traditional knowledge and climate change adaptation, and to encourage respect for traditional knowledge and the role of indigenous peoples in policy development."	"Lack of studies on the indigenous people from the Asia Pacific region has driven to a lack of understanding and failure to comprehend the related existing literature in a systematic way….The processes develop diverse skills, greater understanding of cultures, gaining valuable previous experience, and getting more social supports that are vital in the community climate change adaptation process."
23. Shawoo et al. (2019)	"TEK may be defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment"	"Several studies present the value of TEK and argue for its incorporation within Western-based science to inform environmental governance, arguing that combining diverse knowledge types enables the management of uncertainty within socio-ecological systems, enabling TEK to help build resilience."	"Western science comes with a prototype for what counts as science today, meaning that Indigenous perspectives are often not considered legitimate."	"Smith (1999) call for decolonising methodologies when accessing knowledge that require academics to approach research with IPs as partnerships that enable Indigenous leaders and knowledge keepers to fully drive, plan and design the process. At present, the platform does not appear to have the appropriate structures in place to account for adherence to such principles.	"However, this incorporationist or integrationist perspective toward TEK has a number of political considerations which are often overlooked, such as: a) who has the privilege of integrating TEK and according to what ethical, ontological, and epistemological frameworks?; and (b) how do the incorporating frameworks (i.e., science), which are necessarily selective, affect the integrity of TEK as a system of knowledge?	"when the two knowledge systems are characterized by differing underlying worldviews, which can lead to selective assimilation over integration, stripping TEK of its holism and cultural characteristics so that it can be fitted as discrete data into Western knowledge frameworks."
24. Singh et al. (2021)	"our working definition of TK as "the knowledge and practices developed individually and/or collectively by farming communities informally for managing the risks to agriculture imposed by climate change and associated environmental stressors."	"TK has tremendous potential for developing the knowledge and practices to cope with climate change and associated environmental stressors taking a heavy toll on sustainable agriculture."	"Integration of TK with formal knowledge requires scientific integrity and provision for reflexive learning between different stakeholders involved in the co-production of inclusive knowledge."	"Inequitable stakeholder participation, especially at the practice level, means poor representation of marginal stakeholder(s) (in our case TK holders) that could distort the balance of power and final outcomes." **No direct mention of either!**	"assign value to the plural knowledge for reducing uncertainty in process and subsequently in the outcomes. This was lacking broadly at the results obtained at the policy level as processes were skewed towards only the formal knowledge and policy makers. This raises an important question: was TK appropriately and ethically mainstreamed with the institutional knowledge?"	"Based on key findings, we opine that there is a pressing need for the capacity development of stakeholders with emphasis on marginal TKholders so that issues of poor communication and distorted balance of power in co-production of adaptive knowledge are effectively addressed."
25. Subercaseaux et al. (2021)	"Traditional knowledge (TEK) is comprehensive and holistic, encompassing various thematic fields."	"Sustainability Science (SS) has emerged as academic response to this challenge. SS recognize the limitations of conventional scientific knowledge to address the complex relationships between social and natural systems, seeking to link scientific and non-scientific."	"The prevailing vision in industrial civilization rejects the traditional knowledge and practices generated during most human history. This vision, simplistic and not very adaptive to local contexts, conceives rural development as a transformation, sudden or gradual, from traditional to industrial modalities."	"experiences in the real-world case of LPB, considering its cultural, social, political, and environmental particularities and complexities." **No direct mention of either!**	"the epistemological approach and positioning developed and presented … allow us to perceive, and thus consider and incorporate in the analysis and reflctions, the emerging complexities from the RAMI processes, corresponding to an own approach and positioning of transdisciplinary sustainability research."	"Transdisciplinarity and the paradigm of complexity provide elements to approach modernization in a comprehensive manner, integrating knowledge from different scientific fields and disciplines as well as traditional non-scientific knowledge."
26. Thompson et al. (2020)	"Indigenous knowledge to refer to a way of knowing that has evolved from the relationship between many generations of Indigenous people and their traditional territories.These lived relationships involve resource use, stewardship, oral histories, and spirituality, and often guide political governance systems."	"Our review also indicates that there is a strong interest in leveraging both scientific and Indigenous knowledge systems in environmental monitoring, and that many synergies can be drawn between both to enhance the information gained through monitoring."	"Such complementary differences include the study of different geographic and temporal scales, the reductionism of science compared to the holism of Indigenous knowledge, and the focus of Indigenous knowledge on extremes compared to science's ability to discern averages."	"power between scientists and Indigenous peoples needs to be equalized… this could be facilitated by recognizing Indigenous authority to manage their territories…participatory CBM as a pathway for the decolonization of academic research if enough time is allocated to build relationships and trust to overcome power imbalances."	"Numerous papers (41%, n = 33) discussed how science and scientists could support Indigenous peoples and their knowledge systems rather than replacing them by making Indigenous knowledge more accessible to people in power."	"Parties interested in creating environmental monitoring initiatives in partnership with Indigenous peoples must closely examine the details of participation, power, and governance in order to create programs that are socially just and effective for monitoring various aspects of complex social-ecological systems, including but not limited to impacts of industrial development and climate change."

Appendix 4. Critical Themes - Page 6

STUDY	FOUNDATIONAL ELEMENTS			CRITICAL PERSPECTIVE of FOUNDATIONAL ELEMENTS		FINDINGS
(Authors & Year)	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/or ESD	Western Epistemology	Colonialism / Decolonization/ Eurocentrism	Epistemological Justice	Critique/ Significance
27. van Bavel et al. (2020)	"Indigenous knowledge systems include scientific, agricultural, technical, and ecological knowledges that pertain to a particular people and its territory. Indigenous knowledges embody a web of relationships within a specific ecological context and evolve through dynamic inter-generational transmission."	"The inclusion of local and Indigenous knowledges in such decision-making processes is leading to a growing recognition of rights and realization of justice for peoples and communities; with value of this inclusion extending into areas of resource management, environmental policy, and climate change adaptation."	"There is a tendency in our own knowledge systems to prioritize or suppress preferential types of evidence…by exploring contrasting views and an apparent impasse of Indigenous and Western scientific knowledges we begin to focus on practical realities of limitations and actionable solutions"	"The inclusion of local and Indigenous knowledges in such decision-making processes is leading to a growing recognition of rights and realization of justice for peoples and communities." **No direct mention of either!**	"One way is to see from one eye with the strengths of Indigenous ways of knowing, and to see from the other eye with the strengths of Western ways of knowing, and to use both of these eyes together. … "Two-Eyed Seeing" and is being employed by many Indigenous scholars as a practical way of framing and navigating this integration of diverse knowledge systems; giving equity to evidences and methodologies."	"By continuing to reference and explain local and Indigenous processes using the same methodologies and concepts taken from Western science, not only do we lose meaning, but we also delegitimize other ways of knowing, and even jeopardizing the opportunities of being able to work together; researchers, scientists, local and Indigenous communities."
28. Vasileiou et al. (2022)	"Indigenous knowledge has been defined as a body of information passed down through generations in a given locality and acquired through the accumulation of experiences, relationships with the surrounding environment, and traditional community rituals, practices and institutions."	"Local knowledge encourages community participation and empowerment; offers detailed knowledge of the local context; holds the potential of transferring useful knowledge and practices to other contexts facing similar risks; and operates as a useful model for educating people in disaster risk management."	"Scientists also had the opportunity to increase their understanding of local knowledge and cultivate respect for local knowledge that could not be scientifically explained but helped communities endure disasters."	"These included the contradictions and differences that may exist between local and scientific knowledge and understanding, inadequate risk communication, distrust towards official institutions and government, imposition of measures without considering the particular social, political, economic and cultural context of communities, as well as scientific products or interventions that do not meet local needs." **No direct mention of either!**	"Alongside the plethora of advantages for local communities, incorporating local knowledge is additionally proposed to enrich and enhance scientific knowledge itself."	"Two main problems were reported in the literature that motivated researchers to attempt knowledge integration. These were, on the one hand, the non-adoption or even opposition by local communities of top-down DRR measures - though acceptance of scientific DRR measures is highly variable across the globe and appears to relate to the amount of economic resources communities hold - and on the other the limitations and insufficiency of scientific or local knowledge alone."
29. Zurba et al. (2022)	"ILK embodies a cumulative body of knowledge, practices, and beliefs, evolving and governed by adaptive processes and handed down through generations by cultural transmissions, about the relationship of living beings (including humans) with one another and with their environment."	"both knowledge systems possess complementary aspects that together cultivate holistic pictures of research contexts, problems, and solutions (Ban et al. 2018). Both generate observations, develop methods to test those observations, and deploy their knowledge to solve problems that enhance knowledge holders understanding of the natural world."	Power asymmetries in knowledge co-production often arise around the reductive but instructive binary of Western Scientific Knowledge (WSK) and ILK systems. WSK is heavily influenced by positivism and often conceptualizes knowledge as products that are packaged in categories, abstract generalizations, ordered observations, and testable hypotheses rather than in processes that incorporate actions, experiences, and relationships."	"context-dependent considerations regarding data sovereignty and decolonising methodologies will also be essential for ethical knowledge co-production processes in Nunatsiavut and elsewhere." "Literature reviews can inform co-productive endeavors in collaborative research contexts where the roles of knowledge co-production and decolonising research in those processes are not well documented, such as the Inuit Nunangat region."	"Understanding roles, mechanisms, and loci of power helps co-producers confront contextually varied, potentially unpredictable, or even imperceptible barriers, including epistemological clashes, power asymmetries, competing modes of transmission and communication, funders influence on research, uncertainties in knowledge validation, and tokenism."	"Our review suggests that emerging forms of knowledge co-production principles and approaches yield immense potential in diverse contexts. Yet in many regions, including Nunatsiavut, principles alone may not be enough to account for systemic and contextualized issues (e.g., colonisation and data sovereignty) that can present roadblocks to equitable sustainability science in the twenty-first century if left unaddressed."
30. Zvobgo et al. (2022)	"Indigenous knowledge refers to the understanding, skills, and philosophies developed by societies with long histories of interaction with their natural surroundings (IPCC 2018b)."	"the highly context-specific nature of adaptation has led scholars to highlight the need for inclusion of IK and LK for enhanced efficacy of adaptation projects due to their social acceptability and rich understanding of local environmental parameters."	"There is also a lack of coverage and respect of this knowledge in formal climate adaptation channels in African iNDCs. Analysis of African iNDCs showed that IK and LK was barely included in adaptation planning, despite Africa being one of the regions with rich IK and LK practices used for climate change adaptation."	**No direct mention of either!**	"Yet we found IK and LK is barely included in planned adaptation, only 10.4% of the African governments acknowledge and include IK and LK in planned adaptation. Given the evidence of the high reliance of African communities on IK and LK for water sector adaptation, this is a concerning lack of consideration of IK and LK to give effect to planned responses."	"However, little is known in Africa about what effect indigenous knowledge (IK) and local knowledge (LK) are having on climate change adaptation actions."

Appendix 4. Theme Distribution and Overall Theme Treatment Rating in the 30 SR's

Study	Indigenous & Traditional Knowledge (ITEK)	ITEK & SD and/or ESD	Western Epistemology / Eurocentrism	Colonialism / Globalization / Decolonization	Epistemological Justice	Score
Downey et al. (2021)	5	4	5	5	4	23 / 25 (92%)
Doyon et al. (2017)	5	4	4	5	5	23 / 25 (92%)
Drake et al. (2018)	5	4	2	5	2	18 / 25 (72%)
Druker-Ibanez & Cacaeres-Jensen (2019)	5	5	5	5	5	25 / 25 (100%)
Galway et al. (2019)	5	2	1	5	1	14 / 25 (56%)
Hadlos et al. (2022)	3	4	5	5	4	20 / 25 (80%)
Hanspach et al. (2020)	5	4	4	4	2	19 / 25 (76%)
Knopp et al. (2022)	5	3	2	2	3	15 / 25 (60%)
Lam & Hinz (2020)	5	4	5	5	3	22 / 25 (88%)
Lam & Dodd (2019)	5	4	3	5	4	16 / 25 (64%)
Loch & Riechers (2022)	5	4	5	5	4	23 / 25 (92%)
Makate (2019)	5	3	3	2	4	14 / 25 (56%)
Malapane et al. (2022)	3	3	5	5	4	19 / 25 (76%)
Manningtyas & Furuya (2022)	4	4	1	2	2	13 / 25 (52%)
Mbah et al. (2021)	5	4	5	5	5	24 / 25 (96%)
McElwee et al. (2020)	4	4	4	4	4	20 / 25 (80%)
Petzold et al. (2020)	4	3	3	5	4	18 / 25 (72%)
Proulx et al. (2021)	4	3	4	5	3	19 / 25 (76%)
Reed et al. (2021)	4	4	3	5	4	19 / 25 (76%)
Reyes-Garcia et al. (2019)	5	4	2	3	3	14 / 25 (56%)
Salim et al. (2023)	5	5	2	4	4	20 / 25 (80%)
Shaffril et al. (2020)	3	5	3	2	3	16 / 25 (64%)
Shawoo et al. (2019)	5	4	5	4	4	22 / 25 (88%)
Singh et al. (2021)	3	4	2	2	3	12 / 25 (48%)
Subercaseaux et al. (2021)	3	4	3	2	4	14 / 25 (56%)
Thompson et al. (2020)	5	5	3	4	5	22 / 25 (88%)
van Bavel et al. (2020)	4	4	4	4	4	20 / 25 (80%)
Vasileiou et al. (2022)	4	3	3	5	4	19 / 25 (76%)
Zurba et al. (2022)	4	4	3	4	4	19 / 25 (76%)
Zvobgo et al. (2022)	4	4	2	4	3	17 / 25 (68%)

Note. The ratings are based on a scale of 1-5, where 1 indicates that the theme was not mentioned or given minimal attention, and 5 indicates that the theme was a major focus and given significant attention.