

UNIVERSIDAD POLITÉCNICA DE MADRID

Escuela Técnica Superior de Ingeniería de Montes, Forestal y del Medio
Natural



**Integrating Nonhuman Species' Voices in
Biodiversity-inclusive Urban Planning:
Opportunities for Tackling Challenges**

DOCTORAL THESIS

Submitted for the degree of Doctor by:

Jing Lu

Master of Urban and Environmental Planning

Madrid, 2025



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Under the supervision of:

Dr. José Antonio Manzanera

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External Reviewers:

Thesis Defense Committee:

Thesis Defense Date:

This thesis has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 945139, under Line 11A of Urban and Peri-urban Green Infrastructure as an Ecosystem Service of Health and Biodiversity.

Acknowledgement

I would like to express my heartfelt gratitude to my supervisor, José Antonio Manzanera. His kindness and openness allowed me to delve into my thesis topic of interest, and his integrity, dedication, patience, reliability, and encouragement have not only helped with this thesis but have also greatly contributed to my personal and academic growth, leaving a lasting impact on my future career and life. I am grateful for the opportunity to learn from his expertise and to receive continuous encouragement and support during every stage of this journey.

I would love to thank my co-supervisor, Ana Hernando, and my industrial tutor, Jesús Zamora Rodríguez, for their kindness and encouragement. I want to acknowledge the financial support from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie (MSCA) grant agreement No. 945139, as well as from Fundación Tatiana Pérez de Guzmán el Bueno, without which this research would not have been possible.

I am deeply thankful to all collaborators, colleagues, scholars, reviewers and friends who have contributed to, critiqued, and assisted with this thesis and to those who have inspired my academic pursuits in general. I want to extend my special gratitude to Li Li and Yunqing Xu, with whom I have collaborated on two publications related to this thesis, and foreseeably, more collaborations in the future. I have learned a great deal from both, which has profoundly shaped my thesis research. I want to thank Katia Attuyer for our collaborative teaching and research; the qualitative approaches I learned throughout our collaboration have prepared me for designing and conducting the first chapter project of this thesis. I am grateful to all three of them for being my collaborators, mentors, friends, and, most importantly, my role models as women in academia who embody integrity, rigor, care, and compassion. In addition, I would like to thank Susana Martín Fernández for all her help with the statistical analysis in the second chapter project of this thesis, and Bing Chen and Muhammad Jamal Ahmed for their comments and help with the third chapter project. I'm also grateful to Alicia Lopez, Jinjian Zhu, Jing Gan, Melissa Herliz, Tinsae Yimam, and Yonas Abate for their invaluable help in recruiting participants, and to all participants for sharing their valuable views and perspectives in the first two projects. Additionally, I would like to express my appreciation for all the comments, help, and encouragement I received during academic conferences and from network exchanges with URBIO, UBHub, IUCN CEM, LRG, MSCA Alumni, and others. Additionally, I would like to express my deeply gratitude to the external reviewers' valuable and insightful comments and suggestions to

help shape this thesis research better. Thank you very much, Dr. Diana Dushkova, Dr. Christina Alida Breed, and Dr. Holly Kirk!

I would like to dedicate a special acknowledgment to my advisors, colleagues, and friends at the Institute of Ecology of TU Berlin for my third year's research secondment and its collaborative projects. I received tremendous support from my secondment advisor, Boris Schröder-Esselbach, as well as from Ingo Kowarik, Birgit Seitz, Moritz von der Lippe, Jana Carus, Sebastian Fiedler, Malia Scoville, Maria Stefanie Ludwig, Morgan Rogers, and Thore Immanuel Schomann. I value all our exchanges during research meetings, collaborations, and lunch chats. This experience has reinforced my dedication and purpose in my research and career.

I am profoundly grateful to my family, my parents, and my partner Zhiwei, for their unwavering support, love, and endless sacrifices, which have been the guiding light throughout my academic journey. Their encouragement, words of wisdom, and belief in my abilities have inspired me to persevere through challenges and strive for excellence. Thank you for your faith in me, which has fueled my determination to overcome obstacles and pursue my dreams. Thank you for everything.

Furthermore, I extend my appreciation to my friends, especially other fellows from the MSCA SDGine program, with whom I shared unforgettable memories in Madrid, and for their moral support in our fight against systemic suppression together, which has enriched my life experience. I'd like to thank Chian-Yi Liao and Rong Xu for our daily virtual chats that helped me through my time living alone in a foreign country. Additionally, I want to thank my lifelong family-like bond friends, Yanying Zi, Anne Newman, Jiafei Wu, Jiang Ying, and Gang Wang, for being present in my life and for all your love and support.

Lastly, I want to take a moment to recognize the faith I have in myself, along with my curiosity, courage, and persistence during tough times. I'm also proud of my commitment to nurturing my inner flame in my life and career.

Abstract

Cities play a vital role in tackling the biodiversity crisis, acknowledged through global and local commitments. Success relies on innovative urban planning and design. The Kunming-Montreal Global Biodiversity Framework promotes biodiversity-inclusive planning and design (BIPD), positioning biodiversity as nonhuman stakeholders in decision-making. Nonetheless, current BIPD efforts have notable shortcomings, often emphasizing large cities in the Global North while overlooking vulnerable communities in the Global South. Government initiatives alone cannot reverse biodiversity loss; active participation from public, private, and civil society sectors is essential. Additionally, divides between disciplines hinder urban professionals—such as planners and architects—from effectively implementing biodiversity-inclusive practices in urban ecology.

My thesis aims to understand challenges and identify opportunities for BIPD that incorporate nonhuman species' voices in urban planning. I examine involving nonhuman species in urban practices to raise awareness and develop tools for biodiversity-inclusive transformations. This engagement includes diverse stakeholders across the Global North and South, focusing on nonhuman inhabitants and supporting disadvantaged communities. The research employs various methods and is divided into three chapters.

Project 1: Understanding Built-environment professionals' (BEPs) Perspectives on BIPD

This study employs Q-Methodology to analyze BEPs' perspectives from Ethiopia, China, Spain, and the U.S., identifying four views: Pluralist, Enthusiast, Pragmatist, and Contextualist. Challenges include BEPs' lack of biodiversity data awareness, structural barriers, and misaligned values. Our research indicates that not all challenges are equally difficult. BEPs exhibit readiness to transcend legislative structural barriers and leverage professional norms to advocate for urban biodiversity, particularly when equipped with evidence-based tools. Pluralists and Enthusiasts demonstrate heightened interest in multidisciplinary collaboration and prescriptive, visual tools to communicate biodiversity's value to stakeholders.

Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study

The planning and management of BIPD projects is key to global conservation. Building consensus based on environmental ethics is crucial for the success of these projects. This study refines the ecocentric-anthropocentric attitude scale with biophilia tendencies to evaluate environmental attitudes and applies it to stakeholders in Zhangjiagang Bay Eco-Park, a BIPD project in China recognized in the UN's SDGs Good Practice list. The paper reveals diverse stakeholder value patterns and proposes new measures for sustainable

projects. The authors demonstrate that the adapted scale aligns with environmental philosophy theories, showing strong reliability and explanatory power for effective project management.

Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between Urban Ecology (UE) and Urban Planning and Design (UPD)

Research is needed to thoroughly investigate how interdisciplinary collaborations impact silos between UE and UPD. This study reassesses research publications in both fields, analyzing their interconnections using natural language processing (NLP) and machine learning. We evaluate discursive similarities and differences, revealing the evolving role of interdisciplinary collaboration. Importantly, we uncover cross-disciplinary themes, exploring how collaborative research can promote biodiversity-inclusive transformative change in urban environments.

Conclusion

This research identifies opportunities for BIPD through inter- and transdisciplinary collaborations. BEPs show enthusiasm for biodiversity innovation and willingness to address diverse norms and values. Aligning environmental values is crucial for success. Collaborations enhance urban ecology and planning, particularly in spatial modeling and health-related ecosystem services. This study uniquely examines nonhuman species as stakeholders in the Global North and South, emphasizing BEPs' pivotal role, the need for inclusive stakeholder engagement, and collaborative knowledge production to harmonize ecological and human priorities in urban sustainability.

Resumen

Las ciudades juegan un papel vital en la lucha contra la crisis de biodiversidad, reconocido en compromisos globales y locales. El éxito depende de una planificación y diseño urbano innovadores. El Marco Global de Biodiversidad Kunming-Montreal promueve la planificación inclusiva de biodiversidad (BIPD), representando especies no humanas en la toma de decisiones. Pero la BIPD presenta deficiencias, centrada en ciudades del Norte Global mientras ignora comunidades vulnerables del Sur. Las iniciativas gubernamentales no revierten la pérdida de biodiversidad; la participación de los sectores público, privado y de la sociedad civil es esencial. Las divisiones entre disciplinas impiden a profesionales urbanos—como planificadores y arquitectos—implementar prácticas de biodiversidad en la ecología urbana.

Se estudian desafíos e identifican oportunidades para que la BIPD incorpore las especies no humanas en la planificación urbana. Examinó esta incorporación para crear conciencia y desarrollar herramientas para transformaciones pro-biodiversidad. Este compromiso incluye partes interesadas en el Norte y Sur Global, centrándose en especies no humanas y apoyando a comunidades desfavorecidas. La investigación se divide en tres capítulos.

Proyecto 1: Perspectivas de los BEPs en la BIPD

Se analizan con el Método Q las perspectivas de BEPs de Etiopía, China, España y EE. UU., identificando cuatro puntos de vista: Pluralista, Entusiasta, Pragmatista y Contextualista. Los retos incluyen falta de conciencia sobre biodiversidad, barreras estructurales y valores desalineados. Los BEPs están dispuestos a superar barreras legislativas estructurales y aprovechar normas profesionales para defender la biodiversidad urbana, si disponen de herramientas contrastadas. Los Pluralistas y Entusiastas prefieren la colaboración multidisciplinaria y las herramientas visuales prescriptivas para comunicar el valor de la biodiversidad a los implicados..

Proyecto 2: Actitudes Ambientales de los Participantes en un Estudio de Caso de BIPD

La BIPD es clave para la conservación global. El consenso basado en ética ambiental es crucial para el éxito de estos proyectos. Se refina la escala de actitud ecocéntrica-antropocéntrica con tendencias de biofilia para evaluar actitudes ambientales y se aplica a las partes interesadas en el Eco-Parque de Zhangjiagang Bay, un proyecto de BIPD en China con Buenas Prácticas de los ODS de la ONU. Se revelan patrones de valor diversos entre las partes interesadas y se proponen nuevas medidas para proyectos sostenibles. La escala

adaptada se alinea con la filosofía ambiental, mostrando fiabilidad y poder explicativo para la gestión de proyectos.

Proyecto 3: Impacto de Colaboraciones Interdisciplinarias en los Silos Disciplinarios entre UE y UPD

Se investigan las colaboraciones interdisciplinarias entre la ecología urbana y la planificación. Se reevalúan las publicaciones de investigación en ambos campos y sus interconexiones usando procesamiento de lenguaje natural (PLN) y aprendizaje automático. Evaluamos similitudes y diferencias discursivas, revelando el papel evolutivo de la colaboración interdisciplinaria. Se han descubierto temas transdisciplinarios, explorando cómo la investigación colaborativa promueve la biodiversidad en entornos urbanos.

Conclusión

Se identifican oportunidades para la BIPD a través de colaboraciones inter- y transdisciplinarias. Los BEPs muestran entusiasmo por la innovación en biodiversidad y disposición favorable. Los valores ambientales son cruciales para el éxito. Las colaboraciones mejoran la ecología urbana y la planificación, particularmente en modelado espacial y servicios ecosistémicos de salud. Este estudio examina las especies no humanas como partes interesadas en el Norte y Sur Global, enfatizando el papel fundamental de los BEPs, la necesidad de compromiso inclusivo de las partes interesadas y la producción colaborativa de conocimiento para armonizar prioridades ecológicas y humanas en sostenibilidad urbana.

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Abbreviations and Acronyms

AEA	Attitude toward the Environment
AHCI	Arts & Humanities Citation Index
Apathy	Environmental apathy
BEPs	Built Environment Professionals
BIPD	Biodiversity-Inclusive Urban Planning and Design
BT scale	Biophilia Tendency Scale
CBD	Convention on Biological Diversity
CE	Civil Engineering
CIs	Confidence Intervals
Dom	Dominionistic
EA scale	Ecocentric and Anthropocentric Attitude toward the Environment Scale
Eco	Ecocentric
Ecol	Ecological focus or Ecologicistic
EPA	Environmental Protection Agency
Env	Environmental Science or Engineering
Environ	Environmental focus
EU	European Union
GDP	Gross Domestic Product
GIS	Geographic Information System
GPSC	Global Platform for Sustainable Cities
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
Inter	Interdisciplinary collaboration
KMGBF	Kunming-Montreal Global Biodiversity Framework
LA	Landscape Architecture
LDA	Latent Dirichlet Allocation
MaxEnt	Maximum Entropy
Moral	Moralistic
Mul	Specialized in two or more disciplines
Natur	Naturalistic
NbS	Nature-based Solutions
Neg	Negativistic
NEP	New Environmental Paradigm Scale
NLP	Natural Language Processing
PPP	Purchasing power parity
SCIE	Science Citation Index Expanded
SDGs	Sustainable Development Goals
SDM	Species Distribution Modeling
Socio-econ	Socioeconomic focus
SSCI	Social Science Citation Index
Strong-A	Strong-anthropocentric
TPB	Theory of Planned Behavior

TU Berlin	Technische Universität Berlin
UD	Urban Design
UE	Urban Ecology
UP	Urban Planning
UPD	Urban Planning and Design
UPM	Universidad Politécnica de Madrid
UN-Habitat	United Nations Human Settlements Programme
USA	United States of America
Util	Utilitarian
Weak-A	Weak-anthropocentric
ZJG Bay Eco-Park	Zhangjiagang Bay Eco-Park

1. Introduction

The collapse of the Convention on Biological Diversity (CBD)'s Aichi Targets necessitates an ambitious conservation objective for the CBD's post-2020 framework to bend the curve of species loss, exemplified by the "Half-Earth" initiative (CBD, 2021; Neugarten et al., 2024; Whitmee et al., 2015). This transformation in conservation will extend beyond traditional protected areas, promoting urban coexistence between humans and biodiversity while supporting Sustainable Development Goals (SDGs) (Hill et al., 2021; König et al., 2020; Sachs et al., 2019; Wu et al., 2022). Cities increasingly play a vital role in global biodiversity conservation and enhancement (Croeser et al., 2024; Knapp et al., 2021; Parris et al., 2018). There is a growing recognition of the significance of urban biodiversity, as it contributes to countering the global extinction crisis (IPBES, 2022; Knapp et al., 2021), promoting multispecies justice (Celermajer et al., 2020; Kopnina & Washington, 2020), and providing synergetic benefits for human well-being (Cox et al., 2017; Shwartz et al., 2023; Soga & Gaston, 2021) and climate change mitigation and adaptation (Gorman et al., 2023; Pörtner et al., 2023).

This acknowledgment transcends academic circles and is acknowledged by political goals, targets, initiatives, and commitments at global, national, and local government levels (Bulkeley et al., 2021; Sachs et al., 2019). Globally, Parties to the Convention on Biological Diversity (CBD) have emphasized the importance of involving cities and local governments in biodiversity conservation and sustainable development (Chandra & Idrisova, 2011; Convention on Biodiversity Diversity, 2021) and are moving to introduce legislation mandating that new urban development leads to no net loss in biodiversity (Convention on Biodiversity Diversity, 2020). Additionally, UN-Habitat's New Urban Agenda, adopted in 2016, includes a commitment in its vision statement to "protect, conserve, restore, and promote ecosystems, water, natural habitats, and biodiversity; minimize environmental impact; and shift towards sustainable consumption and production patterns (United Nations, 2017)." The United Nations Decade for Nature Restoration (2021-2031) (United Nations General Assembly, 2019) calls for a halt to the global degradation and destruction of ecosystems, while urban ecosystems are one focus area (Kowarik et al., 2025). Furthermore, the Global Platform for Sustainable Cities (GPSC) launched the "Cities 4 Biodiversity" program in 2021 to provide technical

and financial assistance to cities for integrating biodiversity and climate solutions into urban planning (Beatley & Brown, 2022).

There has been a notable increase in interest and commitment from intergovernmental, national, and local levels in responding to global challenge initiatives, primarily in the Global North. For instance, the European Union (EU) Biodiversity Strategy for 2030 aims to ensure that Europe's biodiversity is on the path to recovery for the benefit of people, the climate, and the planet. In this strategy, Target 14 specifies that all cities across European countries with at least 20,000 inhabitants should implement an ambitious urban greening plan (European Commission, 2020; Mahmoud et al., 2024). Additionally, EU member states are moving to implement the European Nature Restoration Regulation (European Union, 2024), which outlines the CBD and Kunming-Montreal targets for member states. This includes objectives for achieving no net loss of urban tree canopy cover and increasing the total area of urban green spaces (Kowarik et al., 2025). According to IUCN (2019), biodiversity compensation is mandated in 37 countries, primarily in the Global North, while over 100 countries have established or are developing biodiversity compensation or offset policies. The United Kingdom has led the way in making biodiversity net gains mandatory for new urban housing projects since 2023 (Cooper et al., 2023; UK Governments, 2024). Additionally, no net loss legislation is effective in various European countries, including Sweden and Germany (Kowarik et al., 2025). Australia has adopted impact-specific policies aimed at achieving overall environmental gain, while in the United States, policies regarding wetlands are designed to maintain the current state without overall net losses of functions and values (Maron et al., 2018). Currently, over 130 cities, subnational governments, and their networks have signed the Edinburgh Declaration on Biodiversity (Pierce et al., 2024). This declaration was issued by the CBD Secretariat to encourage cities and regional governments to commit to biodiversity actions by signing the commitment directly (Scottish Government, 2021). The database by the Urban Biodiversity Hub has counted at least 123 local governments from 31 countries that have developed biodiversity-related strategies or reports worldwide (Nilon et al., 2017; Pierce et al., 2024).

Though not as ambitious as the Global North countries, there have been promising efforts and commitments from several countries in the South. For example, China has demonstrated a commitment to an ecological civilization for a more harmonious relationship with nature since 2012, when this goal was formally adopted in its

Constitution (Wu & Wallace, 2014; Wang et al., 2020). Moreover, several countries in the South, including China, Chile, Colombia, South Africa, and Ghana, have initiated or adopted biodiversity offsetting schemes under fixed or unspecified scenarios (IUCN, 2019; Maron et al., 2018). Additionally, China, South Africa, Uganda, and some other countries from the Global South, have introduced legally binding obligations to perform impact assessments for development activities in urban areas, including checks for endangered species (Kowarik et al., 2025).

Achieving these commitments is rooted in local actions, with innovations in urban planning and design being crucial (Pierce et al., 2024). The Kunming-Montreal Global Biodiversity Framework (KMGBF) promotes biodiversity-inclusive urban planning and design (BIPD) to enhance native biodiversity and support sustainable urbanization (Convention on Biodiversity Diversity, 2022), which holds high legitimacy and binding nature for the signatory states (Kowarik et al., 2025). Researchers further define BIPD as a collaborative process that intentionally positions local biodiversity as the nonhuman uses of place to inform design thinking and decision-making (Hernandez-Santin et al., 2023). Decisions made by city residents have a significant impact on biodiversity, influencing both the direct and indirect effects arising from urban environments (Pedersen, 2018). As rapid urbanization is expected to exceed 68% of the global population residing in urban areas (United Nations General Assembly, 2018), the local environmental impacts of cities, along with their broader influences, must be addressed to bend the curves of biodiversity loss and meet global biodiversity targets (Pierce et al., 2021). Therefore, multidisciplinary urban researchers—such as ecologists, planners, architects, designers, and others—strive to enhance knowledge, create tools, and foster consensus, positioning local biodiversity as nonhuman stakeholders alongside human citizens in decision-making and design processes.

However, the literature highlights several significant drawbacks in current initiatives, research, and practices concerning BIPD. First, existing action agendas tend to focus on limited audiences, which leads to an excessive emphasis on large cities in the Global North while neglecting vulnerable communities or stakeholders situated in the Global South (Chan et al., 2022; Knapp et al., 2021). Most pressing urban challenges are often found in the Global South, where dramatic transformations associated with urbanization are expected to occur (McPhearson et al., 2016), particularly in Africa and Asia, which are projected to have the most cities becoming megacities by 2030 (Knapp et al., 2021). Moreover, cities in the Global South face a shortage of urban scientists and

resources (McPhearson et al., 2016), particularly more generalists who lack the capacity for specialization (Acuto et al., 2018), as well as limited research attention (Knapp et al., 2021; McDonald et al., 2019). Notably, 72% of studies examining the direct impact of urban growth on biodiversity originate from high-income countries, including the United States and the European Union, which account for only around 17% of the global population (McDonald et al., 2019). Such geographical biases in research hinder scientists from truly understanding how urbanization affects biodiversity and how we can design and manage biodiverse urban areas, without acknowledging the differences in historical legacies and the complex problems intertwined with issues of biodiversity, poverty, and inequality widely present in the cities of the Global South (Knapp et al., 2021; Seto et al., 2012). In this regard, researchers have advocated for more studies in middle- and low-income countries, particularly in Africa and Asia, which have undergone rapid urbanization, on the impacts of urban growth on biodiversity (Knapp et al., 2021; McDonald et al., 2019).

Furthermore, initiatives from governments alone are unlikely to reverse negative trends in biodiversity; broader stakeholder involvement is essential across public, private, and non-profit sectors, along with the engagement of civil society stakeholders (Chan et al., 2022). Past experiences have shown that short-lived action agendas are unlikely to generate catalytic effects, such as increasing participation in biodiversity action or stimulating the wider application of successful approaches (Chan et al., 2022). Moreover, a successful action agenda that encourages societal actors to contribute to biodiversity goals is becoming increasingly complex and must perform several functions over time, including facilitating the organization of events and interfaces between public and private actors (Chan et al., 2022; Kowarik et al., 2025). Such a situation is more challenging in the Global South, where more attention should be directed toward citizens' basic needs (Acuto et al., 2018). Therefore, researchers have called for more comprehensive and catalytic agendas that mobilize actions from diverse actors across society, including non-profit organizations, businesses, investors, civil society groups, and local communities, particularly marginalized and Indigenous groups in the Global South, to inspire and engage societal actors to take action (Chan et al., 2022; McPhearson et al., 2016). In this context, there is a need for research to better understand the diverse perspectives of stakeholders regarding BIPD across geographical regions in both the Global North and South, as well as across sectors and civil societies, to increase participation in biodiversity action and stimulate wider applications.

To effectively engage broader participation across sectors and civil societies for BIPD, a key challenge is balancing human perceptions and needs with ecological requirements to preserve and enhance biodiversity (Aronson et al. 2017). The priority placed on BIPD is influenced by social, cultural, and economic factors (Aronson et al. 2017), making it difficult to reach a consensus. Without a solid understanding of the diverse environmental perspectives of stakeholders, urban projects focusing on biodiversity often fail prematurely or gradually fade away due to unsustainable implementation or management in the long run (EPA 2022; Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020). The critical first step to success lies in environmental consensus-building rooted in a belief in environmental ethics and values (Parris et al., 2018). Research on environmental ethics and values remains primarily focused on the growing theoretical complexity of its classifications (Chang et al. 2011; Cocks & Simpson 2015; Thompson & Barton 1994) and does not fully translate this progress into urban applied fields. The nature of BIPD offers potential from both ecocentric and anthropocentric perspectives in environmental ethics (Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020). For this reason, cases of BIPD present an ideal scenario to test the practical application of theoretical classifications using appropriate environmental attitude assessment tools (Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020) with a particular focus on species level to better understand and engage diverse actors in collectively moving toward a biodiverse urban future through BIPD.

In addition to the significance of broader participation of diverse actors from the Global North and South, literature highlights disciplinary and practice-academic gaps that hinder urban built environment professionals (BEPs)- such as urban planners, landscape architects, civil engineers, and architects- from implementing informed, biodiversity-inclusive planning and design practices (Hernandez-Santin et al., 2023; Kay et al., 2022). This is particularly important for incorporating advances in urban ecology research into real-world practice (Aronson et al., 2017; Hernandez-Santin et al., 2023; Kay et al., 2022; McPhearson et al., 2016). Although there is a long tradition of integrating ecological principles into the planning process, guided by landscape urbanism (Ahern et al., 2006; McHarg, 1969), and movements centered on concepts and practices such as urban green infrastructure planning (Mell, 2017) and biophilic urbanism (Beatley, 2011), BEPs' practices have faced criticism from ecologists. Concerns include a focus on the expansion and the connectivity of green spaces and

neglecting the potential of the built environment as habitats (Apfelbeck et al., 2019), treating biodiversity largely as incidental and passive stakeholders rather than engaging actively and explicitly (Hernandez-Santin et al., 2023), a relative lack of attention toward animals (Apfelbeck et al., 2020), and oversimplifying the complexity of ecological relationships and their interactions (Weisser & Hauck, 2024). So far, most research on urban planning and design that focuses on urban biodiversity treats nonhuman species as passive stakeholders. The idea is that “urban form leads to changes in species diversity within urban areas,” which accounts for 66% of all relevant research since 2000 (Hernandez-Santin et al., 2023). In this sense, there is still a long way to go in terms of actively involving nonhuman species and explicitly considering biodiversity in the urban planning and design process (Hernandez-Santin et al., 2023).

While criticizing current urban practices, urban ecologists propose promising innovative approaches and advocate for a shift in urban ecology from a biologically based discipline to an increasingly interdisciplinary field (Grimm et al., 2000; Kowarik, 2023; Sukopp, 2008). Recent advancements in urban ecology have produced sophisticated knowledge and tools that have the potential to inform urban planning and design. For instance, Plummer and her colleagues (2020) developed species-habitat models to predict bird populations for urban development planning scenarios, aiming to support the on-site compensation policy of “no biodiversity net loss” in the UK (Cooper et al., 2023). By employing citizen-science data on animal species and Maximum entropy (MaxEnt) species distribution modeling (SDM), researchers in China and South Korea have mapped habitat cores and ecological corridors for urban biodiversity conservation (Qian et al., 2023; Serret et al., 2022). Furthermore, recent urban ecology efforts have started integrating biodiversity science into urban practices. Building on the target species selection framework (Apfelbeck et al., 2019) and species’ life-cycle study (Weisser & Hauck, 2017), Weisser, Hauck, and their teams (2024) employed the Animal-Aided Design approach to explicitly consider animals as stakeholders in their project design practices in Germany and Switzerland. Guided by the framework of Biodiversity Sensitive Urban Design (Garrard et al., 2018). Australia’s largest urban renewal project, Fishermans Bend in Melbourne, stands out as one of the earliest urban developments of this scale to explicitly incorporate biodiversity targets (Kirk et al., 2021).

However, BEPs have not yet widely integrated advances in urban ecology research into practical urban planning and design. Although limited in number, studies have sought to investigate the reasons and challenges behind this situation, primarily from the

perspectives of ecologists. Some studies attribute this phenomenon to BEPs' value bias and lack of willingness, noting that they prioritize biodiversity lower than other competing interests (Aronson et al., 2017; Kay et al., 2022). Additionally, knowledge gaps and disciplinary silos are frequently discussed, highlighting BEPs' lack of empirical ecological knowledge (McPhearson et al., 2016) essential for developing "hands-on" transdisciplinary real-world solutions (Acuto et al., 2018; Pickett et al., 2022; Frantzeskaki et al., 2024). Moreover, BEPs may experience path dependence (Wilson, 2014) and tend to rely on their socio-technical regimes, which can lead to resistance to change or reluctance to pursue external collaborations (Dorst et al., 2022; Seto et al., 2012).

While these studies provide an initial understanding of the challenges, they tend to critique BEPs without thoroughly examining their perspectives on BIPD. They engage only a specific interest group of BEPs attracted to the Summit related to urban wildlife (Kay et al., 2022), excluding most BEPs that shape the urban landscape, which usually focuses on various social, economic, and environmental objectives. Traditionally, few BEPs engage with biodiversity topics, as biodiversity is not an explicit goal in their practices but rather a constraint that must be managed when necessary (Weisser & Hauck, 2024). Furthermore, studies involving BEPs mostly concentrate on related topics, such as Nature-based Solutions (NbS) (Dorst et al., 2022), which do not specifically address BIPD; instead, the value of urban biodiversity is often overlooked in the design and assessment of many NbS programs (Croeser et al., 2024). Even when considering studies on related topics, the voices of BEPs from the Global South are severely underrepresented despite their pressing urban challenges amidst limited resources (McPhearson et al., 2016). Without specifically understanding the perspectives of a diverse group of BEPs from various professional backgrounds and global regions regarding BIPD, it is difficult to transform global biodiversity commitments from being merely advocated by ecologists (McPhearson et al., 2016) to fostering real-world actions. Additionally, these discussions often stop at identifying barriers (Dorst et al., 2022; Kay et al., 2022) rather than exploring opportunities involving BEPs. Therefore, further studies are required to investigate the perspectives of a broad profile of BEPs across the Global North and South regarding BIPD to better understand the challenges and opportunities in implementing BIPD.

Further to the understanding of urban practitioners' and stakeholders' perspectives on BIPD, effective implementation of such planning hinges on inter- and transdisciplinary

collaborations and knowledge sharing (Bakker et al., 2024) across urban ecology, planning, and design disciplines (Frantzeskaki et al., 2024; Kay et al., 2021). Yet, these collaborations and knowledge sharing rarely succeed (Deutsch et al., 2023), partly due to disciplinary vocabularies and varying interpretations of similar concepts (Felson & Ellison, 2021), as well as a lack of meaningful pluralization of knowledge (Deutsch et al., 2023) for real-world actions (Frantzeskaki et al., 2024). However, considering the various initiatives and policies implemented by global, intergovernmental, national, and local entities, along with pioneering interdisciplinary efforts such as the Berlin School of Urban Ecology, which has supported initiatives like detailed urban biotope mapping since 1979 (Kowarik, 2023); the CityScapeLab Berlin, which investigates the impacts of urbanization on biodiversity across spatial and temporal scales (von der Lippe et al., 2020); and the urban concept of “fourth nature” in natural wastelands (Stadtbrachen) that prioritize species conservation while integrating design approaches (Kowarik, 2023), it is both timely and important to understand how interdisciplinary research collaboration between urban ecology and urban planning and design affects the disciplinary silos between these two fields. Such studies will offer insights into opportunities for bridging these significant fields, potentially reversing the traditionally low participation of ecologists in urban policies and practices that shape urban developments (McPhearson et al., 2016) and aiding BEPs in navigating the complexities of ecological factors intertwined with the socioeconomic and political intricacies of planning processes (Deutsch et al., 2023; Frantzeskaki et al., 2024; McPhearson et al., 2016), and moving from theory to practice and work together to better support biodiversity in cities (Kay et al., 2022).

To address these research gaps, my thesis research aims to understand the challenges and, more importantly, identify opportunities for BIPD that intentionally incorporate the voices of nonhuman species in urban planning and design. In this research, I define biodiversity-inclusive urban planning and design (BIPD) as a collaborative process that intentionally positions local biodiversity as the nonhuman users of place to inform design thinking and decision-making (Hernandez-Santin et al., 2023). In BIPD, nonhuman species are considered active stakeholders, ensuring that “Biodiversity’s needs are explicitly considered within the design process” (Hernandez-Santin et al., 2023). BIPD emphasizes the ethical and active participatory role of nonhuman urban inhabitants, who hold an ethically just position as “subjects” in the urban planning, design, and decision-making processes, rather than being treated as “objects” to be dealt with (Weisser & Hauck, 2024). BIPD serves as an umbrella term that unites similar

terms used across disciplines (Hernandez-Santin et al., 2023) and explicitly addresses urban biodiversity's needs in the planning and design process. This includes 'biodiversity sensitive' urban design (Garrard et al., 2018), 'wildlife-inclusive' design (Apfelbeck et al., 2020), 'animal-aided' design (Weisser & Hauck, 2017), 'multispecies' design (Gatto & McCardle, 2019), and 'rewilding' (Kowarik, 2023). Furthermore, BIPD aligns with the theories of environmental ethics, particularly the biophilia hypothesis and its applications in urban planning and design, as seen in biophilic urbanism (Beatley & Brown, 2022), although with some notable distinctions. Biophilic urbanism acknowledges the innate tendencies of human and biodiversity interactions that celebrate the ecocentric values of biodiversity itself; meanwhile, it focuses more strongly on the health and well-being benefits of human-nature interactions, which may not position nonhuman species as active stakeholders. Instead, it centers on the idea that "nature in cities provides critical services for people, and planning and design could benefit biodiversity." In this sense, urban biodiversity acts in an "incidental stakeholder" role (Hernandez-Santin et al., 2023). Similarly, other related planning concepts, such as Urban Green Infrastructure and Nature-based Solutions, which emphasize the multifunctionality of nature as well as climate mitigation and adaptation, also treat urban biodiversity primarily as incidental stakeholders, though there are some exceptions that actively consider nonhuman species (Croeser et al., 2024).

In this regard, this thesis research examines the potential of actively involving the voices of nonhuman species in urban practices, with the goal of raising awareness and creating tools for inter- and transdisciplinary collaboration that promote biodiversity-inclusive urban transformations. This engagement involves a diverse range of stakeholders and actors across the Global North and South, aiming to include nonhuman urban inhabitants while addressing the needs of disadvantaged communities. This research utilizes a range of methods and is structured into three projects in this thesis.

1.1. Project 1: Understanding BEPs' Perspectives on BIPD

The first project aims to investigate the perspectives of BEPs on BIPD from four countries in both the Global North and South: the United States, Spain, China, and Ethiopia. This will help us understand the challenges of implementing BIPD in accordance with BEPs and identify potential opportunities to intentionally incorporate

the voices of nonhuman species in urban practices involving BEPs from various sectors, including public, private, and non-profit organizations. These countries selected represent various levels of economic development, ranging from low, middle, and high income, as well as a spectrum of urbanization rates, including nations in Asia and Africa that are experiencing significant urban growth.

Specifically, this project investigates the perspectives of a broad profile of BEPs across four countries in both the Global North and South regarding BIPD, drawing on theories of Lock-in Effects (Wilson, 2014) and the Theory of Planned Behavior (TPB) (Ajzen, 1991). The TPB is one of the most influential models for predicting and explaining individuals' intention to engage in specific behaviors (Liu et al., 2020). It deconstructs a person's behavioral intentions into three constructs of attitudes, social and subjective norms and perceived behavioral control (Ajzen, 1991). Recently, some studies have extended the TPB model by incorporating additional constructs, such as moral norms to understand green purchasing behavior (Liu et al., 2020) and personal norms alongside environmental concerns for public transit behavioral intentions (Ali et al., 2023). By extensively comparing various extension of TPB research, these studies argue that moral and environmental concerns should be included as an extension of TPB, which are significant prediction of intentions on environmentally responsible behaviors (Ali et al., 2023; Liu et al., 2020). In addition, Wilson (2014) discussed how path dependency and "lock-in" effects pose severe hindrances to social-ecological resilience and transitional changes, as they can trap stakeholders in pathways from which they find it difficult to escape. He categorized lock-in effects at the community level into three types: 1) structural, which are beyond the control of individual communities, 2) economic, related to communities' economic capital, and 3) social-psychological, associated with community-level endogenous social and psychological factors (Wilson, 2014). Given the potential challenges of implementing BIPD, it is appropriate to reference the extension of TPB and Lock-in effects as an initial framework to help understand the BEPs' intentions in involving biodiversity as nonhuman stakeholders in their practice, specifically taking citizen-science-based species distribution modelling (SDM), which is widely studied in urban ecology (Plummer et al., 2020; Serret et al., 2022), as an example.

To elicit the BEPs' perspectives, we employ Q methodology, a mixed-method quantitative and qualitative research technique (Artis et al., 2020). This methodology has been increasingly utilized in conservation and sustainability research (Seghezze et

al., 2023; Sneegas et al., 2021). Q methodology employs factor analysis to statistically identify patterns of perspectives based on participants' rank-sorting of items, allowing for interpretation and comparison of these perspective patterns (Zabala & Pascual, 2016). While Q methodology is typically applied to understand viewpoints within a single geographical location, it can also be used to analyze viewpoints across multiple locations (Artis et al., 2020).

1.2. Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study

The second project zooms into a case study project in a Global South country, specifically the Zhangjiagang Bay Eco-Park (hereinafter ZJG Bay Eco-Park) project in Zhangjiagang City, situated in the Yangtze River Delta of China. This project intentionally incorporates nonhuman species into its design process and is recognized as one of the UN's SDG Good Practices, serving as a BIPD case study site amid rapid urbanization. In this project, I aim to enhance environmental assessment tools by integrating biophilic orientations to better understand stakeholders' environmental attitudes at the species level. The urban stakeholders examined include a diverse array of actors involved in the project's development, such as local governmental officials and decision-makers from various departments, professionals from planning and design sectors, contractors responsible for park construction, as well as volunteers from local engagement teams, and local residents and business owners who reside within or near the regenerated park or who were relocated due to the Eco-Park regeneration process. By capturing the diverse attitudes of stakeholders regarding nonhuman species during the project, this project will provide important insights into urban stakeholders' perspectives on BIPD and develop tools for stakeholder engagement, particularly for involving nonhuman species in urban practice to foster consensus building.

In this project, I will first conduct a literature review to understand the interconnected relationship between environmental ethics and China's top-down ecological civilization policies, as well as the theoretical progress of environmental assessment tools and their applications in urban biodiversity-inclusive planning and design projects. This is followed by the discussion of implementing the UN's SDG-listed Good Practice of ZJG Eco-Park project under the ecological civilization in China, followed by an examination

of different environmental attitude assessment tools and the adaptation of the selected tool.

The ZJG Bay Eco-Park has been selected as a BIPD case study site primarily based on two considerations. First, this project is among the few practical urban planning and design initiatives that actively considered nonhuman species from the outset during the conceptual phase of planning and design (Zhangjiagang Natural Resources and Planning Bureau, 2019). This includes various habitats such as forests for songbirds, open waters for waterfowl, tidal flat wetlands for wading birds and fish, and others (Figure 1.2.1). After completing the first phase of this ecosystem restoration, over 36 hectares of wetlands and green spaces have been restored, and more than 12.5 hectares of beach on the north side of Laosha Wharf has been leveled and afforested, predominantly with over 3000 trees, including pond fir, metasequoia, and Mexican larch. The previous production coastline has now been transformed into an ecological coastline, where some endangered species, both on land and underwater, have been observed again. These include the reed parrotbill, known as the 'giant panda of birds,' and the Yangtze finless porpoise, referred to as the 'giant panda of water' (Figure 1.2.2) (United Nations, 2021). Meanwhile, the Chinese philosophy of ecological civilization shares the same theoretical roots of process philosophy with environmental ethics (Wang et al., 2020) and is widely acknowledged in both government and research circles in China, a Global South country that has experienced rapid urbanization over the past decade.



Figure 1.2.1 Master plan for ZJG Bay Eco-Park with permission of Zhangjiagang Bay Management Office to adapt these maps from Chinese to English and use them in this research



Figure 1.2.2 Observed protected animals after the ecological restoration with permission of Mr. Guozhong Xu, Mr. Yongxiang Wang, and Mr. Minjun Zhou to use photos in this research

1.3. Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between UE and UPD

The third project builds on the understanding of urban practitioners' and stakeholders' perspectives on BIPD, as derived from the literature review and the previous two projects. It examines the impact of collaborative research on urban biodiversity between scholars in urban ecology (UE) and urban planning and design (UPD), focusing on the disciplinary silos of these two fields of study. Additionally, it explores potential opportunities to promote and realize BIPD through inter- and transdisciplinary collaborations that aim to bridge the gaps between disciplines and between research and practice. To provide a comprehensive overview of the research landscape and its evolution regarding the collaborative research on this topic, I employ advanced Natural Language Processing (NLP) techniques to analyze the extensive number of unstructured texts of publications in the Web of Science from 2000 to 2023.

Specifically, we examined the thematic and vocabulary similarities and differences within the modeled topic clusters, as well as the evolutionary trends in topics and vocabularies, along with sentiments regarding biodiversity across three categories: 1) publications linked solely to authors in urban ecology; 2) publications linked solely to authors in urban planning and design; and 3) publications from authors in both disciplines. Our dataset includes articles indexed in the Web of Science Core Collections of Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (AHCI) related to urban biodiversity, identified through the query (ALL=(Urban*) AND ALL=(Plan* or Design* or Landscape Arch*)) AND ALL= (Eco* or Bio* or Wild* or Green or Specie* or Animal* or Plant* or Vegetation*) conducted on November 10, 2024, at the Technische Universität Berlin (TU Berlin). We first refined the search results to include publications from 2000-2023, ensuring they were written in English, included departmental affiliations, and excluded non-academic or duplicate document types. This process yielded 13,669 articles across 731 journals. We downloaded the metadata and extracted author affiliations from the indexed addresses, indicating their departmental ties. The metadata was

meticulously cleaned and screened for relevance in Excel. We then limited our dataset to the Web of Science categories of “Biodiversity Conservation,” “Ecology,” “Urban Studies,” and “Regional & Urban Planning," arriving at a final total of 2,319 articles.

Lastly, in accordance with the regulations of the Universidad Politécnica de Madrid (UPM) for preparing thesis documents, following to this Chapter 1: Introduction, this thesis will be structured into Chapter 2: Objectives, Chapter 3: Methods, Chapter 4: Results, Chapter 5: Discussion, and Chapter 6: Conclusion, followed by the References and Annexes of submitted or published publications related to this thesis thus far. In Chapter 2, I will concisely outline the overall research objectives and project-specific objectives in bullet points. In Chapters 3 and 4, each project will be presented sequentially, from Project 1 to Project 3. In Chapter 5, I will first discuss each chapter in the same order, concluding with an overarching discussion that integrates findings from the three projects, and I will present the key findings in bullet points in Chapter 6: Conclusion as the key takeaways of this thesis study.

2. Objectives

The overall objective of my thesis research is to understand the challenges and, more importantly, to identify opportunities for BIPD that, by definition, intentionally incorporate the voices of nonhuman species in urban planning and design. In particular, I examine the potential of actively involving these voices in urban practices, aiming to raise awareness and create tools for inter- and transdisciplinary collaboration that promote biodiversity-inclusive urban transformations. The specific objectives for the three projects are listed below:

2.1. Project 1: Understanding BEPs' Perspectives on BIPD

By understanding the diverse perspectives from a wide range of backgrounds, sectors, and professional focuses within the built environment professions across both the Global North and South, this Project 1 will help address the limited understanding of BEPs' perspectives on BIPD, particularly by engaging with those who are geographically and professionally underrepresented. It will also discuss potential opportunities for implementing BIPD with BEPs. Additionally, this Project 1 provides evidence of BEPs' views on implementing BIPD in low- and middle-income countries in the Global South, largely understudied areas that require greater attention. This project aims to address three knowledge gaps:

- 1) Uncovering the diverse perspectives of various BEPs on BIPD,
- 2) Providing in-depth, specific, and nuanced evidence of the perspectives of various BEPs across the Global North and South to extend to those who are understudied and hard to reach,
- 3) Understanding the challenges and opportunities of implementing BIPD through the lens of BEPs in relation to the frameworks of the TPB and Lock-in effects.

2.2. Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study

This Project 2 extends the understanding of stakeholders' attitudes on BIPD in a middle-income country in the Global South through a BIPD case study that intentionally considers nonhuman species in the design process. Considering the broader

stakeholders involved in the study, this research evaluates stakeholders' environmental attitudes at the species level. It advances an assessment tool that draws from the theories of environmental ethics, Kellert's biophilic typologies, and Chinese ecological civilization. The aim is to further explore opportunities for mainstreaming BIPD by understanding the challenges through the perspectives of residents, decision-makers, and professionals in the BIPD case study. In this project, the aims are:

- 1) Enhancing environmental assessment tools by integrating biophilic orientations to better understand stakeholders' environmental attitudes at the species level,
- 2) Developing a stakeholder engagement tool and applying it in a BIPD case study of ZJG Bay Eco-Park to assess decision-makers' and stakeholders' attitudes toward integrating nonhuman species into BIPD projects and their relation to local-level commitment to pursuing ecological civilization in China.

2.3. Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between UE and UPD

Building on the advanced understanding gained from Project 1 and Project 2, Project 3 utilizes an AI-driven Natural Language Processing technique to examine the interdisciplinary collaborative research's impact on urban biodiversity, focusing on the intersection of urban ecology (UE) and urban planning and design (UPD). This study aims to enhance the understanding of the current state of interdisciplinary research and identify opportunities to bridge the disciplinary silos between these two fields of study.

This project has two primary aims:

- 1) Examining the impact of collaborative research on urban biodiversity between scholars in UE and UPD, focusing on the disciplinary silos of these two fields of study.
- 2) Exploring potential opportunities to promote and realize BIPD through inter- and transdisciplinary collaborations that aim to bridge the gaps between disciplines and between research and practice.

3. Methods

To achieve the overall objectives of understanding the challenges and identifying the opportunities of BIPD, which, by definition, intentionally involves nonhuman species as active stakeholders in urban planning and design, it is crucial to understand the perspectives of stakeholders regarding BIPD. This should particularly include stakeholders from low- and middle-income countries in the Global South. Furthermore, as identified in the existing literature, disciplinary silos between urban ecology and urban planning and design adversely affect the implementation of BIPD. Additionally, ecologists have criticized BEPs for their practices, particularly regarding the lack of integration of advancements in urban ecology. Therefore, the research project design should incorporate materials and information that reflect this advancement and elicit perspectives from a broader range of BEPs, extending to a wider audience of stakeholders across various sectors, including public, private, and non-profit sectors, as well as general societal stakeholders.

To translate these complex overall aims and requirements into concrete research projects, I designed three projects to address a subset of the aims in detail and select relevant approaches and materials that represent the voices of nonhuman species. Moreover, I employed methods and developed tools to investigate stakeholders' perspectives and identify disciplinary silos, as well as potential opportunities for transformative urban biodiversity changes, while ensuring active stakeholder participation through real-world actions. Specifically, I developed Project 1: Understanding BEPs' Perspectives on BIPD to uncover the insights of built-environment professionals in both the Global North and South, encompassing low-, middle-, and high-income countries, as well as low-, middle-, and high-levels of urbanization. Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study focuses on a rapidly urbanizing city in a middle-income country in China, aiming to understand stakeholders' attitudes toward BIPD, including residents, professionals, and government decision-makers. Lastly, Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between UE and UPD utilizes novel AI-driven Natural Language Processing techniques to unveil the similarities and differences between these two fields and examine how such similarities and differences evolve over time in an objective and unbiased manner.

In Project 1, I selected species-distribution modeling (SDMs) and their research advances in potential applications in urban planning (Serret et al., 2022) as an example of the knowledge advancements in urban ecology and as a representation of the new concept of BIPD, which intentionally positions nonhuman species as active stakeholders among the participants of BEPs. Specifically, I chose Maximum Entropy (MaxEnt) SDMs that predict suitability based on a species' environmental response, work well with presence-only data collected through citizen science projects such as iNaturalist, eBird, and the Global Biodiversity Information Facility (GBIF), and hold great potential for application in urban planning and design. Additionally, their mapping format facilitates relatively easy comprehension for BEP participants without prior knowledge of BIPD. Considering the ambitious objectives of investigating perspectives from countries with varying levels of GDP and urbanization rates, as well as diverse profiles of the BEPs, Q-methodology stands out as an appropriate method for eliciting perspectives, making it feasible for thesis research conducted by a sole researcher across four countries. Q-methodology, as a mixed-methods approach, also complements quantitative analysis in understanding the overall perspectives among BEPs, allowing for more detailed and nuanced discussions with interview quotes to comprehend the motivations and justifications behind their perspectives. In conclusion, Q-methodology fits well with the aims and scopes of Project 1.

In Project 2, I chose the ZJG Bay Eco-park as a BIPD case study site based on three main considerations: 1) It is located in a rapidly urbanizing second-tier city in China, a middle-income Asian country in the Global South; 2) Its conceptual design and first-phase implementation explicitly addressed the needs of nonhuman species and demonstrated immediate improvements in the recovery of endangered species, recognized as a UN SDG good practice; 3) It is an ongoing project that presents a fleeting opportunity to capture the attitudes of stakeholders involved in such a BIPD project, with the potential for longitudinal investigation if funding and resources become available in the coming years. Given this fleeting opportunity window to gather stakeholders' views on integrating nonhuman species into urban design, I determined that questionnaire surveys would be the most effective approach. In the meantime, it would not make sense for me to consult SDMs or any other scientific or technical advances in urban ecology with the public stakeholders who have no prior knowledge or interest. A significant challenge in assessing the stakeholders' views on BIPD lies in ensuring appropriate representation. Therefore, in this Project 2, I began with the

theoretical quest of environmental ethics and investigated the unique cultural and philosophical traces of the non-Western origins of Chinese ecological civilization. To specifically represent nonhuman species in the assessment, I referred to Kellert's biophilic typologies to intentionally narrow down to the species diversity level. As a result, I developed a new assessment tool that integrates ecocentric-anthropocentric attitudes and biophilic typologies to align with environmental ethics theories and Chinese philosophies, and most importantly, to reflect nonhuman species in the assessment survey statements. Consequently, I developed a new assessment tool that investigates stakeholders' attitudes toward nonhuman species, and this tool would be useful for BEPs to employ in practical BIPD projects.

Regarding Project 3, I originally planned to use focus groups, inviting both urban ecologists and built-environment professionals to gather their insights on how to bridge the disciplinary silos between these two fields. However, this approach cannot effectively illustrate collaborative efforts across these fields, is limited to a small selection of experts' opinions, and does not analyze the temporal and historical evolution. Therefore, I utilized emerging AI-driven Natural Language Processing techniques to explore the extensive volume of publications from 2000 to 2023 to demonstrate the role of collaborative research in the disciplinary silos and identify potential opportunities and themes for bridging these divides.

3.1. Project 1: Understanding BEPs' Perspectives on BIPD

3.1.1. Q methodology

We employ Q methodology, a mixed quantitative and qualitative research technique (Artis et al., 2020), to illustrate BEPs' typology of viewpoints on BIPD. This methodology has been increasingly utilized in conservation and sustainability research (Seghezzi et al., 2023; Sneegas et al., 2021). Q methodology employs factor analysis to statistically identify patterns of perspectives based on participants' rank-sorting of items, allowing for interpretation and comparison of these perspective patterns (Zabala & Pascual, 2016). While Q methodology is typically applied to understand viewpoints within a single geographical location, it can also be used to analyze viewpoints across multiple locations (Artis et al., 2020).

To involve BEPs from both the Global North and South, we selected the United States, Spain, China, and Ethiopia as our case study countries, each characterized by distinctive levels of national urbanization rate (United Nations Population Division, 2022) and national GDP per capita, purchasing power parity (PPP) (World Bank, 2022). We also purposively sampled BEPs in these four countries to ensure diversity (Table 3.1.1), engaging those who may not typically have an interest in the topic of urban biodiversity across built-environment disciplines, including ecological-environmental and socioeconomic focus areas, as well as the public, private, and non-profit sectors. In total, we recruited 36 participants with professional experience ranging from 6 to over 30 years, yielding an average of 14.2 years of experience. We also diversify the cities where participants practice as much as possible to include medium-sized to small cities. Considering the diverse profile of the participants and the scarcity of BIPD practice, the vast majority of the recruited BEPs may lack knowledge or experience with BIPD.

To facilitate specific and concrete interviews, we provided a brief introduction to BIPD and utilized examples of species distribution modeling and mapping (Plummer et al., 2020; Serret et al., 2022) to present a vivid illustration and enhance understanding. Before commencing, this research received ethical approval from the Universidad Politecnica de Madrid (UPM) (reference No. UAPGIAAESO-JAM-DATOS-20231114), and all participants signed informed consent to participate.

3.1.2. Q statements

We initially conducted thirteen semi-structured interviews from December 2023 to February 2024 to develop a concourse of 340 statements (Zabala & Pascual, 2016), reflecting BEPs' intentions to incorporate BIPD in their practices. We inductively coded the interview transcripts using NVivo 12 (QSR International, 2018) and categorized the statements into four themes: Environmental Concerns, Attitudes, Subjective Norms, and Perceived Behavioral Control (TPB) (Ali et al., 2023; Ajzen, 1991). The last theme of TPB included Understanding Silos and Lock-in Effects (Wilson, 2014).

From this coded concourse, we selected 25 representative statements to match with the P-sample of 23 participants for Q-sorting interviews (Watts & Stenner, 2005). These statements were edited for clarity and relevance across countries and cultures while retaining the original meaning (Table 4.1.2). The statements were translated into Chinese and Spanish, and the translations were validated by both ecologists and BEPs who are native to these languages for use in China and Spain. For participants in Ethiopia, we communicated in English, having consulted their language preferences. English is widely used alongside their federal working language, Amharic, across all sectors in Ethiopia; for example, the nation's Constitution is written in both English and Amharic (Eshetie, 2010). We tested the Q-set with two respondents to ensure the statements were clear, comprehensive, and suitable for both face-to-face and online settings.

3.1.3. Conducting Q sorts

The Q sorts and post-sort interviews took place between March and April 2024. Each interview lasts between 60 and 90 minutes, either online or in person, depending on the participants' availability. We conducted all Q sorts using the Q-Tip platform (<https://qtip.geography.wisc.edu/>), a free online tool for Q-method research developed by the University of Wisconsin-Madison. Participants were asked to sort the 25 statements onto a nine-column distribution board from Q-Tip (Figure 4.1.1), based on their opinions regarding the extent to which they agreed or disagreed with each statement relative to others. During the post-sort interviews, we first discussed the participants' sorts and then posted two follow-up questions. The first question aimed to capture BEPs' proposed strategies by asking for their top three suggestions for

approaches that they believe would help integrate BIPD into urban practice. The second question sought to gauge their intentions for change by having them select from a five-point Likert scale to rate how BIPD should be incorporated into the legal framework, ranging from “not necessary”, “conceptual”, “non-statutory” to “statutory” (Table 4).

3.1.4. Q analysis

Following standard analytical processes in Q Method (Zabala & Pascual, 2016) and recommendations to minimize bias (Zabala et.al., 2018), we analyzed the Q sorts using the R package ‘qmethod’ version 1.8.4. (Zabala, 2014) and Ken-Q Analysis software version 2.0.1 (Banasick, 2023). After computing intercorrelations among individual Q sorts, we extracted four factors using Principal Components Analysis with eigenvalues greater than 1.77 and applied Humphrey’s rule to test the retention of these factors. The cumulative explanatory variance of these four factors was 70.8% (Table 4.1.1). We used the default Varimax rotation and retained the automatically flagged defining sorts for each factor, with the resulting minimum factor loading exceeding 0.60.

To aid in interpretation, we consulted the composite ideal sorts (Table 4.1.2 and Figure 4.1.1), as aggregated by Ken-Q Analysis software (Banasick, 2023), which represent a shared viewpoint for each factor. Further, we employed NVivo 12 (QSR International, 2018) to organize the post-sort interview transcripts for each factor and to gain insights into participants’ perspectives through illustrative quotes.

Table 3.1.1 Summary of research participants

Study country			Professional background									Total participants per country	
Name	National Urbanization (%)	National GDP per capita, (PPP) (current international \$)	Discipline						Focus			Concourse	Q-sort
			UP	UD	LA	CE	Env	Mul	Ecol	Environ	Socio-econ		
Ethiopia	Low	Low	4	1	1	4	0	0	0	5	5	4	6
China	Medium	Lower middle	3	2	1	0	2	1	2	2	5	3	6
Spain	High	Upper middle	1	1	2	3	1	0	2	3	3	3	5
USA	High	High	3	0	2	1	1	2	3	3	3	3	6
Total participants per background			11	4	6	8	4	3	7	13	16	13	23

Source: National urbanization (urban population as a percentage of total population) (%): Low < 35%, Medium 35%-75%, High > 75% (United Nations Population Division, 2022); National GDP per capita, purchasing power parity (PPP) (current international \$): Low < 15, Lower middle 15-45, Upper middle 45-65, High > 65 (World Bank, 2022).

UP = urban planning; UD = urban design; LA = landscape architecture; CE = civil engineer; Env = environmental science or engineering; Mul = specialized in two or more disciplines; Ecol = ecological focus; Environ = environmental focus; Socio-econ = socioeconomic focus.

3.2. Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study

3.2.1. Environmental ethics and their relationship with China's ecological civilization

Whitehead's philosophy anticipated the development of environmental ethics and may have influenced Leopold's 'The Land Ethic' from 1970 (Callicott, 1980; Henning, 2016). Leopold is widely considered to be the founding father of 'environmental ethics.' This means that process philosophers were the key contributors to the seminal discussions that constituted the field of environmental ethics (Henning, 2016) (Figure 3.2.1). In the view of pioneering environmental philosophers, there is no 'ethic' in environmental ethics unless it recognizes the intrinsic value of the nonhuman (Cocks & Simpson, 2015; Leopold, 1949). Therefore, in the early discussions that constituted the field of environmental ethics, there are two major perspectives: ecocentrism, which celebrates the intrinsic value of nature, independent from its direct value to human beings (Cocks & Simpson, 2015); and anthropocentrism, in which the nonhuman environment is measured by its tangible and intangible value to human beings (Norton, 1984). Later, researchers started to further divide the anthropocentric perspective into strong anthropocentrism and weak anthropocentrism (Cocks & Simpson, 2015; Norton, 1984). In strong anthropocentrism, the nonhuman environment is regarded as a commodity or merely an object of use, while the weak anthropocentrism perspective measures the natural environment by its value to human beings, but the value is significantly expanded beyond the commodities associated with strong anthropocentrism (Cocks & Simpson, 2015). Further, the biophilia hypothesis boldly asserts the existence of a biologically based innate human need to affiliate with life and lifelike processes. E.O. Wilson (1984) and Kellert (1996) refined a typology of environmental values that reflects a range of physical, emotional, and intellectual expressions of the attitudes toward nature, such as 'utilitarian', 'naturalistic', 'ecologistic-scientific', 'aesthetic', 'symbolic', 'humanistic', 'moralistic', 'dominionistic', and 'negativistic' environmental valuations with a specific focus of species.

Almost a century later, Chinese intellectuals have been attracted to the philosophy of Whitehead, who called his thought 'the philosophy of organism (Henning, 2016; Wang et al., 2020; Whitehead et al., 1978). Whitehead's thoughts on process philosophy not only

provided them with a theoretical foundation (Figure 3.2.1) to shift from the celebrated achievement of ‘modernism’ and economic growth in Chinese society to the more cutting-edge thought on the European ‘postmodernism’ and to the fulfillment of the dual commitments of the Chinese government of ecological civilization and scientific ways of thinking. It joins the recent revival of traditional Chinese wisdom with China’s environmental movement (Wang et al. 2020). China has welcomed Whitehead’s thought and sees it as a way of clarifying and supporting the commitment to an ecological civilization, which has been strongly re-emphasized by President Xi (Wang et al., 2020).

Since 2007, China has continuously demonstrated its commitment to a much more harmonious relationship with the environment (Wu & Wallace, 2014). There is plentiful evidence in this regard. The Communist Party formally drafted the goal of becoming an ecological civilization into its Constitution in 2012. Thirty-six universities have organized Centers for Process Studies in China, and Wang and his colleagues (2020) documented hundreds of publications associated with Whiteheadian thought on ecological civilization since 2002. It has also launched a series of national and regional ecological-oriented mega-planning projects.

Despite U.S. propaganda, which often criticizes China’s commitment as halfhearted (Wang et al., 2020), the real question appeared to be centered on whether the interest in the ecological civilization is solely a top-down process of the political leadership imposed on the people or is embraced and actively responded to by all levels of decision-makers and the public in China. There is a lack of research from the bottom-up perspective to answer this question: Are decision-makers and stakeholders at the local levels fully committed to pursuing ecological civilization, and what are their attitudes toward integrating nonhuman species in the BIPD projects? The analysis of this information is very relevant because it is important to provide useful preliminary steps for understanding and influencing behavioral changes.

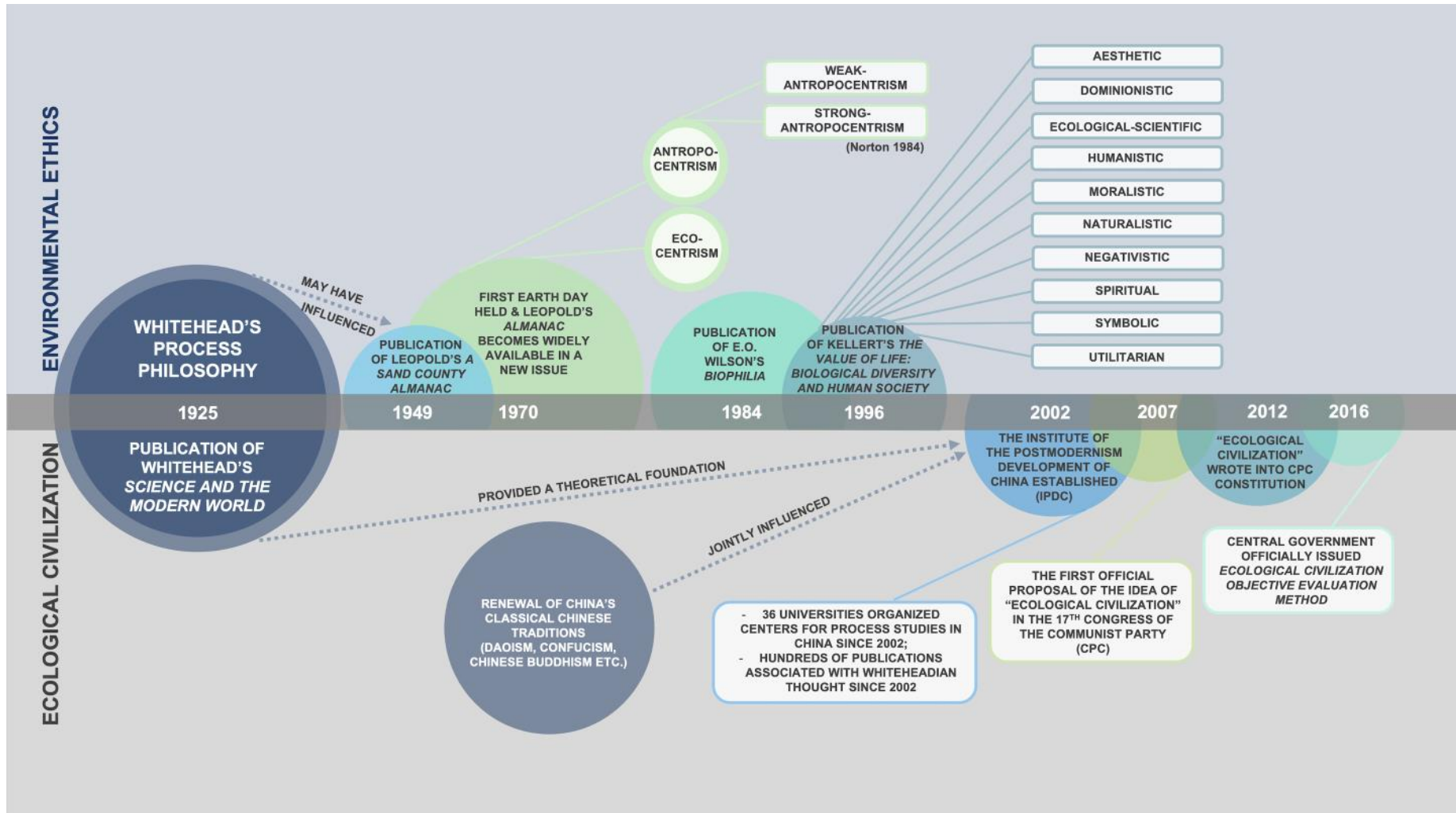


Figure 3.2.1 Historical traces and relationship of Process Philosophy, Environmental Ethics, and Chinese Ecological Civilization.

Referring to the historical theoretical analysis conducted in section 3.2.1, Jing Lu has prepared this figure to reflect and compare the historical evolution and relationships between Environmental Ethics and Ecological Civilization.

3.2.2. Environmental assessment tools and their applications to BIPD projects

A growing number of researchers have pointed out the pivotal practical values of environmental ethics theoretical classifications (Chang et al., 2011; Cocks & Simpson, 2015; Thompson & Barton, 1994) and have developed a variety of scales to assess environmental attitudes since the 1970s (Dunlap & Van Liere, 1978; Maloney & Ward, 1973; Weigel & Weigel, 1978). Amongst all, the New Environmental Paradigm Scale (NEP) has been recognized as the most well-known and widely applied scale because of its relatively high reliability and generality (Dunlap & Jones, 2002; Hong, 2006; Hong & Fan, 2016; La Trobe & Acott, 2000; Stern et al., 1995). It was first introduced in China by Dayong Hong (2006) and later became popular in Chinese academic circles and was applied broadly to environmental education and conservation behavior as well (Chang et al., 2011; Luo & Deng, 2007; Wu et al., 2012; Wu & Zhu, 2017; Yu, 2014). With its broad scope, the NEP scale encompasses diverse environmental theories and topics, including anthropocentrism, human exceptionalism, and ecological equilibrium, among others. This tool is effective at capturing the environmental worldview but falls short of explaining the strong links between attitudes and actions (Thompson & Barton, 1994; Wu & Zhu, 2017). Ecocentric and anthropocentric individuals may, although not always, express positive attitudes toward environmental issues, with the difference in these two orientations translating into actions absent from the NEP scale (Cocks & Simpson, 2015).

In this regard, Thompson and Barton (1994) operationalized the Ecocentric and Anthropocentric Attitude toward the Environment Scale (EA scale) and found that ecocentric attitudes were significant predictors of both self-reported and observed behaviors even after controlling for a traditional measurement of environmental attitudes. Later, Røskraft's team (2007) in Norway used this EA scale to evaluate the belief-attitude relation among sheep farmers, wildlife managers, and research biologists toward carnivores. The results suggested that environmental beliefs might transform ecocentric values into negative or positive attitudes toward one specific environmental category based on the cognitive hierarchy model. Furthermore, Kopnina and Cocis (2017) adjusted the EA scale to better fit the field of environmental education, with a specific connection to sustainable development aims and tested it on three groups of students in different majors. The results demonstrated that different environmental attitudes result in variations in motivations and choices of conservation

behavior. For instance, ecocentric individuals are more likely to act on pro-environmental attitudes and engage in conserving behaviors. Typical examples of this can be found in environmental organizations.

Along with theoretical progress in environmental ethics, researchers continuously specify the typologies in environmental perspectives (Callicott, 1992; Kellert, 1996; Norton, 1984, 1995). Inspired by Kellert's environmental value typology (Diehm, 2012; Kellert, 1996, 2008; Wilson, 1984), Delavari-Edalat and Abdi (2010) developed the Biophilia Tendency Scale (BT scale) and conducted a survey on the two ethnic groups of Asia and White British in an urban park in the UK, finding differences in negativistic, moralistic, and naturalistic values. Unlike the NEP and the EA scales, the statements in the BT scale focus specifically on talking about the perspectives at the species level toward trees. Perhaps partly due to its narrow focus, the BT scale is not used as widely as the other two. However, the detailed differential classifications based on the theoretical typologies of the BT scale make it possible to raise these environmental value distinctions to the conscious level, which helps understand the underlying motivations, which is particularly important in the applied fields of BIPD, where environmental behaviors are constantly taking place.

Urban green spaces are integral components for urban biodiversity, contributing to the conservation of ecosystems and the welfare of the population by forming part of a network that connects the city with nature (Cameron & Blanuša, 2016). Since this requires a long-term environmental commitment and problem-solving in a complex environment, BIPD are highly relevant to the influence of different environmental attitudes. Previous studies have indicated its pivotal practical values in the realm of environmental education and the promotion of outdoor conservation programs (Chang et al., 2011; Cocks & Simpson, 2015; Thompson & Barton, 1994), by using different environmental attitude assessment tools. Some researchers have also begun to investigate the environmental perspective of urban green spaces of users after the fact (Chang et al., 2011; Luo & Deng, 2007), but their orientations at an early stage that shapes the implementation process have not yet been assessed (Parris et al., 2018). It also calls for appropriate environmental orientation tools that can be applied to BIPD projects to proactively assess these orientations. On the one hand, such tools should better reflect the progress in increasingly more specific theoretical ethical classifications. For instance, it might work better to further differentiate strong-anthropocentric and weak-anthropocentric orientations on the EA scale to apply the

theoretical progress in the urban-applied field of BIPD. On the other hand, to improve the policy implications of environmental assessment, which is particularly important in the practical fields of BIPD, tools should be better able to explain motivation and provide more detailed environmental perspectives. The BT scale, originally designed for detailed attitudes of trees, is a winner in this regard. To sum up, an early conscious understanding and evaluation of underlying attitudes can help craft messages tailored to different environmental perspectives and establish a consensus amid the constant conflicts between growth and protection over time, facilitating more constructive behaviors, careful maintenance, and long-term sustainable successes (Zuniga-Teran et al., 2020).

3.2.3. ZJG Bay in China: UN-listed SDG Good Practice

In line with the national strategy for ecological civilization, the local government initiated ZJG Bay Eco-Park as part of the ongoing mega BIPD projects along the Yangtze River. These projects involve collective efforts from various sectors and are in different phases, spanning a long period (Figure 3.2.2).

There are two main merits of studying the ZJG Bay Eco-Park project in this study. First, under the natural protection strategy and local government initiation, this large-scale project involves multiple critical aspects of removing polluting industries, restoring the ecological landscape, building green infrastructure, restore biodiversity by actively considering nonhuman species, and ensuring public access to the eco-park (Figure 3.2.3). Subject to a variety of consultations and collaboration with fishing farms, semi-operational port enterprises, villages, local grassroots volunteer groups, professional planners, and construction companies (United Nations, 2021), the project is ideal for studying the environmental perspectives of stakeholders at an operational level and for assessing the extent to which it aligns with the central government's position on the ecocentrism-anthropocentrism spectrum and biophilic tendencies at the species level, as well as its impact on the project.

Secondly, implementing the ZJG Bay Eco-Park project will require tremendous effort in a complex and dynamic process without guaranteeing long-term sustainable success. In other words, although being recognized as UNSDG Good Practice in its initial phase consolidates the results of its eco-actions, it remains to be seen whether the project will continue its good practice to promote sustained effects. Right now, it presents a fleeting

opportunity to understand the environmental perspectives of those who have contributed to the success of stage one of the ZJG Bay Eco-Park project, as well as the potential areas that are worth looking into and that could provide insights into the actions in its later stages. In this sense, the proactive nature of this study sets it apart from the previous studies on environmental attitudes, which mostly assess BIPD projects after the fact, and gives it the potential to monitor and influence both the building and continuity of consensus.

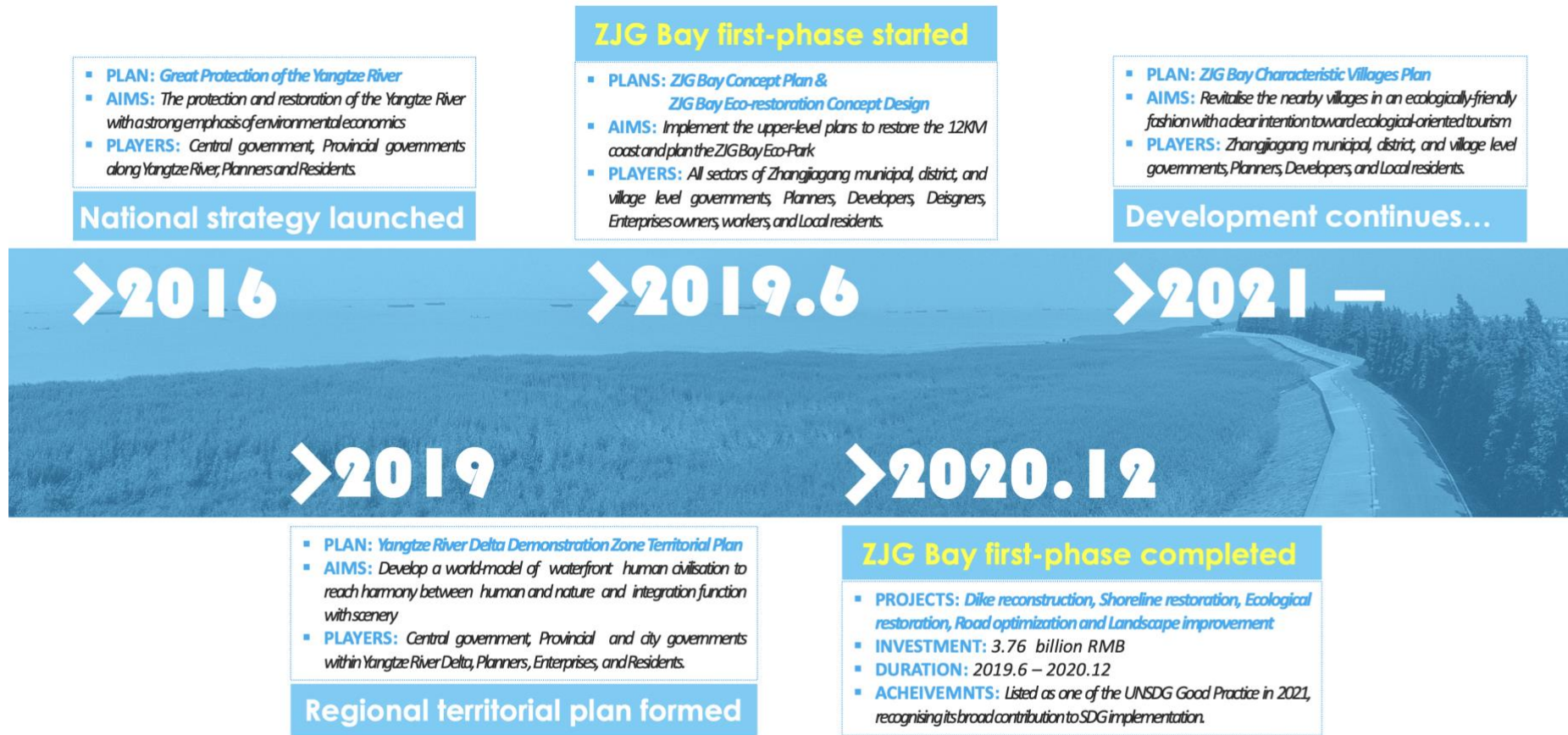


Figure 3.2.2 Timeline of ZJG Bay Eco-Park project planning and implementation. (Image by Jing Lu)



Figure 3.2.3 Before and after the phase-one implementation of the ZJG Bay Eco-Park (2019-2020). Reprinted from (Zhangjiagang Bay Management Office & Fan n.d.), with permission.

3.2.4. Adaptation of the survey instrument

Referring to the earlier discussions on the differences in environmental attitude assessment tools, the EA and the BT scales outweigh the NEP scale with regard to the potential of showing the motivations behind behaviors for better practical policy implications. Comparing the EA and the BT scales with each other, the former reflects a general orientation on the spectrum of anthropocentric to ecocentric attitudes, and the latter differentiates more detailed perspectives, which are particularly applicable to BIPD projects. As a result, the authors decided to adapt a new scale by incorporating both the EA and the BT scales to create a two-tier assessment tool. Since the statements in the EA scale are more universally applied than those of the BT scale, the authors mainly used the statements from the EA scale and incorporated some of the statements from the BT scale where needed. By simultaneously assessing the stakeholders' attitudes on both the EA and BT scales, as opposed to the original EA scale, the newly adapted EA scale will be able to assess both general orientation and specific typologies across biodiversity levels. For this reason, this paper refers to the adapted EA scale as the AEA scale. There were four steps in the process of adapting the AEA scale:

1. *Upgrade the EA scale to four sub-scales:* To better reflect recent theoretical advances and societal changes, the authors further specify the strong anthropocentric and weak anthropocentric viewpoints in the EA scale according to the definitions outlined in Cocks and Simons' study (2015). This resulted in the four sub-scales of 'Ecocentrism,' 'Weak Anthropocentrism,' 'Strong Anthropocentrism,' and 'Apathy' in this upgraded EA scale (Table 4.2.1).
2. *Incorporate BT statements:* Since there are only two original statements that relate to weak anthropocentric values in the existing EA scale, more statements in this subscale were needed, so the authors incorporated adapted statements from the BT scale. The authors selected the ecologicistic and moralistic tendencies in addition to the utilitarian, negativistic, dominionistic, and naturalistic typologies already embedded in the EA scale. This adapted version now has six major sub-scales of the BT scale originating from Kellert's typology definition (Kellert, 1991, 1996) at the species level listed in Table 3.2.1.

3. *Optimize the total number of statements*: Previous researchers operated 22 to 33 statements of the EA scale in their questionnaire (Bjerke & Kaltenborn 1999; Kopnina & Cocis 2017; Thomposn & Barton 1994). To optimize the length of the AEA scale and to balance out the statements in each subscale, the authors decided to add three adapted statements related to weak anthropocentric values from the BT scale and made it all-together five statements for the weak anthropocentric sub-scale, and consequently, the total number of statements add up to 20 with an equal number of five statements in each of the four EA sub-scales. A further statement selection procedure was carried out based on the criteria of ‘common selections among past researchers’, ‘diversity in environmental value tendencies’, ‘no ambiguity in definitions’, and ‘cultural relevance to China’. The conciseness of the final AEA scale makes it easier to apply in practice. The full statements and their association with the sub-scales are outlined in Table 4.2.1.

4. *Finalize the scale and adapt it to the Chinese version*: Each statement in this AEA scale is assigned with the Likert scale from 1 to 5 selection options from strongly-agree (1), agree (2), neutral (3), disagree (4) and strongly-disagree (5). The full AEA scale was then translated into Chinese following the procedures of forward and backward translations to ensure the quality of the adapted Chinese version.

Table 3.2.1 Six Kellert’s typologies

Typologies	Definitions
<i>Ecologistic</i>	<i>Interest in the ecological value of species, and their relationship to the environment</i>
<i>Moralistic</i>	<i>Opposition to cruelty and harm toward species</i>
<i>Naturalistic</i>	<i>Interest in direct outdoor recreational contact with species</i>
<i>Utilitarian</i>	<i>Interest in utilization of the species, or subordination of their habitat for the practical benefit of humans</i>
<i>Negativistic</i>	<i>Fear, dislike or indifference toward species</i>
<i>Dominionistic</i>	<i>Interest in the mastery, control, and dominance of the animals</i>

Source: Data from Kellert (1996).

3.2.5. Sampling and data collection

In mid-October 2021, the questionnaire was distributed to the stakeholders listed in Table 3.2.2 using the widely used Chinese questionnaire platform WJX (<https://www.wjx.cn/libt/10122.aspx>) and received a total of 272 responses within one week. The breakdown of the final respondents was 26.1% local officials, 39.3% professionals, and 34.6% local residents. All of the collected data was imported into SPSS (IBM SPSS Statistics version 21 & 27) to verify the validity (Cronbach's Alpha Test) and reliability (KMO and Bartlett's Test) of the adapted scale. The authors also calculated mean values by sub-scales and sub-groups to understand the central tendency of probability distributions of each sub-scales and sub-groups, conducted categorical principal component analysis to analyze the relative impact of the sub-groups on the sub-scales, and conducted cross sub-scale partial correlation analysis by group type to understand the strength of the relationship between each of the sub-scales. From Table 3.2.3, we can also observe a high level of park usage, with 56.62% of stakeholders visiting at least once a month and 60.29% staying more than an hour during each visit. This demonstrates strong support for the ZJG Bay Eco-park. In other words, one of the initial objectives of 'returning the ZJG Bay to the residents' has been achieved.

Table 3.2.2 Questionnaire participants

Stakeholders	Roles	Specifications
Local officials	Initiators	Municipal mayor offices, natural resources and planning bureau, environmental protection bureau, village committees etc.
Professionals	Implementers	Urban planners, landscape architects and engineers, local volunteer groups and construction personnel and managers
Residents	Influenced	The villagers and middle school students from the surrounding area, fishing farmers and enterprise owners & employees who made their living from ZJG Bay before the establishment of the Eco-Park

Table 3.2.3 Participants' Visit Frequency and Duration per Visit to ZJG Bay Eco-park

Visit frequency	Percentage (%)	Stay duration	Percentage (%)
None	4.41%	Less than half an hour	9.56%

Less than 5 times	38.97%	Half an hour or above, less than one hour	30.15%
Once or twice a month	25.37%	One hour or above, less than four hours	45.22%
Once or twice a week	11.40%	Four hours and above	15.07%
Every day or every the other day	19.85%		

3.3. Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between UE and UPD

3.3.1 Data preprocessing

We employed the Python Natural Language Toolkit (PNLK) library (Bird et al., 2009) to preprocess unstructured text from the articles' abstracts and author affiliations into two corpora. This process included tokenization, stop-word filtering, part-of-speech tagging (Brill, 1995), and the lemmatization of nouns, verbs, and adjectives (Eckstein, 2023). Based on a list of filter words or stems (Table 3.3.1) identified from the preprocessed corpus of author affiliations, we classified the articles into three disciplinary categories: 1,055 counts in Urban Ecology (UE), 506 counts in Urban Planning and Design (UPD), and 758 counts in Interdisciplinary Collaboration (Inter).

Table 3.3.1 Classification stems for disciplines of UE, UPD, and Inter

UE Classification Stems	UPD Classification Stems
agr	adm
agron	anthropol
anim	architecture
bio*	civil
bot	community
conservat	design
crop	dev
ecol	econ
ecosyst	geog
entomol	govern*
evolut*	govt
fishery	hist
forest*	human
geol	land
hort	landscape
life	plan*
microbiol	publ
nat*	soc*
nutr	spatial
plant	urban
protect	
resource	
sense	

vet
wildlife
zool
Note: Classification stems are extracted from the 'Addresses' Index of Web of Science, which contains authors' departmental affiliations. UE refers to authors affiliated solely with UE classification stems, UPD refers to authors affiliated solely with UPD classification stems and Inter denotes those authors affiliated with both UE and UPD stems.

3.3.2 Topic modeling

To identify the key topic clusters and their relationships within these three disciplinary areas, we began modeling topics using Latent Dirichlet Allocation (LDA) analysis from the PNLK library (Bird et al., 2009). We merged the abstracts and keywords during preprocessing and normalized the text before conducting the LDA modeling. We employed the Coherence Score and Grid Search functions to ensure high-quality topic generation, allowing the model to determine the optimal number of topics with the best coherence score. We saved the results for each major topic, including the top extracted words (Table 4.3.1) and visual representations of the modeled topics (Figure 4.3.1, 4.3.2, and 4.3.5) for further analysis (Chuang et al., 2012; Sievert & Shirley, 2014). The authors, experts in urban planning and urban ecology, independently reviewed each topic cluster's top words and corresponding article titles. They discussed their proposed thematic labels in meetings to reach a consensus on the agreed labeling of topics and identify the essential thematic terms and vocabularies across the three disciplines (Table 4.3.1).

3.3.3 Cosine similarity analysis

To quantify discursive overlaps and thematic interdependencies across disciplines, we subsequently conducted a cosine similarity analysis on the 30 most frequent terms. Cosine similarity measures the angular alignment between term-frequency vectors, with values ranging from 0 (no overlap) to 1 (complete overlap) (Singhal, 2001), using the Scikit-learn library (Pedregosa et al., 2011). We performed bootstrapping (Efron & Tibshirani, 1994) with 1,000 resamples to assess the robustness of the cosine similarity scores and derived 95% confidence intervals (CIs) from the bootstrap distribution to quantify uncertainty. We tested pairwise differences between similarities for significance by checking if their CIs excluded zero ($\alpha = 0.05$). Results were visualized

through heat maps and network graphs (Hagberg et al., 2008). Heat maps highlighted gradients of similarity, and the edge thickness of the network graph corresponded to the magnitude of cosine similarity.

3.3.4 Trend analysis

To analyze the evolutionary trends in topics and essential vocabularies from 2000 to 2023 across three disciplines, we generated annual publication trends (Figure 4.3.3) and examined year-by-year publication differences (Table 3.3.2). We divided the entire 24-year period into four segments: 2000-2009, 2010-2014, 2015-2019, and 2020-2023, acknowledging the significant increase in publications within these intervals (Table 3.3.2). Next, we conducted LDA topic modeling and cosine similarity analyses for each segment across disciplines (Table 4.3.1, Figure 4.3.2, 4.3.5, and 4.3.6) to establish a foundation for analyzing topic evolution and overlap. After identifying the essential vocabularies that highlight the similarities and differences among disciplines, we examined their frequency and occurrences over time (Figure 4.3.3, 4.3.6 and 4.3.7) in the PNLK library (Bird et al., 2009) to gain insight into thematic focuses and shifts across disciplines. Furthermore, we assessed the research impact and relevance of the three disciplines over time by analyzing trends in average citation rates per year for articles (Table 3.3.2 and Figure 4.3.3). To calculate these citation rates, we divided the total number of citations by the number of years since publication.

3.3.5 Sentiment analysis on biodiversity framing

For our sentiment analysis on the framing of biodiversity, we built on the methods from the previous study of Armstrong et al.'s work on understanding the disciplinary divide between urban ecology and urban planning regarding "urbanization" (Armstrong et al., 2022) to implement a more effective strategy that addressed the shortcomings of lexicon-based machine learning algorithms for academic datasets. These algorithms are often trained on movie reviews or social media posts and fall short of accurately measuring sentiment in the more neutral tone of scientific papers (Yousif et al., 2017). Our dataset consisted of abstracts averaging fewer than 300 words each. so we used straightforward filter stems representing biodiversity: 'biol*,' 'biodivers*,' 'ecol*,' or 'ecos*.' To analyze each abstract, we leveraged the PNLK library (Bird et al., 2009), extracting the contextual corpus within a 15-word window to provide context from the surrounding sentences. We also prepared the substantive *indicator words*, as well as the *link words* (such as 'increasing' or 'loss') (Table 3.3.3) (Armstrong et al., 2022), for

conducting lexicon-based sentiment analysis. Each word was assigned with a polarity score of +1 or -1, allowing us to compile the sentiment scores for articles by discipline and compare mean scores across disciplines using a *t*-test (Figure 4.3.4). We carried out multiple sensitivity analyses to evaluate the robustness of our findings (Figure 4.3.4).

Table 3.3.2 Annual publication counts, differences, percentage differences, and cumulated citation rate

Publication Year	Annual Publication Counts			Annual Count Differences			Annual Percentage Differences (%)			Annual Cumulated Citation Rate		
	UE	UPD	Inter	UE	UPD	Inter	UE	UPD	Inter	UE	UPD	Inter
2000	10	6	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2001	4	7	3	-6	1	3	-60.0	16.7	NA	11.4	7.3	1.7
2002	12	3	2	8	-4	-1	200.0	-57.1	-33.3	20.3	8.6	6.0
2003	11	8	1	-1	5	-1	-8.3	166.7	-50.0	24.5	14.9	15.4
2004	13	10	4	2	2	3	18.2	25.0	300.0	29.7	17.4	17.8
2005	14	8	4	1	-2	0	7.7	-20.0	0.0	37.0	24.2	22.1
2006	26	9	5	12	1	1	85.7	12.5	25.0	44.7	27.2	33.2
2007	29	5	7	3	-4	2	11.5	-44.4	40.0	52.9	30.2	45.7
2008	29	5	9	0	0	2	0.0	0.0	28.6	57.3	33.8	53.9
2009	40	15	18	11	10	9	37.9	200.0	100.0	63.9	40.9	60.2
2010	36	12	16	-4	-3	-2	-10.0	-20.0	-11.1	69.6	47.3	68.4
2011	43	19	23	7	7	7	19.4	58.3	43.8	79.8	51.3	72.5
2012	55	17	30	12	-2	7	27.9	-10.5	30.4	86.5	55.9	80.5
2013	43	17	34	-12	0	4	-21.8	0.0	13.3	92.3	60.3	89.0
2014	48	24	44	5	7	10	11.6	41.2	29.4	99.0	64.3	97.9
2015	60	25	39	12	1	-5	25.0	4.2	-11.4	106.2	68.2	108.1
2016	59	29	53	-1	4	14	-1.7	16.0	35.9	114.5	74.0	115.9
2017	57	19	65	-2	-10	12	-3.4	-34.5	22.6	123.9	78.8	127.5
2018	71	34	56	14	15	-9	24.6	78.9	-13.8	131.8	90.2	136.1
2019	82	39	59	11	5	3	15.5	14.7	5.4	142.7	94.7	145.9
2020	75	29	51	-7	-10	-8	-8.5	-25.6	-13.6	150.5	102.2	160.5
2021	74	48	85	-1	19	34	-1.3	65.5	66.7	156.5	107.9	171.5
2022	85	60	68	11	12	-17	14.9	25.0	-20.0	161.4	114.7	181.8
2023	72	46	74	-13	-14	6	-15.3	-23.3	8.8	165.5	120.3	188.9

Note:

The years highlighted in bold indicate significant increases across disciplines in that year. The year 2004 was not chosen as an interval year due to the low total counts between 2000 and 2004. Therefore, the selected time segments are 2000-2009, 2010-2014, 2015-2019, and 2020-2023.

Table 3.3.3 Biodiversity indicator and link word stems with polarity and category

Indicator Word Stem	Polarity	Link Word Stem	Polarity
diversity	1	accelerate	1
biodiversity	1	advanc	1
bird	1	benefit	1
connectivity	1	cause	1
conservation	1	damag	-1
deforest	-1	declin	-1
disturbance	-1	decrea	-1
ecosystem	1	degrade	-1
endemic	1	destroy	-1
exotic	-1	destruct	-1
extinction	-1	drive	1
fauna	1	encourag	1
flora	1	enhanc	1
forest	1	favor	1
fragmentation	-1	flourish	1
invasive	-1	increa	1
abundance	1	loss	-1
connectivity	1	neg	-1
nonnative	-1	posit	1
		problem	-1
		reduc	-1
		risk	-1
		threat	-1

Note:

Listed words are stems, and so any word beginning with the stem will be captured. For instance, deforest will capture deforestation, deforesting, etc.

4. Results

4.1. Project 1: Understanding BEPs' Perspectives on BIPD

During the interviews for both the concourse and Q sorts, we found that only four out of the total 36 participants had heard of or used SDMs before, representing 11.1% of the BEPs surveyed. We identified four factors (F) that account for 19 of the 23 participants' Q sorts and revealed four distinct viewpoints on BIPD (Table 4.1.1). The remaining four Q sorts were classified as confounded Q sorts (Table 2) due to significant loading onto multiple factors. We named the four factors: Pluralist, Enthusiast, Pragmatist, and Contextualist. Notably, all perspectives support BIPD and are generally independent of participants' countries or professional backgrounds, except for the Contextualist perspective, which is represented solely by Ethiopian participants (Table 3.1.1 and 4.1.1). Professionals from Ethiopia appear in all factors, while professionals from the United States are represented in three factors, and professionals from China and Spain are represented in two factors. Similarly, there is no clear pattern among participants' professional backgrounds or practicing areas, as they are also distributed across factors.

4.1.1. Factor 1 – Pluralist

The Pluralist views BIPD holistically, recognizing the importance of biodiversity interwoven with many other public interests and considering how to balance them together. This perspective is shared by the largest number of participants across countries and backgrounds. They regard biodiversity as an interwoven fabric in a holistic system and cannot be discussed separately from other socioeconomic factors. In this context, they feel neutral about prioritizing socioeconomic needs in urban practice (S9, 0) (Table 4.1.2). As one participant from China said: *“It frames in a way that excludes biodiversity from the societal socioeconomic needs. But they are interconnected, and the ecological benefits the urban socioeconomic development.”* They are also neutral about the statement “BIPD has to be biodiversity centric, as the earth is increasingly losing biodiversity to a tipping point (S1, 0**)", while all other viewpoints support this statement. They do not relate to the urgency and instead adopt a contextually-sensitive approach. One professional from China noted: *“It depends on the nature of the projects. Some projects may prioritize biodiversity as it fits with the contextual situation and project goal...Then planners may need to balance socioeconomic requirements with biodiversity.”* They slightly disagree

(S20, -1**) with the statement that it is luxurious to consider the needs of nonhuman species. As one participant from the United States stated, *“on a practical level, it is really challenging to balance providing for other species when there are vulnerable humans whose needs should be met.”* One option to balance the competing interests is through time: *“It almost feels like a short-term versus a long-term issue. We must prioritize meeting the needs of the people who are in vulnerable states now.”*

Nevertheless, Pluralists value the rights of nonhuman species to exist and their voices to be represented, which they perceive it an objective potentially achievable through BIPD with sufficient detail. They strongly agree with the statement that “BIPD helps represent nonhuman species’ voices in the urban practice (S8, +4*).” A participant from the United States stated that *“we as humans have had a major impact on the Earth, and we are not the only species to live here. And we need to take other species into consideration in our plans.”* Pluralists also favor BIPD as it delves into sufficient detail (S5, +2*), leading to the following assertion from an Ethiopian professional: *“Such detailed consideration will be coming into force, and people will try to understand the impacts and consider this.”*

However, another professional from the United States expressed concern regarding the applicability of SDM examples, stating, *“I’m afraid that I don’t have a deep understanding of biodiversity...I love the modeling to help us make informed decisions, but I guess I would want more, like a data package to explain how to interpret them.”* Meanwhile, a participant from China, who has previously employed SDMs in her practice, further elaborated on the incompatibility of data and methods currently supported by ecologists for direct application in planning. She remarked: *“Ecology and biology are very specialized disciplines, and some experts only study one specie, but planning needs to be holistic and comprehensive. It won’t work to include only one specie in planning.”* Despite the challenges, she considered that the best way to realize BIPD is through multidisciplinary collaboration, emphasizing that some BEPs should be equipped with ecological knowledge to the extent of *“being able to effectively communicate with ecologists”*. She explained, *“BEPs with a specialization in ecology are still generalists and do not need to delve deeply into scientific details, which should be the job of ecologists and biologists. But these BEPs should know how to translate and integrate these data into prescriptive planning actions.”*

This perspective also exhibits good control of their ability to go beyond mandatory regulations (S11, -4) because it works against their professional norms. One participant from the United States remarked: *“We're not only planning because we're required to. We're planning to guide future development, and we have the flexibility to consider any information that we need to consider.”* This aligns with their heightened positive attitude (Table 4.1.2) regarding mainstreaming BIPD into the urban practice (S6, +3), considering BIPD an emerging hot topic and innovative direction. A professional from China described their view: *“Globally, it has become a hot theme in planning practice recently. Biodiversity is the innovative way to go for the future planning and design practice.”*

4.1.2. Factor 2 –Enthusiast

The *Enthusiast* favors the idea of BIPD and advocates prioritizing biodiversity but struggles to convey the significance to others, feeling pessimistic about mainstreaming BIPD. Professionals with this viewpoint embrace the urgency of biodiversity conservation and support incorporating biodiversity in urban practice as much as possible. A participant from the United States mentioned that *“if we are talking about incorporating biodiversity into planning and design, we should focus on what can be done to increase biodiversity. I agree with both parts of the sentence. It should be biodiversity-centric, and the Earth is increasingly losing (biodiversity) to a tipping point (S1, +2*)”*. Further, they are the ones most likely to agree not to leave out biodiversity information if they are available (S10, +3) (Table 4.1.2). One professional from Spain emphasized the significance of data availability of BIPD by saying: *“We should try to work with as much information and data as it is available, but especially in relation to this topic.”* Similarly, they strongly disagree with the notion of “not involving BIPD in the urban practice because there are no such mandatory regulations” (S11, -4), as articulated by a professional from Spain: *“I’m not planning just to meet mandatory regulations but to improve an existing situation.”*

Professionals sharing this perspective tend to experience a heightened sense of struggle over the prioritization of biodiversity against other considerations with the concern that their stakeholders may not care as much. One participant from the United States remarked, *“Now the struggle mainly is to convey the urgency to others. The urgency element of environment versus other factors. (S19, +3)”* The *Enthusiast* perspective is also the only one that expresses pessimism about mainstreaming BIPD into urban practice (S6,

-1*) (Table 4.1.2). A professional from the United States illustrated this with an example: *“There's a pretty high-profile example in our city right now. What is being proposed as the revitalization of the harbor is, in a lot of ways, fairly similar to what's there already. I guess that as someone who's environmentally minded, I wish that there was more thought that went into how to develop it as a like environmental, ecological space first and foremost.”*

4.1.3. Factor 3 – Pragmatist

The *Pragmatist* emphasizes flexibility and adaptability based on real-world conditions. They view biodiversity conservation as an ongoing issue and trend, but not necessarily as an urgent one. Regarding the statement “it is very likely to mainstream BIPD into the urban practice in the near future (S6, +2)”, an Ethiopian participant expressed optimism, stating, *“because this kind of idea and issue is a (a) currently ongoing issue.”* Similarly, when talked about their strongly agreed statement that “BIPD has to be biodiversity centric, as the earth is increasingly losing biodiversity to a tipping point (S1, +4)”, one professional from China discussed that *“I think this is a core trend in our profession and practice (nowadays), and we should work toward it.”* Their interpretation does not convey a sense of urgency; rather, they view the issue through the lens of political trends or professional fashion, implying a tendency to “fit in” or “grasp opportunities.”

In contrast to other perspectives (Table 4.1.2), *Pragmatists* disagree with the assertion that “to promote BIPD, built environment professionals’ major struggle is how to convey the significance and urgency of biodiversity to their stakeholders (S19, -3**). One participant from Ethiopia indicated that *“stakeholders may be restricted to (certain) land uses due to biodiversity concerns, which would further limit a community and landowner to profit from their property.”* They appear to align with their stakeholders’ perspective, weighing biodiversity considerations against immediate socioeconomic concerns to arrive at more practical and tangible solutions prioritizing the latter.

Pragmatists justify their trade-off decisions to prioritize socioeconomic considerations by viewing biodiversity as inseparable from human well-being. Among all perspectives, this group is the most aligned with the claim that biodiversity conservation is for human survival (S3, +3**) (Table 4.1.2). A professional from the United States asserted, *“Biodiversity survival and human survival are kind of one and the same. We depend on it,*

and when we degrade the environment, we're degrading ourselves and our ability to eat nutritious food.” The data from statement ranking (S9, 2*) further demonstrates their recognition of the instrumental value of biodiversity, as they uniquely align with the idea that “built environment professionals have to prioritize socioeconomic needs before considering biodiversity in urban practice” (Table 4.1.2). Their interpretation suggests that by prioritizing socioeconomic concerns, they can simultaneously address biodiversity needs, as both are interrelated. One participant from the United States emphasized, *“In the cities, we need to be able to say why biodiversity is important from an urban kind of human perspective, and if we can make those linkages between those needs, then we'll also be considering biodiversity.”*

4.1.4. Factor 4 – Contextualist

The *Contextualist* feels a strong urgency for biodiversity conservation in the face of urbanization but is constrained by inadequate contextual capacity to achieve its goals. They underscore this urgency in response to the statement, “BIPD has to be biodiversity-centric, as the earth is increasingly losing biodiversity to a tipping point” (S1, +4). The Ethiopian professional remarked, *“Because (we are) now currently increasingly losing biodiversity at (an) alarming rate. This is a global issue now, especially in developing nations with its (rapid) urbanization and deforestation.”* They highlight the significance of biodiversity conservation in the natural habitats of developing nations to mitigate human disturbances (S7, +3): *“In the urban setting, to protect the natural habitat (away from human disturbances), biodiversity is the key issue for reducing human disturbance to the natural habitat.”* They primarily view humans as a threat to biodiversity within the urban context.

Despite their strong commitment to biodiversity conservation, *Contextualists* are acutely aware of their stakeholders’ struggles with primary socioeconomic needs and are attentive to the structural challenges that prevent them from realizing what they believe is right. This group uniquely agrees with the statement that “when humans can’t meet their own needs, it’s too luxurious to consider the needs of nonhuman species” (S20, +3**). They frame their reasoning primarily through the lens of their stakeholders, explaining: *“When humans cannot meet their interest or their own needs, they don't bother about others, (especially) for developing countries that are still striving for food security, urbanization, and migration*

(issues).” This implies a sense of vulnerability from this professional that their stakeholders are economically locked in, while he finds it difficult to propose win-win solutions.

Meanwhile, this group perceives themselves as having a more central role in urban practice and decision-making across disciplines, which may further narrow their capacity to find effective solutions. In contrast to all other viewpoints (Table 4.1.2), they disagree with the statement that “despite understanding differences, built environment professionals can still work effectively with ecologists and biologists in the BIPD projects (14, -3^{**})”. They argue that “*biologists only can work (on the BIPD) unless urban planners incorporate*” despite recognizing that planning is inherently a multi-sectoral effort.

4.1.5. Consensus statements

Four statements emerged as statistically significant consensus among BEPs, with statement 12 not significant at $p < 0.01$, while statements 10, 18, and 24 were identified at $p < 0.05$ (Table 4.1.2). Among these, all BEPs across viewpoints agree only with statement 10 and disagree with statement 24. They collectively support the inclusion of biodiversity information in their practice, as “*it aligns with their professional conduct not to leave out available information and is essential to consider biodiversity data as part of the decisions,*” according to one participant from the United States. Participants also presented arguments opposing the notion that BIPD is not feasible in the already developed areas. As one participant from China stated, “*There are numerous examples that BIPD is implemented in the developed areas; for instance, in high-density cities, we can involve biodiversity vertically.*”

4.1.6. Post-sort questions

The top three suggestions put forth by participants regarding the involvement of BIPD in urban practice were concentrated across eight themes (Figure 4.1.2 and 4.1.3): Data availability and methodology awareness, Public engagement and education promotion, Regulatory framework incorporation, Consensus building and synergy with other public interests, Best practice case studies and pilot projects, Multidisciplinary collaboration, Financing and incentives and Others. The leading three are Data availability and

methodology awareness, Public engagement and education promotion, Regulatory framework incorporation, with the latter two being uniquely proposed across all four perspectives (Figure 4.1.3). Therefore, we categorized these themes into four categories (Figure 4.1.2): Knowledge-related, Engagement-related, Structure-related, and Others, with Knowledge-related constituting the top category, accounting for 41.7% of all responses (Figure 4.1.3). Notably, the suggestions of *Pluralists* and *Pragmatists* are relatively balanced across the first three categories (Figure 4.1.2), while *Enthusiasts* exhibit a stronger preference for Knowledge-related suggestions (66.7%). Conversely, *Contextualists* provided no suggestions related to knowledge. This finding aligns with the Q-sort results, indicating that *Enthusiasts* are particularly passionate about incorporating biodiversity data, while *Contextualists* express a heightened sense of vulnerability regarding all propositions that are beyond their control and based on external or structural factors. Both *Pluralists* and *Pragmatists* suggested all three themes within the Knowledge-related category, with Data availability and methodology awareness being the most popular, while Multidisciplinary collaboration was the least favored.

There is a discernible trend toward increasing support for the statutory incorporation of BIPD, transitioning from “Not necessary” to “Statutory” (Table 4.1.3). This trend is evident across all groups, although the degree of support varies significantly. *Pluralists*, *Enthusiasts*, and *Contextualists* exhibit a gradual increase in support for integrating BIPD, demonstrating a clear preference for statutory incorporation. However, *Pragmatists* present a less clear pattern. Their responses indicate support to integrate BIPD, while also valuing diverse methods of incorporation beyond legal frameworks. A participant from the US strongly agrees with the conceptual integration, stating that “*conceptual incorporation about biodiversity consideration is important if it is done well, ... because they are rules of thumb that you can use that would make a huge difference compared to what we do now.*” Another Ethiopia participant also supports conceptual integration but feels neutral about integrating as plans or policies because “*indigenous residents have valuable conceptual insights into local wildlife and green spaces, (which) should be valued and incorporated.*”

Table 4.1.1 Factor loadings for each participant's Q sort

Practice areas	Practice sectors and focuses	Years of experience	F1	F2	F3	F4
F1: Pluralist						
Shanghai, China	Private consulting <i>Biodiversity planning, landscape design</i>	10-15	0.8260	0.1571	0.1066	0.1712
Addis Ababa, Ethiopia	Government <i>Urban and industrial park civil engineering</i>	15-20	0.7575	0.1508	0.2558	0.3042
Shanghai, China	Government & Non-profits <i>Strategic planning, climate changes, innovative industries and policy research</i>	10-15	0.7040	0.2467	0.0521	0.0227
Multiple cities, USA	Government & Non-profits <i>Holistic sustainable planning</i>	10-15	0.6952	0.3839	0.3125	0.0461
Madrid, Spain	Government & Academia <i>Green infrastructure, landscape planning</i>	20-25	0.6832	0.5188	0.0304	0.0436
Multiple cities, Ethiopia	Academia & Private Consulting <i>Urban planning and design, urban regional planning</i>	10-15	0.6525	0.2083	0.2296	0.4930
Multiple cities, China	Private consulting <i>Urban and industrial planning and design</i>	15-20	0.6425	0.5777	0.1385	0.0558
State government & Baltimore, USA	Government <i>Capital improvement programs, energy efficiency</i>	10-15	0.6334	0.319	0.1616	0.1368
Shanghai & Suzhou, China	Government & Private Consulting <i>Urban planning, landscape architecture, urban management</i>	15-20	0.6052	0.1619	0.4807	0.1972
F2: Enthusiast						

Milwaukee & Hamtramck, USA	Government & Non-profits <i>Community & economic development urban planning, urban beautification programs</i>	5-10	0.3388	0.8065	0.0500	0.0913	-
Baltimore, USA	Private consulting <i>Eco-restoration, stormwater management planning and engineering</i>	5-10	0.1169	0.7549	0.0035	0.1248	
New York & the Northeast Region, USA	Government & Private Consulting <i>Ecological landscape architecture</i>	10-15	0.2683	0.7372	0.3819	0.0562	
Barcelona, Spain	Government & Academia <i>Landscape architecture and open space design</i>	15-20	0.4848	0.6758	0.0834	0.1184	
Madrid, Spain	Government & Private Consulting <i>Civil and environmental engineering and construction</i>	20-25	0.2710	0.6675	0.4080	0.2982	
Dire Dawa, Ethiopia	Government <i>Urban structure planning</i>	10-15	0.3466	0.6332	0.1306	0.3080	
F3: Pragmatist							
Addis Ababa, Ethiopia	Government <i>Environmental engineering</i>	10-15	0.3177	-0.1222	0.7317	0.0309	
Guiyang & multiple cities, China	Private consulting <i>Urban development planning</i>	10-15	0.0852	0.5476	0.6275	0.0068	
USA and multiple countries worldwide	Government & Academia & Non-profits <i>Biodiversity urban planning and research</i>	10-15	0.3059	0.1355	0.6098	0.2331	
F4: Contextualist							
Addis Ababa, Ethiopia	Government <i>Urban beautification, green space planning</i>	15-20	0.0396	0.0527	0.0443	0.7442	
Confounded Q sorts							
Multiple cities, China	Private consulting <i>Ecological landscape architecture and stormwater management design</i>	20-25	0.6472	0.4793	0.4487	0.1639	

Madrid, Spain	Government & Private Consulting <i>Landscape architecture, urban park planning, green infrastructure planning</i>	20-25	0.4884	0.4392	0.4489	0.4307
Addis Ababa, Ethiopia	Government <i>Urban master planning, land bank administration</i>	15-20	0.2158	0.5281	0.5605	0.2269
Galicia & multiple other cities, Spain	Private consulting & Government & Academia <i>Landscape architecture, green space planning and design, green infrastructure planning</i>	25-30	0.4010	0.4887	0.5075	0.3244
Eigenvalues			6.0122	5.3740	3.1275	1.7651
Explanatory variance (%)			26.14	23.37	13.60	7.67
Reliability			0.9730	0.9600	0.9231	0.8000
Number of defining Q sorts			9	6	3	1

Factor loadings range from complete agreement (1) to complete disagreement (-1). Bolded numbers for F1, F2, F3 and F4 are Q sorts with factor loadings >0.60 and are significant at $p < 0.01$.

Table 4.1.2 Q Statements and rankings for each factor

Q Statements	F 1	F2	F 3	F 4
1. BIPD has to be biodiversity centric, as the earth is increasingly losing biodiversity to a tipping point	0**	2*	4	4
2. Humans should conserve biodiversity because it is essential to our mental health	2	4	3	2**
3. The most important reason for biodiversity conservation is human survival	1	1	3**	-1
4. BIPD is a valuable layer in considering development patterns and how to use space	3	2	1	1
5. BIPD gets down to a granular enough detail that are useful for the urban practice	2*	0	1	0
6. It is very likely to mainstream BIPD into the urban practice in the near future	3	1**	2	2
7. In the urban settings, BIPD is a suitable approach to reduce human disturbance to the natural habitats	2	2	1**	3
8. BIPD helps represent nonhuman species' voices in the urban practice	4*	1	-1	0
9. Built environment professionals have to prioritize socioeconomic needs before considering biodiversity in the urban practice	0	-2	2*	-1
10. As built environment professionals, we should not leave out biodiversity information or data if they are available**	1	3	2	0
11. It is not necessary for built environment professionals to involve BIPD in the urban practice because there are no such mandatory regulations	-4	-4	0	0
12. The primary challenge for BIPD is that built environmental professionals do not have quality nonhuman species data in cities to inform practice*	0	-1	0	1
13. The major barrier to involve BIPD into urban practice is that built environment professionals do not know how to do it	-1	0	1	-1
14. Despite understanding differences, built environment professionals can still work effectively with ecologists and biologists in the BIPD projects	1	1	1	3**
15. It is not practical to involve BIPD in the urban practice because biodiversity knowledge is too specific and narrowly focused	3**	-1	0	0
16. Planning and design are not science, so biodiversity scientific data cannot be translated into design solutions or policy decisions	-3	-2	0	-1
17. As built environment professionals, we cannot make the biodiversity-inclusive shift in the urban practice because we all work in institutional silos	-2	0	-2	1

18. It is only possible to make the biodiversity-inclusive shift in the urban practice after it is integrated into the existing regulatory framework**	0	-1	0	2
19. To promote BIPD, built environment professionals' major struggle is how to convey the significance and urgency of biodiversity to the stakeholders	1	3	3**	2
20. When humans can't meet their own needs, it's too luxurious to consider the needs of nonhuman species	1**	-3	-4	3**
21. It is impossible to involve BIPD in cities where land is profitable and generates revenue	-1	-3	-3	-2
22. The added-up of additional time, capacity and coordination efforts make it difficult to implement BIPD in the urban practice	0	0	-1	3**
23. As built environment professionals, BIPD is not something we typically do, and we don't find the motivation to change	-2	0	-2	-2
24. In the urban settings, BIPD is only feasible in the urban expansion areas or new cities, but not in the already developed ones**	-2	-2	-2	-4
25. Built environment professionals will implement BIPD projects only if there are successful examples elsewhere	-1	1	-1	1

F1 =Pluralist, F2 =Enthusiast, F3 =Pragmatist and F4 =Contextualist. Statements are listed in order of the numbers on the statement cards and scores illustrate the level of agreement with each statement from -4 'strongly disagree' to +4 'strongly agree'. Distinguishing statements are noted for each factor with a * if significant at $p < 0.05$ or ** if significant at $p < 0.01$. Consensus statements are noted for each statement with a * if non-significant at $p < 0.05$ or ** if non-significant at $p < 0.01$.

Table 4.1.3 Participants' intentions of incorporating BIPD into the legal framework by factors according to four five-point Likert scale selections

Incorporation Level	Mean	Median	Standard Deviation	Minimum	Maximum
F1 Pluralist (n=9)					
Not necessary	1.2	1.0	0.4	1	2
Conceptual	1.6	1.0	0.8	1	3
Non-statutory	2.7	3.0	0.8	2	3
Statutory	4.4	4.0	0.5	4	5
F2 Enthusiast (n=6)					
Not necessary	1.0	1.0	0.0	1	1
Conceptual	2.0	2.0	0.8	1	3
Non-statutory	2.0	2.0	0.6	1	3
Statutory	4.5	4.5	0.6	4	5
F3 Pragmatist (n=3)					
Not necessary	1.0	1.0	0.0	1	1
Conceptual	3.7	4.0	2.1	1	5
Non-statutory	3.7	4.0	1.5	2	4
Statutory	4.7	5.0	0.6	4	5
F4 Contextualist (n=1)					
Not necessary	1.0	1.0	NaN	1	1
Conceptual	3.0	3.0	NaN	3	3
Non-statutory	4.0	4.0	NaN	4	4
Statutory	5.0	5.0	NaN	5	5

Note: The four choices are defined as follows: Not necessary to incorporate, Conceptual incorporation is good enough, Non-statutory incorporation is sufficient, and Statutory incorporation is necessary. Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. NaN indicates that the standard deviation cannot be calculated for a sample size of 1.

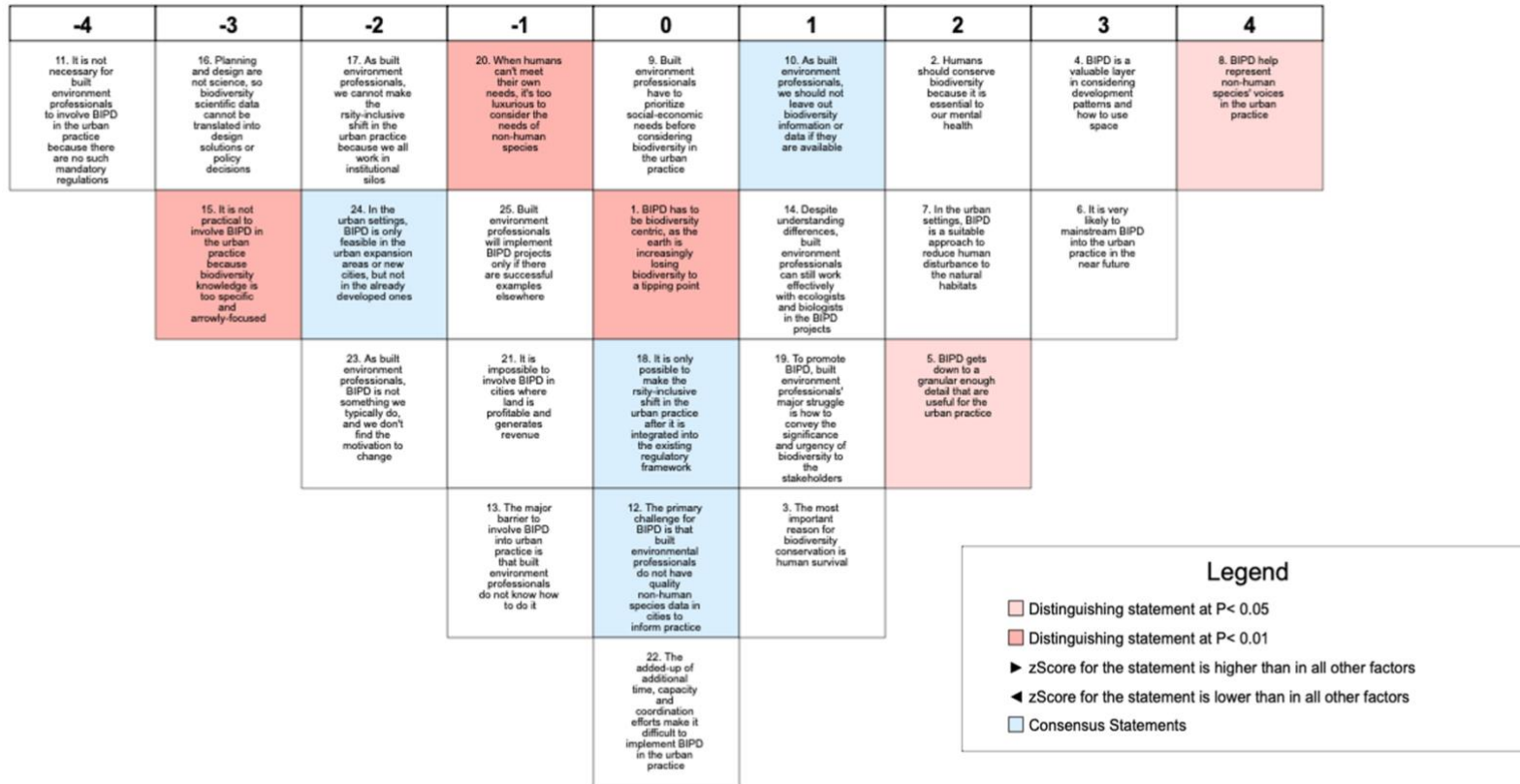


Figure 4.1.1 A Composite Ideal Sort aggregated by Ken-Q software by the factor on a nine-column Q-Sort distribution board. Participants place one statement in each blank, and there is no difference in value based on the vertical order of statements in each column

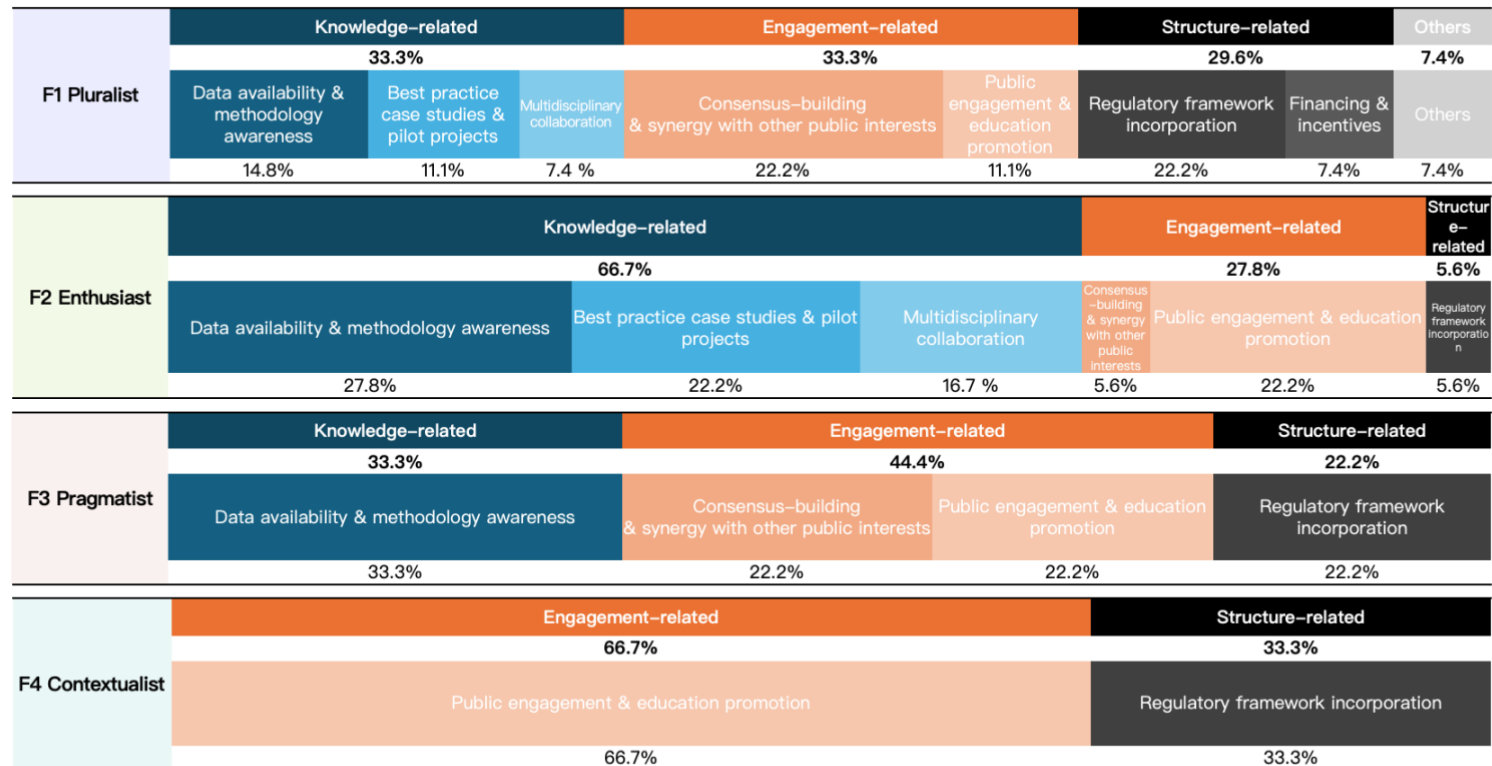


Figure 4.1.2 Bar chart of percentage by counts of the participants’ top three suggestions per factor.

Suggestion categories are grouped as Knowledge-related (in blue), Engagement-related (in orange), Structure-related (in dark grey) and Others (in light grey).

Data availability & methodology awareness	Public engagement & education promotion	Regulatory framework incorporation	Consensus-building & synergy with other public interests	Best practice case studies & pilot projects	Multidisciplinary collaboration	Financing & incentives	Others
Planners need clear methodology on when and how to implement it	Professionals and citizens should all get involved in the systematic biodiversity monitoring from the beginning instead of focusing only on flag species	Mandatory regulatory framework is necessary to engage all sectors to act	Most importantly, planners should carefully position biodiversity objectives that are suitable for the specific projects by understanding the true underlying needs from different stakeholders to reach a solution accepted by all	Case studies and pilot BIPD examples are good starting points	Persons from different disciplines should interact and sit together at the same table with sufficient time to speak to each other and influence the other side	Work with the government and provide incentives, ask real estate developers to change their behaviors	More attention and budget are in need for sustainable maintenance to balance low maintenance while minimizing human disturbance and human perceived wilderness
Professionals needs reference and data, and recipes of how to use and treat them, which may facilitate things to happen	Develop a multidisciplinary curriculum with both biologists and built environment students for a better future environmental generation	BIPD should become one of the legally-binding planning objectives in the spatial territorial plans	The most important is consensus building within the profession and the wider public	Case studies and best practice examples are beneficial	Collaborations across professions such as planners, engineers and ecologists on small-medium projects with full BIPD studies first	It would help us produce more well-rounded plans that consider other factors like biodiversity if we are able to incorporate long-term financial impacts and investments	Design urban zoos and recreational parks in the urban planning and design
Having a data layer to be able to easily pull in data to make this kind of things easier, like the EPA has - a tool about environmental justice layer to identify vulnerable populations and look at proposed projects against that data	From the bottom-up perspective, it requires a better public promotion and engagement to infiltrate such new knowledge and tools for policy incorporation and awareness raising	One of the approaches is compulsory regulations	To make it happen, planners should synergize biodiversity messages and issues with equity, mental health, climate change, carbon neutrality	Pilot projects in big cities with more resources first and replicate widely nationwide	Having better collaborations between the scientific community and city practitioners. Having more conversations about the importance of this having more research is always helpful		
Involve such new approaches in the urban planning and design, civil engineering, and landscape architecture practices	High school curriculum to educate about BIPD	Respect relevant regulations in place, such as the 30% regulation of green spaces has not yet got enough attention by politicians and in practices	Urban agriculture in the peri-urban areas, would promote the integration of BIPD simultaneously	Best practice examples to facilitate changes, such as markers of what this is with a plate or sign saying this is a park but also a habitat	Multidisciplinary team in the city		
Having a better understanding of BIPD through mapping ... First implement in a few spaces, like community green spaces and make it approved by the planning commission	Change the perceptions of beauty of the landscape design and understand the impact of different species on the environment	Multi-sectoral governmental collaborations to push forward biodiversity conservation in planning	Accomplish multiple goals together to align biodiversity goes alongside with other topics, such as health benefits, clean water benefits etc.	Examples of codes and regulations or model ordinances would be helpful to take references and understand how to integrate	At least biologists, ecologists, or environmentalists considered as the stakeholders, and better to be part of the team to have a say		
I think access to data is really a big one...A lot of times the barriers are that we don't necessarily have the data that we need or it's not very accurate	Education to people working in the space and the clients. Biodiversity cannot be incorporated in all but potentially partially in some projects	Top-down policies for animal species data monitoring and ecological corridors, which will provide efficient data support for modeling and planning. It will also trickle down to local levels in practice to make a convincing case backed up with detailed data	BIPD is incorporated in the framework for the project or the vision before evening getting to the point, you know, in the project requirements early on	Good practice examples to follow			
Conferences, researches and academic discussions bring what is advanced in research practice. Practitioners read papers to improve their work	Raise the public awareness, and the BIPD should be calibrated into the subject of urban planning and design education	The high-level management in urban centers support BIPD into the legal framework to increase the impact	Integrate nature into infrastructure	Available pilot projects to test the good practices and to be involved in the big projects			
More quality available data in an easier way to use for planners	Community engagement in urban planning process	Scientific-oriented, evidence-based designs with some regulatory flexibility in planning or implementation	Link biodiversity into other priorities of the city to understand what biodiversity meant - really scientific, so that they're motivated to do it				
Guides for other engineers to follow, and if it is legalized, it is better	Promote and involve the public for the maintenance	Link to larger framework and legislation with larger impact - cities and biodiversity planners to think more comprehensively					
Community-driven planning with ecological knowledge	Raise awareness and community participation	Top-down policies to direct the science into practice					
Following the science, don't design too much to allow nature to evolve itself	Education across all levels - from kindergarten to all levels						
Institutional and technical support this topic - how easy it is to actually do it							

Method-related
Engagement-related
Structure-related
Others
F1 Pluralist
F2 Enthusiast
F3 Pragmatist
F4 Contextualist

Fig. 3. Quotes of the participants' top three suggestions by category in a descending order per suggestion numbers. Background of every suggestion quote and category name from different factor is colored respectively according to the legends.

Figure 4.1.3 Quotes of the participants' top three suggestions by category in descending order per suggestion numbers. The background of every suggestion quote and category name from different factors is colored respectively according to the legends.

4.2. Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study

4.2.1. The case study on implementing the ZJG Bay Eco-park

The introduction of the 2019 Action Plan for Yangtze River Protection and Restoration has both urged and provided a critical foundation for implementing the plan. The Zhangjiagang Municipal Government established several interlinked local policies and procedures (Table 4.2.1) for this ongoing project. It began leading the enforcement of the project with three identified main goals. Firstly, to convert the industrial land along the river into ecological land to realize industrial retreat and restore the river shoreline. Meanwhile, to restore the wetland along the river and purify the water while implementing the ten-year fishing ban. Secondly, to adopt low-impact development, build high-standard dikes and ecological landscaping, restrict commercial development, and recover the ecosystem. Thirdly, to integrate local cultural features and further improve the ecological environment in Xiang Hill and Shuanshan Island to inspire villages to carry out various green development initiatives, such as eco-tourism and modern agriculture, while enhancing public awareness of the ecological environment.

Table 4.2.1 Main Plans and Policies at National and Local Levels

Level	Time	Document	Highlights
National Level	4 Jan 2016	2016 Symposium Chaired by Xi Jinping of Promoting the Development of Yangtze River Economic Belt	<ul style="list-style-type: none"> ▪ Prioritise ecological conservation and boost green development. ▪ Promote the high-quality development of the Yangtze River Economic Belt.
	7 Jan 2017	Yangtze River Economic Belt Ecological Environment Protection Plan	<ul style="list-style-type: none"> ▪ Set the planning goals of maintaining a harmonious, healthy, clean, beautiful and safe Yangtze River.
	31 Dec 2018	Three-year Action Plan for Transformation and Development of Zhangjiagang Riverside Economic Belt (2019-2021)	<ul style="list-style-type: none"> ▪ By the end of 2020, 85% of the water quality of Yangtze River should be Class III or above, and less than 2% of the water in Yangtze River shall be below Class IV (non-functioning water); ▪ By the end of 2020, more than 90% of dark-colored, smelly water within municipal administration shall be eliminated, and over 97% of the centralized drinking water

				source shall be above Class III water quality.
Local Level	June 2019	Zhangjiagang Concept Plan	Bay	<ul style="list-style-type: none"> Convert the industrial land along the river into ecological land. Adopt low-impact development, build high-standard dike and ecological landscaping.
	13 Dec 2019	Action plan for Yangtze River Protection and Restoration (2019 -2020)		<ul style="list-style-type: none"> Integrate local cultural features and improve the ecological environment in Xiang Hill and Shuanshan Island.
	13 Dec 2019	The Implementation Plan of Yangtze River Arterial Waterway Fishing Ban and the Compensation Scheme for Fishermen in Zhangjiagang City		<ul style="list-style-type: none"> Implement the fishing ban regulation along the arterial waterway within the Zhangjiagang Municipal Administration. Compensate for the fishermen involved.
	12 Jan 2020	2020 Zhangjiagang Municipal Working Priorities in Promoting Yangtze River Economic Belt		<ul style="list-style-type: none"> Prioritise Yangtze River ecological environment. Correct previous practices that cause ecological and environmental problems. Accelerate industrial upgrading and transformation to focus on green economy.
	3 Nov 2021	Notice of Zhangjiagang 14 th Five-Year Plan on Water Resources		<ul style="list-style-type: none"> Create a Yangtze River Ecological Restoration Corridor by incorporating the ZJG Bay Eco-park. Align with the protection and development of ZJG Bay Eco-park, promote water culture icon into the Zhangjiagang Yangtze River Art & Culture Festival
	On-going	Zhangjiagang Bay Waterfront Ecological Conservation Plan		<ul style="list-style-type: none"> Form an integrated riverfront ecological structure. Optimise riverfront land use. Set aside ecological corridor. Actively restore the ecological environment. Construct transport and other infrastructure

Source: Open resources of Chinese government documents

Under this framework, detailed scheme design began in June 2019, providing specific guidance to complete the main construction by December 2020. A total investment of 3.76 billion RMB consists of two major parts (Table 4.2.2). First, 1.49 billion RMB was funded by the municipal government and the town government (Free Trade Zone), with a focus on relocating polluting industries, cleaning the wharf, and ecological renovation along a total of 12 km of coastline. Of this, 9 km has been transitioned from industrial production to ecological space. Second, an additional government fund of 2.27 billion RMB was allocated for ecological enhancement (with future environmental premiums and new industries planned for later), covering five key projects: a once-in-a-century

river embankment reconstruction and upgrading project, the environmental improvement and upgrading project outside the river embankment, the cleanup, renovation, and restoration project of Haihong marine engineering shipyard, the comprehensive environmental improvement project (including roads and villages) inside the river embankment, and the repair project of Zhanggao Road (Zhangjiagang Municipal Government Office, 2019). By integrating dike reconstruction, shoreline restoration, ecological restoration, road optimization, and landscape enhancement, it establishes a 1.4 million m² waterfront hydrophilic landscape belt.

With the full support of the municipal Party committee and the municipal government, a special leading group was established to ensure comprehensive yet efficient enforcement and coordination. The main leaders of the municipal Party committee and municipal government serve as the team leaders, while relevant municipal leaders and leaders of the Free Trade Zone act as deputy team leaders. A regular work consultation mechanism has been established, comprising meetings on specific topics every two weeks, with the attendance of key leaders. The leading group comprises front-line headquarters, four implementation groups, and five engineering teams, each with designated roles and tasks to guarantee cooperation and steady progress on the overall project. Furthermore, regarding the ecological protection of adjacent Shuanshan Island since 2010, surrounding villages in the region, such as Yongxing Village, have taken advantage of environmental changes and government subsidy policies by building ecological parks, conserving historic homes, and creating new jobs, which is beginning to bring prosperity to villagers through cultural and eco-tourism.

Notably, due to foundational work, including port cleanup and field studies before initiating the project, potential socio-economic impacts and professional planning were rapidly verified. Since July 2010, illegal occupation, construction, and land use of the Yangtze River beach have been rigorously rectified. Eight wharves have been banned, and inefficient uses (houses, storage yards, and enterprise operations) have been corrected (United Nations, 2021). From July 2019, nearly 26 high-polluting fishing farms and semi-operational port enterprises were removed with agreed compensation based on specified standards, minimizing negative impacts on employees. Communication has been established, and a wide consensus has been built, resulting in a strong commitment supported by formal plans. Meanwhile, some industrial and port infrastructure were intentionally preserved as industrial heritage. For instance, the previously abandoned maritime waterway sign and lighthouse were converted into a

sculpture resembling a ‘fish basket,’ not only saving reconstruction costs but also creating a new landmark for Zhangjiagang, visible both during the day and at night with colorful sky lights (Figure 4.2.1).

Table 4.2.2 ZJG Project Milestones by Main Stakeholders

Time	Milestones	Stakeholders & Responsibilities
Jun 2019	The first-phase plan and design started	<ul style="list-style-type: none"> ▪ Mobilize funding: Zhangjiagang Municipal Government, Zhangjiagang Free Trade Zone, and State-owned enterprises. ▪ Prepare concept plan and design: Zhangjiagang Natural Resources and Planning Bureau.
Sep 2019- Dec 2020	The first-phase construction started <ul style="list-style-type: none"> ▪ Step A: Remove polluting industrial uses, restore the dam and coastline ▪ Step B: Improve ecological and landscape environment 	<ul style="list-style-type: none"> ▪ Industrial removal and compensation arrangement: Zhangjiagang Free Trade Zone Enterprise Service Bureau. ▪ Construction: Zhangjiagang Tongzhou Shaxi Waterway Company. ▪ Management and Operation: Zhangjiagang Bay Administration and Zhangjiagang Ecological Development Ltd.
Jan 2021-	The second-phase started	<ul style="list-style-type: none"> ▪ Prepare ZJG Bay Characteristic Villages Plan: Zhangjiagang Natural Resources and Planning Bureau. ▪ Implement and revitalise villages in an ecological-oriented tourism fashion to foster the green economy: Chaonan Village, Yongxin Village, Beiyin Village.

Source: Zhangjiagang Municipal Government Office

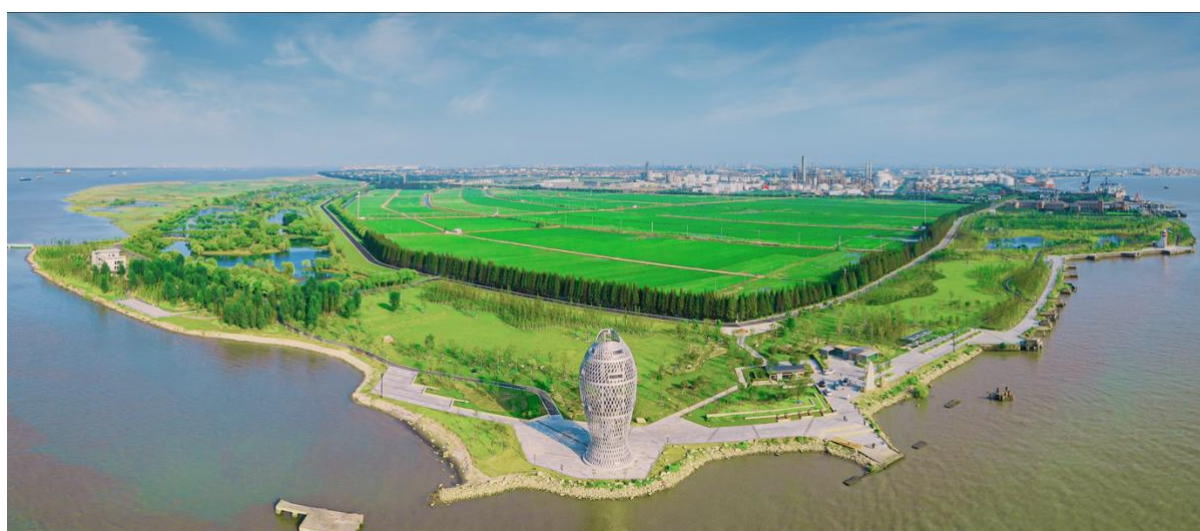


Figure 4.2.1 Bay View with the ‘Fish Basket’ and Transformed Industries (with permission of Mr. Pincai Fan to use this photo in the chapter).

Furthermore, since the project's implementation, the local government's reports and policy documents have consistently addressed its status and progress. They highlight its relevance to the local agenda and provide prioritized phases ranging from restoration construction to normalized operation and further quality enhancement, including ecological improvement and cultural excavation (Table 4.2.3). In addition to formal institutions, cultural activities and public engagement have also been ongoing. Since 2004, Zhanghaijiang has celebrated the Yangtze River Culture Festival annually for nearly two decades, dedicated to promoting cultural exchange among cities along the Yangtze River (China-Daily, 2018). Among the activities, the Ecological Yangtze River -- Zhangjiagang Bay Summit brought together experts and scholars to share research insights and suggestions regarding the effective protection of the Yangtze River, the promotion of industrial transformation, the branding of cultural tourism, and the refinement of ecological culture rooted in traditional Chinese culture, among other topics. All these efforts have subtly increased environmental awareness and social engagement, establishing the Annual Festival as a unique cultural brand that attracts broader attention and influence. This initiative has also been supported by follow-up plans aimed at enhancing the project's ecological value. At the time of writing this chapter, a Zhangjiagang Riverside Ecological Protection Plan is being developed, which includes a five-part program focused on creating a large regional ecological structure based on a systematic investigation of ecological values and influencing factors (Zhangjiagang Natural Resources and Planning Bureau, 2021).

Table 4.2.3 Local Government Reports on Priority and Progress of ZJG Bay Project

Time	Document	Highlights
20 Jan 2020	2020 Zhangjiagang Municipal Government Work Report	<ul style="list-style-type: none"> ▪ Upgrade Yangtze River environmental protection actions. ▪ Complete Yangtze River Waterfront Ecological Protection Plan, Zhangjiagang Bay Concept Plan and Design, and Tongzhousha Jiangxin Island Wetland Master Plan. ▪ Promote the Pilot Tests on Yangtze River Economic Belt territorial land use regulation and correction.
6 Jan 2021	2021 Zhangjiagang Municipal Government Work Report	<ul style="list-style-type: none"> ▪ Perform high-quality management of Zhangjiagang Bay. ▪ Start the Three-year Action Plan of the Zhangjiagang Bay Characteristic Village Plan.

7 Jan 2022	2022 Municipal Work Report	Zhangjiagang Government	▪ Promote the sustainable and normalized management and operation of the Zhangjiagang Bay.
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Source: Zhangjiagang Municipal Government Office

Coincidentally, shortly after the project was initiated, COVID-19 emerged in China. The ecological engineering departments of the Zhangjiagang Bay project immediately responded, successfully establishing a zero-infection zone at the site. Construction workers commuted in batches using special vehicles, and the health status of the workers as well as the site's hygiene were monitored closely. Meanwhile, project management was effectively coordinated through the advance ordering and timely supply of construction materials, aided by government transportation assistance. To ensure efficient coordination among various sectors, an information exchange system was established to regularly report issues and progress. After the project officially resumed in February 2020, work continued at full speed, and the first-phase main project was successfully completed according to the original plan within four months. Therefore, there were no adverse impacts on the project's progress, and it ultimately proceeded without any delays.

As an ongoing project with long-term effects to be developed and monitored, positive results have begun to manifest despite the impacts of COVID-19. Notable changes have occurred before and after, and the project has achieved its original goals of restoring the ecological environment, creating a vibrant and biodiverse Yangtze River Estuary, and improving drinking water safety. By viewing the mountains, rivers, forests, fields, and lakes along the river as an interconnected system, the integrated application strategy of ecological technologies—such as windbreak forest planting and ecological wetland construction—was implemented to achieve stormwater management, water purification and utilization, and water conservation. So far, over 36 hectares of wetlands and green spaces have been restored, and more than 200 mu of beach on the north side of Laosha Wharf have been leveled and afforested, primarily by planting over 3,000 trees, including pond fir, metasequoia, Mexican larch, and others. With the previous production coastline transformed into an ecological coastline, some endangered species, both on land and underwater, have been observed again, including Reed Parrotbill, known as "giant panda in bird," and Yangtze Finless Porpoise, known as "giant panda in water" (Figure 1.2.2).

As part of the project to convert previous industrial brownfields into green spaces, the industrial heritage of local enterprises was also carefully preserved by recycling industrial steel waste and shaping it into a landscape landmark using 3D printing technology. By doing so, the newly built Zhangjiagang Bay Eco-park, now accessible to all, offers ecological scenery and captures industrial memory, providing a rich experience of ecology and heritage together. Furthermore, with greatly improved infrastructure under low-impact development, local villagers have engaged in leisure agriculture and cultural tourism while continuously monitoring water and soil quality. The project has also begun to demonstrate its effects. According to the Free Trade Zone government, around 100 batches of government visits and inspections have been received monthly, totaling 590 batches from June to December 2020.

4.2.2. Stakeholders' environmental attitudes analysis

The reliability of the AEA scale was acceptable, with Cronbach's Alpha values for all variables of 0.76, and the validity of the survey with KMO and Bartlett's Test was good (0.81, $p < 0.01$) (Table 4.2.4).

The general tendency of the stakeholders of the ZJG Bay Eco-Park project was coherent with the weak-anthropocentric orientation, considering the lowest mean value of all participants (1.33, closest to the Likert scale category of "1" as "strongly-agree" to the statements) to be weak-anthropocentric (Table 4.2.5). However, strong-anthropocentric orientations for all participants (Weak-A = 0.804, -0.372 and Strong-A = 0.789, 0.324) were almost equal competitors (Table 4.2.6). If we consider the EA scale as a spectrum with increasing ecocentric inclinations from environmental apathy, strong-anthropocentric, weak-anthropocentric, and ecocentric, the stakeholders in this study can be said to fall between the weak-anthropocentric and strong-anthropocentric standpoints.

In terms of the cross-subscale orientations by sub-groups, there were significant statistical correlations and rich diversity patterns (Table 4.2.6, 4.2.7, and Figure 4.2.2). To begin with, surprisingly, officials with either ecocentric or strong-anthropocentric viewpoints also supported environmental apathy statements; the officials with ecocentric orientation correlated with environmental apathy and negativistic subscales (0.252, $p < 0.05$), which was not observed in the other two groups and was contrary to common sense (Table 4.2.7). This result was in line with officials' relatively high value of environmental apathy (0.610, 0.688) in the variable principal normalization pattern (Table 4.2.6 and Figure 4.2.2). It revealed that local officials of the ZJG Bay Eco-Park project were possibly experiencing internal conflicts in environmental attitude values – two distinct values of ecocentrism and environmental apathy both seemed to appeal to them. Meanwhile, building on previous findings of the correlation between anthropocentrism and environmental apathy (Røskaft et al., 2007), this study indicated that officials with strong-anthropocentric perspectives had the highest correlation to environmental apathy (0.572, $p < 0.01$) of all stakeholder groups (Table 4.2.7). In addition, there are variations across groups, but generally, officials who acknowledged weak-anthropocentric viewpoints had the strongest correlation with naturalistic typologies (0.960, $p < 0.01$), the value of experiencing the natural environment appealed to them most (Table 4.2.7).

Second, the choices of professionals highly correlated to the definitions of these tendencies in both sub-scales, while at the same time demonstrating diverse value orientations. For instance, professionals with an ecocentric orientation scored the highest correlation with ecologicistic tendency (0.977, $p < 0.01$), while those prone to strong anthropocentric statements had the strongest correlation (0.991, $p < 0.01$) with utilitarian tendency (Table 4.2.7). Weak-anthropocentric professionals correlated to all of Kellert's typology tendencies except for negativistic ones. The variable principal normalization graph (Figure 4.2.2) also clearly demonstrated this pattern of knowledge of professionals. Environmental apathy and negativistic were lowest (0.126) compared to the other two groups, indicating the strong pro-environmental inclinations of professionals as a result of their environmental knowledge (Table 4.2.7).

Lastly, residents were more sensitive to moralistic statements despite having the lowest mean values towards ecocentric attitudes. Residents with weak-anthropocentric viewpoints had the highest correlation with ecocentrism (0.530, $p < 0.01$), and had a stronger correlation (0.780, $p < 0.01$) to the moralistic view (Table 4.2.7). The variable principal normalization pattern not only coincided with the significance of the impact of moralistic statements on residents but also revealed that the dominionistic subscale was also relatively significant for residents. A similar pattern was also found for professionals but not for officials, who's moralistic and dominionistic components were much lower than other counterparts (Table 4.2.6 and Figure 4.2.2).

Table 4.2.4 The adapted ecocentric and anthropocentric attitude toward the environment (AEA) scale

	Statements	Scales		Mean scores			F-values	p
		EA scale	BT scale	Officials	Professionals	Residents		
1	One of the worst things about overpopulation is that many natural areas are being destroyed for development	Eco	Ecol	1.770	1.837	1.840	0.731	0.393
2	We have a duty to save woodlands for the sake of all human beings	Weak-A	Moral	1.070	1.033	1.160	2.616	0.107
3	I enjoy walking in nature because I'm amazed at and enjoy the individuality of beauty of trees and flowers	Weak-A	Natur	1.110	1.077	1.210	4.616	0.033**
4	The worst thing about the loss of the rain forest is that it will restrict the development of new medicines	Strong-A	Util	1.790	1.827	1.860	1.027	0.312
5	It seems to me that most conservationists are pessimistic and somewhat paranoid	Apathy	Neg	2.730	2.857	2.600	0.780	0.378
6	I prefer wildlife reserves to zoos	Eco	Ecol	1.350	1.637	1.660	1.007	0.316
7	I do not think the problem of depletion of natural resources is as bad as many people make it out to be	Apathy	Neg	3.210	3.633	2.870	4.877	0.028**
8	The thing that concerns me most about deforestation is that there will not be enough lumber for future generations	Strong-A	Util	2.450	2.290	2.130	2.129	0.146
9	I love being out in nature to find comfort when I am unhappy	Weak-A	Natur	1.680	1.393	1.470	11.690	0.001*
10	Most environmental problems will solve themselves given enough time	Apathy	Neg	2.340	2.367	2.130	1.160	0.282
11	I don't care about environmental problems	Apathy	Neg	4.440	4.583	4.520	1.104	0.294
12	One of the most important reasons to keep lakes and rivers clean is so that people have drinking water	Strong-A	Util	2.070	2.127	2.020	8.896	0.003*
13	It makes me sad to see natural environments destroyed	Eco	Moral	1.140	1.190	1.240	1.024	0.312
14	The most important reason for conservation is human survival	Strong-A	Dom	1.390	1.343	1.320	3.907	0.049**
15	One of the best things about recycling is that it saves money	Strong-A	Util	2.560	2.490	2.270	3.135	0.078
16	I feel better about myself when I know more different type of trees and flowers	Weak-A	Ecol	1.590	1.530	1.570	2.762	0.098
17	Too much emphasis has been placed on conservation	Apathy	Neg	3.550	3.453	2.960	0.325	0.569
18	Nature is valuable for its own sake, independent of human interests	Eco	Ecol	2.920	2.757	3.020	0.527	0.468

19	I enjoy being out in nature because it is a great stress reducer for me	Weak-A	Natur	1.340	1.367	1.430	2.349	0.127
20	Human are as much as part of the ecosystem as other animals	Eco	Ecol	1.100	1.137	1.220	0.036	0.849

*p<0.01 ** p<0.05

Officials, n=71; Professionals, n=115; Residents, n=94

AEA scale reliability test: Cronbach's Alpha of all variables (n=20) = 0.76 (>0.7)

AEA scale validity test: Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.81(>0.8); Bartlett's Test of Sphericity – p (sig.) <0.01

Eco: ecocentric; Weak-A: weak-anthropocentric; Strong-A: strong-anthropocentric; Apathy: environmental apathy. Ecol: ecologicistic; Natur: naturalistic; Moral: moralistic; Dom dominionistic; Util: utilitarian; Neg: negativistic sub-scales.

Sources: Data from Delavari-Edalat and Abdi 2010; Kopnina and Cocis 2017; Thompson and Barton 1994.

Table 4.2.5 Mean-value by sub-scales and sub-groups of the AEA scale

Scales		Mean scores			
Sub-scales	Orientations	Officials	Professionals	Residents	All participants
EA Scale	Eco	1.66	1.71	1.80	1.73
	Weak-A	1.36	1.28	1.37	1.33
	Strong-A	2.05	2.02	1.92	1.99
	Apathy	3.25	3.38	3.02	3.22
BT Scale	Ecol	1.75	1.78	1.86	1.80
	Natur	1.38	1.28	1.37	1.34
	Moral	1.11	1.11	1.20	1.14
	Dom	1.39	1.34	1.32	1.35
	Util	2.22	2.18	2.07	2.15
	Neg	3.25	3.38	3.02	3.22

Eco: ecocentric; Weak-A: weak-anthropocentric; Strong-A: strong-anthropocentric; Apathy: environmental apathy. Ecol: ecologicistic; Natur: naturalistic; Moral: moralistic; Dom: dominionistic; Util: utilitarian; Neg: negativistic sub-scales.

Table 4.2.6 Partial correlations between sub-scales of the AEA Scale

Scales	EA Scale				BT Scale					
	Eco	Weak-A	Strong-A	Apathy	Ecol	Natur	Moral	Dom	Util	Neg
Officials (n=71)										
Eco	1.000	0.484**	0.305	0.252*	0.944**	0.494**	0.465**	0.144	0.295*	0.252*
Weak-A	0.484**	1.000	0.405**	0.199	0.655**	0.960**	0.400**	0.205	0.390**	0.199
Strong-A	0.305	0.405**	1.000	0.572**	0.359*	0.428**	-0.113	0.407**	0.982**	0.572**
Apathy	0.252*	-0.199	0.572**	1.000	0.318	0.234	-0.168	0.131	0.582**	1.000
Professionals (n=115)										
Eco	1.000	0.503**	0.275*	0.115	0.977**	0.444**	0.287*	0.270	0.291*	0.115
Weak-A	0.503**	1.000	0.362**	-0.088	0.531**	0.913**	0.634**	0.376**	0.329**	-0.088
Strong-A	0.275*	0.362**	1.000	0.341**	0.291*	0.253	0.323**	0.522**	0.991**	0.341**
Apathy	0.115	-0.088	0.341**	1.000	0.094	-0.061	-0.061	0.024	0.363**	1.000
Residents (n=94)										
Eco	1.000	0.530**	0.274	0.130	0.960**	0.547**	0.432**	0.211*	0.253	0.130
Weak-A	0.530**	1.000	0.387**	-0.091	0.563**	0.940**	0.780**	0.448**	0.328*	-0.091
Strong-A	0.274	0.387**	1.000	0.508**	0.352**	0.303*	0.207	0.462**	0.985**	0.508**
Apathy	0.130	-0.091	0.508**	1.000	0.183	-0.127	-0.184	-0.084	0.530**	1.000

****.** Correlation is significant at the 0.01 level (2-tiered).

***.** Correlation is significant at the 0.05 level (2-tiered).

Controlled variables including education level, gender, age, park visit frequency & park visit duration.

Eco: ecocentric; **Weak-A:** weak-anthropocentric; **Strong-A:** strong-anthropocentric; **Apathy:** environmental apathy. **Ecol:** ecologicistic; **Natur:** naturalistic; **Moral:** moralistic; **Dom:** dominionistic; **Util:** utilitarian; **Neg:** negativistic sub-scales.

Table 4.2.7 Categorical Principal Component Analysis by sub-scales and sub-groups of the AEA scale

Scales	Sub-scales	Dimension 1, Dimension 2				
		Orientations	Officials	Professionals	Residents	All participants
EA Scale	Eco		0.629, -0.454	0.720, 0.046	0.657, -0.123	0.678, -0.191
	Weak-A		0.746, -0.382	0.822, -0.315	0.772, -0.479	0.804, -0.372
	Strong-A		0.798, 0.324	0.815, 0.251	0.787, 0.378	0.789, 0.324
	Apathy		0.610, 0.688	0.126, 0.952	0.365, 0.868	0.317, 0.886
BT Scale	Ecol		0.748, -0.355	0.704, 0.019	0.660, -0.014	0.686, -0.138
	Natur		0.750, -0.433	0.751, -0.330	0.731, -0.487	0.762, -0.387
	Moral		0.315, -0.612	0.630, -0.274	0.588, -0.578	0.542, -0.469
	Dom		0.360, -0.020	0.595, -0.037	0.548, -0.170	0.518, -0.050
	Util		0.776, 0.340	0.804, 0.264	0.763, 0.415	0.775, 0.360
	Neg		0.610, 0.688	0.126, 0.952	0.365, 0.868	0.317, 0.886

Eco: ecocentric; Weak-A: weak-anthropocentric; Strong-A: strong-anthropocentric; Apathy: environmental apathy. Ecol: ecologicistic; Natur: naturalistic; Moral: moralistic; Dom dominionistic; Util: utilitarian; Neg: negativistic sub-scales.

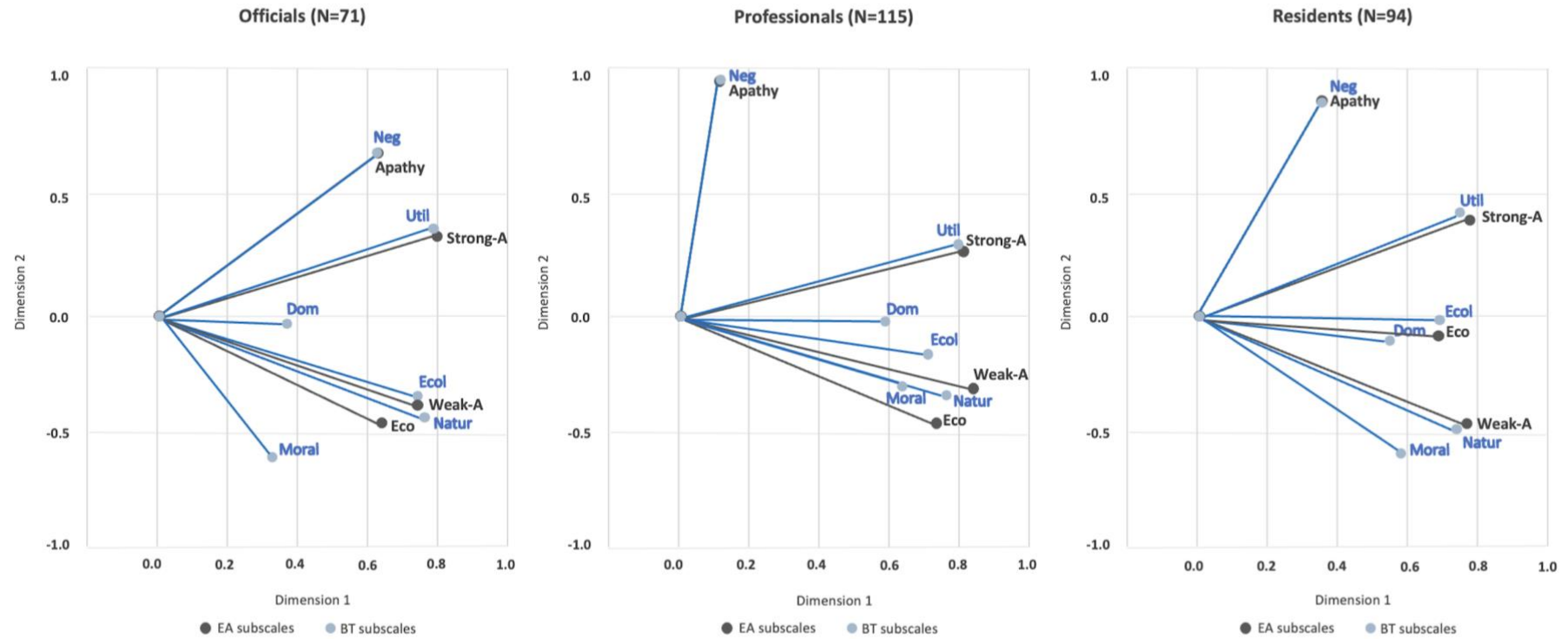


Figure 4.2.2 Categorical Principal Component Analysis variable principal normalization by sub-groups

4.3. Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between UE and UPD

4.3.1. Thematic topic clusters and vocabulary overlap

Based on the optimal modeled topics for each discipline, the labeled thematic topics and several extracted keywords offer initial insights into discursive overlaps and potential similarities and differences among the disciplines (Table 4.3.1 and Figure 4.3.5). First, UE and UPD have more unique words than shared ones, while Inter intersects with UE and UPD with distinct focuses, respectively. The only significant keyword shared across the three disciplines is ‘model(ing),’ highlighting a common methodology. The primary terms shared by the UE and Inter disciplines pertain to biodiversity at two levels: species diversity, such as ‘specie(s),’ and ecosystem diversity, such as ‘forest.’ In contrast, UPD and Inter both use terms that refer to physical spaces, such as ‘green’ and ‘space,’ while sharing a more social focus on ‘health’ or ‘social’ concerns. Furthermore, the larger number of unique words in UE and UPD indicates the diverse knowledge foundations of the two disciplines (Table 4.3.1 and Figure 4.3.5). UE specifies unique scientific concepts related to biodiversity. For instance, at the species level, key terms include ‘native’ and ‘richness’; at the ecosystem level, important terms encompass ‘ecosystem’ and ‘service.’ Meanwhile, UPD outlines spatial scales of ‘region,’ ‘local,’ and ‘neighborhood,’ along with socio-economic terms like ‘growth,’ ‘housing,’ ‘market,’ and ‘economic.’ Additionally, Inter appears to serve as a transitional ground between the distinctive focuses of UE and UPD. For example, UE emphasizes biodiversity, while UPD focuses explicitly on socio-economic issues. Positioned in between, Inter explores biodiversity elements at both the species and ecosystem levels, possibly primarily within the green spaces, examining spatial patterns and socio-ecological interactions (Table 4.3.1 and Figure 4.3.5). Another potential transitional trend is that Inter explores techniques that connect UE’s interests in biodiversity science with UPD’s application focus on ‘planning,’ ‘design,’ or ‘policy.’ Key terms related to these techniques unique to Inter include the study of ‘(spatial) patterns,’ ‘(land) cover,’ and ‘management.’

4.3.2. Similarities and differences among disciplines, clusters, and extracted keywords

We observed clear patterns of thematic divergence and alignment among disciplines, confirmed by statistically validated cosine similarities and pairwise comparisons. Initially, we identified a disciplinary divide between UE and UPD (Table 4.3.2), where UE exhibits a low overlap with UPD ($\cos = 0.27$, CI [0.23, 0.37]). In contrast, Inter exhibits moderate overlap with UPD ($\cos = 0.50$, CI [0.40, 0.53]) and strong overlap with UE ($\cos = 0.67$, CI [0.57, 0.73]). Similar trends were noted in cosine similarity by clusters (Figure 4.3.1), indicating that UPD clusters have lower similarity scores with UE clusters, while other disciplines display moderate to high overlap across clusters. Additionally, the magnitude of similarities and pairwise comparisons among the three disciplinary domains implies that Inter demonstrates a statistical improvement in thematic overlap between UE and UPD. The cosine similarities between Inter-UE and Inter-UPD are significantly stronger than those between UE-UPD (Table 4.3.3). Moreover, Inter shows a greater overlap with UE than UPD (Table 4.3.3). This variation in similarities may arise from terminology gaps, particularly regarding biodiversity terms (Figure 4.3.7 (c)-(d)). We examined the presence of bilaterally overlapping vocabulary related to biodiversity and green space (Figure 4.3.7 (c)-(d)), which were previously identified through topic modeling (Table 4.3.1). Biodiversity-related terms appeared very rarely in UPD (mean = 0.03, SD = 0.07), in contrast to Inter (mean = 0.28, SD = 0.25) and UE (mean = 0.53, SD = 0.31) (Figure 4.3.7 (c)). Conversely, terms related to green space appear relatively frequently across all disciplines, differing only in their extent (Figure 4.3.7 (d)).

We further investigated potential divergences across disciplines by closely examining the topic terms within each cluster, especially those related to previously identified biodiversity and applicability (Table 4.3.1). We explored the differences in vocabulary associated with biodiversity levels (Figure 4.3.3 (c)-(d)) and those related to applicability (Figure 4.3.6). The main topic terms for UE2, Inter1, and Inter2 focused on ecosystem diversity (Table 4.3.1). In contrast, Inter3, UE1, and UE3 included species diversity in their top topic terms while ranking among the bottom three in mean percentages of applicability-related vocabularies (Figure 4.3.6). The mean cosine similarity scores of UE2, Inter1, and Inter2 with all UPD clusters were 0.52, which is 1.4 times higher than the scores of Inter3, UE1, and UE3, which stood at 0.38. While these differences lack statistical significance, the results indicate a potential connection between reduced applicability and an emphasis on species diversity, which may affect the possible divergences across disciplines.

In addition to the potential divergences identified, we uncovered significant cross-disciplinary themes through variations in similarity between specific cluster pairs (Figure 4.3.5). For instance, UE2, which focuses on spatial analysis and modeling within urban landscapes and ecosystem services, significantly overlaps with UPD2, which is focused on urban growth and spatial modeling and boasts a similarity score of 0.62. In comparison, the average similarity score for other UE and UPD clusters is 0.39. Additionally, the highest similarity among all clusters is seen between UE2 and Inter1 regarding spatial modeling and urban landscape patterns, at 0.74. Thus, we pinpoint a vital interdisciplinary connection related to the shared methodology of spatial modeling, especially among UE2, Inter1, and UPD2. Another notable cross-disciplinary theme pertains to ecosystem services associated with health and well-being, linking UE2, Inter2, and UPD3. Inter2, which focuses on urban socio-ecological interactions and human well-being, connects with UPD3 regarding the design of urban green spaces and their benefits for social well-being, showing a similarity score of 0.61. Moreover, Inter2 links to UE2, which deals with spatial analysis and modeling within urban landscapes and ecosystem services, with a score of 0.69. These two critical cross-disciplinary themes—spatial modeling and ecosystem services related to health and well-being—are backed by their normalized occurrence frequency. Terms related to health and well-being, as well as modeling, appeared with notable frequency across disciplines (Figure 4.3.7 (a)-(b)). Interestingly, the normalized frequency of health and well-being has increased significantly across disciplines since 2010 (Figure 4.3.7 (a)). In contrast, the trend for modeling has remained consistent throughout the entire period (Figure 4.3.7 (b)), suggesting a potential shift in popularity over the years.

4.3.3. Trends

The similarity patterns observed between UE and UPD have remained relatively stable and have gradually increased in the recent period since 2020 (Figure 4.3.2). The similarities between UE and UPD range from low to moderate ($\cos = 0.38\text{--}0.51$, mean = 0.46), with the most recent UPD segment (2020-2023) demonstrating an upward trend in similarity with UE segments over time ($\cos = 0.46\text{--}0.51$, mean = 0.48) (Figure 4.3.2). Notably, Inter shows a greater similarity with UE and UPD and started to change earlier (Figure 4.3.2). The similarity between Inter and UE has risen from moderate to high ($\cos = 0.53\text{--}0.75$, mean = 0.68), with this change beginning in the 2010-2014 period. In the earlier 2000-2009 timeframe, the mean similarity between Inter and UE segments was

0.58, whereas the mean similarity of later Inter segments with UE increased to 0.71. Similar trends can be observed between Inter and UPD, though to a lesser extent, with a mean similarity increasing from 0.45 to 0.56 when comparing segments before and after 2010 (Figure 4.3.2).

Inter increasingly plays a significant role across disciplines regarding the growth rate of publications, the impact of those publications, and the trends associated with thematic keywords. Inter has been growing the fastest in terms of publications and has surpassed the UE, leading in citation scores since 2015, despite being about 25% short of the total number of publications compared to the UE (Table 3.3.2 and Figure 4.3.3 (a)-(b)). In contrast to the minimal usage of biodiversity-related terms in UPD, their usage in Inter has significantly increased, especially since 2015 (Figure 4.3.3 (c)-(d)). Additionally, there are clear differences in the levels of biodiversity across species and ecosystems: the vocabulary related to ecosystems has expanded more rapidly than that for species, with the former nearly matching UE levels around 2015 (Figure 4.3.3 (c)-(d)). Moreover, the normalized frequency of health and well-being terms in Inter has increased more rapidly than in the other two disciplines, although all have risen since 2010 and more sharply since 2015. (Figure 4.3.7 (a)). The variations in thematic vocabulary, particularly regarding ecosystem diversity and health and well-being, may help explain the increasing trend of similarities among disciplines.

4.3.4. Sentiments

Overall, sentiments regarding biodiversity were notably more negative in UPD compared to UE and Inter, which exhibited similar sentiments without any statistically significant differences. UE discusses biodiversity in a more positive light than UPD ($p < 0.01$, Figure 4.3.4 (a)). A comparable analysis between Inter and UPD revealed that Inter frames biodiversity significantly more positively ($p < 0.01$, Figure 4.3.4 (a)). Conversely, UE and Inter showed no substantial differences in their biodiversity sentiments (p -value = 0.892, Fig. 4.3.4 (a)). Our results remained consistent throughout various sensitivity analyses (Figure 4.3.4 (b)-(d)). While these robustness tests typically reduce the sample size, the findings continually indicate a substantial and statistically significant distinction between UE or Inter and UPD, with UE and Inter reflecting similar sentiments.

Table 4.3.1 List of thematic topic clusters and vocabulary overlaps in each discipline

Discipline	Name of cluster	Size of cluster	Topic top words	Common words	Bilateral overlapping words	Unique words
UE (coherence : 0.57)	UE1: Population, community, and diversity of urban species	403/ 1055	['specie', 'urban', 'plant', 'habitat', 'native', 'diversity', 'population', 'area', 'richness', 'community']	Spaces: 'urban', 'study' 'area', 'land';	Species diversity (objects): 'specie', 'plant', 'tree';	Species diversity (science): 'native', 'diversity', 'population', 'community', 'richness'; Ecosystem diversity (science): 'habitat', 'conservation', 'ecological', 'ecosystem', 'service'.
	UE2: Spatial analysis and modeling within the urban landscape and ecosystem services	364/ 1055	['urban', 'land', 'ecosystem', 'landscape', 'study', 'model', 'ecological', 'water', 'area', 'service']	Methods: 'model'.	Ecosystem diversity (objects): 'forest' 'landscape', 'water', 'soil'.	
	UE3: Conservation of urban species, habitats and ecosystems	247/ 1055	['specie', 'soil', 'forest', 'plant', 'area', 'conservation', 'increase', 'habitat', 'land', 'tree']			
Inter (coherence : 0.59)	Inter1: Spatial modeling and patterns of the urban landscape	313/ 758	['urban', 'land', 'landscape', 'area', 'model', 'study', 'forest', 'spatial', 'cover', 'pattern']		Spaces: 'spatial', 'green', 'space';	Spaces: 'park', 'cover'; Techniques: 'pattern', 'management'.
	Inter2: Urban socio-ecological interactions and human well-being	229/ 758	['urban', 'green', 'space', 'study', 'park', 'city', 'health', 'landscape', 'social', 'management']		Social focus: 'health', 'social'.	
	Inter3: Urban greenery and urban forestry	181/ 758	['tree', 'urban', 'plant', 'specie', 'soil', 'green', 'water', 'study', 'forest', 'area']			

UPD (coherence : 0.63)	UPD1: Urban development planning and socio-economic policy	219/506	['city', 'urban', 'development', 'land', 'policy', 'local', 'economic', 'plan', 'housing', 'market']	NA	Spatial scales: 'region', 'city', 'local', 'neighborhood'; Socio-economic focus: 'growth', 'development', 'housing', 'market', 'economic', 'public'; Applicability focus: "plan", 'policy', 'design'; Others: 'data'.
	UPD2: Urban growth and spatial modeling	140/506	['urban', 'city', 'spatial', 'study', 'area', 'land', 'model', 'growth', 'data', 'region']		
	UPD3: Urban green space design and the benefits of social well-being	81/506	['space', 'green', 'study', 'urban', 'park', 'health', 'public', 'design', 'neighborhood', 'social']		

Table 4.3.2 Comparison of cosine similarity with confidence intervals for UE, UPD, and Inter

Comparison	Similarity (cos)	95% CI	Interpretation
UE vs. Inter	0.67	[0.57, 0.73]	Strongest alignment , but slightly wider CI suggests moderate variability.
UPD vs. Inter	0.50	[0.40, 0.53]	Moderate overlap , with more precise estimate (tighter CI).
UE vs. UPD	0.27	[0.23, 0.37]	Weakest connection , with weak but stable similarity (narrow CI).

Notes: all cosine similarities are statically significant, $p < 0.001$, confidence intervals (CIs) $\alpha = 0.05$.

Table 4.3.3 Pairwise comparison of cosine similarity confidence intervals for UE, UPD, and Inter

Comparison (Pair 1 vs Pair 2)	CI Pair 1	CI Pair 2	Overlap between CIs
UE-Inter vs UPD-Inter	[0.57, 0.73]	[0.40, 0.53]	No overlap, significant difference
UE-Inter vs UE-UPD	[0.57, 0.73]	[0.23, 0.37]	No overlap, significant difference
UPD-Inter vs UE-UPD	[0.40, 0.53]	[0.23, 0.37]	No overlap, significant difference

Notes: All three pairwise similarities are statically significant, $p < 0.001$, $\alpha = 0.05$.

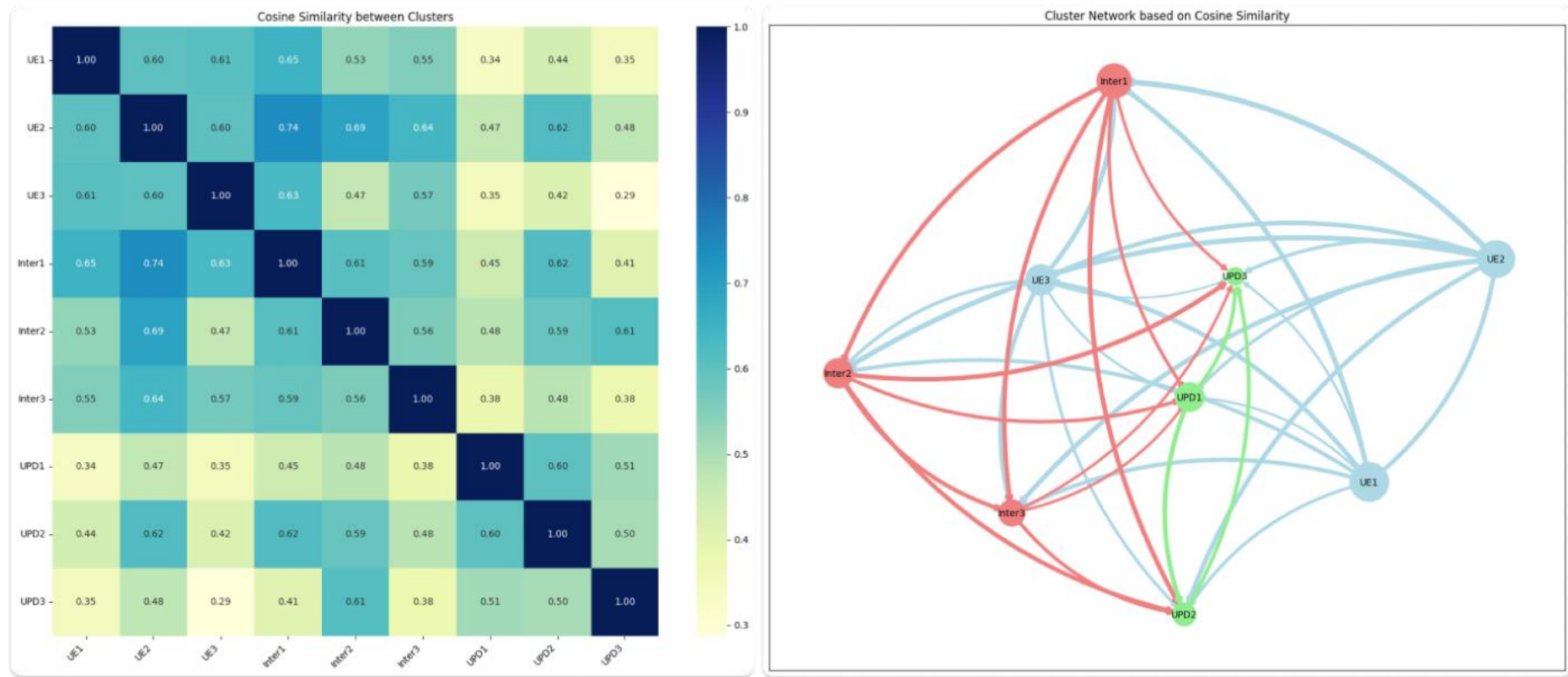


Figure 4.3.1 Cosine similarity matrix heatmap and network graph of disciplinary clusters: UE1: Population, community, and diversity of urban species; UE2: Spatial analysis and modeling within the urban landscape and ecosystem services; UE3: Conservation of urban species, habitats, and ecosystems; Inter1: Spatial modeling and patterns of the urban landscape; Inter2: Urban socio-ecological interactions and human well-being; Inter3: Urban greenery and urban forestry; UPD1: Urban development planning and socio-economic policy; UPD2: Urban growth and spatial modeling; UPD3: Urban green space design and the benefits of social well-being.

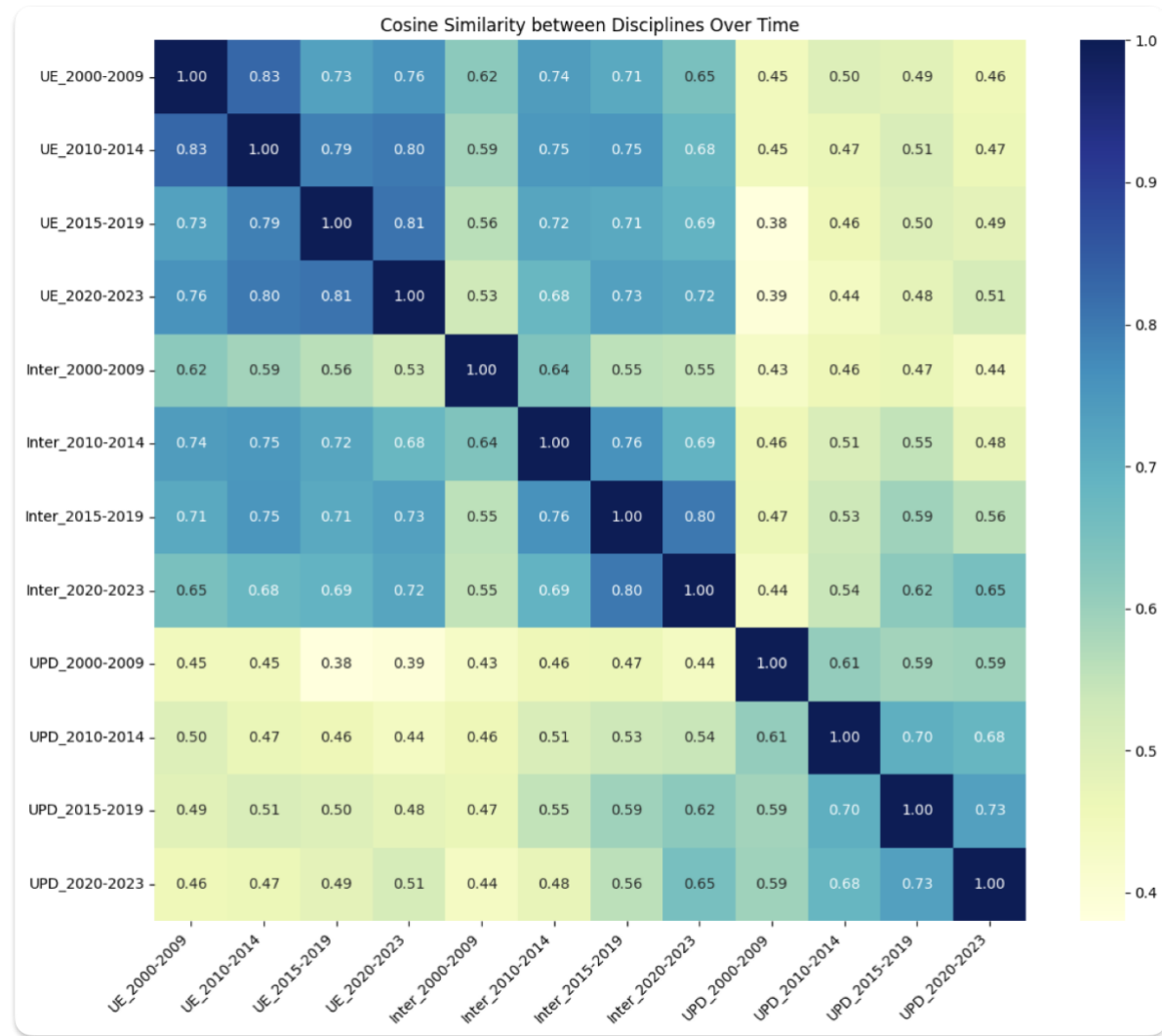


Figure 4.3.2 Heatmap of cosine similarity matrix for disciplinary time segments from 2000 to 2023

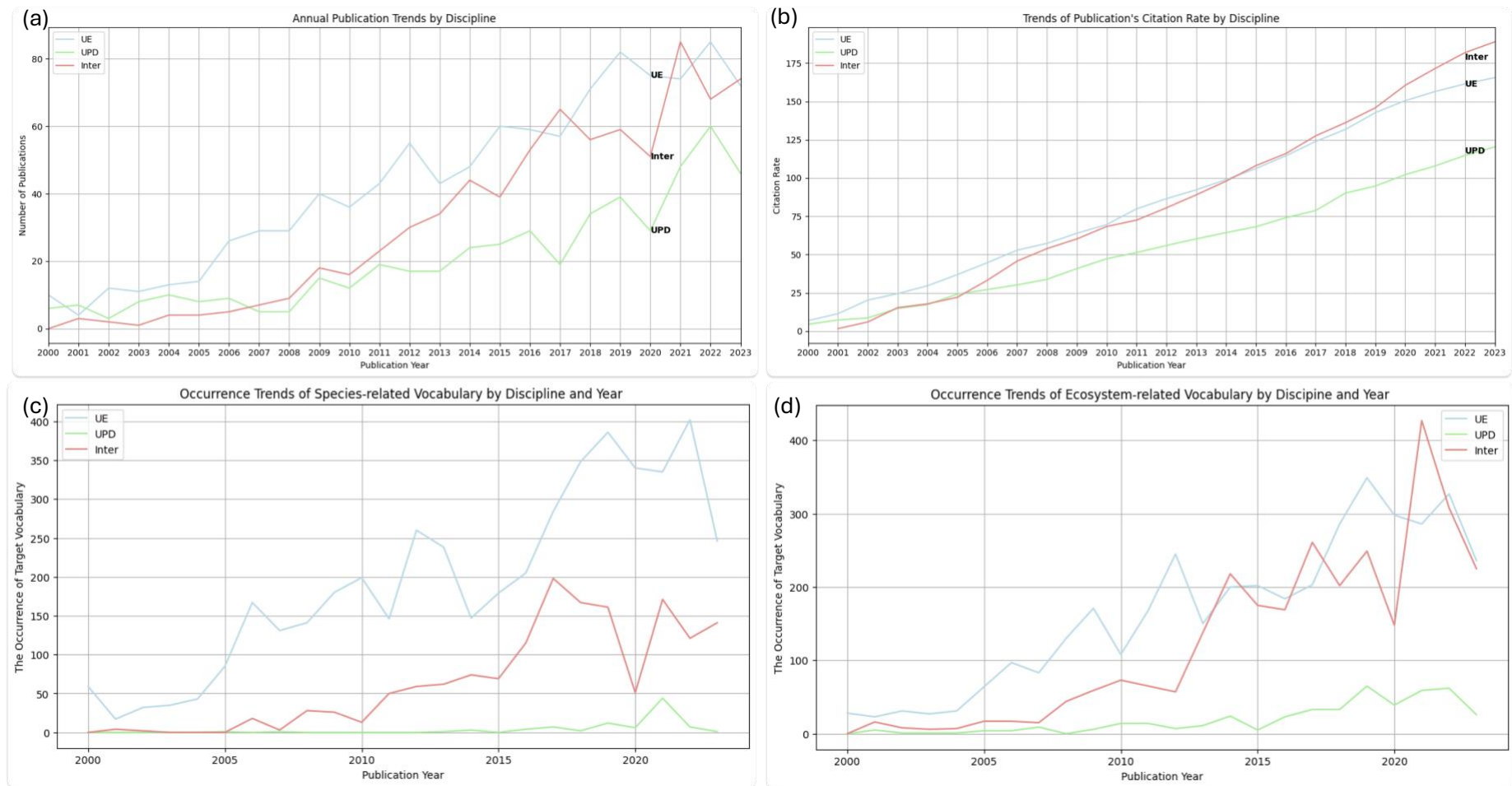


Figure 4.3.3 Trend analysis (a)-(d): (a) Annual publication trends by discipline; (b) Trends of publication's citation rate by discipline; (c) Occurrence trends of species-related vocabularies by discipline. The vocabularies in the search include: 'spec*', 'pollinator*', 'bird*', 'predator*', 'herbivor*', 'biodiversity,' 'richness,' 'abundance,' 'endemic,' 'keystone,' 'invasive,' 'index,' 'taxonomy,' 'niche,' 'flora,' and 'fauna.' (d) Occurrence trends of ecosystem-related vocabularies. The vocabularies in the search include: 'ecol*', 'ecosystem,' 'green,' 'habitat,' 'forest,' 'wetland,' 'grassland,' 'conservation,' and 'services.'

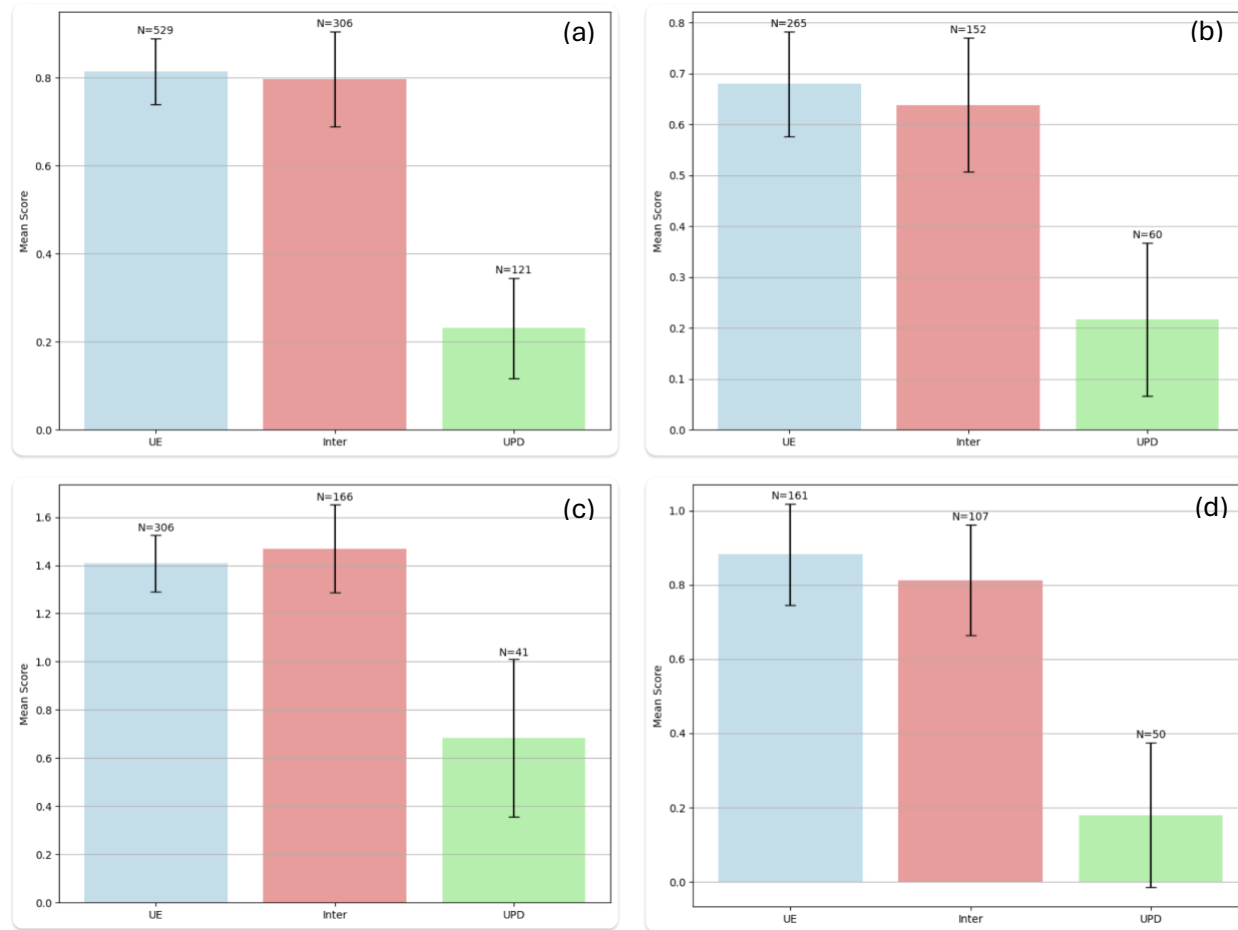


Figure 4.3.4 Mean contextual-corpora sentiment scores by discipline, including sensitivity analysis: (a) full sample size; (b) reduced to a randomly selected 50% sample size; (c) excluded samples with a score of 0; (d) filtering samples based on publication years from 2020 to 2023. Sample sizes are indicated above error bars, which represent \pm standard error. Blue: UE; green: UPD; Red: Inter.

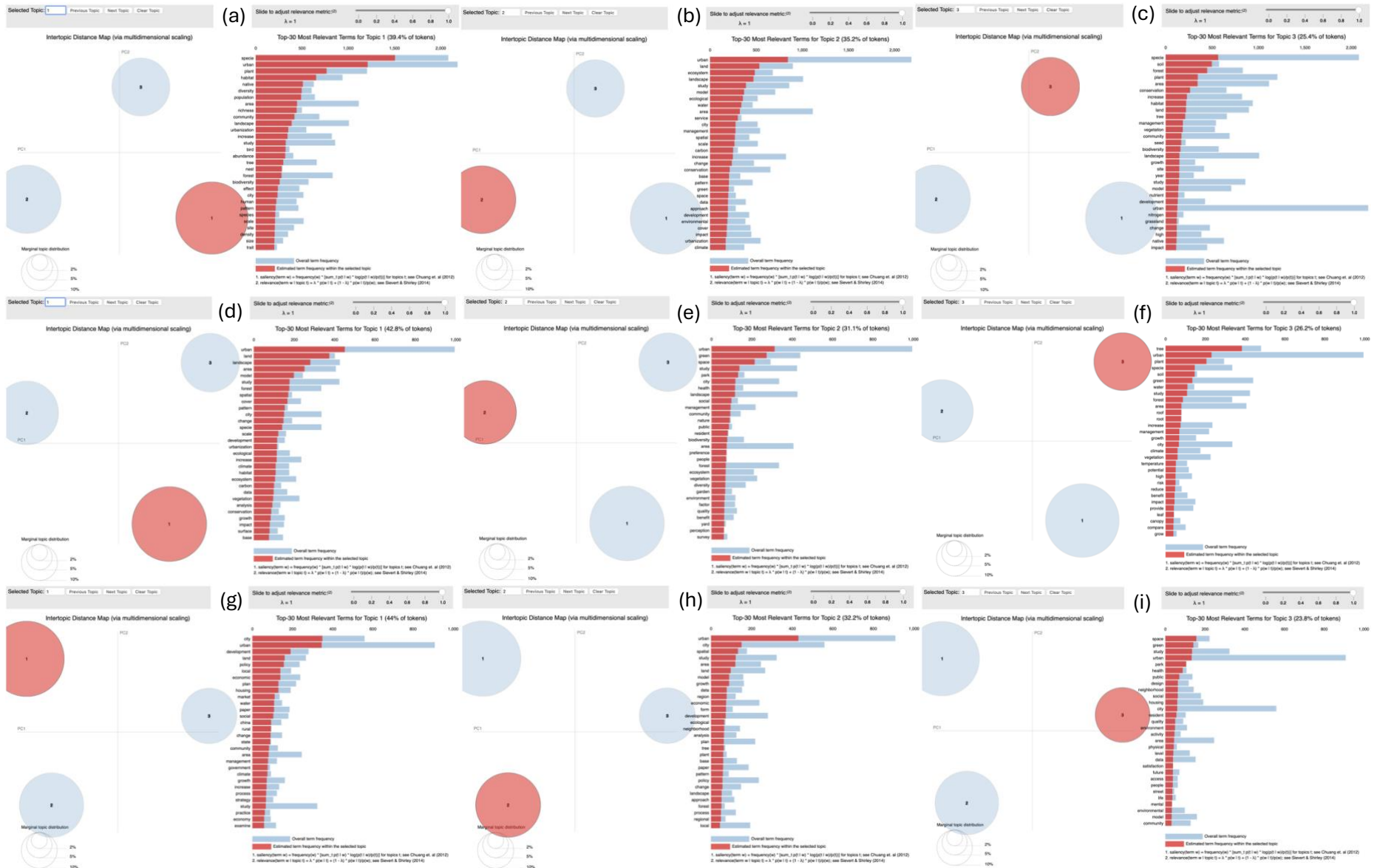


Figure 4.3.5 Inter-topic distance map and the Top 30 most relevant terms by cluster: UE1: Population, community, and diversity of urban species (a); UE2: Spatial analysis and modeling within the urban landscape and ecosystem services (b); UE3: Conservation of urban species, habitats, and ecosystems (c); Inter1: Spatial modeling and patterns of the urban landscape (d); Inter2: Urban socio-ecological interactions and human well-being (e); Inter3: Urban greenery and urban forestry (f); UPD1: Urban development planning and socio-economic policy (g); UPD2: Urban growth and spatial modeling (h); UPD3: Urban green space design and the benefits of social well-being (i).

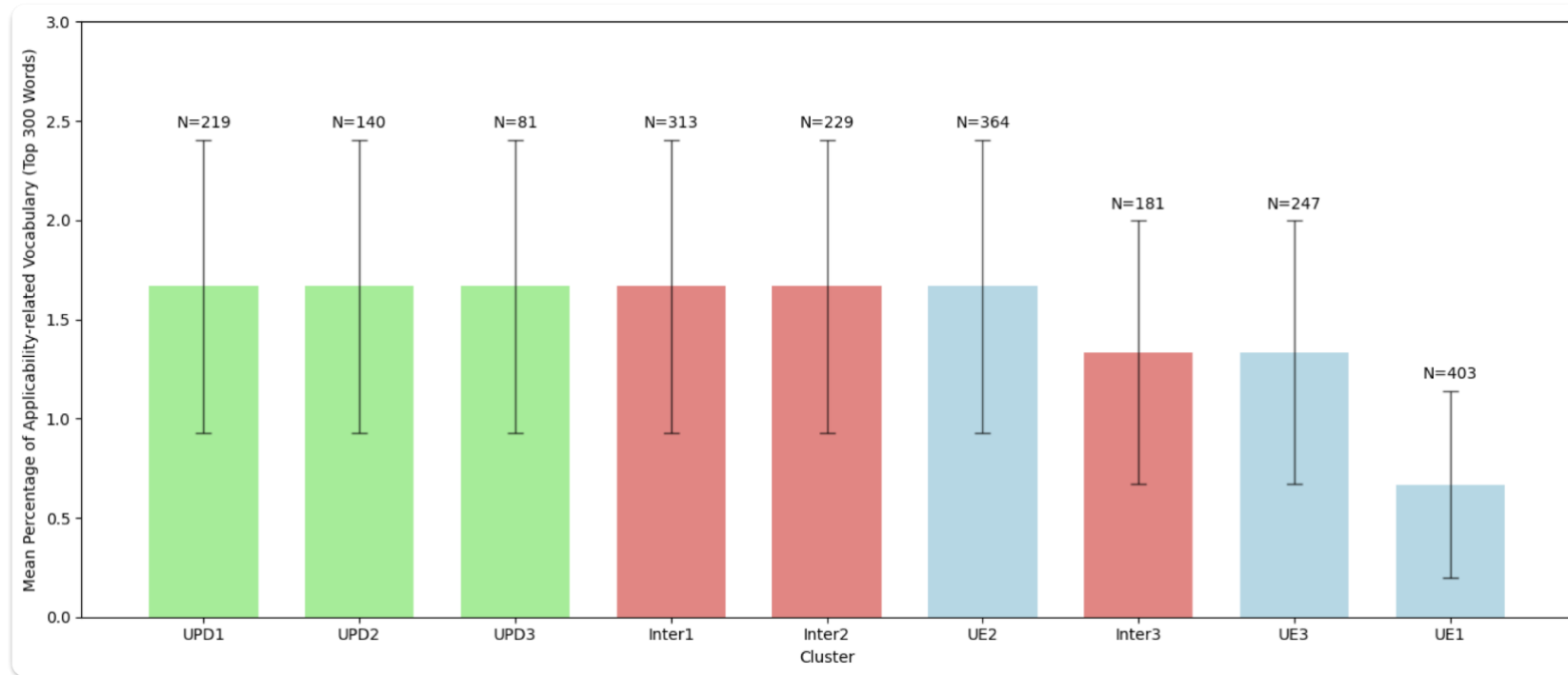


Figure 4.3.6 Mean percentage of applicability-related vocabulary by cluster. The applicability vocabulary in the search includes: ‘plan*,’ ‘design,’ ‘policy,’ and ‘strategy.’ The mean percentage of applicability-related vocabulary is calculated using the top 300 vocabulary terms, considering the standard vocabulary size per abstract. The vocabulary sample size ranges from 9,431 to 55,596, while the mean percentage varies from 0.67% to 1.67%. The number of articles by cluster is indicated above the error bars. The error bars represent \pm standard error, and the p-value is less than 0.01. Blue: UE; green: UPD; Red: Inter.

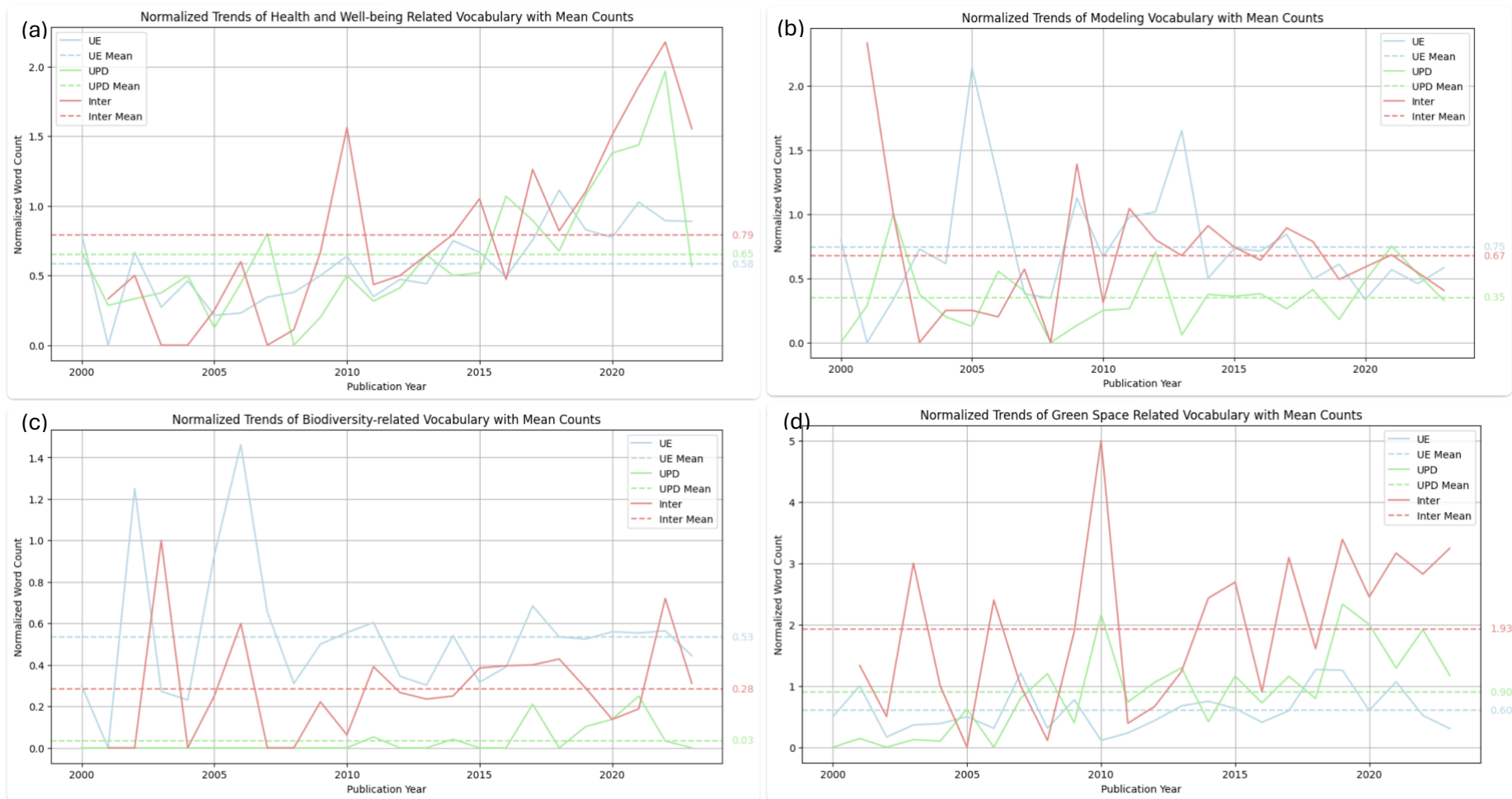


Figure 4.3.7 Normalized trend analysis (a)-(d): (a) Normalized trends of health-related vocabulary with mean counts. The searched vocabulary includes: ‘health*,’ ‘immun*,’ ‘mindful*,’ ‘tranquil*,’ ‘connected*,’ ‘satisfact*,’ ‘physical,’ ‘wellbeing,’ ‘mental,’ ‘belonging,’ ‘anxiety,’ ‘exercise,’ ‘fitness,’ ‘happiness,’ ‘activity,’ ‘strength,’ ‘stress,’ ‘contact,’ and ‘perception’; (b) Normalized trends of modeling vocabulary with mean counts. The searched vocabulary is ‘model*.’; (c) Normalized trends of biodiversity-related

vocabulary with mean counts. The searched vocabulary includes: 'biol*,' 'biodivers*,' 'ecol*,' 'ecos*'; (d) Normalized trends of green space-related vocabulary with mean counts. The searched vocabulary is 'green,' 'space,' 'park,' 'garden,' 'roof,' 'yard,' 'landscape,' 'infrastr*.'

5. Discussion

5.1. Project 1: Understanding BEPs' Perspectives on BIPD

Our study provides well-informed and nuanced evidence to better understand the challenges and opportunities of realizing BIPD from the perspectives of BEPs. We engaged a diverse group of BEPs from geographically understudied regions of the Global South, as well as professionals across sectors with socioeconomic expertise who have not typically been involved in this topic. Unlike previous studies that highlight barriers stemming from BEPs' low value priorities towards ecology and their reluctant attitudes (Dorst et al., 2022; Kay et al., 2022), our findings are surprisingly positive, given the broad profile of BEPs examined. We identified three major challenges: the misaligned value orientations between BEPs and their stakeholders, structurally imposed barriers, and BEPs' limited awareness of ecological knowledge. Our study uncovered potential opportunities that have not yet been elaborated on in previous research regarding BEPs' willingness and capacity to overcome some of these challenges, while other challenges may need further support, particularly from ecologists. We will first discuss these challenges and the perceived behavioral control of BEPs associated with them, along with BEPs' coping mechanisms. This will be followed by a discussion of the potential opportunities forward, referencing the frameworks of the TPB and lock-in effects.

Our study reveals that BEPs in both the Global North and South hold positive attitudes toward biodiversity, despite their diverse value patterns associated with nature. These values resonate with the multiple ways in which individuals conceive a good quality of life, as discussed in the IPBES report (IPBES, 2022; Pascual et al., 2023). For instance, *Enthusiasts*, who support prioritizing biodiversity in all sorts of planning practices, hold an ecocentric worldview; while the *Pluralist* recognizes the interconnectedness of systems, exhibiting a more pluricentric worldview. Regarding specific values, both *Enthusiasts* and *Contextualists* tend to acknowledge the intrinsic value of biodiversity, whereas *Pragmatists* appear to celebrate its instrumental value more. Despite these diverse value patterns, all BEPs favor the idea of BIPD and express a willingness to integrate it into their practices. This is evident from the consensus statement among BEPs that they will not overlook biodiversity information if it is made available, and their support to the statutory incorporation of BIPD across perspectives.

However, BEPs perceive a disconnect from their ecological values and attitudes with their stakeholders' viewpoints, over which they feel limited perceived behavioral control and seek assistance from additional data and methods beyond their current professional knowledge. All BEPs, except for *Pragmatists*, identify a major struggle in conveying the significance and urgency of biodiversity to stakeholders. In their view, the challenge is not due to BEPs' reluctance or resistance, but rather a mismatch between BEPs' ecological values and attitudes and those of their stakeholders – namely, residents, officials, clients, and others – acting as a significant barrier to the implementation of BIPD. To cope with this mismatch, BEPs discussed their attempts primarily in their engagement-related suggestions, including engaging public, promoting education, and synergizing biodiversity with other public interests. Such coping approaches rested within their accustomed professional knowledge; however, BEPs also felt a sense of insufficiency when addressing such challenges by solely relying on their current knowledge. For instance, *Enthusiasts*, who experience a heightened struggle to convey the significance of biodiversity to their stakeholders, place greater hope in acquiring additional biodiversity-related knowledge, as evidenced by a high proportion (66.7%) of knowledge-related suggestions. These suggestions encompass a broad array of ways of accessing data and methods, case studies, and multidisciplinary collaborations. *Pluralists* made similar knowledge-related suggestions, but in a more balanced manner alongside other categories of suggestions, and they also emphasized the importance of sufficient details in the example methods of SDMs to help convey the significance of biodiversity while engaging with stakeholders.

Regarding the challenges associated with structural barriers, BEPs demonstrate varying degrees of perceived control. Unlike previous studies emphasizing inadequate legislation as a significant barrier (Dorst et al., 2022), BEPs in our study favor the statutory incorporation of BIPD while feeling a stronger sense of control over this barrier. This sense of control is supported by BEPs' professional norms, as rules-in-use enable them to operate beyond the structural barriers of legislation, which exist as rules-in-form, to better serve the public interest (Gorrdard et al., 2016). Consequently, some BEPs, particularly *Pluralists* and *Enthusiasts*, generally view themselves as having the ability to transcend legislation and regulations, perceiving this as an integral part of their role in the decision-making process and in fostering a better urban future. This flexibility and potential for innovation contribute to a reduced degree of structural lock-in for them and reveal opportunities to act on BIPD involving BEPs' expertise.

In contrast, BEPs' perceived control over the structural-physical barriers, such as land use conflicts and competing resources, is more limited with their current expertise alone. Both *Contextualist* and *Pluralist* mentioned their dilemma in balancing the competing agendas of biodiversity with the socioeconomic public interest, particularly in the Global South, when their stakeholders are often economically locked in⁴¹ and require innovative, tailored solutions. They either experience a sense of vulnerability beyond their control or address these competing agendas by prioritizing the socioeconomic needs of the public or postponing biodiversity considerations to the future. In this context, BEPs often feel they lack options. As a result, their actions may reflect a path dependency that prioritizes socioeconomic needs while downgrading biodiversity considerations, potentially attracting criticism for resistance to change with their socio-technical regime (Dorst et al., 2022). However, it seems likely that BEPs struggle more due to their inadequate capacity to engage stakeholders and collaboratively move towards BIPD than from their attitudinal resistance to change. For instance, some *Pluralists*, upon learning about SDM examples for the first time, expressed that this data-rich evidence would help them facilitate stakeholders' understanding of the significance of biodiversity, demonstrating a strong interest in these data and methods and an expectation that such biodiversity evidence would assist in addressing the challenges of competing agendas, combined with their expertise in consensus building with stakeholders.

From the previous discussion, we can observe a pattern in which BEPs resort to additional biodiversity knowledge when they exhaust resources within their existing professional toolkits to address the challenges of misaligned values and structural-physical barriers. This is evidenced by the fact that they proposed the highest number of suggestions within the Knowledge-related category. Interestingly, while BEPs did not endorse the statement that their lack of ecological knowledge is a major barrier in the Q-sort. One possible explanation for this contradiction may lie in BEPs' lack of awareness of their own ecological knowledge deficits. Previous studies (McPhearson et al., 2016) have pointed out BEPs' lack of empirical ecological knowledge; however, a more pressing issue is that many BEPs are simply unaware that such ecological data and methods exist. Without this foundational knowledge awareness, it may be challenging for them to accurately assess whether their lack of ecological knowledge constitutes a major barrier or not, let alone to incorporate it into their practices. When presented with relevant data and methods, BEPs immediately express interest and perceive them as helpful, particularly in that the explicit and visual representations,

supported by sufficient data, help speak to the sense and sensibility of the stakeholders so that they would care. Nevertheless, in addition to recognizing their usefulness, some *Pluralists*, particularly with previous experience of the SDM examples, voiced concern regarding the applicability of these tools, suggesting that current available data and methods developed in urban ecology may not be readily actionable for prescribing real-world solutions. These findings reinforce existing research that emphasizes the knowledge gaps and disciplinary silos hindering BIPD (Kay et al., 2022; Pickett et al., 2022) and further highlight the critical absence of basic awareness among many BEPs regarding the existence of ecological data and methodologies. Consequently, our findings emphasize the necessity of strategies that promote positive changes by empowering BEPs with a deeper understanding of advancements in ecological knowledge and improving the practical applicability of these methodological advancements from ecologists.

Having discussed the three identified challenges and their coping strategies, we find promising opportunities for realizing BIPD by learning from the perspectives of a broader profile of BEPs. First, BEPs exhibit positive attitudes toward biodiversity despite their varying value patterns associated with nature. Their professional norms facilitate adaptive changes by involving biodiversity in their practices. They are willing to overcome structural regulatory barriers and bridge gaps in values and attitudes with stakeholders through public engagement and consensus-building initiatives. If equipped with better biodiversity knowledge, particularly through evidence-based and readily applicable tools, BEPs may experience improved perceived control in communicating effectively with their stakeholders during these initiatives regarding competing structural-physical conflicts, facilitating a collaborative transition towards BIPD.

A consensus among all perspectives indicates that BEPs will not overlook biodiversity data if it is available to them. Specifically, BEPs are likely to act quickly when they are aware of advancements in biodiversity knowledge, informed on how to access such data, employ relevant methods, or understand whom to consult or collaborate with. *Pluralists* and *Enthusiasts* demonstrate a greater willingness to acquire more knowledge, proposing various Knowledge-related suggestions, including increasing data availability and methodological awareness, drawing inspiration from successful case studies, and pursuing collaborations with other disciplines.

Learning from BEPs' perspectives, not all challenges are equally difficult. The more pressing barrier impeding BIPD lies in the fact that biodiversity data and methods have not yet been made available and applicable for BEPs. This echoes similar claims within related fields emphasizing disciplinary silos and knowledge gaps (Acuto et al., 2018; Dorst et al., 2022; Kay et al., 2022; McPhearson et al., 2016). However, in addition to this, primary efforts should not only focus on raising awareness and understanding of biodiversity knowledge among BEPs, as emphasized by ecologists (Kay et al., 2022; McPhearson et al., 2016), but also on providing accessible biodiversity data and methods to BEPs, especially those urgently in need and those that are practically applicable. In our findings, for a broader profile of BEPs across sectors, professional backgrounds, and geographical regions globally, the vast majority have very limited awareness of the existence of biodiversity data, tools, and knowledge advances made by ecologists. Furthermore, those few BEPs with experience in BIPD expressed concern that the tools developed by ecologists are not easily applicable in urban planning and design practices. In this study, BEPs from various perspectives indicate that a key direction for the much-needed advances is the development of applicable evidence-based tools to facilitate effective communications in engaging with urban stakeholders for a collective transformative shift toward biodiverse cities.

This is hardly a single discipline effort. An imperative step forward is to collaboratively advance biodiversity knowledge and build multidisciplinary evidence (Grove et al. 2024; Pickett et al. 2024) to empower BEPs with accessible data and applicable tools. Our findings suggest that the common ground between the two disciplinary perspectives may already exist (Pickett et al., 2022). A noteworthy example is the *Pluralist* perspective identified in our study, which is widely shared among BEPs and aligns well with the value turn recently promoted within the conservation ecology community (Pickett et al., 2024; IPBES, 2022), transitioning from “nature for itself” to “nature for people” (Mace, 2014). Another example is the *Enthusiast* perspective, characterized by a propensity for ecocentric values. These practitioners may approach more radically towards a biodiverse urban future and exhibit greater openness to adapting new methods and collaborating with ecologists. Additionally, we have identified some novel research endeavors along this line in urban ecology, such as incorporating urban ecology data and methodological advances into the standard planning and design framework (Apfelbeck et al., 2020; Weisser & Hauck, 2024), balancing scientific measures and community meaningfulness in selecting target species and developing biodiversity objectives in an urban renewal project (Kirk et al., 2021). Still, further

research is needed to better understand how to facilitate transdisciplinary knowledge advancement and awareness. For instance, further studies could explore the methods and tools that BEPs consider applicable in BIPD, strategies to transfer the knowledge advance and narrow gaps between urban ecologists and BEPs, and the role of biodiversity in setting objectives for BIPD. Additionally, more studies, particularly those employing qualitative approaches, would help uncover the BEPs' views in greater detail in each country, especially in the Global South. This includes exploring how their views may differ based on factors such as gender, age, or the size of the cities where they practice.

In conclusion, our research challenges the notion that BEPs resist incorporating biodiversity into their practices by broadly exploring their viewpoints. Conversely, BEPs appreciate biodiversity and demonstrate both the desire and ability to overcome legislative structural barriers to implement BIPD. Insights from their perspectives reveal that the primary challenge hindering BIPD is the unavailability and inapplicability of biodiversity data and methodologies for BEPs. To fully leverage their potential and reshape urban environments, it is vital to equip BEPs with accessible biodiversity information and collaborate with them to create pragmatic, applicable solutions, especially in developing evidence-based tools for effective communication with urban stakeholders. This is particularly crucial in more challenging regions, such as the Global South, where contextualized strategies through stakeholder co-production are necessary. Transdisciplinary collaboration, with increased partnerships between ecologists and BEPs from diverse geographic areas and professional backgrounds, could elevate biodiversity considerations from advocacy to essential elements within comprehensive plans and urban renewal initiatives. This could lead to meaningful changes and potentially mainstream BIPD to transform cities into biodiversity-rich areas.

5.2. Project 2: Assessing Stakeholders' Environmental Attitudes in a BIPD Case Study

The adapted AEA scale, with its acceptable reliability and good validity, connects well with the more sophisticated theoretical classifications, aligns with the recent progress in environmental philosophy, and is shown to have quality explanation and implication value for BIPD. With the AEA scale better specifying the two-tier sub-categories, the case study survey results of the ZJG Bay Eco-Park project effectively show the detailed environmental orientations of the stakeholders. It can further provide actionable policy implications to ensure the ZJG Bay Eco-Park project's long-term adherence to the UN SDG standards and also improve public participation and consensus-building in BIPD practice beyond this study site.

First, it is important to conduct an AEA scale survey at the start of projects to better understand specific attitude orientations, which helps stakeholders understand their own motivations as well as the motivations of others toward environmental conservation behaviors. This action would help all stakeholders to understand the underlying reasons and meaningfulness of other perspectives and facilitate the consensus-building in pro-environmental actions of all sorts. In this study, conducted right after phase one of the project, we found similar standpoints for all stakeholders oriented to weak-anthropocentric relating to the relational values of nature, with professionals slightly more prone to weak-anthropocentric than other groups. Such consensus might explain the success of phase one of the ZJG Bay Eco-Park recognized by UN SDG. At the same time, professionals working on the later phases and the long-term management of ZJG Bay Eco-Park should be aware of these differences in perspective. Of course, it would be even better and is suggested that future studies incorporate the AEA study findings from earlier stages to look at how the effect of these attitude differences in the long term. This is particularly important in these policy-driven urban fields, where the underlying motivations are of greater significance in creating communication and planning strategies that incorporate the desires of the different stakeholders. Urban and landscape professionals should therefore shift from their previous neglect (Parris et al., 2018) and pay more attention to the theoretical progress and practical applications of environmental ethics.

Second, by understanding the stakeholders' tendencies, decision-makers could use multiple communication strategies tailored to their desires to motivate pro-

environmental actions and improve awareness. Since the public better recognized moralistic statements that were possibly influenced by the Chinese classic philosophy of ‘harmony of man and nature’ that resonates in China’s ecological civilization policies (Henning, 2016; Wang et al., 2020), it makes sense to stress the importance of moralistic values while designing the policy messages to accelerate the process towards an ecological civilization, leading to greater gains with minimal effort. For instance, when framing the vision and positioning of policy actions or projects that are particularly ecological civilization related, it might unite stakeholders more to emphasize the perspective of the moral duties to other species and the natural environment. Learning from this finding, the choice of the Whiteheadian process philosophy, which incorporates ecological civilization with Chinese classic philosophy well (Wang et al., 2020), is potentially shown to be a good choice in the sense that it is easier to reach a consensus in Chinese culture and society.

Third, the AEA scale could also inform planners and designers to better facilitate bottom-up participation from cradle to grave in the long course of planning, design, and management. Based on the results in this study, the naturalistic experience that promotes contact with nature and facilitates the non-materialized enjoyment of the interactions with other species and the natural space, such as psychological, mental health, aesthetics and the like would be best accepted by the stakeholders and should therefore be prioritized (Soga & Gaston, 2021). This means that the planning, design, and management of the later phases of the ZJG Bay project could benefit significantly from research on the preferable naturalistic-oriented experience in the ZJG Bay Eco-Park. By improving the sense of pleasure and increasing the possible uses of ZJG Bay Eco-Park, it would serve as a good alternative measure of environmental education provision and ecological civilization promotion. While places that rely more on volunteering from bottom-up require consensus-building at the start and continuously throughout the process to make a project possible, the evaluation of attitudes is important for places like China to ensure long-term application and quality implementation.

Besides, in terms of long-term effects, ongoing environmental education about environmental knowledge and ecological civilization is highly necessary, particularly for government officials and residents. A better understanding of different attitudes, based on carefully designed education and publicity, can better facilitate bottom-up initiatives, ensure ongoing commitment and consensus, and foster spontaneous

behaviors that reduce administrative costs. One of the more striking findings in this case study is the internal conflict of officials that was repeatedly revealed in the analysis. Such findings provide a good example that local governments and residents are made up of a complexity of different divisions and individuals that do not always share the same visions. Such complexity has been discussed in the theoretical debates in political ecology (Goldman et al., 2018; Roberts, 2020). The internal conflict might be a result of the suppressed waterfront development needs of the local officials, fish farmers, and semi-operational port enterprise owners under the top-down state-imposed ecological civilization movements. Giving the fact that the ZJG Bay Eco-Park project aims at restoring the previously polluted environment, another possible explanation of such internal conflict might be due to the slow response of the locals from shifting the previous polluting practices to the more pro-environment mindsets. The specific reasons of the uneven power dynamics involving knowing and managing BIPD projects among state governments, local governments, professionals, and residents are still yet to be exposed with the help of follow-up qualitative studies.

However, what we can derive from current findings are that some of the local officials who contributed to the success of phase one of the ZJG Bay Eco-Park project might not have the same level of commitment to the national policy of ecological civilization, but they still managed to get their job done under the Chinese leadership system. Without doubt, government officials are more exposed to the national policy of ecological civilization than the public with a series of relevant policy documents and biodiversity-inclusive projects similar to the ZJG Bay Eco-Park project. However, unlike residents and professionals who still appeal to relatively plain beliefs with moralistic orientations, officials seem to be scientifically objective, with a highly ecologicistic orientation, as well as somewhat indifferent, with a strong inclination towards strong environmental apathy. It seems that the existing ecological civilization education within the government system has spoken to sense but not to sensibility. This could be an alarming sign if internal resistance begins to gain momentum. In this sense, there are calls for immediate actions of bottom-up planning improvements and ongoing environmental education on important ecological issues to increase moral responsibility and make it possible for people to genuinely embrace the policy of ecological civilization that is currently imposed from the top down.

To wrap up, this study points out that environmental ethics and ecological civilization share the same theoretical roots in Whitehead's process philosophy and demonstrates

the importance of the theoretical development of environmental ethics in the urban-applied fields. With its increased diversity and specificity, it can provide detailed explanations of motivation to help raise awareness of ecological civilization and facilitate consensus building. Aligning with the theoretical progress in environmental ethics, the AEA scale adapted in this study is a more fine-grained tool for assessing environmental attitudes, with strong explanatory power and potential value when applied to the planning and management of biodiversity-inclusive projects.

The implementation and findings of this adapted scale in the ZJG Bay Eco-Park project provide an excellent example. The stakeholders involved have similar environmental attitudes of the weak-anthropocentrism with slight inclination differences towards strong-anthropocentrism across sub-groups, indicating a shared appreciation of the relational values of nature. Importantly, it also unveils the potential hidden conflicts in the internal values of the local officials who align with two different orientations of ecocentric and environmental apathy. In addition, the public is more sensitive to moralistic statements and the naturalistic experience appeals to them the most. The internal conflicts of officials and the knowledge gap between professionals and residents require ongoing environmental education and policies to raise awareness on important ecological issues instead of simply imposing a policy of ecological civilization from the top down.

With its strong perspective explanation power, this AEA scale could be used to facilitate bottom-up stakeholder participation and a consensus-building process of crafting and communicating urban planning and management policies. Urban and landscape professionals could use this AEA scale early in BIPD projects to better understand stakeholders' environmental value patterns and tailor their proposals and policies. This means that this scale can inform actionable policy implications not only for the future phases of the ZJG Bay Eco-Park project, but also universally for projects outside China. There are several potential lines of further study to expand the knowledge and understanding of environmental ethic theories to be of use in the planning and management of BIPD projects. First, building on the quantitative analysis of this study, follow-up qualitative studies such as interviews with the stakeholders of the ZJG Bay Eco-Park could provide more in-depth insights to explain the underlying reasons for their environmental attitudes and sources of internal confusion and conflicts. Second, since the ZJG Bay Eco-Park project is still in progress, it would benefit from a longitudinal study to determine the stakeholders' environmental attitudes and value

changes over time to potentially understand the mutual impacts of implementing BIPD projects like this one and to shape the environmental attitudes and values toward an ecological civilization. Third, more comparative studies, such as across countries or sub-populations, could consolidate an expanded knowledge in this important field of study. Another potential of further study is inspired by a lesson learned while conducting this case study. This AEA scale is limited to 20 statements for easier practical implementation, which also reduces the number of Kellert's typologies involved. Further studies might consider making the AEA scale longer to include more Kellert's typologies to test and optimize the tool. Finally, there is a need for more in-depth studies rooted in the Global South and for the development of the theories and tools that derive from the local contexts of the Global South. Additionally, it is essential to mitigate the bias arising from a strong Western influence.

5.3. Project 3: Investigating the Impact of Interdisciplinary Collaborations on Disciplinary Silos between UE and UPD

Recent studies have identified disciplinary silos as a major barrier to promoting biodiversity-inclusive urban planning (Kay et al., 2022), primarily relying on qualitative methods such as interviews and focus groups. In contrast, this study goes back to the original research publications in both fields and analyzes their interconnections on a larger scale by utilizing extensive unstructured text data, made possible through NLP and machine learning techniques. We evaluate and compare the discursive similarities and differences, as well as the evolving role of interdisciplinary collaboration between the two fields. Crucially, we uncover cross-disciplinary themes and explore the progress and potential of how collaborative research bridging these fields can advance biodiversity-inclusive transformative change in urban environments.

We find that interdisciplinary collaborative research between urban ecology and urban planning and design significantly reduces disciplinary silos in thematic topics. Our findings align with the previous study conducted by Armstrong and their colleagues (2022), which found that there is a disciplinary divide regarding sentiment between the two fields. Additionally, we identify a divide between the two fields regarding thematic overlap. What's more, in our study, we find that interdisciplinary collaborative research shows a statistical improvement in thematic overlap through pairwise comparisons, while this is not evident in terms of sentiment framing related to biodiversity. Our findings provide statistical support for the increasing advocacy within urban ecology for a research shift toward interdisciplinarity (Frantzeskaki et al., 2024; Grimm et al., 2000; Kowarik, 2023), as well as the growing promotion of interdisciplinary collaborations between ecologists and planners to foster a biodiversity-inclusive transformative change in cities (Armstrong et al., 2022; Maron et al., 2025; McPhearson et al., 2016; Pickett et al., 2022).

Our findings align with some arguments for this disciplinary divide noted in previous research and provide more detailed insights, particularly regarding the transitional roles of interdisciplinary collaboration research. For instance, we observe differences in the value-laden focuses of socio-economic and biodiversity, as well as sentiments about how biodiversity is framed in both fields. This confirms that differences in biodiversity priorities pose one of the barriers to creating biodiversity-inclusive cities (Aronson et al., 2017; Kay et al., 2022). Our findings also align with the knowledge gaps identified in

earlier studies, linking planners who lack ecological expertise to the challenges of implementing transdisciplinary solutions (Frantzeskaki et al., 2024; McPhearson et al., 2016; Pickett et al., 2022), while providing additional insights. We observe that collaborative research converges more closely with urban ecology than with urban planning and design, indicating a greater influence of urban ecology on interdisciplinary collaborative research. Collaborative research significantly expanded the vocabulary related to biodiversity sciences at both the species and ecosystem levels. However, biodiversity-related terms are rarely found in urban planning and design. Additionally, clear differences exist in biodiversity levels across species and ecosystems: the ecosystem-related vocabulary has expanded more rapidly than that related to species. One plausible reason may stem from planners in collaborative research attempting to address the knowledge gap in biodiversity expertise with the assistance of ecologists. In other words, there is a significant knowledge gap in biodiversity among planners, particularly at the species level, where urban planning and design research rarely involves terminology related to species diversity.

In contrast to prior research focused on disciplinary divides (Armstrong et al., 2022; Kay et al., 2022), we uncover significant connections in themes that unite both fields, with interdisciplinary collaboration acting as a transitional middle ground. According to our findings, we highlight spatial modeling and ecosystem services related to human health and well-being as two major themes. The shared emphasis on ecosystem services associated with health and well-being is somewhat anticipated, as supporting these aspects has been a primary objective of urban planning and design since the inception of modern urban planning, which aimed to create civilized and hygienic spaces (Szczygiel & Hewitt, 2000; Weisser & Hauck, 2024). Moreover, there has been widespread recognition across disciplines that biodiversity would enhance human well-being in urban settings (Beatley, 2011; Marselle et al., 2019). This is further emphasized as a target (Target 12) in the Kunming Montreal Global Biodiversity Framework (KMGBF), which aims to enhance both human well-being and biodiversity synchronously by improving urban green and blue spaces (CBD, 2022).

Building on this recognition, we underline the crucial role of interdisciplinary collaboration in aligning ecologists' understanding of urban nature's ecosystem services with planners' perspectives on its value to human well-being. In our dataset, UE2 highlights various services provided by urban ecosystems, including supporting services such as habitat provision and connectivity, regulating services for climate

mitigation, thermal comfort, and control of epidemic diseases, along with cultural services associated with recreation and mental health. In contrast, UPD3 focuses on the relational values of urban green spaces and their impacts to mental health, quality of life, physical activity, social cohesion, and overall human well-being. Meanwhile, Inter2 has a more comprehensive approach that bridges both domains, addressing relational values of urban green spaces concerning physical and mental health benefits, personal perceptions and preferences, connection to nature, sense of identity, and individual well-being, alongside cultural services from recreational activities, gardening, landscape management, and the regulating services of urban forests and green infrastructure. Interdisciplinary collaboration studies appear to have established links that connect urban nature's ecosystem services primarily to relational values for humans, suggesting a pathway for integrating biodiversity conservation into urban policy and design decisions (IPBES, 2022).

Nonetheless, the potential of employing a common methodology of spatial modeling for transdisciplinary integration may have been underestimated, particularly at the species diversity level. It is this research explicitly emphasizes the necessity of spatial modeling as a common approach to bridging the gaps between urban ecology and urban planning and design. Learning from the trends of the two shared themes in this study, we observe that the theme of modeling has remained steady, while the popularity of health and well-being themes has grown across disciplines since 2010. It seems that both fields may not have recognized the frequent use of modeling within the other discipline, despite both considering it a fundamental aspect of their own practices.

When we analyze our dataset of publication titles for clusters related to spatial modeling, we observe differences in their modeling approaches across fields and levels of biodiversity. Urban ecologists emphasize developing tools to model, evaluate, and assess the impact of urban biodiversity and its coupling effects with other ecosystem services across species and ecosystem levels. Examples include “using GIS-linked Bayesian Belief Networks as a tool for modeling urban biodiversity¹” and “Differences in spatial predictions among species distribution modeling methods vary with species traits and environmental predictors¹.” In contrast, modeling studies in urban planning and design concentrate on aggregating multifunctional strategies and serving multiple objectives for application in planning and design. Notably, they primarily focus on the level of ecosystem diversity, relying on landscape ecology principles to understand landscape patterns, networks, and their effects. Examples include “Clustering urban

multifunctional landscapes using the self-organizing feature map neural network model¹" and "Modeling informed by landscape ecology principles: case study using scenario-based planning¹," among others. These differences again highlight the potential lack of emphasis on applicability in urban ecology, as well as the insufficient understanding of species diversity in planning, leading to an over-reliance on ecological principles and oversimplifying the complex nature of ecological relationships and their interactions in practical applications (Weisser & Hauck, 2024).

Learning from their different approaches in the two fields, a clear need exists to connect urban ecology science with planning actions (Hernandez-Santin et al., 2023; McPhearson et al., 2016; Weisser & Hauck, 2024). There is a significant opportunity to consolidate the models developed in urban ecology research, enabling them to serve multiple functions while simultaneously achieving various objectives and contributing to planning efforts. In our dataset, current collaborative research demonstrates stronger connections at the ecosystem level such as "Determining socio-economic drivers of urban forest fragmentation using historical remote sensing images¹" and "Habitat attributes of landscape mosaics along a gradient of matrix development intensity¹;" and by employing synergetic approaches for a comprehensive framework, exemplified by "Towards a comprehensive framework for modeling urban spatial dynamics¹" and "Using ecosystem service bundles to detect trade-offs and synergies across urban-rural complexes¹." Conversely, at the species level, more studies focus on anthropocentric threats to urban species diversity rather than on proactively establishing linkages to inform planning, with a few exceptions like "Conceptual framework for choosing target species for wildlife-inclusive urban design¹" and "Evaluating the potential for bird-habitat models to support biodiversity-friendly urban planning¹," among others. The limited connections at the species level may arise from heightened challenges in addressing the substantial gaps related to the lack of interest in the applicability of ecological science in urban ecology, insufficient understanding of species diversity among planners and designers, challenges in integrating data from the species level to meet various planning objectives, and the neglected potential of species-level modeling to guide urban planning and design, while species-level considerations are crucial for human-biodiversity interactions in urban parks (Palliwoda et al., 2017). However, this also opens avenues for more collaborative research to bridge these gaps.

Lastly, we see a potential leading role for interdisciplinary collaborative research, which

has recently gained popularity and impact. Collaborative research has been growing in prominence, reflected in the sharp rise in publications and citation ratings since 2015. Interdisciplinary collaborations have engaged with transdisciplinary themes earlier and are emerging faster, showcasing great potential to bridge disciplinary silos. Over the past decade, collaborative research has fostered thematic intersections between disciplines, significantly engaging with the key theme of ecosystem services for health and well-being. It has also aligned more closely with urban ecology studies in terms of biodiversity terminology, particularly at the ecosystem level. Additionally, collaborative research shows a wider capacity to forge links among disciplines. This includes aligning ecologists' understanding of urban nature's ecosystem services with planners' perspectives on their value to humans, particularly relational values. Interdisciplinary collaborations also seek to strengthen spatial models of urban biodiversity by incorporating socio-economic factors and adopting synergistic strategies to create a holistic framework that can support urban planning and design.

Coupled with greater attention to the potential of spatial modelling of species diversity within urban landscapes, we anticipate that interdisciplinary collaborations can lead the way to leverage transformative change, embedding diverse values of nature across disciplines, creating a biodiversity-inclusive urban future (Armstrong et al., 2022; CBD, 2022; IPBES, 2022). Furthermore, achieving Target 12 of the KMGBF significantly hinges on how effectively scholars, practitioners, and policymakers can address overlapping and conflicting challenges to form a profound common commitment to seeking solutions. This necessitates translating interdisciplinary research into real-world actions, such as engaging in industry-academia partnerships to advance biodiversity-inclusive design (ICON SCIENCE, 2022; Hernandez-Santin et al., 2023), incorporating biodiversity evidence into urban design practices (Weisser & Hauck, 2017; Weisser & Hauck, 2024), and promoting a global political commitment alongside the practical application of 'Nature Positive' to achieve a 'net gain' for nature (CBD, 2022; Kiss et al., 2025; Maron et al., 2024).

Endnotes

¹Note that we omit the parenthetical citation for these quotes of paper titles. The references are available from the authors; we do not cite the paper here as our intent is to illustrate a broader practice rather than implicitly criticize specific authors.

5.4. Opportunities for integrating nonhuman species' voices in UPD

This research examines the challenges and opportunities of BIPD, which, by definition, aims to intentionally incorporate the voices of nonhuman species into urban planning and design. By conducting surveys with a diverse group of BEPs from various professional backgrounds and regions around the world, including both the Global North and South, as well as local government officials, professionals, and residents involved in an urban regeneration project that specifically considers the needs of nonhuman species in park design in Eastern China, my research highlights the challenges of knowledge gaps related to BEPs' lack of awareness about existing biodiversity and tools, differing values between BEPs and human stakeholders, and structural-physical barriers. I also identified several opportunities for implementing BIPD from the perspectives of stakeholders and through inter- and transdisciplinary collaborations.

Specifically, drawing on the findings of Project 1, this research challenges the notion that BEPs resist incorporating biodiversity into their practices by broadly exploring their perspectives. Conversely, BEPs appreciate biodiversity and demonstrate both the desire and ability to overcome legislative structural barriers to implement BIPD. In other words, BEPs from both the Global North and South are eager for evidence on biodiversity and exhibit positive attitudes toward BIPD, particularly employing SDMs to showing readiness for innovation. Their varied value patterns and professional norms indicate a willingness to overcome legislative structural barriers for transformative change. Insights from their perspectives reveal that the primary challenge hindering BIPD is the unavailability and inapplicability of biodiversity data and methodologies for BEPs. To fully leverage their potential and reshape urban environments, it is vital to equip BEPs with accessible biodiversity information and collaborate with them to create pragmatic, applicable solutions, especially in developing evidence-based tools for effective communication with urban stakeholders. This is particularly crucial in more challenging regions, such as the Global South, where contextualized strategies through stakeholder co-production are necessary.

Furthermore, building on what we learned from Project 2, we deepen our understanding of the broader spectrum of stakeholders' attitudes regarding BIPD involved in the ZJG

Bay Eco-park, a BIPD case study site that intentionally considers nonhuman species in its design. Our findings emphasize the importance of aligning environmental values among stakeholders as critical for the successful implementation of biodiversity-inclusive urban practices. In the Chinese case study, stakeholders expressed relational values towards nature, and residents were particularly attuned to moralistic and naturalistic values. Additionally, we enhance the stakeholders' attitudes assessment tool, which captures environmental orientations at the species level, a dimension previously absent in studies and particularly relevant to biodiversity-inclusive transformations through participatory processes.

Considering the significance of inter- and transdisciplinary gaps discussed in Projects 1 and 2, we conducted Project 3 to further investigate the status quo of interdisciplinary research collaborations on urban biodiversity and explore potential directions for bridging the gaps between urban ecology and urban planning and design. By employing an innovative AI-driven approach that enables us to examine a large volume of publications, I find significant connections in themes that unite both fields, including spatial modeling and ecosystem services related to human health and well-being. Furthermore, the findings suggest a potential leading role for interdisciplinary research collaborations between these two fields. This research goes beyond the current focus on disciplinary silos, highlighting that significant progress has been made through collaborative research between the two fields, and advocating for further studies and actions to translate such advances into real-world changes. While broadly involving stakeholders to transform interdisciplinary research collaborations into transdisciplinary partnerships that bridge research-practice gaps, increased collaboration among ecologists, BEPs, and stakeholders from diverse geographic areas and professional backgrounds could elevate biodiversity considerations from advocacy to essential components within comprehensive plans and urban renewal initiatives.

With these three interconnected projects, this thesis research advances the knowledge in urban planning and design in the following three aspects:

- 1) **Reconsidering Biodiversity and Stakeholders' Roles:** This research reevaluates the anthropocentric framework that underpins current urban planning and design practices worldwide. Linked to the biophilia hypothesis, this research advances biodiversity-inclusive urban planning and design (BIPD) by adding a new ethical and practical dimension that recognizes biodiversity or nonhuman species as legitimate stakeholders in the urban planning process. It

also explores pathways for mainstreaming BIPD by understanding the perspectives of stakeholders. Moreover, the research emphasizes that active participation from the public, private, and civil society sectors is crucial for addressing biodiversity crises and implementing effective measures.

- 2) **Bridging Global North and South perspectives:** This research intends to better understand and further integrate the diverse perspectives of stakeholders regarding BIPD across geographical regions in both the Global North and South, as well as across different sectors of society. This is done with the aim to increase the engagement of various stakeholders and their participation in biodiversity-related actions, and to stimulate wider applications of various methods and tools to inspire and engage societal actions. By doing so, it contributes to the research community by including voices from the largely under-represented Global South, while many further studies are needed to address the geographic and socio-political imbalances in BIPD research.
- 3) **Inter- and transdisciplinary approach and breaking disciplinary silos:** Through innovative methods such as Q-methodology, the ecocentric-anthropocentric attitude scale, and natural language processing, this thesis research breaks down disciplinary silos between urban ecology and urban planning and design. It emphasizes the potential of inter- and transdisciplinary collaboration to transform professional norms, attitudes, and practices in biodiversity transformation and governance.

This novel interdisciplinary study identifies opportunities for involving nonhuman species as stakeholders in urban practices by broadly examining perspectives from Global North and South stakeholders. My findings highlight the importance of empowering built environment professionals with advancements in transdisciplinary biodiversity knowledge for broader stakeholder participation and the pluralization of values toward nature shared by various urban stakeholders. I repeatedly learned from the process that we should never underestimate the commitment and power of diverse stakeholders. Their plural knowledge and values, combined with inter- and transdisciplinary collaborations, can transform our cities into biodiversity-rich environments and inform the initiatives and policies across governmental levels to collectively bend the curve for the global biodiversity loss.

6. Conclusions

- This research advances knowledge regarding urban biodiversity and design in three aspects: 1) Reconsidering biodiversity and the stakeholder's role, 2) Bridging Global North and South perspectives, and 3) Inter- and transdisciplinary approach that breaks down disciplinary silos.
- This research highlights the challenges of knowledge gaps related to BEPs' lack of awareness about existing biodiversity and tools, differing values between BEPs and human stakeholders, and structural-physical barriers.
- There are several opportunities for implementing BIPD from the perspectives of stakeholders and through interdisciplinary collaborations.
- BEPs from both the Global North and South are eager for evidence on biodiversity and exhibit positive attitudes toward BIPD, showing readiness for innovation.
- BEPs' varied value patterns and professional norms indicate a willingness to overcome structural barriers for transformative change.
- BEPs perceive the primary challenge hindering BIPD as the unavailability and inapplicability of biodiversity data and methodologies.
- To fully leverage their potential and reshape urban environments, it is vital to equip BEPs with accessible biodiversity information and collaborate with them to create pragmatic, applicable solutions, especially in developing evidence-based tools for effective communication with urban stakeholders.
- Aligning environmental values among stakeholders is crucial for the successful implementation of biodiversity-inclusive urban practices. In the Chinese case study, stakeholders shared relational values towards nature, and residents were particularly attuned to moralistic and naturalistic values.
- Advancing the stakeholders' attitudes assessment tool that captures the environmental orientations at the species level, which was lacking in previous studies and is especially relevant to biodiversity-inclusive transformations through participatory processes.
- Regarding interdisciplinary research collaborations between urban ecology and urban planning, significant connections have been observed in themes that unite both fields, including spatial modeling and ecosystem services related to human health and well-being.

- This novel interdisciplinary study identifies opportunities for involving nonhuman species as stakeholders in urban practices by broadly examining perspectives from Global North and South stakeholders.
- The findings highlight the importance of empowering built environment professionals with advancements in transdisciplinary biodiversity knowledge to promote broader stakeholder participation and pluralize the values toward nature shared by various urban stakeholders.
- We should never underestimate the commitment and power of diverse stakeholders. Their plural knowledge and values, combined with inter- and transdisciplinary collaborations, can transform our cities into biodiversity-rich environments.

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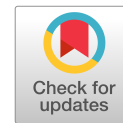
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Annexes

1. **Lu, J.**, Xu, Y., Zhu, J., & Hernando, A. (2023). Assessing Environmental Attitudes under China's Accelerating Ecological Civilization: A Case of the Urban Green Infrastructure Project in Zhangjiagang Bay. *Journal of Urban Planning and Development*, 149(4), 05023041. <https://doi.org/10.1061/JUPDDM.UPENG-4277>
(Published journal article in relation to Project 2)
2. Xu, Y., **Lu, J.**, & Zhu, J. (2023). "UN SDG Good Practice" in China: Ecological Restoration of the Zhangjiagang Bay. In W. Leal Filho, T. F. Ng, U. Iyer-Raniga, A. Ng, & A. Sharifi (Eds.), *SDGs in the Asia and Pacific Region* (pp. 1–26). Springer International Publishing. https://doi.org/10.1007/978-3-030-91262-8_103-1
(Published book chapter in relation to Project 2)
3. **Lu, J.**, Li, L., Hernando, A., J. & Manzanera. (2025). *From Criticism to Collaboration: Empowering Built-Environment Professionals for Biodiverse Cities in the Global North and South*. bioRxiv. <https://doi.org/10.1101/2025.01.15.633110>
(Submitted and under review in relation to Project 1)



Assessing Environmental Attitudes under China's Accelerating Ecological Civilization: A Case of the Urban Green Infrastructure Project in Zhangjiagang Bay

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Abstract: The planning and management of urban green infrastructure (UGI) are at the forefront of global biodiversity conservation. Building an environmental consensus rooted in environmental ethics and values is pivotal to the lasting success of UGI projects. Reflecting the specific classification into ecocentrism–anthropocentrism and Kellert's typologies and the theoretical connections between environmental ethics and ecological civilization, this study upgrades the adapted ecocentric and anthropocentric attitude toward the environment (AEA) scale accordingly to assess environmental attitudes and applies it in a survey of the main stakeholders involved in Zhangjiagang Bay Eco-Park, an ecological restoration project in China included in the UN's sustainable development goals (SDGs) Good Practice list. The paper unveils the diverse hidden value patterns of stakeholders and suggests new measures for sustainable UGI management. The authors argue that the AEA scale adapted and tested in this study connects well with the theories of environmental philosophy and is proven with good reliability, strong explanatory power, and potential value for UGI planning and management. **DOI:** [10.1061/JUPDDM.UPENG-4277](https://doi.org/10.1061/JUPDDM.UPENG-4277). *This work is made available under the terms of the Creative Commons Attribution 4.0 International license, <https://creativecommons.org/licenses/by/4.0/>.*

Practical Applications: In the policy-driven fields of urban practice, consensus building is one of the most important but, at the same time, most difficult processes to achieve. Without a good understanding of the diverse environmental perspectives of stakeholders, urban planning projects often die prematurely or gradually fade out due to unsustainable implementation or management in the long run. Drawing from the theoretical progress in environmental ethics, the authors adapted an AEA scale with two-tiered subscales that could indicate the general orientation on the spectrum of anthropocentric to ecocentric attitudes and reveal the specific motivations behind behaviors for better practical policy implications. The results of this case study indicate an overall weak-anthropocentric orientation and, more specifically, show the internal value conflicts of local officials and the significance of naturalistic and moralistic perspectives for the public. This study also pinpoints the value and urgency of ongoing environmental education on important ecological issues to enable the public to genuinely embrace the policy of ecological civilization that is currently imposed from the top down. With its strong power to explain value orientation, this AEA scale could be used to facilitate stakeholder participation from the bottom up and a process of crafting and communicating urban planning and management policies while building consensus.

Author keywords: Environmental ethics; Kellert typology; Anthropocentrism; Ecocentrism; Urban planning and management; Urban green infrastructure.

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Note. This manuscript was submitted on July 24, 2022; approved on May 8, 2023; published online on September 19, 2023. Discussion period open until February 19, 2024; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Urban Planning and Development*, © ASCE, ISSN 0733-9488.

Introduction

Urbanization places one of the greatest threats to global biodiversity (Seto et al. 2012). Urban green infrastructure (UGI) is considered a novel ecosystem in cities (Pickett et al. 2001) and is playing an increasingly important role in global biodiversity conservation, particularly through planning, design, and management (Aronson et al. 2017). The key challenge in UGI conservation, design, and management is to balance human perceptions and needs with the ecological requirements to preserve and enhance biodiversity (Aronson et al. 2017). The priority that it places on conservation planning and design is subject to social, cultural, and economic factors (Aronson et al. 2017), which is never an easy process to reach a consensus. Without a good understanding of the diverse environmental perspectives of the stakeholders, UGI projects often die prematurely or gradually fade out due to unsustainable implementation or management in the long run (EPA 2022; Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020). The imminent and pivotal first step to success lies in environmental consensus-building rooted in the belief in environmental ethics and values (Parris et al. 2018).

Research relevant to environmental ethics and values remains primarily focused on the growing theoretical complexity of its

classifications (Chang et al. 2011; Cocks and Simpson 2015; Thompson and Barton 1994) and does not fully translate this progress into the urban applied fields. The nature of UGIs provides potential in both ecocentric and anthropocentric perspectives in environmental ethics (Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020). For this reason, UGIs are an ideal scenario to test the practical application of theoretical classifications using suitable environmental-attitude assessment tools (Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020). Meanwhile, the Chinese resonant philosophy of *ecological civilization* shares the same theoretical roots of process philosophy with environmental ethics (Wang et al. 2020) and is widely acknowledged in both government and research circles in China. For this reason, the authors selected the Zhangjiagang Bay (ZJG Bay) Eco-Park project in the Yangtze River Delta of China, which is included in the UN's SDG Good Practice list, as a UGI case study site.

This paper starts with a review of the literature to understand the interconnected relationship between environmental ethics and China's top-down ecological civilization policies and the theoretical progress of the environmental assessment tools and their applications in UGI projects. This is followed by the discussion of implementing the UN's SDG listed Good Practice of ZJG Bay Eco-Park project under the ecological civilization in China. Next, the authors examine different environmental attitude assessment tools and adapt the selected tool. Finally, the authors present the survey data of ZJG Bay Eco-Park, discuss the results, and draw conclusions based on the findings.

Environmental Ethics and Their Relationship with China's Ecological Civilization

Whitehead's philosophy anticipated the development of environmental ethics and may have influenced Leopold's *The Land*

Ethic from 1970 (Callicott 1980; Henning 2016). He is widely considered to be the founding father of *environmental ethics*. This means that process philosophers were the key contributors to the seminal discussions that constituted the field of environmental ethics (Henning 2016) (Fig. 1). In the view of pioneering environmental philosophers, there is no *ethic* in environmental ethics unless it recognizes the intrinsic value of the nonhuman (Cocks and Simpson 2015; Leopold 1949). Therefore, in the early discussions that constituted the field of environmental ethics, there were two major perspectives: ecocentrism, which celebrates the intrinsic value of nature, independent from its direct value to human beings (Cocks and Simpson 2015), and anthropocentrism, in which the nonhuman environment is measured by its tangible and intangible value to human beings (Norton 1984). Later, researchers started to further divide the anthropocentric perspective into strong anthropocentrism and weak anthropocentrism (Cocks and Simpson 2015; Norton 1984). In strong anthropocentrism, the nonhuman environment is considered to be a commodity or merely an object of use, while the weak anthropocentrism perspective measures the natural environment by its value to human beings, but the value is significantly expanded beyond the commodities associated with strong anthropocentrism (Cocks and Simpson 2015). Further, the biophilia hypothesis boldly asserts the existence of a biologically based innate human need to affiliate with life and lifelike processes. Wilson (1984) and Kellert (1996) refined a typology of environmental values that reflects a range of physical, emotional, and intellectual expressions of the attitudes toward nature, such as *utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic, and negativistic* environmental valuations.

Almost a century later, Chinese intellectuals have been attracted to the philosophy of Whitehead, who called his thought *the philosophy of organism* (Henning 2016; Wang et al. 2020; Whitehead et al. 1978). Whitehead's thoughts on process philosophy not

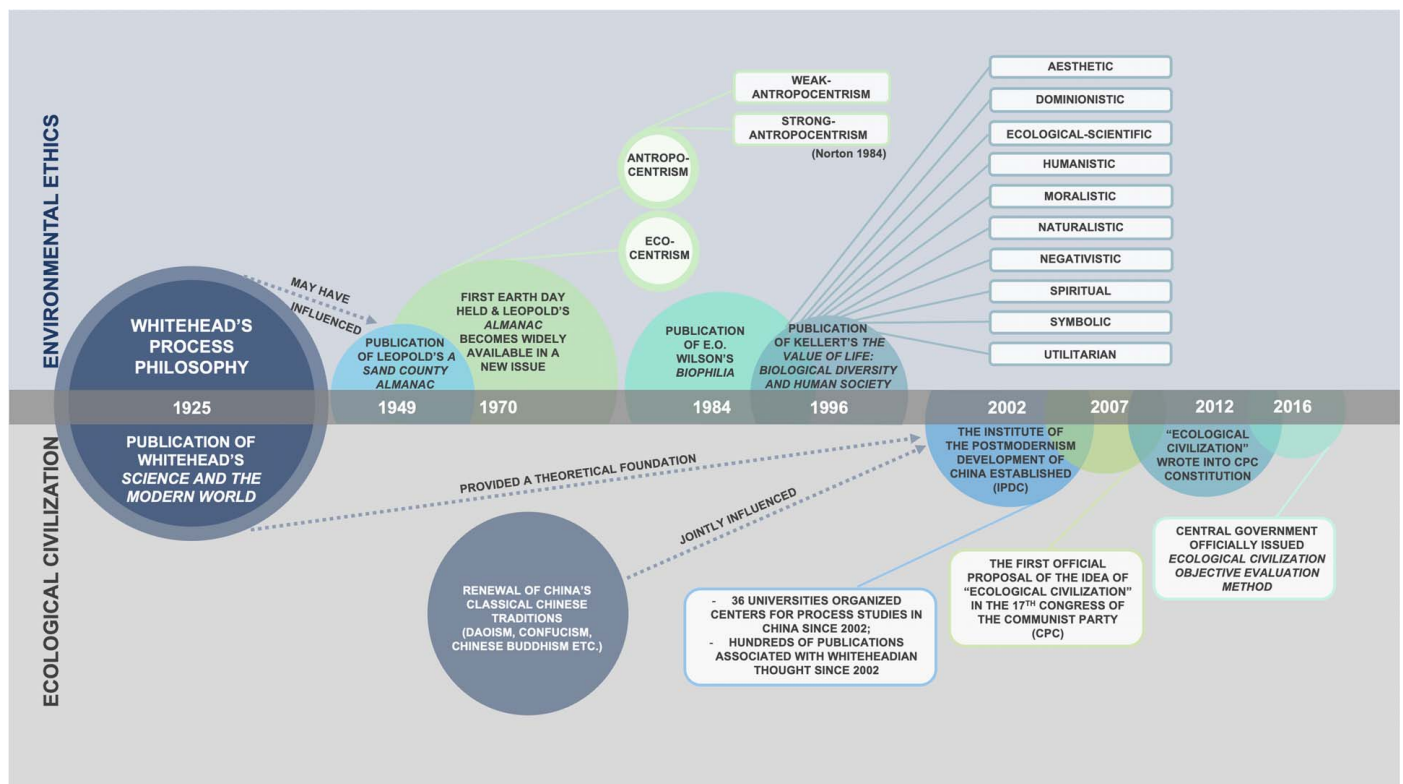


Fig. 1. Historical traces and relationships between process philosophy, environmental ethics, and Chinese ecological civilization.

only provided them with a theoretical foundation (Fig. 1) to shift from the celebrated achievement of *modernism* and economic growth in Chinese society to the more cutting-edge thought on the European *postmodernism* and also to the fulfillment of the dual commitments of the Chinese Government of ecological civilization and scientific ways of thinking. It joins the recent revival of traditional Chinese wisdom with China's environmental movement (Wang et al. 2020). China has welcomed Whitehead's thought and sees it as a way of clarifying and supporting the commitment to an ecological civilization, which has been strongly re-emphasized by President Xi (Wang et al. 2020).

Since 2007, China has continuously demonstrated its commitment to a much more harmonious relationship with the environment (Wu and Wallace 2014). There is plentiful evidence in this regard. The Communist Party formally drafted the goal of becoming an ecological civilization into its Constitution in 2012. Thirty-six universities have organized Centers for Process Studies in China, and Wang et al. (2020) documented hundreds of publications associated with Whiteheadian thought on ecological civilization since 2002. It has also launched a series of national and regional ecological-oriented mega-planning projects.

Despite US propaganda, which often criticizes China's commitment as halfhearted (Wang et al. 2020), the real question appeared to be centered on whether the interest in the ecological civilization is solely a top-down process of the political leadership imposed on the people or is embraced and actively responded to by all levels of decision-makers and the general public in China. There is a lack of research from the bottom-up perspective to answer this question: are decision-makers at different levels also fully on-board in terms of the commitment to pursuing ecological civilization? The analysis of this information is very relevant because it is important to provide useful preliminary steps for understanding and influencing behavioral changes.

Environmental Assessment Tools and Their Applications to UGIs

A growing number of researchers have pointed out the pivotal practical values of environmental ethics theoretical classifications (Chang et al. 2011; Cocks and Simpson 2015; Thompson and Barton 1994) and have developed a variety of scales to assess environmental attitudes since the 1970s (Dunlap and Van Liere 1978; Maloney and Ward 1973; Weigel and Weigel 1978). Among all, the New Environmental Paradigm (NEP) scale has been recognized as the most well-known and widely applied scale because of its relatively high reliability and generality (Dunlap and Jones 2002; Hong 2006; Hong and Fan 2016; La Trobe and Acott 2000; Lalonde and Jackson 2002; Stern et al. 1995). It was first introduced in China by Hong (2006) and later became popular in Chinese academic circles and was applied broadly to environmental education and conservation behavior as well (Chang et al. 2011; Luo and Deng 2008; Wu et al. 2012; Wu and Zhu 2017; Yu 2014). With its broad scope, the NEP scale touches on diverse environmental theories and topics, such as anthropocentrism, human exceptionalism, ecological equilibrium, and so on. This tool is effective at capturing the environmental worldview but falls short of explaining the strong links between attitudes and actions (Thompson and Barton 1994; Wu and Zhu 2017). Ecocentric and anthropocentric individuals may, although not always, express positive attitudes toward environmental issues, with the difference in these two orientations translating into action that is absent from the NEP scale (Cocks and Simpson 2015).

In this regard, Thompson and Barton (1994) operationalized the Ecocentric and Anthropocentric Attitude toward the Environment (EA) scale and found that ecocentric attitudes were significant predictors of both self-reported and observed behaviors even after controlling for a traditional measurement of environmental attitudes. Later, Røskoft's (2007) team in Norway used this EA scale to evaluate the belief–attitude relation among sheep farmers, wildlife managers, and research biologists toward carnivores. The results suggested that environmental beliefs might transform ecocentric values into negative or positive attitudes toward one specific environmental category based on the cognitive hierarchy model. Furthermore, Koprina and Cocis (2017) adjusted the EA scale to better fit the field of environmental education, with a specific connection to sustainable development aims, and tested it on three groups of students in different majors. The results demonstrated that different environmental attitudes result in variations in motivations and choices of conservation behavior. For instance, ecocentric individuals are more likely to act on proenvironmental attitudes and engage in conserving behaviors. Typical examples of this can be found in environmental organizations.

Along with theoretical progress in environmental ethics, researchers continuously specify the typologies in environmental perspectives (Callicott 1992; Kellert 1996; Norton 1984, 1995). Inspired by Kellert's environmental value typology (Diehm 2012; Kellert 1996; Wilson 1984), Delavari-Edalat and Abdi (2010) developed the Biophilia Tendency (BT) scale and conducted a survey on the two ethical groups of Asia and White British in an urban park in the United Kingdom, finding differences in negativistic, moralistic, and naturalistic values. Unlike the NEP and the EA scales, the statements in the BT scale focus specifically on talking about the perspectives toward trees. Perhaps partly due to its narrow focus, the BT scale is not used as widely as the other two. However, the detailed differential classifications based on the theoretical typologies of the BT scale make it possible to raise these environmental value distinctions to the conscious level, which helps understand the underlying motivations, which is particularly important in the applied fields of UGI planning and design, where environmental behaviors are constantly taking place.

UGI is urban green spaces that contribute to the biodiversity and conservation of ecosystems and the welfare of the population by forming part of a network of spaces that connect the city and nature (Cameron and Blanuša 2016). Since this requires a long-term environmental commitment and problem-solving in a complex environment, the planning and design of UGIs are highly relevant to the influence of different environmental attitudes. Previous studies have indicated its pivotal practical values in the realm of environmental education and the promotion of outdoor conservation programs (Chang et al. 2011; Cocks and Simpson 2015; Thompson and Barton 1994) by using different environmental attitude assessment tools. Some researchers have also begun to investigate the environmental perspective of UGIs of users after the fact (Chang et al. 2011; Luo and Deng 2008), but their orientations at an early stage that shapes the implementation process have not yet been assessed (Parris et al. 2018). It also calls for appropriate environmental orientation tools that can be applied to UGIs to proactively assess these orientations. On the one hand, such tools should better reflect the progress in increasingly more specific theoretical ethical classifications. For instance, it might work better to further differentiate strong-anthropocentric and weak-anthropocentric orientations on the EA scale to apply the theoretical progress in the urban-applied field of UGIs. On the other hand, to improve the policy implications of environmental assessment, which is particularly important in the practical fields of UGIs, tools should be better able to explain motivation and provide more detailed environmental perspectives. The

BT scale, originally designed for detailed attitudes of trees, is a winner in this regard. To sum up, an early conscious understanding and evaluation of underlying attitudes can help craft messages tailored to different environmental perspectives and establish a consensus amid the constant conflicts between growth and protection over time, facilitating more constructive behaviors, careful maintenance, and long-term sustainable successes (Zuniga-Teran et al. 2020).

ZJG Bay in China: UN-Listed SDG Good Practice

Following the imposed national strategy of ecological civilization, ZJG Bay Eco-Park was initiated by the local government as part of the ongoing mega UGI projects along the Yangtze River that involve collective efforts by different sectors and that are in different phases spread over a long period (Fig. 2).

There are two main merits of studying the ZJG Bay Eco-Park project in this study. First, under the natural protection strategy and local government initiation, this large-scale project involves multiple critical aspects of removing polluting industries, restoring the ecological landscape, building green infrastructure, maintaining biodiversity, and ensuring public access to the eco-park (Fig. 3). Subject to a variety of consultations and collaboration with fishing farms, semioperational port enterprises, villages, local grassroots volunteer groups, professional planners, and construction companies (United Nations 2021), the project is ideal for studying the environmental perspectives of stakeholders at an operational level and for assessing the extent to which it aligns with the central government's position on the ecocentrism–anthropocentrism spectrum and its impact on the project.

Second, implementing the ZJG Bay Eco-Park project will require tremendous effort in a complex and dynamic process, without guaranteeing long-term sustainable success. In other words, although being recognized as UNSDG Good Practice in its initial phase consolidates the results of its ecoactions, it still remains to be seen whether the project will continue its good practice to

promote sustained effects. Right now, it presents a fleeting opportunity to understand the environmental perspectives of those who have contributed to the success of stage one of the ZJG Bay Eco-Park project, as well as the potential areas that are worth looking into and that could provide insights into the actions in its later stages. In this sense, the proactive nature of this study sets it apart from the previous studies on environmental attitudes, which mostly assess UGIs after the fact, and gives it the potential to monitor and influence both the building and continuity of consensus.

Adaptation of the Survey Instrument and Data Collection

Adaptation of the Survey Instrument

Referring back to the earlier discussions on the differences in environmental attitude assessment tools, the EA and BT scales outweigh the NEP scale with regard to the potential of showing the motivations behind behaviors for better practical policy implications. Comparing the EA and the BT scales, the former reflects a general orientation on the spectrum of anthropocentric to ecocentric attitudes, and the latter differentiates more detailed perspectives, which are particularly applicable to UGIs. As a result, the authors decided to adapt a new scale by incorporating both the EA and the BT scales to create a two-tier assessment tool. Since the statements in the EA scale are more universally applied than those of the BT scale, the authors mainly used the statements from the EA scale and incorporated some of the statements from the BT scale where needed. By simultaneously assessing the stakeholders' attitudes on both the EA and BT scales, as opposed to the original EA scale, the newly adapted EA scale will be able to assess both general orientation and specific typologies. For this reason, this paper refers to the adapted EA scale as the AEA scale. There were four steps in the process of adapting the AEA scale:

1. *Upgrade the EA scale to four subscales:* To better reflect recent theoretical advances and societal changes, the authors further

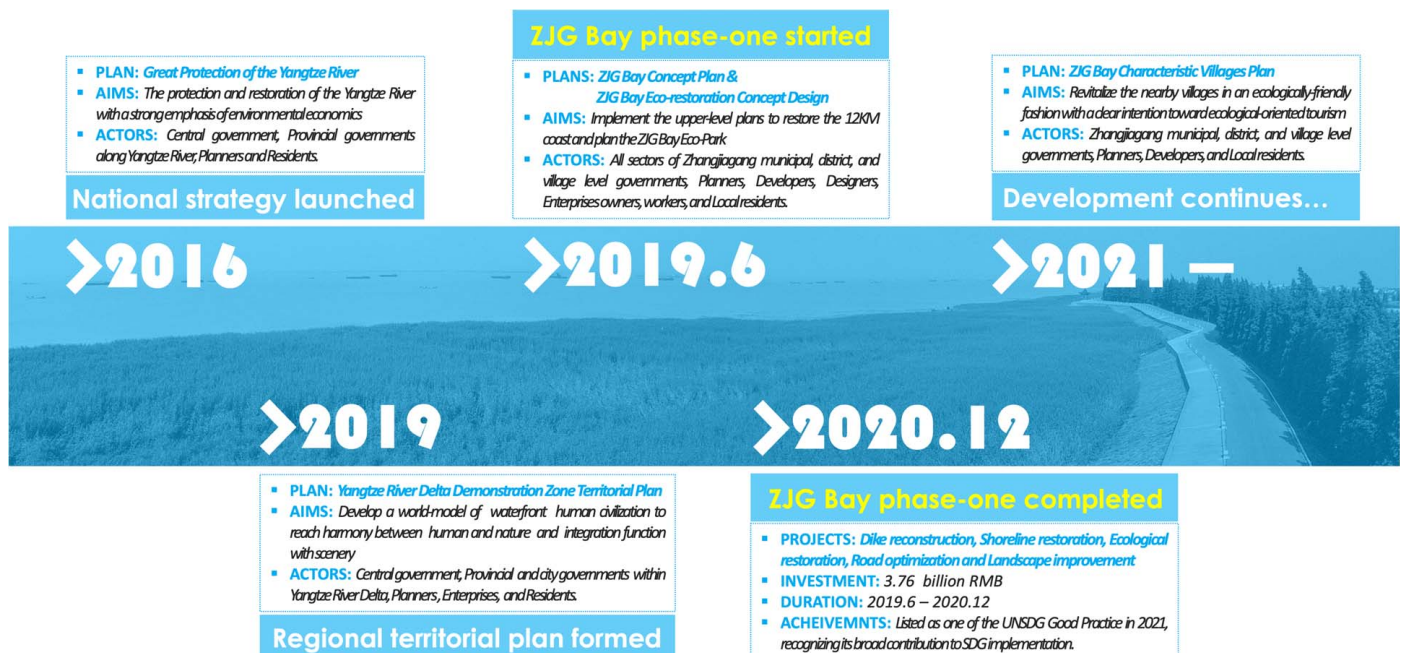


Fig. 2. Timeline of ZJG Bay Eco-Park project planning and implementation. (Image by Jing Lu.)



Fig. 3. (a) Before the phase-one implementation of the ZJG Bay Eco-Park (2019–2020) (image courtesy of Zhangjiagang Bay Management Office); and (b) after the phase-one implementation of the ZJG Bay Eco-Park (2019–2020) (image courtesy of Pincai Fan).

- specify the strong anthropocentric and weak anthropocentric viewpoints in the EA scale according to the definitions outlined in Cocks and Simons' (2015) study. This resulted in the four subscales of *Ecocentrism*, *Weak Anthropocentrism*, *Strong Anthropocentrism*, and *Apathy* in this upgraded EA scale (Table 2).
- 2. Incorporate BT statements:** Since there are only two original statements that relate to weak anthropocentric values in the existing EA scale, more statements in this subscale were needed, so the authors incorporated adapted statements from the BT scale. The authors selected the ecologicistic and moralistic tendencies in addition to the utilitarian, negativistic, dominionistic, and naturalistic typologies already embedded in the EA scale. This adapted version now has six major subscales of the BT scale originating from Kellert's (1991, 1996) typology definition listed in Table 1.
 - 3. Optimize the total number of statements:** Previous researchers operated 22–33 statements of the EA scale in their questionnaire (Kaltenborn and Bjerke 2002; Kopnina and Cocis 2017; Thompson and Barton 1994). To optimize the length of the AEA scale and to balance out the statements in each subscale, the authors decided to add three adapted statements related to weak anthropocentric values from the BT scale and made it all-together five statements for the weak anthropocentric subscale, and consequently, the total number of statements add up to 20 with an equal number of five statements in each of the four EA subscales. A further statement selection procedure was carried out based on the criteria of “common selections among past

Table 1. Kellert's six typologies

Typologies	Definitions
Ecologicistic	Interest in the ecological value of species and their relationship to the environment
Moralistic	Opposition to cruelty and harm toward species
Naturalistic	Interest in direct outdoor recreational contact with species
Utilitarian	Interest in the utilization of the species or subordination of their habitat for the practical benefit of humans
Negativistic	Fear, dislike, or indifference toward species
Dominionistic	Interest in the mastery, control, and dominance of the animals

Source: Data from Kellert (1996).

researchers,” “diversity in environmental value tendencies,” “no ambiguity in definitions,” and “cultural relevance to China.” The conciseness of the final AEA scale makes it easier to apply in practice. The full statements and their association with the subscales are outlined in Table 2.

- 4. Finalize the scale and adapt it to the Chinese version:** Each statement in this AEA scale is assigned with the Likert scale from 1 to 5 selection options denoting strongly agree (1), agree (2), neutral (3), disagree (4), and strongly disagree (5). The full AEA scale was then translated into Chinese following the procedures of forward and backward translations to ensure the quality of the adapted Chinese version.

Sampling and Data Collection

In mid-October 2021, the questionnaire was distributed to the stakeholders listed in Table 3 using the widely used Chinese questionnaire platform WJX and received a total of 272 responses within 1 week. The breakdown of the final respondents was 26.1% local officials, 39.3% professionals, and 34.6% local residents. All of the collected data were imported into SPSS (IBM SPSS Statistics versions 21 and 27) to verify the validity (Cronbach's alpha test) and reliability (KMO and Bartlett's test) of the adapted scale. The authors also calculated mean values by subscales and subgroups to understand the central tendency of probability distributions of each subscales and subgroups, conducted a categorical principal component analysis to analyze the relative impact of the subgroups on the subscales, and conducted a cross-subscale partial correlation analysis by group type to understand the strength of the relationship between each of the subscales.

Data Analysis and Discussion

Data Analysis Results

The reliability of the AEA scale was acceptable, with Cronbach's alpha values for all variables of 0.76, and the validity of the survey with KMO and Bartlett's test was good (0.81, $p < 0.01$) (Table 2).

The general tendency of the stakeholders of the ZJG Bay Eco-Park project was coherent with the weak-anthropocentric orientation, considering the lowest mean value of all participants (1.33, closest to the Likert scale category of “1” as “strongly agree” to the statements) to be weak-anthropocentric (Table 4). However, strong anthropocentric orientations for all participants (Weak-A = 0.804, -0.372 and Strong-A = 0.789, 0.324) were almost equal competitors (Table 5). If we consider the EA scale as a spectrum with increasing ecocentric inclinations from environmental apathy, strong-anthropocentric, weak-anthropocentric, and ecocentric, the stakeholders in this study can be said to fall between the weak anthropocentric and strong-anthropocentric standpoints.

Table 2. Adapted ecocentric and anthropocentric attitude toward the environment (AEA) scale

No.	Statements	Scales				Mean scores				F-values	p
		EA scale	BT scale	Officials	Professionals	Residents	Professionals	Residents	Professionals		
1	One of the worst things about overpopulation is that many natural areas are being destroyed for development	Eco	Ecol	1.770	1.837	1.840	1.840	1.840	0.731	0.393	
2	We have a duty to save woodlands for the sake of all human beings	Weak-A	Moral	1.070	1.033	1.160	1.160	1.160	2.616	0.107	
3	I enjoy walking in nature because I am amazed at and enjoy the individuality of beauty of trees and flowers	Weak-A	Natur	1.110	1.077	1.210	1.210	1.210	4.616	0.033**	
4	The worst thing about the loss of the rain forest is that it will restrict the development of new medicines	Strong-A	Util	1.790	1.827	1.860	1.860	1.860	1.027	0.312	
5	It seems to me that most conservationists are pessimistic and somewhat paranoid	Apathy	Neg	2.730	2.857	2.600	2.600	2.600	0.780	0.378	
6	I prefer wildlife reserves to zoos	Eco	Ecol	1.350	1.637	1.660	1.660	1.660	1.007	0.316	
7	I do not think the problem of depletion of natural resources is as bad as many people make it out to be	Apathy	Neg	3.210	3.633	2.870	2.870	2.870	4.877	0.028**	
8	The thing that concerns me most about deforestation is that there will not be enough lumber for future generations	Strong-A	Util	2.450	2.290	2.130	2.130	2.130	2.129	0.146	
9	I love being out in nature to find comfort when I am unhappy	Weak-A	Natur	1.680	1.393	1.470	1.470	1.470	11.690	0.001*	
10	Most environmental problems will solve themselves given enough time	Apathy	Neg	2.340	2.367	2.130	2.130	2.130	1.160	0.282	
11	I do not care about environmental problems	Apathy	Neg	4.440	4.583	4.520	4.520	4.520	1.104	0.294	
12	One of the most important reasons to keep lakes and rivers clean is so that people have drinking water	Strong-A	Util	2.070	2.127	2.020	2.020	2.020	8.896	0.003*	
13	It makes me sad to see natural environments destroyed	Eco	Moral	1.140	1.190	1.240	1.240	1.240	1.024	0.312	
14	The most important reason for conservation is human survival	Strong-A	Dom	1.390	1.343	1.320	1.320	1.320	3.907	0.049**	
15	One of the best things about recycling is that it saves money	Strong-A	Util	2.560	2.490	2.270	2.270	2.270	3.135	0.078	
16	I feel better about myself when I know more different type of trees and flowers	Weak-A	Ecol	1.590	1.530	1.570	1.570	1.570	2.762	0.098	
17	Too much emphasis has been placed on conservation	Apathy	Neg	3.550	3.453	2.960	2.960	2.960	0.325	0.569	
18	Nature is valuable for its own sake, independent of human interests	Eco	Ecol	2.920	2.757	3.020	3.020	3.020	0.527	0.468	
19	I enjoy being out in nature because it is a great stress reducer for me	Weak-A	Natur	1.340	1.367	1.430	1.430	1.430	2.349	0.127	
20	Humans are as much a part of the ecosystem as other animals	Eco	Ecol	1.100	1.137	1.220	1.220	1.220	0.036	0.849	

Source: Data from Delavari-Edalat and Abdi (2010), Koprina and Cocis (2017), and Thompson and Barton (1994).

Note: AEA scale reliability test: Cronbach's alpha of all variables ($n = 20$) = 0.76 (>0.7)

AEA scale validity test: Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy = 0.81 (>0.8); Bartlett's test of sphericity— p (sig.) <0.01 .

Officials, $n = 71$; professionals, $n = 115$; residents, $n = 94$.

Eco = ecocentric; Weak-A = weak-anthropocentric; Strong-A = strong-anthropocentric; Apathy = environmental apathy; Ecol = ecologicistic; Natur = naturalistic; Moral = moralistic; Dom = dominionistic; Util = utilitarian; and Neg = negativistic subscales.

* $p < 0.01$, ** $p < 0.05$.

Table 3. Questionnaire participants

Stakeholders	Roles	Specifications
Local officials	Initiators	Municipal mayor offices, natural resources and planning bureau, environmental protection bureau, village committees, and so on
Professionals	Implementers	Urban planners, landscape architects and engineers, local volunteer groups, and construction personnel and managers
Residents	Influenced	The villagers and middle school students from the surrounding area, fishing farmers, and enterprise owners and employees who made their living from ZJG Bay before the establishment of the eco-park

Table 4. Mean values by subscales and subgroups of the AEA scale

Scales		Mean scores			
Subscales	Orientations	Officials	Professionals	Residents	All participants
EA scale	Eco	1.66	1.71	1.80	1.73
	Weak-A	1.36	1.28	1.37	1.33
	Strong-A	2.05	2.02	1.92	1.99
	Apathy	3.25	3.38	3.02	3.22
BT scale	Ecol	1.75	1.78	1.86	1.80
	Natur	1.38	1.28	1.37	1.34
	Moral	1.11	1.11	1.20	1.14
	Dom	1.39	1.34	1.32	1.35
	Util	2.22	2.18	2.07	2.15
	Neg	3.25	3.38	3.02	3.22

Note: The boldface values represent the lowest mean scores in each row. Eco = ecocentric; Weak-A = weak-anthropocentric; Strong-A = strong-anthropocentric; Apathy = environmental apathy; Ecol = ecologicistic; Natur = naturalistic; Moral = moralistic; Dom = dominionistic; Util = utilitarian; and Neg = negativistic subscales.

In terms of the cross-subscale orientations by subgroups, there were significant statistical correlations and rich diversity patterns (Tables 5 and 6 and Fig. 4). To begin with, surprisingly, officials with either ecocentric or strong-anthropocentric viewpoints also supported environmental apathy statements; the officials with ecocentric orientation correlated with environmental apathy and negativistic subscales ($0.252, p < 0.05$), which was not observed in the other two groups and was contrary to common sense (Table 6). This result was in line with officials' relatively high value of

environmental apathy (0.610, 0.688) in the variable principal normalization pattern (Table 5 and Fig. 4). It revealed that local officials of the ZJG Bay Eco-Park project were possibly experiencing internal conflicts in environmental attitude values—two distinct values of ecocentrism and environmental apathy both seemed to appeal to them. Meanwhile, building on previous findings of the correlation between anthropocentrism and environmental apathy (Røskoft et al. 2007), this study indicated that officials with strong-anthropocentric perspectives had the highest correlation to environmental apathy ($0.572, p < 0.01$) of all stakeholder groups (Table 6). In addition, there are variations across groups, but generally, officials who acknowledged weak-anthropocentric viewpoints had the strongest correlation with naturalistic typologies ($0.960, p < 0.01$); the value of experiencing the natural environment appealed to them most (Table 6).

Second, the choices of professionals highly correlated to the definitions of these tendencies in both subscales, while simultaneously demonstrating diverse value orientations. For instance, professionals with ecocentric orientation scored the highest correlation with ecologicistic tendency ($0.977, p < 0.01$), while those prone to strong-anthropocentric statements had the strongest correlation ($0.991, p < 0.01$) with utilitarian tendency (Table 6). Weak-anthropocentric professionals correlated to all of Kellert's typology tendencies except negativistic ones. The variable principal normalization graph (Fig. 4) also clearly demonstrated this pattern of knowledge of professionals. Environmental apathy and negativism were the lowest (0.126) compared to the other two groups, indicating the strong proenvironmental inclinations of professionals due to their environmental knowledge (Table 6).

Finally, residents were more sensitive to moralistic statements despite having the lowest mean values toward ecocentric attitude. Residents with weak-anthropocentric viewpoints had the highest correlation with ecocentrism ($0.530, p < 0.01$) and had a stronger correlation ($0.780, p < 0.01$) to the moralistic view (Table 6). The variable principal normalization pattern not only coincided with the significance of the impact of moralistic statements on residents but also revealed that the dominionistic subscale was also relatively significant for residents. A similar pattern was also found for professionals but not for officials, whose moralistic and dominionistic components were much lower than other counterparts (Table 5 and Fig. 4).

Discussions

The adapted AEA scale, with its acceptable reliability and good validity, connects well with the more sophisticated theoretical

Table 5. Categorical principal component analysis by subscales and subgroups of the AEA scale

Scales		Dimension 1, Dimension 2			
Subscales	Orientations	Officials	Professionals	Residents	All participants
EA scale	Eco	0.629, -0.454	0.720, 0.046	0.657, -0.123	0.678, -0.191
	Weak-A	0.746, -0.382	0.822, -0.315	0.772, -0.479	0.804, -0.372
	Strong-A	0.798, 0.324	0.815, 0.251	0.787, 0.378	0.789, 0.324
	Apathy	0.610, 0.688	0.126, 0.952	0.365, 0.868	0.317, 0.886
BT scale	Ecol	0.748, -0.355	0.704, 0.019	0.660, -0.014	0.686, -0.138
	Natur	0.750, -0.433	0.751, -0.330	0.731, -0.487	0.762, -0.387
	Moral	0.315, -0.612	0.630, -0.274	0.588, -0.578	0.542, -0.469
	Dom	0.360, -0.020	0.595, -0.037	0.548, -0.170	0.518, -0.050
	Util	0.776, 0.340	0.804, 0.264	0.763, 0.415	0.775, 0.360
	Neg	0.610, 0.688	0.126, 0.952	0.365, 0.868	0.317, 0.886

Note: Eco = ecocentric; Weak-A = weak-anthropocentric; Strong-A = strong-anthropocentric; Apathy = environmental apathy. Ecol = ecologicistic; Natur = naturalistic; Moral = moralistic; Dom = dominionistic; Util = utilitarian; and Neg = negativistic sub-scales.

Table 6. Partial correlations between subscales of the AEA scale

Scales	EA scale				BT scale					
	Eco	Weak-A	Strong-A	Apathy	Ecol	Natur	Moral	Dom	Util	Neg
Officials (n = 71)										
Eco	1.000	0.484 ^a	0.305	0.252^b	0.944 ^a	0.494 ^a	0.465 ^a	0.144	0.295 ^b	0.252^b
Weak-A	0.484 ^a	1.000	0.405^a	0.199	0.655 ^a	0.960^a	0.400 ^a	0.205	0.390 ^a	0.199
Strong-A	0.305	0.405^a	1.000	0.572^a	0.359 ^b	0.428^a	-0.113	0.407 ^a	0.982^a	0.572^a
Apathy	0.252 ^b	-0.199	0.572^a	1.000	0.318	0.234	-0.168	0.131	0.582 ^a	1.000
Professionals (n = 115)										
Eco	1.000	0.503 ^a	0.275 ^b	0.115	0.977^a	0.444 ^a	0.287 ^b	0.270	0.291 ^b	0.115
Weak-A	0.503 ^a	1.000	0.362 ^a	-0.088	0.531 ^a	0.913^a	0.634 ^a	0.376 ^a	0.329 ^a	-0.088
Strong-A	0.275 ^b	0.362 ^a	1.000	0.341 ^a	0.291 ^b	0.253	0.323 ^a	0.522 ^a	0.991^a	0.341 ^a
Apathy	0.115	-0.088	0.341 ^a	1.000	0.094	-0.061	-0.061	0.024	0.363 ^a	1.000
Residents (n = 94)										
Eco	1.000	0.530^a	0.274	0.130	0.960 ^a	0.547 ^a	0.432 ^a	0.211 ^b	0.253	0.130
Weak-A	0.530^a	1.000	0.387 ^a	-0.091	0.563 ^a	0.940^a	0.780^a	0.448 ^a	0.328 ^b	-0.091
Strong-A	0.274	0.387 ^a	1.000	0.508 ^a	0.352 ^a	0.303 ^b	0.207	0.462 ^a	0.985^a	0.508 ^a
Apathy	0.130	-0.091	0.508 ^a	1.000	0.183	-0.127	-0.184	-0.084	0.530 ^a	1.000

Note: The boldface values are highlighted significant correlations. Controlled variables including education level, gender, age, park visit frequency, and park visit duration. Eco = ecocentric; Weak-A = weak-anthropocentric; Strong-A = strong-anthropocentric; Apathy = environmental apathy; Ecol = ecologicistic; Natur = naturalistic; Moral = moralistic; Dom = dominionistic; Util = utilitarian; and Neg = negativistic subscales.

^aCorrelation is significant at the 0.01 level (two-tiered).

^bCorrelation is significant at the 0.05 level (two-tiered).

classifications, aligns with the recent progress in environmental philosophy, and is shown to have a quality explanation and implication value for UGI planning and design. With the AEA scale better specifying the two-tier subcategories, the case study survey results of the ZJG Bay Eco-Park project effectively show the detailed environmental orientations of the stakeholders. It can further provide actionable policy implications to ensure ZJG Bay Eco-Park project's long-term adherence to the UN SDG standards and also improve public participation and consensus-building in UGI planning and design practice beyond this study site.

First, it is important to conduct an AEA scale survey at the start of projects to better understand specific attitude orientations, which helps stakeholders understand their motivations and the motivations of others toward environmental conservation behaviors.

This action would help all stakeholders to understand the underlying reasons and meaningfulness of other perspectives and facilitate consensus-building in proenvironmental actions of all sorts. In this study, conducted right after phase one of the project, we found similar standpoints for all stakeholders, with professionals slightly more prone to weak-anthropocentric than other groups. Such consensus might explain the success of phase one of the ZJG Bay Eco-Park recognized by UN SDG. At the same time, professionals working on the later phases and the long-term management of ZJG Bay Eco-Park should be aware of these differences in perspective. Of course, it would be even better, and it is suggested that future studies incorporate the AEA study findings from earlier stages to look at how the effect of these attitude differences in the long term. This is particularly important in these policy-driven urban

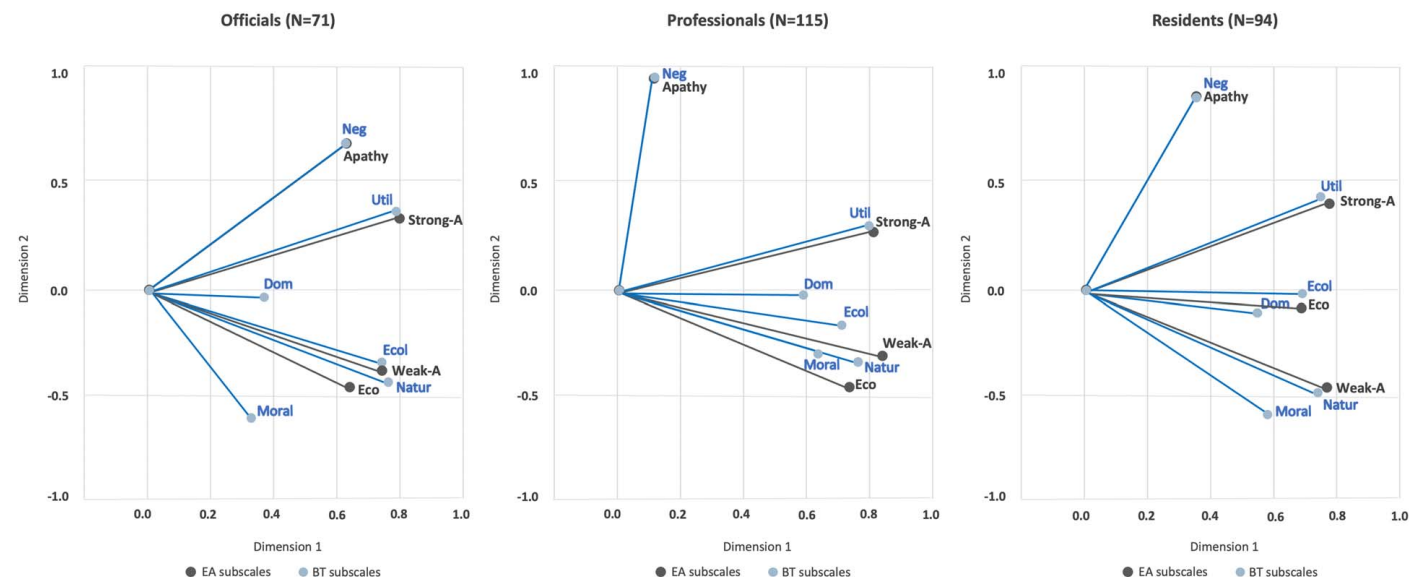


Fig. 4. Categorical principal component analysis variable principal normalization by subgroups.

fields, where the underlying motivations are of greater significance in creating communication and planning strategies that incorporate the desires of the different stakeholders. Urban and landscape professionals should therefore shift from their previous neglect (Parris et al. 2018) and pay more attention to the theoretical progress and practical applications of environmental ethics.

Second, by understanding the stakeholders' tendencies, decision-makers could use multiple communication strategies tailored to their desires to motivate proenvironmental actions and improve awareness. Since the public better recognized moralistic statements that were possibly influenced by the Chinese classic philosophy of *harmony of man and nature* that resonates in China's ecological civilization policies (Henning 2016; Wang et al. 2020), it makes sense to stress the importance of moralistic values while designing the policy messages to accelerate the process toward an ecological civilization, leading to greater gains with minimal effort. For instance, when framing the vision and positioning of policy actions or projects that are particularly ecological-civilization related, it might unite stakeholders more to emphasize the perspective of the moral duties to other species and the natural environment. Learning from this finding, the choice of the Whiteheadian process philosophy, which incorporates ecological civilization with Chinese classic philosophy well (Wang et al. 2020), is potentially shown to be a good choice in the sense that it is easier to reach a consensus in Chinese culture and society.

Third, the AEA scale could also inform planners and designers to better facilitate bottom-up participation from cradle to grave in the long course of planning, design, and management. Based on the results of this study, the naturalistic experience that promotes contact with nature and facilitates the nonmaterialized enjoyment of the natural space, such as psychological, mental health, aesthetics, and the like, would be best accepted by the stakeholders and should therefore be prioritized. This means that the planning, design, and management of the later phases of the ZJG Bay project could benefit significantly from research on the preferable naturalistic-oriented experience in ZJG Bay Eco-Park. By improving the sense of pleasure and increasing the possible uses of ZJG Bay Eco-Park, it would serve as a good alternative measure of environmental education provision and ecological civilization promotion. While places that rely more on volunteering from the bottom-up require consensus-building at the start and continuously throughout the process to make a project possible, evaluating attitudes is important for places like China to ensure long-term application and quality implementation.

Last but not least, in terms of long-term effects, ongoing environmental education about environmental knowledge and ecological civilization is highly necessary, particularly for government officials and residents. A better understanding of different attitudes, based on carefully designed education and publicity, can better facilitate bottom-up initiatives, ensure ongoing commitment and consensus, and foster spontaneous behaviors that reduce administrative costs. One of the more striking findings in this case study is the internal conflict of officials that was repeatedly revealed in the analysis. Such findings provide a good example that local governments and residents are made up of a complexity of different divisions and individuals that do not always share the same visions. Such complexity has been discussed in the theoretical debates in political ecology (Goldman et al. 2018; Roberts 2020). The internal conflict might be a result of suppressed waterfront development needs of the local officials, fish farmers, and semioperational port enterprise owners under the top-down state-imposed ecological civilization movements. Given the fact that the ZJG Bay Eco-Park project aims to restore the previously polluted environment, another possible explanation of such internal conflict might be due to the slow

response of the locals from shifting the previous polluting practices to the more proenvironment mindsets. The specific reasons for the uneven power dynamics involving knowing and managing UGIs among state governments, local governments, professionals, and residents are still yet to be exposed with the help of follow-up qualitative studies.

However, what we can derive from current findings are that some of the local officials who contributed to the success of phase one of the ZJG Bay Eco-Park project might not have the same level of commitment to the national policy of ecological civilization, but they still managed to get their job done under the Chinese leadership system. Without a doubt, government officials are more exposed to the national policy of ecological civilization than the public with a series of relevant policy documents and ecological-oriented projects similar to the ZJG Bay Eco-Park project. However, unlike residents and professionals who still appeal to relatively plain beliefs with moralistic orientations, officials seem to be scientifically objective, with a highly ecologicistic orientation, and somewhat indifferent, with a strong inclination toward strong environmental apathy. It seems that the existing ecological civilization education within the government system has spoken to sense but not to sensibility. This could be an alarming sign if internal resistance begins to gain momentum. In this sense, there are calls for immediate actions of bottom-up planning improvements and ongoing environmental education on important ecological issues to increase moral responsibility and make it possible for people to genuinely embrace the policy of ecological civilization that is currently imposed from the top down.

Conclusions

This study points out that environmental ethics and ecological civilization share the same theoretical roots in Whitehead's process philosophy and demonstrates the importance of the theoretical development of environmental ethics in urban-applied fields. With its increased diversity and specificity, it can provide detailed explanations of motivation to help raise awareness of ecological civilization and facilitate consensus building. Aligning with the theoretical progress in environmental ethics, the AEA scale adapted in this study is a more fine-grained tool for assessing environmental attitudes, with strong explanatory power and potential value when applied to UGI planning and management.

The implementation and findings of this adapted scale in the ZJG Bay Eco-Park project provide an excellent example. The stakeholders involved have similar environmental attitudes of weak-anthropocentrism with slight inclination differences toward strong-anthropocentrism across subgroups. Importantly, it also unveils the potential hidden conflicts in the internal values of the local officials who align with two different orientations of ecocentric and environmental apathy. In addition, the public is more sensitive to moralistic statements, and the naturalistic experience appeals to them the most. The internal conflicts among officials and the knowledge gap between professionals and residents require ongoing environmental education and policies to raise awareness of important ecological issues instead of simply imposing a policy of ecological civilization from the top down.

With its strong perspective explanation power, this AEA scale could be used to facilitate bottom-up stakeholder participation and a consensus-building process of crafting and communicating urban planning and management policies. Urban and landscape professionals could use this AEA scale early in UGI projects to better understand stakeholders' environmental value patterns and tailor their proposals and policies. This means that this scale can

inform actionable policy implications not only for the future phases of the ZJG Bay Eco-Park project but also universally for projects outside China.

There are several potential lines of further study to expand the knowledge and understanding of environmental ethic theories for use in UGI planning and management. First, building on the quantitative analysis of this study, follow-up qualitative studies such as interviews with the stakeholders of the ZJG Bay Eco-Park could provide more in-depth insights to explain the underlying reasons for their environmental attitudes and sources of internal confusion and conflicts. Second, since the ZJG Bay Eco-Park project is still in progress, it would benefit from a longitudinal study to determine the stakeholders' environmental attitudes and value changes over time to potentially understand the mutual impacts of implementing UGI projects like this one and to shape environmental attitudes and values toward an ecological civilization. Third, more comparative studies, such as across countries or sub-populations, could consolidate an expanded knowledge in this important field of study. Another potential for further study is inspired by a lesson learned while conducting this case study. This AEA scale is limited to 20 statements for easier practical implementation, which also reduces the number of Kellert's typologies involved. Further studies might consider making the AEA scale longer to include more Kellert's typologies to test and optimize the tool.

Data Availability Statement

All data, models, and codes generated or used during the study appear in the published article.

Acknowledgments

This project is funded by the University Research Centre for Urban and Environmental Studies of Xi'an Jiaotong-Liverpool University (UES-WJ-21032106) and Jing Lu's Marie Skłodowska-Curie Actions Grant No. 945139 (European Union's Horizon 2020 Research and Innovative Programme) as part of her dissertation process. The authors thank Fundación Tatiana Pérez de Guzmán el Bueno for their financial support, Susana Martín Fernández (Universidad Politécnica de Madrid) for all her help with the statistical analysis of this article, and the editor and two anonymous reviewers for their valuable comments and suggestions.

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Implementing the
UN Sustainable Development Goals –
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SDGs in the Asia and Pacific Region

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Implementing the UN Sustainable Development Goals – Regional Perspectives

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The process leading to the implementation of the UN Sustainable Development Goals (SDGs) has been negatively influenced by the COVID-19 pandemic. The health crisis as a whole, and its substantial socio-economic impacts in particular, have led to many setbacks. These vary from the emerging of competing priorities, to restrictions in the availability of financial resources needed to implement the SDGs. The extent of this problem may be better understood if it is considered that there are at present doubts, as to whether the SDGs may be reached by 2030. This state of affairs suggests that new - and innovative approaches - to support the implementation of the SDGs are needed. One of them is the support to regional implementation efforts across the various geographical regions, and the documentation and promotion of these experiences. It is also important to promote studies, research, projects and good practice, which illustrate how the SDGs may be implemented in practice. This series has a specific regional scope, tackling the SDGs in a way that it takes the particularities of each region into account.

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ISSN 2731-5576

ISSN 2731-5584 (electronic)

Implementing the UN Sustainable Development Goals – Regional Perspectives

ISBN 978-3-031-17462-9

ISBN 978-3-031-17463-6 (eBook)

<https://doi.org/10.1007/978-3-031-17463-6>

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“UN SDG Good Practice” in China: Ecological Restoration of the Zhangjiagang Bay

Yunqing Xu, Jing Lu, and Jinjian Zhu

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Abstract

Zhangjiagang Bay is the last bay before the Yangtze River enters the sea. Despite many polluting enterprises and breeding industries, the port is crucial to the Yangtze River’s transportation and Zhangjiagang City’s economy. Centered on

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W. Leal Filho et al. (eds.), *SDGs in the Asia and Pacific Region*, Implementing the UN Sustainable Development Goals – Regional Perspectives,

https://doi.org/10.1007/978-3-030-91262-8_103-1

the national strategy of “Great Protection of the Yangtze River” since 2019, a sum of 3.76 billion RMB has been invested in the removal of industries from the region, dike reconstruction, shoreline, and ecological restoration, aiming to build a 1.4 million m² waterfront hydrophilic landscape belt for the public. It then moves into the next phase of developing a series of “beautiful villages” via eco-parks, historic buildings, cultural and eco-tourism, and eco-agriculture. A critical discussion of its implementation will shed light on the difficult choices, continued investments, and collective and coordinated efforts by government departments, industries, and communities despite the influence of COVID-19 and competing priorities. Building on the theoretical concepts of environmental ethics and extending its application in educational fields, this study also provides an in-depth examination of the environmental attitudes of the main stakeholders of this nine-goal-achieving “UN SDG Good Practice,” which becomes increasingly important for this kind of urban green infrastructure that critically requires long-term cross-sectoral commitment, resources, and actions for sustained effects.

Keywords

UN SDGs’ implementation · Ecological civilization · Urban green infrastructure (UGI) · Best practices · Environmental attitude assessment · Landscape and urban planning

Introduction

Entering the last decade set to accelerate the 2030 Agenda for Sustainable Development, indicators have shown a slowing pace and widening gap with every passing year. According to the Economic and Social Commission for Asia and the Pacific (ESCAP 2022), the estimated year to achieve SDGs has been further extended from 2052 to 2065. Countries and regions have been facing continued human-induced and natural disasters, coinciding with the severe pandemic’s consequences since late 2019. Throughout the Asia and Pacific region, slow and even stagnant progress has been found across Goals 4, 5, 6, 8, 11, and 14. Moreover, regression in climate action (Goal 13) has been found in every Asia-Pacific subregion. Significant strain also lies in efforts toward the attainment of good health and well-being (Goal 3), including equal access to medical care and mental health problems caused by the imposition of social distancing and isolation (Farrell et al. 2020; Filho 2021). On the bright side, since the outbreak of COVID-19, there have been some positive environmental gains due to a significant reduction in carbon emissions with decreased travel, a reduced level of industrial and economic activities during the lockdowns, and subsequent fewer use of fossil fuels. There are also opportunities to restore urban natural spaces partially because of fewer visitors and a growing awareness and renewed interest in urban green infrastructures (UGIs) with evidence for both physical and mental health (Twohig-Bennett and Jones 2018). However, a significant barrier also lies in the

intensifying financial burden widely encountered by countries (Filho 2021) and the growing stress on generating and allocating resources for restoring economic development and protecting the environment. Therefore, it becomes timely and highly relevant to examine the factors and processes of project implementation, resource mobilization, and awareness consolidation.

Urban green infrastructures (UGIs), as part of a network of spaces and areas that connect the city with unaltered or slightly altered places, are essential to potentially contribute to conserving ecological biodiversity (Manzanera 2021). Numerous researchers have documented the ecosystem services of urban green infrastructure in carbon emission reduction, microclimate adjustments, and human welfare improvements (Mell 2017). For instance, greater exposure to green space is associated with a lower risk of type 2 diabetes, lower resting heart rate, and lower diastolic blood pressure (Twohig-Bennett and Jones 2018). There are also indications that exercising in a natural environment has additional benefits, including stress reduction, attention restoration, social interaction facilitation, a sense of community to prevent loneliness, and so on (Manzanera 2021). Therefore, UGIs play a growing important role in global biodiversity conservation, ecosystem services, and welfare provision (Aronson et al. 2017). However, although UGIs have long been integrated into the field of urban planning and design (Hansen et al. 2013), the conservation priority of UGI planning and design is often subject to social, cultural, and economic factors (Aronson et al. 2017), which is never an easy process to reach consensus. Mainly related to its large-scale nature that requires substantial investment, long periods of construction, and long-term maintenance, UGI projects often die prematurely or gradually fade out due to ineffective and unsustainable implementation or management in the long run (EPA 2022; Hagemann et al. 2020; Thorne et al. 2018; Zuniga-Teran et al. 2020). Besides securing financial resources and continued commitment, a pivotal step to lasting success also lies in environmental consensus-building rooted in the beliefs in environmental ethics and values (Parris et al. 2018). Hence, a good understanding of the environmental perspectives of diverse stakeholders at the earliest possible stage would be highly relevant and helpful.

Since the 17th National Congress of the Communist Party of China in 2007, the Chinese central government has been using the rhetorical label of "ecological civilization," centered on its environmental protection and ecological conservation commitment. Since then, several national and regional ecological-oriented mega-planning projects have been launched (Wang et al. 2020). Zhangjiagang Municipal Government, who oversees Zhangjiagang Bay as a critical part of the upper-level action plan of green infrastructure along the Yangtze River, initiated its strategic goal of ecological restoration along its 12 km coast and started the Zhangjiagang Bay Eco-park (hereinafter, ZJG Bay Eco-park) project, despite the fact that those traditional and polluting industries and uses have been crucial to the local economy. The scheme design of ZJG Bay Eco-park was started in June 2019, followed by the completion of the first phase of main construction by December 2020. 3.76 billion RMB has been invested to dike reconstruction, shoreline restoration, ecological restoration, road optimization, and landscaping improvement (Zhangjiagang

Municipal Government Office, 2019). In June 2021, it was declared by the UN Department of Economic and Social Affairs (UNDESA) as a UN SDG Good Practice, meeting in total nine SDGs in multiple fields related to health and well-being (Goal 3), environmental protection (Goal 6), carbon neutralization (Goal 13), social and economic equity (Goals 4, 8, 9, and 11), and ecological conservation (Goals 14 and 15) (United-Nations 2021). The review was made through a high-level panel committee composing over 20 UN departments, such as the UNDP, UNEP, UN-Habitat, FAO, and WTO, against a set of critical criteria including SDG-specific, results-focused, inclusiveness, accountability, sustainability, and replicability.

The practice of Zhangjiagang Bay provides a pertinent reference for green and low-carbon development and ecological civilization that allows for living well within the environmental limits in the lower reaches of the Yangtze River and other industrial wharf areas worldwide. Moreover, besides its multi-dimensional manifestations of sustainable development, it is also highly relevant to examine the difficult choices, continued investments, and collective and coordinated efforts being made by government departments, industries, and communities in coincidence with the rapid development of stress and competing priorities under the influence of COVID-19. It is also worth noting that being an ongoing project firmly entering into its second phase, it also requires tremendous continuity and consensus in the daily and operational levels of business, where underlying environmental attitudes become relevant for long-term effects. Building on the theoretical concepts of environmental ethics and its extended application in educational fields, this chapter also provides an in-depth examination of the environmental attitudes of the main stakeholders of the nine-goal-achieving “UN SDG Good Practice” discussed in this chapter. It explores the explanatory power of urban green infrastructure projects, which critically require long-term cross-sectoral commitment, resources, and actions for sustained effects. It sheds light on a more explicit understanding of environmental awareness and its implications in consensus-building and behavior-shaping.

China’s National Strategies and Drive for Environmental Protection

Since its opening up in 1978, China has been firmly committed to economic growth and has made tremendous progress in modernization, following a more scientific way of thinking (Wang et al. 2020). However, with the growing concerns intensified by the environmental consequences and social problems of growth, there emerged a revival of traditional Chinese thinking, especially with the seeds of “harmony of man and nature” (*Tianren Heyi* in Chinese). In 2004, the concept of “building a socialist harmonious society” was first put forward at the Fourth Plenary Session of the 16th Central Committee of China, after which it has become a strategic goal of social development referring to a social state in which all walks of life work together (China-Daily 2010). Further, since the 17th National Congress of the Communist Party of China in 2007, the Chinese central government has been using the rhetorical

label of "ecological civilization" (Wang et al. 2020). As a top-level design for fundamental reforms toward an environment-friendly, resource-saving, and ecology-prioritized path, it aims to form a new pattern of modernization emphasizing the harmonious development of man and nature, in keeping with the essence of sustainable development. The term "ecological civilization," Western-influenced but nevertheless Chinese resonant philosophy and traditional culture, is now widely acknowledged and presented in both government and research circles in China.

Noteworthy, the environmental philosophical roots of the concept of "ecological civilization" are recognized as process philosophy, which is also credited as the source of environmental ethics (Henning 2016; Wang et al. 2020). The late philosopher and mathematician Alfred North Whitehead's thought of process philosophy has been helping the Chinese revive and incorporate classical Chinese thought in its ecological dimension to build an ecological civilization, without conflicting with China's significant scientific advances. Whitehead called his thought "the philosophy of organism," emphasizing that organisms are inherently involved in their environments, which constitute the systematic unity in the notions of process and becoming, whereas mechanisms are indifferent to their context (Henning 2016; Wang et al. 2020; Whitehead et al. 1978). Many concepts later became central to environmental thoughts, such as the centrality of constitutive interdependence, the recognition of the intrinsic value of reality, the emphasis on the significance of the environment, and the referencing of the metaphor of organism over mechanism (Henning 2016). It not only provides a theoretical foundation for Chinese intellectuals to move from the celebrated achievement of "modernism" in Chinese society to a more cutting-edge thought on European "postmodernism" but also fulfills the Chinese government's dual commitment to ecological civilization and scientific ways of thinking. It joins the cultural treasures of classical Chinese wisdom with China's environmental movement, and Whitehead's thought has been welcomed in China to clarify and support the commitment to ecological civilization, which is strongly re-emphasized by President Xi (Wang et al. 2020).

Since 2007, these national commitments have manifested in government policies at all levels, including the commitment to large-scale environmental projects, and substantial new research institutions and academic researches on ecological civilization (Wu and Wallace 2014). In 2012, the Communist Party has formally written the goal of becoming an ecological civilization into its Constitution, the mother of all laws in China. One signifying ecological-oriented national strategic plan is the "Great Protection of the Yangtze River" put forward in 2016, emphasizing the dominance of the overall protection and value of environmental economics. Soon after this, the Yangtze River Economic Zone Ecological Protection Plan was jointly released by the Ministry of Environmental Protection, National Development and Reform Commission, and Ministry of Water Resources in July 2017, pushing forward the guidelines for the protection and restoration of the Yangtze River (Ministry of Ecology and Environment 2018). The Yangtze River Economic Belt covers an area of 2.05 billion square kilometers, including 11 provinces and chartered cities, contributing over 40% of China's overall population and GDP (Ministry of Ecology and Environment 2017). To achieve the goals of maintaining

a harmonious, healthy, clean, beautiful, and safe Yangtze River, not only technical advancement and measures in water resources protection, pollution mitigation, and ecological restoration were proposed, but also institutional innovation including environmental monitoring, risk management, and regional cooperation and coordination mechanism of the ecological conservation should be ensured, although the latter is arguably much more challenging to implement and maintain at all levels but has a critical and longer-term effect on achieving sustainable development goals (SDGs).

The most recent 14th Five-Year Plan (FYP) (2021–2025), known as the outline of overall and long-term national economic and social development, has further set China on a solid path to achieving the SDGs and meeting the Paris Agreement (UNDP 2021). Notably, this plan has been the first 5-year plan which has yet to set an explicit GDP growth target, providing critical space and flexibility for the country to pursue other targets, including higher quality and sustainable development (UNDP 2021). Following President Xi's announcement of China's goal to reach the carbon peak by 2030 and carbon neutrality by 2060 at the 75th UN General Assembly in September 2020 (Xinhua 2020b), the 14th FYP presents cross-cutting and recurrent themes on green development and innovation and prioritizes front-loaded actions to realize the low-carbon transformation and to ensure consistency between China's climate pledges and its development vision. This has created a fairly consistent and more favorable environment for directing attention, resources, and efforts toward sustainability; nevertheless, considerable uncertainty and challenges remain alarming. For instance, total emissions consistent with a 1.5 °C warming path would require the GDP annual growth rate to be kept below 4.2%, against the current rate of approximately 5% (He 2020). Secondly, there remains a lack of clear indicators for reducing the "absolute" level of emissions at the speed and rigor required to meet the double carbon targets, despite a heavy reliance on relative tools of limiting per capita energy consumption and carbon intensity (UNDP 2021). Thirdly, much-needed resources are yet to be channeled toward SDGs, which critically require a more holistic approach for managing government budgets and effective creation of the financial space for investments or attracting investments in the key areas to support low-carbon pathways, which however has shadowed by the impacts of the pandemic. The mixture of consolidated commitment, ambitious goals, uncertain variables, and immense challenges under competing priorities, resources, and tools presents substantial constraints for implementing China's green vision, which is of high importance to the country and the world. It is thus also of pragmatic implications to scrutinize the process and factors of real practices in this complex and dynamic context.

This chapter focuses on a large-scale ecological restoration project – Zhangjiagang Bay – which is a main green infrastructure project under the abovementioned "Great Protection of Yangtze River" strategy. It investigates the main steps, factors, relations, and changes from the initiation, planning, implementation, and continuity of the project and its critical governmental and social contexts. It concerns how the top-down campaign to implement an ecological civilization and achieve SDGs is translated into real projects at the local level, as well as how the

resources, expertise, consensus, and institutional mechanism have been built through carrying out this multi-dimensional project. In addition, an evaluation of environmental attitudes has been conducted to examine to what extent ecological civilization and environmental protection have been adopted by various stakeholders, from decision-makers, implementors, and professionals to the general public. This will not only present explicit findings on underlying preferences and improve the suitability of assessment tools but also provide a valuable pre-step for understanding and influencing behavioral change, which is critical for bottom-up initiatives and sustained effects of such complex and long-term projects.

Zhangjiagang Local Initiatives and Project Implementation

The Background and Initiation of the ZJG Bay Eco-Park Project

As an important international trade port in the Yangtze River Basin, the Zhangjiagang port area mainly serves the material transportation of the Yangtze River and the port industry development in Zhangjiagang City (Suzhou Transport Bureau 2022). It has 146 berths, 72 of which have a capacity above 10,000 tons. The port has complete functions and can handle different goods such as containers, timber, steel, grain and oil, the chemical industry, coal, ore, total vehicles, and groceries. Zhangjiagang Bay critically locates in the delta region where the East China Sea meets the Yangtze River. With its strategic location, the port of Zhangjiagang Bay is vital to the transport and economy of the city, even though it also houses a lot of polluting enterprises and breeding industries. The local government chose the latter between keeping the existing port area and restoring the ecology. A critical catalyst has been related to the talk by Xi Jinping promoting the "Great Protection of Yangtze River" in 2016 when he stressed at a symposium in Chongqing that "At present and for a long time to come, we should give overwhelming priority to restoring the ecological environment of the Yangtze River, and work together to protect and avoid large-scale development" (Xinhua 2020a). This prioritized the protection over development, becoming an essential prelude to introducing the Yangtze River Protection Law on 26 December 2020. This Law not only provided an overarching goal and framework of work on ecological protection and green development but also stipulated the national coordination of institutions, mechanisms, and the responsible relevant riverside governments at provincial and city levels.

In line with this general direction and the introduction of the Action Plan for Yangtze River Protection at the national level in January 2019, two local action plans are soon to be prepared by Zhangjiagang Municipal Government, including the *Three-Year Action Plan for Transformation and Development of Zhangjiagang Riverside Economic Belt* (2019–2021), *Three-Year Action Plan to Fight a Tough Battle of Pollution Prevention and Control*, and *Build an "Ecologically-Upgraded Version of the Port City"* (2019–2021). These plans emphasized two related objectives, i.e., one on the economic and industrial transformation and the other on the

ecological improvement of Zhangjiagang Bay. However, it is worth noting that in addition to the requirements of the top-down institutions that speeded up the active local response and promotion of environmental projects, the actions of local leaders are also backed by the long-overdue provision of the scenic viewpoints and recreational opportunities for the locals along the Bay. Before the restoration of the ZJG Bay Eco-park, residents faced the long-standing problem of “not being able to see the river despite living by the river and not able to have hydrophilic activities despite being close to water” (“*Linjiang bujian jiang, Jinshui nan qinshui*”), mainly due to the severe pollution surrounded by fishing farms, manufacturing factories, and industrial docks.

Thus, the local municipality of Zhangjiagang actively put forward a mega-UGI project with the aim of “killing two birds with one stone”: namely, on the one hand, to restore the coastline of Zhangjiagang Bay to meet the paramount goal of Yangtze River Protection and explore a path of green development and, on the other hand, to take this opportunity to return the coastline to the locals, which they have been working on over a decade. The beginning of such efforts dates back to 2010 when the local government started to clean up enterprises and unapproved construction and ban docks. The political task and top-down priorities have played an accelerating role in building consensus and removing barriers and provided an opportunity to align the project with Zhangjiagang municipality’s local agenda of public amenity provision and expand into a much larger-scale and more comprehensive project with multiple steps.

The Implementation of the ZJG Bay Eco-Park Project

The introduction of the *2019 Action Plan for Yangtze River Protection and Restoration* has both urged and provided a critical foundation for implementing the plan. Zhangjiagang Municipal Government set up several interlinked local policies and procedures (Table 1) on this project (still ongoing at the time of writing this chapter) and started leading the enforcement of the project with three identified main goals: firstly, to convert the industrial land along the river into ecological land to realize industrial retreat and restore the river shoreline and, meanwhile, to restore the wetland along the river and to purify the water while implementing the 10-year fishing ban; secondly, to adopt low-impact development, build high-standard dikes and ecological landscaping, restrict commercial development, and recover the ecosystem; and thirdly, to integrate local cultural features and further-improved ecological environment in Xiang Hill and Shuanshan Island to guide villages to carry out a variety of green development initiatives, such as eco-tourism and modern agriculture, and enhance the public awareness of the ecological environment (Fig. 1).

Under this framework, the detailed scheme design was started in June 2019, which provided specific guidance for completing the main part of construction by December 2020. A total of 3.76 billion RMB is invested, composed of two major steps. Firstly, 1.49 billion RMB was funded by the municipal government and town government (Free Trade Zone), focusing on evacuating polluting industries, wharf

Table 1 Main plans and policies at national and local levels

Level	Time	Document	Highlights
National level	4 Jan 2016	2016 symposium chaired by xi Jinping of promoting the development of Yangtze River Economic Belt	Prioritize ecological conservation and boost green development Promote the high-quality development of the Yangtze River Economic Belt
	7 Jan 2017	Yangtze River Economic Belt ecological environment protection plan	Set the planning goals of maintaining a harmonious, healthy, clean, beautiful, and safe Yangtze River
	31 Dec 2018	Three-Year Action Plan for Transformation and Development of Zhangjiagang Riverside Economic Belt (2019–2021)	By the end of 2020, 85% of the water quality of Yangtze River should be class III or above, and less than 2% of the water in Yangtze River shall be below class IV (non-functioning water) By the end of 2020, more than 90% of dark-colored, smelly water within municipal administration shall be eliminated, and over 97% of the centralized drinking water source shall be above class III water quality
Local level	June 2019	Zhangjiagang Bay concept plan	Convert the industrial land along the river into ecological land Adopt low-impact development and build high-standard dike and ecological landscaping
	13 Dec 2019	Action Plan for Yangtze River Protection and Restoration (2019–2020)	Integrate local cultural features and improve the ecological environment in Xiang Hill and Shuanshan Island
	13 Dec 2019	The implementation plan of Yangtze River arterial waterway fishing ban and the compensation scheme for fishermen in Zhangjiagang City	Implement the fishing ban regulation along the arterial waterway within the administration of Zhangjiagang Municipal Government Compensate for the fishermen involved
	12 Jan 2020	2020 Zhangjiagang municipal working priorities in promoting Yangtze River Economic Belt	Prioritize Yangtze River ecological environment Correct previous practices that cause ecological and environmental problems Accelerate industrial upgrading and transformation to focus on green economy
	3 Nov 2021	Notice of Zhangjiagang 14th five-year plan on water Resources	Create a Yangtze River ecological restoration corridor by

(continued)

Table 1 (continued)

Level	Time	Document	Highlights
			incorporating the ZJG Bay eco-park Align with the protection and development of ZJG Bay eco-park and promote water culture icon into the Zhangjiagang Yangtze River art and culture festival
	Ongoing	Zhangjiagang Bay waterfront ecological conservation plan	Form an integrated riverfront ecological structure Optimize riverfront land use Set aside ecological corridor Actively restore the ecological environment Construct transport and other infrastructure

Source: Open resources of Chinese government documents



Fig. 1 Master plan for ZJG Bay Eco-park © with permission of Zhangjiagang Bay Management Office to adapt these maps from Chinese to English and use them in the chapter

cleaning, and ecological renovation of the total 12 km coastline, among which 9 km has been returned from industrial production to ecological space. Secondly, a further government fund of 2.27 billion RMB was invested in ecological enhancement (with future environmental premium and new industries to supplement later), including five key projects such as a once-in-a-century river embankment reconstruction and upgrading project; the environmental improvement and upgrading project outside the river embankment; the cleaning, renovation, and restoration project of Haihong marine engineering shipyard; the comprehensive improvement project of the

environment (including roads and villages) inside the river embankment; and the repair project of Zhanggao Road (Zhangjiagang Municipal Government Office, 2019). Integrating dike reconstruction, shoreline restoration, ecological restoration, road optimization, and landscape improvement, it builds a 1.4 million m² waterfront hydrophilic landscape belt.

Gaining the full support of the municipal Party committee and the municipal government, a special leading group was established to ensure comprehensive but efficient enforcement and coordination. The main leaders of the municipal Party committee and the municipal government serve as the team leader, and the relevant municipal leaders and leaders of the Free Trade Zone shall serve as the deputy team leader. A regular work consultation mechanism has been established, including meetings on specific topics every half a month with the presence of main leaders. The leading group consists of front-line headquarters, four implementing groups, and five engineering groups with designated roles and tasks to ensure cooperation where needed and steady progress of the overall project. Besides, based on the ecological protection of adjacent Shuanshan Island since 2010, surrounding villages in the region, such as Yongxing Village, have also actively taken the opportunity of the environmental changes and government subsidy policies by building ecological parks, conserving historic houses, and creating new jobs, starting to bring prosperity to villagers with cultural and eco-tourism (Table 2).

Notably, thanks to the foundation work, including port cleaning-up and field studies before carrying out the project, potential socioeconomic impacts and professional planning were quickly verified. Since July 2010, the illegal occupation, construction, and land use of the Yangtze River beach have been intensively rectified. Eight wharves have been banned, and low-efficient uses (houses, storage yards, and enterprise uses) have been rectified (United-Nations 2021). From July 2019, nearly 26 high-polluting fishing farms and semi-operational port enterprises were removed with agreed compensation based on specified standards, limiting negative impacts on employees. Communication was made, and consensus has also been widely built, shaping a firm adherence supported by formal plans. Meanwhile, some industrial and port infrastructures were also deliberately retained as industrial heritage. For instance, the previously abandoned maritime waterway sign and lighthouse were transformed into a sculpture in the shape of a "fish basket," not only saving reconstruction costs but also adding a new landmark to Zhangjiagang in both daytime and night with colorful sky lights (Fig. 2).

Moreover, since the project was implemented, the local government work reports and policy documents have continuously addressed the status and progress of the project, reflecting its relevance to the local agenda, providing phased priorities from restoration construction to normalized operation and further to quality advancement including ecological enhancing and cultural excavation (Table 3). In addition to formal institutions, cultural activities and public engagement have also been underway. Since 2004, the Yangtze River Culture Festival has been held annually for almost two decades, dedicated to promoting the cultural exchange of cities along the Yangtze River (China-Daily 2018). Among the activities, the Ecological Yangtze River-Zhangjiagang Bay Summit gathered experts and scholars to exchange

Table 2 ZJG project milestones by main stakeholders

Time	Milestones		Stakeholders and responsibilities
Jun 2019	The first-phase plan and design started		Mobilize funding: Zhangjiagang municipal government, Zhangjiagang free trade zone, and state-owned enterprises Prepare concept plan and design: Zhangjiagang natural Resources and planning Bureau
Sep 2019–Dec 2020	The first-phase construction started	Step A: Remove polluting industrial uses and restore the dam and coastline	Industrial removal and compensation arrangement: Zhangjiagang free trade zone Enterprise Service Bureau Construction: Tongzhou Shaxi waterway company
		Step B: Improve ecological and landscape environment	Management and operation: Zhangjiagang Bay administration and Zhangjiagang ecological development ltd.
Jan 2021-	The second-phase started		Prepare ZJG Bay characteristic villages plan: Zhangjiagang natural Resources and planning Bureau Implement and revitalize villages in an ecological-oriented tourism fashion to foster the green economy: Chaonan Village, Yongxin Village, and Beiyin Village

Source: Zhangjiagang Municipal Government Office



Fig. 2 Bay view with the “fish basket” and transformed industries © with permission of Mr. Pincai Fan to use this photo in the chapter

Table 3 Local government reports on priority and progress of ZJG Bay project

Time	Document	Highlights
20 Jan 2020	2020 Zhangjiagang municipal government work report	Upgrade Yangtze River environmental protection actions Complete Yangtze River Waterfront ecological protection plan, Zhangjiagang Bay concept plan and design, and Tongzhousha Jiangxin Island wetland master plan Promote the pilot tests on Yangtze River Economic Belt territorial land use regulation and correction
6 Jan 2021	2021 Zhangjiagang municipal government work report	Perform high-quality management of Zhangjiagang Bay Start the three-year action plan of the Zhangjiagang Bay Characteristic Village plan
7 Jan 2022	2022 Zhangjiagang municipal government work report	Promote the sustainable and normalized management and operation of the Zhangjiagang Bay

Source: Zhangjiagang Municipal Government Office

research inputs and suggestions on the great protection of the Yangtze River, promotion of industrial transformation, cultural tourism branding, refinement of ecological culture contained in traditional Chinese culture, and so on. All these have been imperceptibly raising environmental awareness and social publicity, making the annual festival a unique cultural brand for wider attention and influence. It was also accompanied by follow-up plans for the project to enhance its ecological value. When writing this chapter, a Zhangjiagang Riverside Ecological Protection Plan is being prepared, composing a five-aspect program that focuses on forming a large regional ecological structure based on a systematic investigation of the ecological value and influencing factors (Zhangjiagang Natural Resources and Planning Bureau 2021).

Coincidentally, soon after the project was initiated, COVID-19 emerged in China. The Zhangjiagang Bay project's ecological engineering departments immediately responded and managed to attain a zero-infection zone for the site. Construction workers commuted to the site in batches with special vehicles, and the health status of the workers and hygiene of the site were taken special care of and were well monitored. Meanwhile, the project management was well coordinated through the advance order of construction materials and the timely supply of materials with governmental transportation assistance. To ensure such highly efficient coordination among different sectors, an information exchange system was established to report the issues and progress regularly. After the project officially resumed in February 2020, the work was back at full speed, and the first-phase main project was successfully completed per the original plan within 4 months. Thus, there were no adverse impacts on the project's progress without any delay in the end.

The Accomplishments and the Next Step Forward

As an ongoing project with more long-term effects to be developed and monitored, positive results have started to be manifested despite the impacts of COVID-19. With evident changes before and after, the project achieved its original aims of restoring the ecological environment, creating a lively and biodiverse Yangtze River Estuary, and improving drinking water safety. Taking the mountains, rivers, forests, fields, and lakes along the river as an organic whole, the integrated application strategy of ecological technologies such as windbreak forest planting and ecological wetland construction was adopted to realize stormwater management, water purification and utilization, and water conservation. So far, over 36 ha of wetlands and green spaces have been restored, and more than 200 mu of beach on the north side of Laosha Wharf has been leveled and afforested, mainly planting over 3000 trees, including pond fir, metasequoia, Mexican larch, and so on. With the previous production coastline being transformed into an ecological coastline, some endangered species both on land and underwater have been observed again, including reed parrotbill, known as “giant panda in bird,” and Yangtze finless porpoise, known as “giant panda in water” (Fig. 3).

As part of the project was to convert the previous industrial brownfields into green spaces, the industrial heritage of local enterprises was also carefully preserved



Fig. 3 Observed protected animals after the ecological restoration © with permission of Mr. Guozhong Xu, Mr. Yongxiang Wang, and Mr. Minjun Zhou to use photos in the chapter

through recycling the industrial waste of steel and sculpturing it into a landscape landmark with 3D printing technology. By doing so, this newly built Zhangjiagang Bay Eco-park, now accessible to all, offers ecological scenery and captured industrial memory to provide a rich experience of ecology and heritage together. Further, with the much-improved infrastructure under low-impact development, local villagers practiced leisure agriculture and culture tourism with continuous water and soil quality monitoring. The project has also started showing demonstration effects. According to the Free Trade Zone government, some 100 batches of government visits and inspections have been received monthly, totaling 590 batches from June to December 2020 (Fig. 4).

Following the UN 2030 Agenda, the first-phase practice of ZJG Bay provides a pertinent reference for ecological civilization, which was listed as one of the UN SDG Good Practices in 2021, recognizing its broad contribution to a total of nine SDGs including health and well-being (SDG 3), carbon neutralization (SDG 13), social and economic equity (SDGs 4, 8, 9, and 11), environmental protection (SDG 6), and ecological conservation (SDGs 14 and 15) (United-Nations 2021). In addition, ZJG Bay Eco-park has also been recognized as one of the political innovations and best practices of the Yangtze River Delta (Yangtze River Delta Committee 2021). This recognition of its first-phase development anticipates a series of follow-up plans and policies (Table 3) and development centralized in the nearby villages to revitalize in an eco-friendly fashion with a clear intention toward ecological-oriented and watertown culture tourism development, which celebrates the recreational value of the park and orients toward weak anthropocentrism in the environmental attitude spectrum (Zhangjiagang Municipal Government 2021).

Environmental Attitudes, Motivations, and Sustainability

Significance of Environmental Attitudes

Decisions are made based on values and behaviors rooted in people's perceptions. At the same time, different environmental attitudes can, sometimes unconsciously, result in variations in motivations and choices of conservation behavior. For instance, those who are more ecocentric are more likely to act on their pro-environmental attitudes and engage in conserving behaviors, with typical examples as environmental organizations (Kopnina and Cocis 2017). Those who are more anthropocentric may be keener to act based on the pragmatic and utility value of environmental actions from the perspective of humankind (Zuniga-Teran et al. 2020). Not intentionally revealing the underlying environmental, ethical values to either anthropocentric or ecocentric perspectives may result in unconsciously promoting one perspective over another (Kortenkamp and Moore 2001), which could be influential to the real project in specific areas with conflicting interests primarily in the long run. Therefore, it brings valuable insights by uplifting such environmental value distinctions to the conscious and explicit level in practical arenas where environmental behaviors constantly take place and involve many people. As urban



Fig. 4 Before and after comparison of the first-phase construction of ZJG Bay Eco-park© with permission of Zhangjiagang Bay Management Office and Mr. Pincai Fan to use photos in the chapter

green infrastructure (UGI) requires long-term environmental commitment and problem-solving in a complex environment and stages of planning, design, enforcement, and operation, examining the environmental attitudes can help reveal the

underlying motivations of various stakeholders and potential influences on the success of the project.

The ZJG project has been initiated and implemented with strong adherence to the environmental value, professional planning with connected objectives, and collective efforts of government, industries, professionals, and the public despite the considerable investment and other practical challenges throughout the difficult period. Consultation, consensus, and coordination need to be obtained with diverse fishing farms, semi-operational port enterprises, villages, local grassroots volunteer groups, professional planners, construction companies, and government officials of different sectors and departments involved. A deeper understanding of environmental attitudes could contribute to unveiling critical and underlying perceptions of its initial and remarkable achievements and further summarizing the essential factors of success at both constitutional and operational levels. It can help examine to what extent the perspectives of multiple stakeholders align with the central government's standing on the ecocentrism-anthropocentrism spectrum, as well as its role and potential implications on the project. This will be built on the methods and findings of previous studies in the realm of environmental education and outdoor conservation program promotion (Chang et al. 2011; Cocks and Simpson 2015; Thompson and Barton 1994) and further extends its application and explanation power to UGI in the urban and sustainability context.

Moreover, the project now enters the second phase, which requires tremendous efforts to implement in a complex and dynamic process. However, it has no guarantee of long-term sustainable success despite its recognition as UN SDG Good Practice, which reaffirms its confidence and probably motivation in pro-environmental actions. Thus, it also presents a fleeting opportunity to understand the environmental perspectives at this very moment and shed light on the noteworthy areas that have potential to influence actions in later stages. Authors believe that earlier conscious understanding and evaluation of underlying attitudes can help craft tailored messages for sectors with different environmental perspectives and establish a shared consensus among constant conflicts between growth and protection over time, facilitating more constructive behaviors, careful maintenance, and long-term sustainable successes (Zuniga-Teran et al. 2020). Therefore, this study takes steps further and sets itself apart from the previous research, mostly evaluating attitudes as an after fact (Chang et al. 2011; Luo and Deng 2008). It conducts the investigation at earlier stages that shape the implementation process (Parris et al. 2018) and thus looks into its potential to monitor and exercise influence in consensus-building along with project continuity.

Evaluation of Environmental Attitudes

The practical values of environmental ethics and theoretic classifications have been established in research for quite some time (Chang et al. 2011; Cocks and Simpson 2015; Thompson and Barton 1994) through developing a variety of measuring scales to assess environmental attitudes since the 1970s (Dunlap and Van Liere 1978;

Maloney and Ward 1973; Weigel and Weigel 1978). To better explain the strong links between attitudes and actions, Thompson and Barton (1994) operationalized the Ecocentric and Anthropocentric Attitudes toward the Environment scale (hereinafter, EA scale). They found out that ecocentric attitudes were significant predictors of both self-reported and observed behaviors. Along with theoretic progress in environmental ethics, researchers continuously specify the typologies in environmental perspectives (Callicott 1992; Kellert 1996; Norton 1984, 1995). Inspired by Kellert's environmental value typology (Diehm 2012; Kellert 1996, 2008; Wilson 1984), Delavari-Edalat and Abdi (2010) developed the Biophilia Tendency scale (hereinafter, BT scale) and pinpointed environmental typological orientation differences of Asia and White British in an urban park in the UK.

With the aim of better reflecting recent theoretic advances and societal changes, the authors further specify the strong anthropocentric and weak anthropocentric viewpoints in the EA scale in accordance with the definitions outlined in Cocks and Simons' study (2015). The strong anthropocentrism perspective takes the nonhuman environment as a commodity or a mere object of use. In contrast, the weak anthropocentrism perspective measures the natural environment by its value to human beings, but the value is significantly expanded beyond the commodities linked with strong anthropocentrism (Cocks and Simpson 2015). Further, the authors incorporate adapted statements from the BT scale, specifically ecologicistic and moralistic tendencies, to form an adapted EA scale that would simultaneously assess the stakeholders' attitudes in both EA scales and six Kellert's typologies of utilitarian, negativistic, dominionistic, moralistic, naturalistic, and ecologicistic (Kellert 1996). For utilitarian individuals, they are interested in the utilization of the species, while negativistic groups fear or feel indifferent toward the species, and dominionistic people take an interest in the mastery and control of other species. Moving a bit toward the ecocentrism end, moralistic individuals oppose cruelty and harm toward the species, naturalistic people are attracted to outdoor recreational engagement with the species, and ecologicistic ones take an interest in the ecological value of the natural environment and the species. Hence, this adapted EA scale is referred to as the AEA scale in this study, which contains five selected statements for each sub-category of ecocentrism, weak anthropocentrism, strong anthropocentrism, and environmental apathy. Meanwhile, these 20 statements also completely cover the abovementioned 6 Kellert's typologies. In this way, this adapted AEA scale is equipped to assess both EA and BT scales simultaneously.

The AEA scale questionnaire was released from the platform of WJX (<https://www.wjx.cn/libt/10122.aspx>) – the online questionnaire platform widely used in China – to the stakeholders listed in Table 4. The online survey enables efficient, accurate, and cost-saving data collection of responses, especially during the uncertainty and inconvenience of travel impacts under COVID-19. It received 272 valid responses within a week in mid-October 2021. All collected data were imported in SPSS for validity and reliability of the adapted scale and mean and cross-sub-scale partial correlation analysis by types of stakeholders.

Table 4 Questionnaire participants

Stakeholders	Numbers	Proportions	Roles	Specifications
Local officials	71	26.1%	Project initiator	Municipal mayor offices, natural resources and planning bureau, environmental protection bureau, village committees, etc.
Professionals	107	39.3%	Project implementer	Urban planners, landscape architects and engineers, the local volunteer groups, and constructors and managers
Citizens and industries	94	34.6%	Project participant and/or visitor	The villagers and middle school students closer by, the fishing farmers and enterprise owners, and employees who used to make their living with ZJG Bay before the establishment of the eco-park

Findings on Attitudes and Challenges for the New Stage

This adapted survey instrument was generally reliable as the alpha values were 0.76 for all variables and with good validity with KMO and Bartlett’s test to be 0.81 ($p < 0.01$). There also observed an overall tendency of the project stakeholders of ZJG Bay Eco-park coherent with the weak anthropocentric orientation, with a mean value of all participants as 1.33, much lower than the other three tendencies in the AEA scale. Despite lacking the survey results before the first-phase implementation of the ZJG Bay Eco-park project, we could infer from the changes to the previous strong anthropocentric uses of the ZJG Bay, for instance, fishing farming, polluting enterprises, breeding industries, and the like, that there present possibilities that the general environmental attitudes of the stakeholders have shifted from strong anthropocentric to weak anthropocentric. From Table 5, we can also see a high intensity of the park uses, with 56.62% of the stakeholders’ visiting at least once per month and 60.29% staying over an hour for each visit, demonstrating a solid acceptance of this ZJG Bay Eco-park. That is to say, one of the initial objectives of “returning the ZJG Bay to the residents” has been fulfilled.

Taking a closer look, it also demonstrated an interestingly decreasing trend in ecocentric orientation from officials and professionals to residents, where officials top in the ecologicistic orientation, professionals outweigh the other two groups in naturalistic tendency, and residents scored highest in dominionistic, utilitarian, and negativistic sub-scales. This pattern, to some extent, reflected the top-down influence of the ecological civilization policy adhering to SDGs from within the government administrative system to the general public. However, it doesn’t mean they were all coherent within the sub-groups. There presented rich diversity among sub-groups in terms of the ecocentric-anthropocentric orientations. For instance, officials with either ecocentric or strong anthropocentric viewpoints also appealed to environmental apathy statements, even though the general orientation of officials was ecocentrism. It was fascinating that local ZJG Bay Eco-park project officials were

Table 5 Participants' visit frequency and duration per visit to ZJG Bay Eco-park

Visit frequency	Percentage (%)	Stay duration	Percentage (%)
None	4.41%	Less than half an hour	9.56%
Less than five times	38.97%	Half an hour or above, less than 1 hour	30.15%
Once or twice a month	25.37%	1 hour or above, less than 4 hours	45.22%
Once or twice a week	11.40%	4 hours and above	15.07%
Every day or every other day	19.85%		

possibly experiencing internal conflicts in environmental orientations – two distinctive values of ecocentrism and environmental apathy appeal to them. In other words, some of the local officials who had contributed to the success of the first phase of the ZJG Bay Eco-park project may not have been with the same level of commitment to the national policy of ecological civilization, but they, however, still managed to get their job done. Another noteworthy finding was the sharp contrast between professionals and the residents that the professionals' choices, though very diverse in nature, highly correlated to the definitions of these tendencies in both sub-scales; however, residents were more sensitive to moralistic statements despite having the lowest means toward ecocentric attitudes. The potential answer to this contradictory pattern lies in the environmental knowledge gaps between professionals and residents, demonstrating the importance of environmental education and subject knowledge in sustainability and ecological civilization.

This finding waves a red flag to the plan and implementation of the future phases of the ZJG Bay Eco-park project, where internal conflicts, particularly relevant to the local officials, should be taken good care of to ensure long-term success and adherence to the UN SDGs. Potential measures are multiple. To start with, building on the quantitative analysis of this study, follow-up qualitative studies such as interviews with the stakeholders of ZJG Bay Eco-park can provide more in-depth insights to explain the underlying reasons for their environmental attitudes and sources of internal confusion and conflicts. In addition, bottom-up planning improvements and continuous environmental education should be conducted to facilitate genuine embracement and consensus-building toward the currently largely top-down imposed policy of ecological civilization.

Interestingly enough, given that the public has a stronger appeal to the moralistic statements, they tend to be compassionate to other lifeforms and thus well align with the promotion of ecological civilization that celebrates humans and nature are in one. Resorting back to the classic thinking of ancient China in the definition of ecological civilization may have been proven to be a smart move shining with Chinese wisdom. Consequently, it guides the follow-up phases in tailoring the planning and design goals and crafting the communication messages to make life easier for the public to understand and embrace the ecological conservation and the green economy shift for the greater good of Zhangjiagang Bay. It also goes beyond the scope of Zhangjiagang Bay to the entire Yangtze River Economic Belt at the national level.

The culturally resonant phrase of ecological civilization also helps level barriers for China to achieve SDGs and fulfill its ambitious green commitment at a time when a smooth consensus could be reached.

Conclusion

Project Success Factors and Implications of Environmental Attitudes

In all, the firm implementation and steady progress of this nine-SDG ZJG project during the pandemic can be mainly ascribed to five critical factors. First, the central government's environmental commitment has been lifted to a new high since it announced China's dual carbon goals at the UN (Xinhua 2020b). Contextualized in the global and regional unsatisfactory progress against the 2030 SDG Agenda, this project's significance becomes easily understood and identified with representativeness from the perspective of green development. Second, China's national strategy of Yangtze River Protection, which was put forward in 2016 (Xinhua 2020a) and formally pushed with guidance and measures in 2019, provides a critical institutional framework for not only the political legitimacy of this project and effective consensus-building within the top-down administrative system but also specific guidance and objectives for real practices. Third, the quick actions of local municipal government in translating objectives into action plans and real projects (United-Nations 2021), which also well connects with local problems and needs, have primarily helped concentrate local powers and resources to connect with central ideas. This sets a critical condition for ensuring a considerable investment of funds and cross-departmental human capital despite various difficulties, including the influence of COVID-19 and competing priorities over time.

Fourth, the accumulative preparation of port rectification dated back to 2010 and gradual publicity of environmental protection through annual cultural festivals since 2004 (China-Daily 2018) have laid a solid ground for the possibility of accelerated phases since 2019. Integrated well with the ideology of ecological civilization rooted in the traditional idea of harmony between man and nature (Wang et al. 2020), it finds an effective language to communicate with stakeholders from enterprise owners to village farmers, enabling cross-sectoral cooperation and even triggering some bottom-up initiatives by villages actively adapting to the new requirements and opportunities. Fifth, the integration of professional groups, expertise, and critical technologies ensures quality delivery in its various interlinked aspects from planning, designing, funding, relocating, building, operating, etc. Sixth, the official recognition of the first-phase project by the high-profile international organization UN helped further consolidate the support for the follow-up phases, commitment of professional groups and technological inputs, as well as its long-term investment and maintenance which otherwise may well become a primary constraint for such a complex and sizable project in the long run.

Nevertheless, despite the numerous accomplishments of the ZJG Bay project and the severe commitment well demonstrated by national leaders, local leaders, and

actors, it does not necessarily mean that everyone's environmental perceptions or motivations are on the same page. Given the variety and large group of stakeholders involved on the implementation front, this is practically unattainable anyway but highly relevant and valuable to analyze and make estimates. The assessment of environmental attitudes conducted in this study contributed to the unveiling of such hidden patterns by different groups of people with more details. On the one hand, it reveals a relatively higher level of government officials than other participating groups in their ecocentric orientation on the spectrum. It explains the critical role and exceptional efficiency within the government and top-down system in funding the project. In this sense, Zhangjiagang Municipal Government was astute in aligning the top-down "political assignments" with the local agenda, which might have removed many obstacles in the first-phase implementation.

On the other hand, there remains a mixed picture of attitudes with evident variety among all groups, including the officials. With the relatively short period of 2 years of the first phase and dominant central stress in the policy concentration and effects timeline, the external reference system might work well in dominating and guiding behavior toward task completion. But internal conflicts may arise when top-down power and monitoring become less stringent or economic growth has been threatened by changing and accumulating international and domestic contexts, such as the tightening of government fiscal revenue, loss of jobs, and reduction of consumption and consumption slowdown of the real economy, especially since 2022. This means that earlier evaluation and regular attitude monitoring would benefit careful planning and program design, keeping motivation and ensuring the delivery of the following steps and long-term operation. Moreover, to ensure a full-fledged and sustainable commitment to SDGs, continuous environmental education should facilitate perceptual basis, genuine embracement, and consensus-building toward SDGs. ZJG Bay project itself could serve as one of the platforms for such environmental education with tangible and observable outcomes. The heavy visits and prolonged stay by visitors in the Eco-park, open freely to the public, have presented such potential and already started to serve the purposes.

Project Replicability and the Prospect of UGIs in SDG Commitment

The ZJG Bay project has successfully achieved the SDGs in the first phase. Despite its huge investment, multiple stakeholders, and complex coordination, it has demonstrated an effective combination of top-down institutions and bottom-up initiatives in a time of changing priorities toward ecological civilization and criteria for success leaning to low-carbon and low-impact development. This requires high sensitivity, firm decision- and choice-making, and efficient mobilization of tangible and intangible resources. The institutional building, cross-sectoral cooperation, and integration of the top-down policies with local agendas bring helpful reference to other riparian areas along the Yangtze River, Huang River, or others keen to recover the ecology from polluting industries. Meanwhile, the removal of polluting industries yet keeping industrial legacy, restoration of ecological features, control of

commercial development, and planning of cultural activities and green economy, including eco-tourism, can all be thoughts of replicability and broader applications. This is especially applicable when China actively revisits its UN SDGs progress and continues to push its climate actions and biodiversity conservation more firmly where UGIs will further rise to have a fuller play.

The AEA scale adapted and applied in this study empowers a practical explanation of the sub-conscious and hidden environmental value patterns across stakeholders and provides actionable implications to ensure long-term adherence to the UN SDG standards and better public engagement and consensus-building in UGI projects alike. This is of particular value for leveraging bottom-up movement to balance administrative forces and costs and sustaining motivation and commitments, especially in difficult times of other social and economic challenges. Therefore, for future large-scale projects alike, AEA scale evaluation could be conducted purposefully and regularly, such as before, in the middle, and after the project. It can monitor any significant changes and relevant factors and make plans and adjustments by considering different perceptions and possible motivations.

It's worth noting that such differences in attitude orientation may not necessarily lead to different behaviors in environment conservation right away, and the ZJG project still managed to achieve positive results with the varied environmental attitudes of its participants. But a good understanding of attitudes helps identify potential areas of attention, estimate behavioral changes when conditions change, and identify effective communication of goals and benefits to different groups. For instance, explicit link with moral duties to other species and the natural environment in policy actions and project plans may be more efficient to gain public support, given the survey finding that the general public, although may tend to take more pragmatic views on their livelihood when choosing between environment and growth, can better recognize the moralistic statements in ecological civilization policies and plans, probably being resonant with the classic Chinese philosophy of "harmony of man and nature" (Henning 2016; Wang et al. 2020). In addition to effects from environmental, biodiversity, and green economy perspectives, benefits can also be explained and explored in terms of people's health and well-being, which also quickly raises importance in the post-pandemic context.

Moreover, this purposeful evaluation and regular monitoring would benefit from continued attention and resources given to environmental education about SDGs and ecological civilization, including government officials and the general public, who are vital to the project implementation and operation. This awaits more substantial and collective progress before taking real and scale effects, but it brings more long-term benefits. It can foster spontaneous behaviors that vastly reduce administrative costs and barriers for the top-down campaign in the whole life cycle of the project. In this regard, the successful designation of UN SDG Good Practice and the ecological transformation, in addition to the industrial transformation that ZJG project brought about, plays a contributing role in providing empirical experience to its considerable gains, which is more tangible and demonstrative to trigger fundamental changes toward pro-environmental actions in its future phases and other similar projects.

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From Criticism to Collaboration: Empowering Built-Environment Professionals for Biodiversity-inclusive Cities in the Global North and South

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Acknowledgments

This research is funded by Jing Lu's Marie Skłodowska-Curie Actions Grant No. 945139 (European Union's Horizon 2020 Research and Innovative Programme) as part of her Ph.D. dissertation, as well as Fundación Tatiana Pérez de Guzmán el Bueno in Spain. The funder played no role in the study design, data collection, data analysis and interpretation, or this manuscript's writing. We are grateful to Alicia Lopez, Jing Gan, Melissa Herliz, Tinsae Yimam, and Yonas Abate for their invaluable help in recruiting interview participants and all interviewees for sharing their valuable views and perspectives.

Author Contribution

J.L. and L.L. conceptualized and designed the study. J.L. recruited the participants and conducted interviews. J.A.M. contributed to the Spanish version of the Q-statements and participated in interviews conducted in Spanish. J.L. analyzed and interpreted the data with the help of L.L.. J.L. wrote the manuscript, and L.L., J.A.M., and A.H. provided additional insights and reviewed the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

All authors declare no financial or non-financial competing interests.

From Criticism to Collaboration: Empowering Built-Environment Professionals for Biodiversity-inclusive Cities in the Global North and South

Abstract

Cities play a crucial role in addressing the biodiversity crisis. Despite advancements in urban ecology, effectively integrating biodiversity into urban planning remains limited. Built-environment professionals (BEPs), who are responsible for local actions, often face criticism for their unwillingness to prioritize biodiversity and are seldom studied from their perspectives, especially those from the Global South. Therefore, understanding the viewpoints of diverse BEPs from both the Global South and North on biodiversity-inclusive urban planning and design (BIPD) is crucial. This study employs Q-Methodology to analyze BEPs' perspectives in Ethiopia, China, Spain, and the United States, revealing four viewpoints: Pluralist, Enthusiast, Pragmatist, and Contextualist. Challenges in realizing BIPD include widespread unawareness among BEPs of existing biodiversity data and methodologies, structural-physical barriers such as land use conflicts and competing resources, and misaligned values with stakeholders. Our research challenges the notion that BEPs resist incorporating biodiversity into their practices by broadly exploring their viewpoints. BEPs exhibit readiness to transcend legislative structural barriers and leverage professional norms to advocate for urban biodiversity, particularly when equipped with evidence-based tools. Pluralists and Enthusiasts demonstrate heightened interest in multidisciplinary collaboration and prescriptive, visual tools to communicate biodiversity's value to stakeholders. Critically, BEPs' capacity to act hinges on the availability of contextually sensitive methods, necessitating empowerment through transdisciplinary collaborations to foster transformative changes in cities, especially in the Global South, where complex socioeconomic-ecological trade-offs demand co-produced solutions.

Keywords: Biodiversity-inclusive planning and design, Urban ecology, Urban planning and design, Q-Methodology, Urban sustainable transition, Transdisciplinarity

Introduction

Cities increasingly play a vital role in global biodiversity conservation and enhancement^{1,2,3}. There is a growing recognition of the significance of urban biodiversity, as it contributes to countering the global extinction crisis^{2,4}, promoting multispecies justice^{5,6}, and providing synergistic benefits for human well-being^{7,8,9} as well as climate change mitigation and adaptation^{10,11}. Despite these recognitions, biodiversity in cities continues to decline, impacting even common species such as the house sparrow¹². To turn these recognitions into real-world actions, innovations in urban planning and design practices that enhance native biodiversity and support inclusive and sustainable urbanization are essential. This concept has been acknowledged by several global targets, initiatives, and commitments^{13,14}. It is encapsulated as biodiversity-inclusive urban planning and design (BIPD), a term coined and promoted in the Kunming-Montreal Global Biodiversity Framework (KMGBF) adopted by the Convention on Biological Diversity¹⁵.

Progress towards such global initiatives is rooted in local actions¹⁴. However, urban professionals in the built environment responsible for engaging citizens in local decision-making may not yet be prepared for BIPD. Built-environment professionals (BEPs), such as urban planners, civil engineers, and landscape architects, have historically focused on improving human well-being rather than considering the needs of other organisms and often lack a background in ecological education¹². Such a situation is more challenging in the Global South, where more generalists lack the capacity for specialization¹⁶, and more attention should be directed toward citizens' basic needs¹⁷. Although there is a long tradition of integrating ecological principles into the planning process, guided by landscape urbanism^{18,19}, and movements centered on concepts and practices such as urban green infrastructure planning²⁰ and biophilic urbanism²¹, BEPs' practices have faced criticism from ecologists. Concerns include a focus on the expansion and the connectivity of green spaces and neglecting the potential of the built environment as habitat²², treating biodiversity largely as incidental and passive stakeholders rather than engaging actively and explicitly²³, a relative lack of attention toward animals²⁴, and oversimplifying the complexity of ecological relationships and their interactions¹². In this regard, BEPs are questioned about their willingness and ability to navigate the complexities of ecological factors intertwined with the socioeconomic and political intricacies of planning processes^{16,24,25}.

While BEPs are being questioned, the shift in urban ecology from a biologically based discipline to an increasingly interdisciplinary field^{27,28,29,30} offers promising opportunities to advance knowledge necessary to explicitly involve urban biodiversity as nonhuman stakeholders in planning and decision-making²³. Recent advancements in urban ecology have produced sophisticated knowledge and tools that have the potential to inform urban

planning and design. For instance, Plummer et al. developed species-habitat models to predict bird populations for urban development planning scenarios, aiming to support the on-site compensation policy of “no biodiversity net loss” in the UK³². By employing citizen-science data on animal species and Maximum entropy (MaxEnt) species distribution modeling (SDM), researchers in China and South Korea have mapped habitat cores and ecological corridors for urban biodiversity conservation^{33,34}. Furthermore, recent efforts in urban ecology have demonstrated the potential for actively integrating biodiversity science into urban practices. Building on the target species selection framework²² and species’ life-cycle study³⁵, Weisser, Hauck, and their teams¹² employed the Animal-Aided Design approach to explicitly consider animals as stakeholders in their project design practices in Germany and Switzerland. Guided by the framework of Biodiversity Sensitive Urban Design³⁶. Australia’s largest urban renewal project, Fishermans Bend in Melbourne, stands out as one of the earliest urban developments of this scale to explicitly incorporate biodiversity targets³⁷.

Nevertheless, these advancements in urban ecology have not been widely reflected in practical urban planning and design. To date, 66% of research on urban planning and design focusing on urban biodiversity is still guided by the idea that “urban form leads to changes in species diversity within urban areas,” treating nonhuman species as passive stakeholders²³. Although limited in number, studies have attempted to investigate the reasons and challenges behind this scenario. Some studies attribute this phenomenon to BEPs’ value bias and lack of willingness to prioritize biodiversity compared to other competing interests^{38,39}. Additionally, knowledge gaps and disciplinary silos are discussed, emphasizing BEPs’ lack of empirical ecological knowledge¹⁶ necessary for prescribing “hands-on” transdisciplinary real-world solutions^{16,26,40}. Moreover, BEPs may experience path dependence⁴¹ and are considered to rely on their socio-technical regimes, leading to resistance to change or reluctance to seek external collaborations^{42,43}. While these studies provide an initial understanding of the challenges, they tend to critique BEPs without thoroughly examining their perspectives on BIPD. They engage only a specific interest group, including some BEPs attracted to the Summit related to urban wildlife³⁹, excluding most BEPs that shape the urban landscape, which usually focuses on various social, economic, and environmental objectives. Traditionally, few BEPs engage with biodiversity topics, as biodiversity is not an explicit goal in their practices but rather a constraint that must be managed when necessary¹². Furthermore, studies involving BEPs mostly concentrate on related topics, such as Nature-based Solutions (NbS)⁴², which do not specifically address BIPD; instead, the value of urban biodiversity is often overlooked in the design and assessment of many NbS programs¹. Even when considering studies on related topics, the voices of BEPs from the Global South are severely underrepresented despite their pressing

urban challenges amidst limited resources¹⁶. Without specifically understanding the perspectives of a diverse group of BEPs from various professional backgrounds and global regions regarding BIPD, it is difficult to transform global biodiversity commitments from being merely advocated by ecologists¹⁶ to fostering real-world actions. Additionally, these discussions often stop at identifying barriers^{39,42} rather than exploring opportunities involving BEPs.

To fill this gap, this study investigates the perspectives of a broad profile of BEPs across four countries in both the Global South and North regarding BIPD, drawing on theories of Lock-in Effects⁴¹ and the Theory of Planned Behavior (TPB)⁴⁴. The TPB is one of the most influential models for predicting and explaining individuals' intention to engage in specific behaviors⁴⁵. It deconstructs a person's behavioral intentions into three constructs: attitudes, social and subjective norms, and perceived behavioral control⁴⁴. Recently, some studies have extended the TPB model by incorporating additional constructs, such as moral norms to understand green purchasing behavior⁴⁵ and personal norms alongside environmental concerns for public transit behavioral intentions⁴⁶. By extensively comparing various extensions of TPB research, these studies argue that moral and environmental concerns should be included as an extension of TPB, which are significant predictors of intentions on environmentally responsible behaviors^{44,46}. In addition, Wilson⁴¹ discussed how path dependency and "lock-in" effects pose severe hindrances to social-ecological resilience and transitional changes, as they can trap stakeholders in pathways from which they find it difficult to escape. He categorized lock-in effects at the community level into three types: 1) structural, which are beyond the control of individual communities; 2) economic, related to communities' economic capital; and 3) social-psychological, associated with community-level endogenous social and psychological factors⁴¹. Given the potential challenges of implementing BIPD, it is appropriate to reference the extension of TPB and Lock-in effects as an initial framework to help understand the BEPs' intentions in involving biodiversity as nonhuman stakeholders in their practice, specifically taking citizen-science-based species distribution modeling (SDM), which is widely studied in urban ecology^{31,34}, as an example. We aim to address three knowledge gaps: 1) uncovering the diverse perspectives of various BEPs' regarding BIPD, 2) providing in-depth, specific, and nuanced evidence of the perspectives of various BEPs across the Global North and South to extend to those understudied and hard to reach, and 3) understanding the challenges and opportunities of implementing BIPD through the lens of BEPs in relation to the frameworks of the TPB and Lock-in effects.

Results

We explored the perspectives of BEPs using the standard protocols of Q-Methodology, which involved two stages of interviews: the Concourse and Q-sets. This was conducted with a carefully selected group of case study countries from both the South and North, along with purposively sampled BEPs to ensure diversity (Table 1). During the Concourse and Q sorts interviews, we discovered that only four out of the 36 participants had heard or used SDMs before, representing just 11.1% of the BEPs surveyed. We identified four factors (F) that account for 19 of the 23 participants' Q sorts and revealed four distinct viewpoints on BIPD (Table 2). The remaining four Q sorts were classified as confounded Q sorts (Table 2) due to significant loading onto multiple factors. We named the four factors *Pluralist*, *Enthusiast*, *Pragmatist*, and *Contextualist*. Notably, all perspectives support BIPD and are independent of participants' countries or professional backgrounds (Table 1 and 2). Professionals from Ethiopia appear in all factors, professionals from the United States in three factors, and professionals from China and Spain in two factors. Similarly, there is no clear pattern among participants' professional backgrounds, as they are also distributed across factors.

3.1 Factor 1 – *Pluralist*

The *Pluralist* views BIPD holistically, recognizing the importance of biodiversity interwoven with many other public interests and considering how to balance them together. This perspective is shared by the largest number of participants across countries and backgrounds. They regard biodiversity as an interwoven fabric in a holistic system and cannot be discussed separately from other socioeconomic factors. In this context, they feel neutral about prioritizing socioeconomic needs in urban practice (S9, 0) (Table 3). As one participant from China said: *“It frames in a way that excludes biodiversity from the societal socioeconomic needs. But they are interconnected, and the ecological benefits of the urban socioeconomic development.”* They are also neutral about the statement “BIPD has to be biodiversity centric, as the earth is increasingly losing biodiversity to a tipping point (S1, 0^{**})”, while all other viewpoints support this statement. They do not relate to the urgency and instead adopt a contextually-sensitive approach. One professional from China noted: *“It depends on the nature of the projects. Some projects may prioritize biodiversity as it fits with the contextual situation and project goal...Then planners may need to balance socioeconomic requirements with biodiversity.”* They slightly disagree (S20, -1^{**}) with the statement that it is luxurious to consider the needs of non-human species. As one participant from the United States stated, *“On a practical level, it is really challenging to balance providing for other species when there are vulnerable humans whose needs should be met.”* One option to balance the competing interests is through time: *“It almost feels like a short-term versus a long-term issue. We must prioritize meeting the needs of the people who are in vulnerable states now.”*

Nevertheless, Pluralists value the rights of non-human species to exist and their voices to be represented, which they perceive as an objective potentially achievable through BIPD with sufficient detail. They strongly agree with the statement that “BIPD helps represent non-human species’ voices in the urban practice (S8, +4*).” A participant from the United States stated that *“we as humans have had a major impact on the Earth, and we are not the only species to live here. And we need to take other species into consideration in our plans.”* Pluralists also favor BIPD as it delves into sufficient detail (S5, +2*), leading to the following assertion from an Ethiopian professional: *“Such detailed consideration will be coming into force, and people will try to understand the impacts and consider this.”*

While expressing interest in BIPD, Pluralists also discuss their concerns about the feasibility of applying SDM examples developed by ecologists in planning practice. One professional from the United States expressed concern regarding the applicability of SDM examples, stating, *“I’m afraid that I don’t have a deep understanding of biodiversity...I love the modeling to help us make informed decisions, but I guess I would want more, like a data package to explain how to interpret them.”* Meanwhile, a participant from China, who has previously employed SDMs in her practice, further elaborated on the incompatibility of data and methods currently supported by ecologists for direct application in planning. She remarked: *“Ecology and biology are very specialized disciplines, and some experts only study one specie, but planning needs to be holistic and comprehensive. It won’t work to include only one specie in planning.”* Despite the challenges, she considered that the best way to realize BIPD is through multidisciplinary collaboration, emphasizing that some BEPs should be equipped with ecological knowledge to the extent of *“being able to effectively communicate with ecologists.* She explained, *“BEPs with a specialization in ecology are still generalists and do not need to delve deeply into scientific details, which should be the job of ecologists and biologists. But these BEPs should know how to translate and integrate these data into prescriptive planning actions.”*

This perspective also exhibits good control of their ability to go beyond mandatory regulations (S11, -4) because it works against their professional norms. One participant from the United States remarked: *“We’re not only planning because we’re required to. We’re planning to guide future development, and we have the flexibility to consider any information we need.”* This aligns with their heightened positive attitude (Table 3) regarding mainstreaming BIPD into the urban practice (S6, +3), considering BIPD an emerging hot topic and innovative direction. A professional from China described their view: *“Globally, it has become a hot theme in planning practice recently. Biodiversity is the innovative way to go for the future planning and design practice.”*

3.2 Factor 2 –Enthusiast

The *Enthusiast* favors the idea of BIPD and advocates prioritizing biodiversity but struggles to convey the significance to others, feeling pessimistic about mainstreaming BIPD. Professionals with this viewpoint embrace the urgency of biodiversity conservation and support incorporating biodiversity in urban practice as much as possible. A participant from the United States mentioned that *“if we are talking about incorporating biodiversity into planning and design, we should focus on what can be done to increase biodiversity. I agree with both parts of the sentence. It should be biodiversity-centric, and the Earth is increasingly losing (biodiversity) to a tipping point (S1, +2*)”*. Further, they are most likely to agree not to leave out biodiversity information if available (S10, +3) (Table 3). One professional from Spain emphasized the significance of data availability of BIPD by saying: *“We should try to work with as much information and data as it is available, but especially in relation to this topic.”* Similarly, they strongly disagree with the notion of “not involving BIPD in the urban practice because there are no such mandatory regulations” (S11, -4), as articulated by a professional from Spain: *“I’m not planning just to meet mandatory regulations but to improve an existing situation.”*

Professionals sharing this perspective tend to experience a heightened sense of struggle over the prioritization of biodiversity against other considerations, with the concern that their stakeholders may not care as much. One participant from the United States remarked, *“Now the struggle mainly is to convey the urgency to others. The urgency element of environment versus other factors. (S19, +3)”* The *Enthusiast* perspective is also the only one that expresses pessimism about mainstreaming BIPD into urban practice (S6, -1*) (Table 3). A professional from the United States illustrated this with an example: *“There’s a pretty high-profile example in our city right now. What is being proposed as the revitalization of the harbor is, (in) a lot of ways, fairly similar to what’s there already. I guess that as someone who’s environmentally minded, I wish that there had been more thought into developing it as an environmental, ecological space first and foremost.”*

3.3 Factor 3 – Pragmatist

The *Pragmatist* emphasizes flexibility and adaptability based on real-world conditions. They view biodiversity conservation as an ongoing issue and trend, but not necessarily as an urgent one. Regarding the statement “it is very likely to mainstream BIPD into the urban practice in the near future (S6, +2)”, an Ethiopian participant expressed optimism, stating, *“because this kind of idea and issue is a (a) currently ongoing issue.”* Similarly, when talked about their strongly agreed statement that “BIPD has to be biodiversity centric, as the earth is increasingly losing biodiversity to a tipping point (S1, +4)”, one professional from China

discussed that “*I think this is a core trend in our profession and practice (nowadays), and we should work toward it.*” Their interpretation does not convey a sense of urgency; rather, they view the issue through the lens of political trends or professional fashion, implying a tendency to “fit in” or “grasp opportunities.”

In contrast to other perspectives (Table 3), *Pragmatists* disagree with the assertion that “to promote BIPD, built environment professionals’ major struggle is how to convey the significance and urgency of biodiversity to their stakeholders (S19, -3**). One participant from Ethiopia indicated that “*stakeholders may be restricted to (certain) land uses due to biodiversity concerns, which would further limit a community and landowner to profit from their property.*” They appear to align with their stakeholders’ perspectives, prioritizing the latter by weighing biodiversity considerations against immediate socioeconomic concerns to arrive at more practical and tangible solutions.

Pragmatists justify their trade-off decisions to prioritize socioeconomic considerations by viewing biodiversity as inseparable from human well-being. Among all perspectives, this group is the most aligned with the claim that biodiversity conservation is for human survival (S3, +3**) (Table 3). A professional from the United States asserted, “*Biodiversity survival and human survival are kind of one and the same. We depend on it and when we degrade the environment, we’re degrading ourselves and our ability to eat nutritious food.*” The data from statement ranking (S9, 2*) further demonstrates their recognition of the instrumental value of biodiversity, as they uniquely align with the idea that “built environment professionals have to prioritize socioeconomic needs before considering biodiversity in urban practice” (Table 3). Their interpretation suggests that by prioritizing socioeconomic concerns, they can simultaneously address biodiversity needs, as both are interrelated. One participant from the United States emphasized, “*In the cities, we need to be able to say why biodiversity is important from an urban kind of human perspective, and if we can make those linkages between those needs, then they’ll also be considering biodiversity.*”

3.4 Factor 4 – Contextualist

The *Contextualist* feels a strong urgency for biodiversity conservation in the face of urbanization but is constrained by inadequate contextual capacity to achieve its goals. They underscore this urgency in response to the statement, “BIPD has to be biodiversity-centric, as the earth is increasingly losing biodiversity to a tipping point” (S1, +4). The Ethiopian professional remarked, “*Because (we are) now currently increasingly losing biodiversity at (an) alarming rate. This is a global issue now, especially in developing nations with its (rapid) urbanization and deforestation.*” They highlight the significance of biodiversity conservation in the natural habitats of developing nations to mitigate human disturbances (S7, +3): “*In*

the urban setting, to protect the natural habitat (away from human disturbances), biodiversity is the key issue for reducing human disturbance to the natural habitat.” They primarily view humans as a threat to biodiversity within the urban context.

Despite their strong commitment to biodiversity conservation, *Contextualists* are acutely aware of their stakeholders’ struggles with primary socioeconomic needs and are attentive to the structural challenges that prevent them from realizing what they believe is right. This group uniquely agrees with the statement that “when humans can’t meet their own needs, it’s too luxurious to consider the needs of non-human species” (S20, +3**). They frame their reasoning primarily through the lens of their stakeholders, explaining: “*When human(s) cannot meet their interest or their own needs, they don't bother about others, (especially) for developing countries that are still striving for food security, urbanization, and migration (issues).*” This implies a sense of vulnerability from this professional that their stakeholders are economically locked in, while he finds it difficult to propose win-win solutions.

Meanwhile, this group perceives themselves as having a more central role in urban practice and decision-making across disciplines, which may further narrow their capacity to find effective solutions. In contrast to all other viewpoints (Table 3), they disagree with the statement that “despite understanding differences, built environment professionals can still work effectively with ecologists and biologists in the BIPD projects (14, -3**).” They argue that “*biologists only can work (on the BIPD) unless urban planners incorporate*” despite recognizing that planning is inherently a multi-sectoral effort.

3.5 Consensus statements

Four statements emerged as statistically significant consensus among BEPs, with statement 12 not significant at $p < 0.01$, while statements 10, 18, and 24 were identified at $p < 0.05$ (Table 3). Among these, all BEPs across viewpoints agree only with statement 10 and disagree with statement 24. They collectively support the inclusion of biodiversity information in their practice, as “*it aligns with their professional conduct not to leave out available information and is essential to consider biodiversity data as part of the decisions*”, according to one participant from the United States. Participants also presented arguments opposing the notion that BIPD is not feasible in the already developed areas. As one participant from China stated, “*There are numerous examples that BIPD is implemented in the developed areas; for instance, in high-density cities, we can involve biodiversity vertically.*”

3.6 Post-sort questions

The top three suggestions put forth by participants regarding the involvement of BIPD in urban practice were concentrated across eight themes (Fig. 2 and 3): Data availability and methodology awareness, Public engagement and education promotion, Regulatory framework incorporation, Consensus building and synergy with other public interests, Best practice case studies and pilot projects, Multidisciplinary collaboration, Financing, and incentives and Others. The leading three are Data availability and methodology awareness, Public engagement and education promotion, and Regulatory framework incorporation, with the latter two being uniquely proposed across all four perspectives (Fig. 3). Therefore, we categorized these themes into four categories (Fig. 2): Knowledge-related, Engagement-related, Structure-related, and Others, with Knowledge-related constituting the top category, accounting for 41.7% of all responses (Fig.3). Notably, the suggestions of *Pluralists* and *Pragmatists* are relatively balanced across the first three categories (Fig. 2), while *Enthusiasts* exhibit a stronger preference for Knowledge-related suggestions (66.7%). Conversely, *Contextualists* provided no suggestions related to knowledge. This finding aligns with the Q-sort results, indicating that *Enthusiasts* are particularly passionate about incorporating biodiversity data, while *Contextualists* express a heightened sense of vulnerability regarding all propositions that are beyond their control and based on external or structural factors. Both *Pluralists* and *Pragmatists* suggested all three themes within the Knowledge-related category, with Data availability and methodology awareness being the most popular, while Multidisciplinary collaboration was the least favored.

There is a discernible trend toward increasing support for the statutory incorporation of BIPD, transitioning from “Not necessary” to “Statutory” (Table 4). This trend is evident across all groups, although the degree of support varies significantly. *Pluralists*, *Enthusiasts*, and *Contextualists* exhibit a gradual increase in support for integrating BIPD, demonstrating a clear preference for statutory incorporation. However, *Pragmatists* present a less clear pattern. Their responses indicate support for integrating BIPD while valuing diverse incorporation methods beyond legal frameworks. A participant from the US strongly agrees with the conceptual integration, stating that “*conceptual incorporation about biodiversity consideration is important if it is done well, ... because they are rules of thumb that you can use that would make a huge difference compared to what we do now.*” Another Ethiopia participant also supports conceptual integration but feels neutral about integrating as plans or policies because “*indigenous residents have valuable conceptual insights into local wildlife and green spaces, (which) should be valued and incorporated.*”

Table 1 Summary of research participants

Study country			Professional background									Total participants per country	
Name	National Urbanization (%)	National GDP per capita, (PPP) (current international \$)	Discipline						Focus			Concourse	Q-sort
			UP	UD	LA	CE	Env	Mul	Ecol	Environ	Socio-econ		
Ethiopia	Low	Low	4	1	1	4	0	0	0	5	5	4	6
China	Medium	Lower middle	3	2	1	0	2	1	2	2	5	3	6
Spain	High	Upper middle	1	1	2	3	1	0	2	3	3	3	5
USA	High	High	3	0	2	1	1	2	3	3	3	3	6
Total participants per background			11	4	6	8	4	3	7	13	16	13	23

Source: National urbanization (urban population as a percentage of total population) (%): Low < 35%, Medium 35%-75%, High > 75% ⁴⁷; National GDP per capita, purchasing power parity (PPP) (current international \$): Low < 15, Lower middle 15-45, Upper middle 45-65, High > 65⁴⁸.

UP = urban planning; UD = urban design; LA = landscape architecture; CE = civil engineer; Env = environmental science or engineering; Mul = specialized in two or more disciplines; Ecol = ecological focus; Environ = environmental focus; Socio-econ = socioeconomic focus.

Table 2 Factor loadings for each participant's Q sort

Practice areas	Practice sectors and focuses	Years of experience	F1	F2	F3	F4
F1: Pluralist						
Shanghai, China	Private consulting <i>Biodiversity planning, landscape design</i>	10-15	0.8260	0.1571	0.1066	0.1712
Addis Ababa, Ethiopia	Government <i>Urban and industrial park civil engineering</i>	15-20	0.7575	0.1508	0.2558	0.3042
Shanghai, China	Government & Non-profits <i>Strategic planning, climate changes, innovative industries and policy research</i>	10-15	0.7040	0.2467	0.0521	0.0227

Multiple cities, USA	Government & Non-profits <i>Holistic sustainable planning</i>	10-15	0.6952	0.3839	0.3125	0.0461	-
Madrid, Spain	Government & Academia <i>Green infrastructure, landscape planning</i>	20-25	0.6832	0.5188	0.0304	0.0436	-
Multiple cities, Ethiopia	Academia & Private Consulting <i>Urban planning and design, urban regional planning</i>	10-15	0.6525	0.2083	0.2296	0.4930	-
Multiple cities, China	Private consulting <i>Urban and industrial planning and design</i>	15-20	0.6425	0.5777	0.1385	0.0558	-
State government & Baltimore, USA	Government <i>Capital improvement programs, energy efficiency</i>	10-15	0.6334	0.319	0.1616	0.1368	-
Shanghai & Suzhou, China	Government & Private Consulting <i>Urban planning, landscape architecture, urban management</i>	15-20	0.6052	0.1619	0.4807	0.1972	-
F2: Enthusiast							
Milwaukee & Hamtramck, USA	Government & Non-profits <i>Community & economic development urban planning, urban beautification programs</i>	5-10	0.3388	0.8065	0.0500	0.0913	-
Baltimore, USA	Private consulting <i>Eco-restoration, stormwater management planning and engineering</i>	5-10	0.1169	0.7549	0.0035	0.1248	-
New York & the Northeast Region, USA	Government & Private Consulting <i>Ecological landscape architecture</i>	10-15	0.2683	0.7372	0.3819	0.0562	-
Barcelona, Spain	Government & Academia <i>Landscape architecture and open space design</i>	15-20	0.4848	0.6758	0.0834	0.1184	-
Madrid, Spain	Government & Private Consulting <i>Civil and environmental engineering and construction</i>	20-25	0.2710	0.6675	0.4080	0.2982	-
Dire Dawa, Ethiopia	Government	10-15	0.3466	0.6332	0.1306	0.3080	-

Urban structure planning

F3: Pragmatist							
Addis Ababa, Ethiopia	Government <i>Environmental engineering</i>	10-15	0.3177	-0.1222	0.7317	0.0309	
Guiyang & multiple cities, China	Private consulting <i>Urban development planning</i>	10-15	0.0852	0.5476	0.6275	0.0068	
USA and multiple countries worldwide	Government & Academia & Non-profits <i>Biodiversity urban planning and research</i>	10-15	0.3059	0.1355	0.6098	0.2331	
F4: Contextualist							
Addis Ababa, Ethiopia	Government <i>Urban beautification, green space planning</i>	15-20	0.0396	0.0527	0.0443	0.7442	
Confounded Q sorts							
Multiple cities, China	Private consulting <i>Ecological landscape architecture and stormwater management design</i>	20-25	0.6472	0.4793	0.4487	0.1639	
Madrid, Spain	Government & Private Consulting <i>Landscape architecture, urban park planning, green infrastructure planning</i>	20-25	0.4884	0.4392	0.4489	0.4307	
Addis Ababa, Ethiopia	Government <i>Urban master planning, land bank administration</i>	15-20	0.2158	0.5281	0.5605	0.2269	
Galicia & multiple other cities, Spain	Private consulting & Government & Academia <i>Landscape architecture, green space planning and design, green infrastructure planning</i>	25-30	0.4010	0.4887	0.5075	0.3244	
Eigenvalues			6.0122	5.3740	3.1275	1.7651	
Explanatory variance (%)			26.14	23.37	13.60	7.67	
Reliability			0.9730	0.9600	0.9231	0.8000	
Number of defining Q sorts			9	6	3	1	

Factor loadings range from complete agreement (1) to complete disagreement (-1). Bolded numbers for F1, F2, F3 and F4 are Q sorts with factor loadings >0.60 and are significant at $p < 0.01$.

Table 3 Q Statements and rankings for each factor

Q Statements	F 1	F2	F 3	F 4
1. BIPD has to be biodiversity centric, as the earth is increasingly losing biodiversity to a tipping point	0**	2*	4	4
2. Humans should conserve biodiversity because it is essential to our mental health	2	4	3	2**
3. The most important reason for biodiversity conservation is human survival	1	1	3**	-1
4. BIPD is a valuable layer in considering development patterns and how to use space	3	2	1	1
5. BIPD gets down to a granular enough detail that are useful for the urban practice	2*	0	1	0
6. It is very likely to mainstream BIPD into the urban practice in the near future	3	1**	2	2
7. In the urban settings, BIPD is a suitable approach to reduce human disturbance to the natural habitats	2	2	1**	3
8. BIPD helps represent non-human species' voices in the urban practice	4*	1	-1	0
9. Built environment professionals have to prioritize socioeconomic needs before considering biodiversity in the urban practice	0	-2	2*	-1
10. As built environment professionals, we should not leave out biodiversity information or data if they are available**	1	3	2	0
11. It is not necessary for built environment professionals to involve BIPD in the urban practice because there are no such mandatory regulations	-4	-4	0	0
12. The primary challenge for BIPD is that built environmental professionals do not have quality non-human species data in cities to inform practice*	0	-1	0	1
13. The major barrier to involve BIPD into urban practice is that built environment professionals do not know how to do it	-1	0	1	-1
14. Despite understanding differences, built environment professionals can still work effectively with ecologists and biologists in the BIPD projects	1	1	1	3**
15. It is not practical to involve BIPD in the urban practice because biodiversity knowledge is too specific and narrowly focused	3**	-1	0	0
16. Planning and design are not science, so biodiversity scientific data cannot be translated into design solutions or policy decisions	-3	-2	0	-1
17. As built environment professionals, we cannot make the biodiversity-inclusive shift in the urban practice because we all work in institutional silos	-2	0	-2	1
18. It is only possible to make the biodiversity-inclusive shift in the urban practice after it is integrated into the existing regulatory framework**	0	-1	0	2

19. To promote BIPD, built environment professionals' major struggle is how to convey the significance and urgency of biodiversity to the stakeholders	1	3	3**	2
20. When humans can't meet their own needs, it's too luxurious to consider the needs of non-human species	1**	-3	-4	3**
21. It is impossible to involve BIPD in cities where land is profitable and generates revenue	-1	-3	-3	-2
22. The added-up of additional time, capacity and coordination efforts make it difficult to implement BIPD in the urban practice	0	0	-1	3**
23. As built environment professionals, BIPD is not something we typically do, and we don't find the motivation to change	-2	0	-2	-2
24. In the urban settings, BIPD is only feasible in the urban expansion areas or new cities, but not in the already developed ones**	-2	-2	-2	-4
25. Built environment professionals will implement BIPD projects only if there are successful examples elsewhere	-1	1	-1	1

F1 =Pluralist, F2 =Enthusiast, F3 =Pragmatist and F4 =Contextualist. Statements are listed in order of the numbers on the statement cards and scores illustrate the level of agreement with each statement from -4 'strongly disagree' to +4 'strongly agree'. Distinguishing statements are noted for each factor with a * if significant at $p < 0.05$ or ** if significant at $p < 0.01$. Consensus statements are noted for each statement with a * if non-significant at $p < 0.05$ or ** if non-significant at $p < 0.01$.

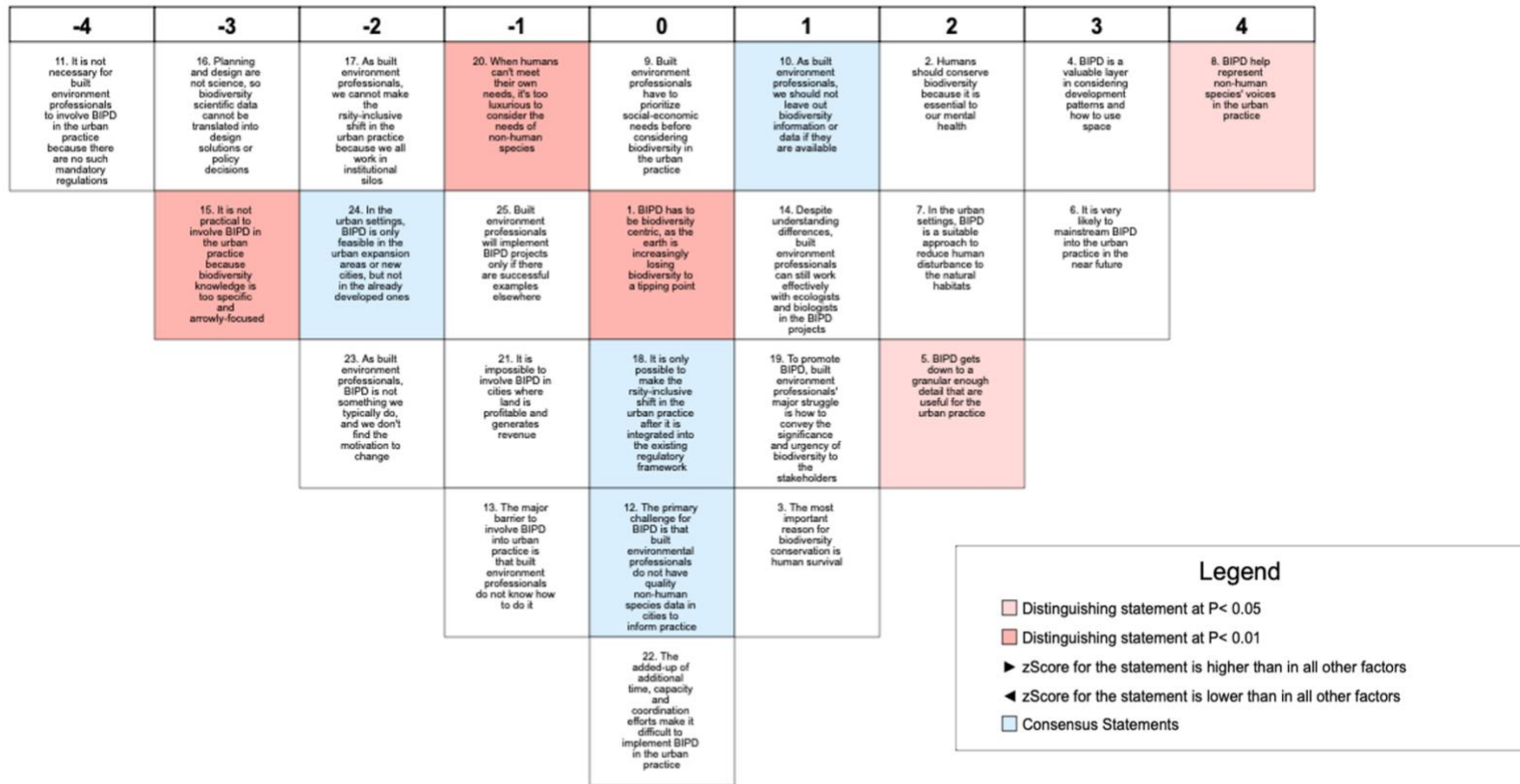
Table 4 Participants' intentions of incorporating BIPD into the legal framework by factors according to four five-point Likert scale selections

Incorporation Level	Mean	Median	Standard	Minimum	Maximum
			Deviation		
F1 Pluralist (n=9)					
Not necessary	1.2	1.0	0.4	1	2
Conceptual	1.6	1.0	0.8	1	3
Non-statutory	2.7	3.0	0.8	2	3
Statutory	4.4	4.0	0.5	4	5
F2 Enthusiast (n=6)					
Not necessary	1.0	1.0	0.0	1	1
Conceptual	2.0	2.0	0.8	1	3
Non-statutory	2.0	2.0	0.6	1	3

Statutory	4.5	4.5	0.6	4	5
F3 Pragmatist (n=3)					
Not necessary	1.0	1.0	0.0	1	1
Conceptual	3.7	4.0	2.1	1	5
Non-statutory	3.7	4.0	1.5	2	4
Statutory	4.7	5.0	0.6	4	5
F4 Contextualist (n=1)					
Not necessary	1.0	1.0	NaN	1	1
Conceptual	3.0	3.0	NaN	3	3
Non-statutory	4.0	4.0	NaN	4	4
Statutory	5.0	5.0	NaN	5	5

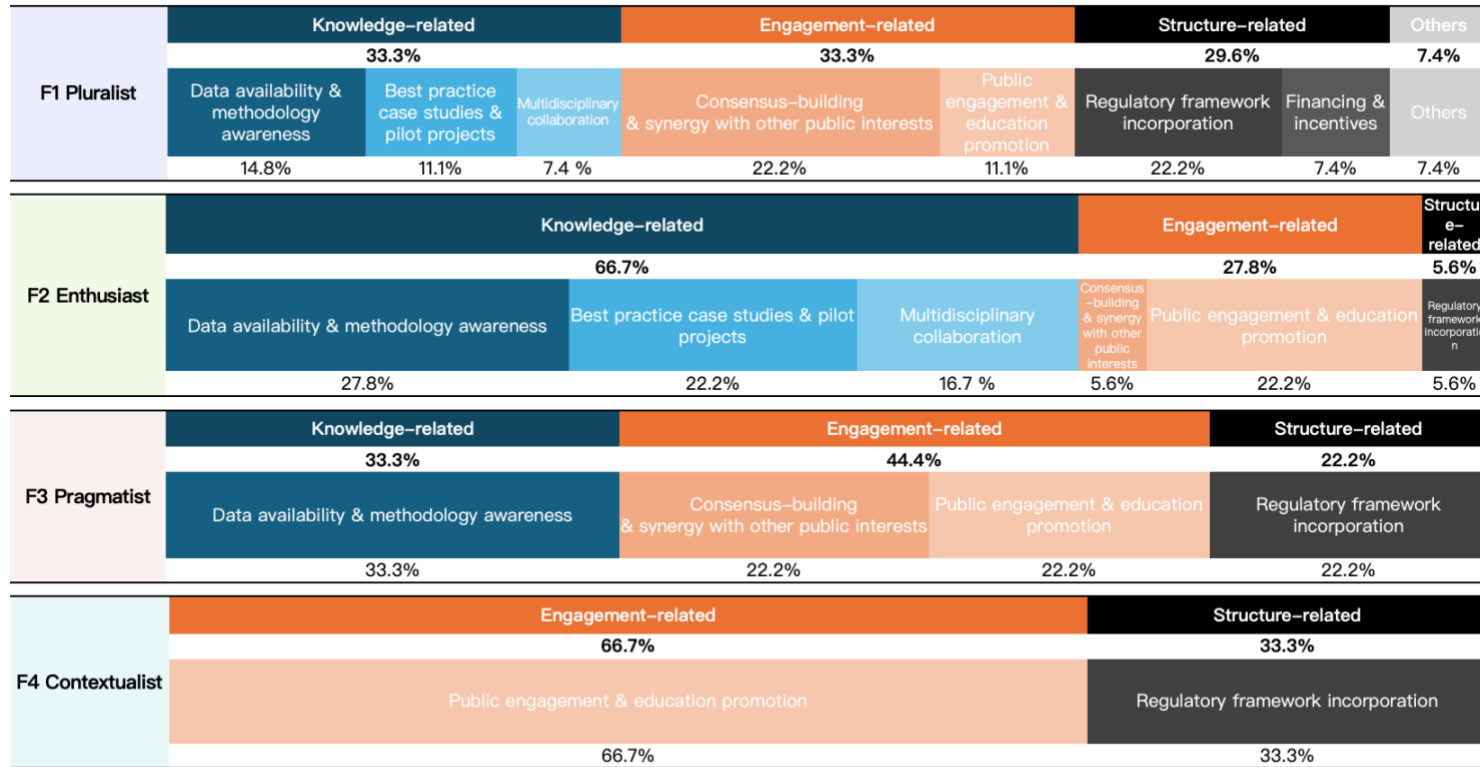
Note: The four choices are defined as follows: Not necessary to incorporate, Conceptual incorporation is good enough, Non-statutory incorporation is sufficient, and Statutory incorporation is necessary. Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. NaN indicates that the standard deviation cannot be calculated for a sample size of 1.

Fig. 1: A Composite Ideal Sort aggregated by Ken-Q software by factor on a nine-column Q-Sort distribution board.



Participants place one statement in each blank, and there is no difference in value based on the vertical order of statements in each column.

Fig. 2: Bar chart of percentage by counts of the participants’ top three suggestions per factor.



Suggestion categories are grouped in Knowledge-related (in blue), Engagement-related (in orange), Structure-related (in dark grey) and Others (in light grey).

Fig. 3: Quotes of the participants’ top three suggestions by category in descending order per suggestion numbers.

Data availability & methodology awareness	Public engagement & education promotion	Regulatory framework incorporation	Consensus-building & synergy with other public interests	Best practice case studies & pilot projects	Multidisciplinary collaboration	Financing & incentives	Others
Planners need clear methodology on when and how to implement it	Professionals and citizens should all get involved in the systematic biodiversity monitoring from the beginning instead of focusing only on flag species	Mandatory regulatory framework is necessary to engage all sectors to act	Most importantly, planners should carefully position biodiversity objectives that are suitable for the specific projects by understanding the true underlying needs from different stakeholders to reach a solution accepted by all	Case studies and pilot BIPD examples are good starting points	Persons from different disciplines should interact and sit together at the same table with sufficient time to speak to each other and influence the other side	Work with the government and provide incentives, ask real estate developers to change their behaviors	More attention and budget are in need for sustainable maintenance to balance low maintenance while minimizing human disturbance and human perceived wilderness
Professionals needs reference and data, and recipes of how to use and treat them, which may facilitate things to happen	Develop a multidisciplinary curriculum with both biologists and built environment students for a better future environmental generation	BIPD should become one of the legally-binding planning objectives in the spatial territorial plans	The most important is consensus building within the profession and the wider public	Case studies and best practice examples are beneficial	Collaborations across professions such as planners, engineers and ecologists on small-medium projects with full BIPD studies first	It would help us produce more well-rounded plans that consider other factors like biodiversity if we are able to incorporate long-term financial impacts and investments	Design urban zoos and recreational parks in the urban planning and design
Having a data layer to be able to easily pull in data to make this kind of things easier, like the EPA has - a tool about environmental justice layer to identify vulnerable populations and look at proposed projects against that data	From the bottom-up perspective, it requires a better public promotion and engagement to infiltrate such new knowledge and tools for policy incorporation and awareness raising	One of the approaches is compulsory regulations	To make it happen, planners should synergize biodiversity messages and issues with equity, mental health, climate change, carbon neutrality	Pilot projects in big cities with more resources first and replicate widely nationwide	Having better collaborations between the scientific community and city practitioners. Having more conversations about the importance of this having more research is always helpful		
Involve such new approaches in the urban planning and design, civil engineering, and landscape architecture practices	High school curriculum to educate about BIPD	Respect relevant regulations in place, such as the 30% regulation of green spaces has not yet got enough attention by politicians and in practices	Urban agriculture in the peri-urban areas, would promote the integration of BIPD simultaneously	Best practice examples to facilitate changes, such as markers of what this is with a plate or sign saying this is a park but also a habitat	Multidisciplinary team in the city		
Having a better understanding of BIPD through mapping... First implement in a few spaces, like community green spaces and make it approved by the planning commission	Change the perceptions of beauty of the landscape design and understand the impact of different species on the environment	Multi-sectoral governmental collaborations to push forward biodiversity conservation in planning	Accomplish multiple goals together to align biodiversity goes alongside with other topics, such as health benefits, clean water benefits etc.	Examples of codes and regulations or model ordinances would be helpful to take references and understand how to integrate	At least biologists, ecologists, or environmentalists considered as the stakeholders, and better to be part of the team to have a say		
I think access to data is really a big one...A lot of times the barriers are that we don't necessarily have the data that we need or it's not very accurate	Education to people working in the space and the clients. Biodiversity cannot be incorporated in all but potentially partially in some projects	Top-down policies for animal species data monitoring and ecological corridors, which will provide efficient data support for modeling and planning. It will also trickle down to local levels in practice to make a convincing case backed up with detailed data	BIPD is incorporated in the framework for the project or the vision before evening getting to the point, you know, in the project requirements early on	Good practice examples to follow			
Conferences, researches and academic discussions bring what is advanced in research to practice. Practitioners read papers to improve their work	Raise the public awareness, and the BIPD should be calibrated into the subject of urban planning and design education	The high-level management in urban centers support BIPD into the legal framework to increase the impact	Integrate nature into infrastructure	Available pilot projects to test the good practices and to be involved in the big projects			
More quality available data in an easier way to use for planners	Community engagement in urban planning process	Scientific-oriented, evidence-based designs with some regulatory flexibility in planning or implementation	Link biodiversity into other priorities of the city to understand what biodiversity meant - really scientific, so that they're motivated to do it				
Guides for other engineers to follow, and if it is legalized, it is better	Promote and involve the public for the maintenance	Link to larger framework and legislation with larger impact - cities and biodiversity planners to think more comprehensively					
Community-driven planning with ecological knowledge	Raise awareness and community participation	Top-down policies to direct the science into practice					
Following the science, don't design too much to allow nature to evolve itself	Education across all levels - from kindergarten to all levels						
Institutional and technical support this topic - how easy it is to actually do it							

Method-related Engagement-related Structure-related Others F1 Pluralist F2 Enthusiast F3 Pragmatist F4 Contextualist

Fig. 3. Quotes of the participants’ top three suggestions by category in a descending order per suggestion numbers. Background of every suggestion quote and category name from different factor is colored respectively according to the legends.

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Discussion

Our study provides well-informed and nuanced evidence to enhance understanding of the challenges and opportunities in realizing BIPD from the perspectives of BEPs. We engaged a diverse group of BEPs from geographically understudied regions in the Global South and professionals across sectors with socioeconomic expertise who have not typically been involved in this topic. Unlike previous studies that emphasize barriers arising from BEPs' low-value priorities regarding ecology and their reluctant attitudes^{39,42}, our findings are surprisingly positive considering the broad profile of BEPs examined. We identified three major challenges: the misalignment of value orientations between BEPs and their stakeholders, structurally imposed barriers, and a lack of basic awareness among BEPs about the existence of biodiversity data and methodologies. Our study identified potential opportunities that have not been fully explored in previous research regarding BEPs' willingness and capacity to overcome certain challenges, while other challenges may require additional support, particularly from ecologists. We will first discuss these challenges and the perceived behavioral control of BEPs associated with them, along with BEPs' coping mechanisms. This will be followed by a discussion of the potential opportunities forward, referencing the frameworks of the TPB⁴⁴ and lock-in effects⁴¹.

Our study reveals that BEPs in both the Global North and South hold positive attitudes toward biodiversity despite their diverse value patterns associated with nature. These values resonate with the multiple ways in which individuals conceive a good quality of life, as discussed in the IPBES report^{4,49}. For instance, *Enthusiasts* who support prioritizing biodiversity in all sorts of planning practices hold an ecocentric worldview, while the *Pluralist* recognizes the interconnectedness of systems, exhibiting a more pluricentric worldview. Regarding specific values, both *Enthusiasts* and *Contextualists* tend to acknowledge the intrinsic value of biodiversity, whereas *Pragmatists* appear to celebrate its instrumental value more. Despite these diverse value patterns, all BEPs favor BIPD and are willing to integrate it into their practices. This is evident from the consensus statement among BEPs that they will not overlook biodiversity information if it is made available and that they support the statutory incorporation of BIPD across perspectives.

However, BEPs perceive a disconnect between their ecological values and attitudes and the viewpoints of their stakeholders, over which they feel limited perceived behavioral control and seek assistance from additional data and methods beyond their current professional knowledge. All BEPs, except for *Pragmatists*, identify a major struggle in conveying the significance and urgency of biodiversity to stakeholders. In their view, the challenge is not due to BEPs' reluctance or resistance, but rather a mismatch between BEPs' ecological values and attitudes and those of their stakeholders – namely, residents, officials, clients,

and others – acting as a significant barrier to the implementation of BIPD. To cope with this mismatch, BEPs discussed their attempts primarily in their engagement-related suggestions, including engaging the public, promoting education, and synergizing biodiversity with other public interests. Such coping approaches rested within their accustomed professional knowledge; however, BEPs also felt a sense of insufficiency when addressing such challenges by solely relying on their current knowledge. For instance, *Enthusiasts*, who experience a heightened struggle to convey the significance of biodiversity to their stakeholders, place greater hope in acquiring additional biodiversity-related knowledge, as evidenced by a high proportion (66.7%) of knowledge-related suggestions. These suggestions encompass a broad array of ways of accessing data and methods, case studies, and multidisciplinary collaborations. *Pluralists* made similar knowledge-related suggestions, but in a more balanced manner alongside other categories of suggestions, and they also emphasized the importance of sufficient details in the example methods of SDMs to help convey the significance of biodiversity while engaging with stakeholders.

Regarding the challenges associated with structural barriers, BEPs demonstrate varying degrees of perceived control. Unlike previous studies emphasizing inadequate legislation as a significant barrier⁴², BEPs in our study favor the statutory incorporation of BIPD while feeling a stronger sense of control over this barrier. This sense of control is supported by BEPs' professional norms, as rules-in-use enable them to operate beyond the structural barriers of legislation, which exist as rules-in-form, to better serve the public interest⁵⁰. Consequently, some BEPs, particularly *Pluralists* and *Enthusiasts*, generally view themselves as capable of transcending legislation and regulations, regarding this as an integral part of their role and professional ethical conduct in the decision-making process and in fostering a better urban future. This flexibility and potential for innovation reduce the degree of structural lock-in⁴⁴ for them and reveal opportunities to act on BIPD involving BEPs' expertise.

In contrast, BEPs' perceived control over the structural-physical barriers⁴¹, such as land use conflicts and competing resources, is more limited with their current expertise alone. Both *Contextualists* and *Pluralists* mentioned their dilemma in balancing the competing agendas of biodiversity with the socioeconomic public interest, particularly in the Global South, when their stakeholders are often economically locked in⁴¹ and require innovative, tailored solutions. They either experience a sense of vulnerability beyond their control or address these competing agendas by prioritizing the socioeconomic needs of the public or postponing biodiversity considerations to the future. In this context, BEPs often feel they lack options. As a result, their actions may reflect a path dependency that prioritizes socioeconomic needs while downgrading biodiversity considerations, potentially attracting

criticism for resistance to change with their socio-technical regime⁴². However, it seems likely that BEPs struggle more due to their inadequate capacity to engage stakeholders and collaboratively move towards BIPD than from their attitudinal resistance to change. For instance, upon learning about SDM examples for the first time, some *Pluralists* expressed that this data-rich evidence would help facilitate stakeholders' understanding of the significance of biodiversity, demonstrating a strong interest in these data and methods and an expectation that such biodiversity evidence would assist in addressing the challenges of competing agendas, combined with their expertise in consensus building with stakeholders.

From the previous discussion, we can observe a pattern in which BEPs resort to additional biodiversity knowledge when they exhaust resources within their existing professional toolkits to address the challenges of misaligned values and structural-physical barriers. This is evidenced by the fact that they proposed the highest number of suggestions within the Knowledge-related category. Interestingly, BEPs did not endorse the statement that their lack of ecological knowledge is a major barrier in the Q-sort. One possible explanation for this contradiction may lie in BEPs' lack of awareness of their own ecological knowledge deficits. Previous studies¹⁶ have pointed out BEPs' lack of empirical ecological knowledge; however, a more pressing issue is that many BEPs may simply be unaware that such ecological data and methods exist. Without this foundational awareness of such knowledge, it may be challenging for them to accurately assess whether their lack of ecological knowledge constitutes a major barrier or not, let alone incorporate it into their practices. When presented with relevant data and methods, BEPs immediately express interest and perceive them as helpful, particularly in that the explicit and visual representations, supported by sufficient data, help speak to the sense and sensibility of the stakeholders so that they would care. Nevertheless, in addition to recognizing their usefulness, some *Pluralists*, particularly with previous experience of the SDM examples, voiced concern regarding the applicability of these tools, suggesting that currently available data and methods developed in urban ecology may not be readily actionable for prescribing real-world solutions. These findings reinforce existing research that emphasizes the knowledge gaps and disciplinary silos hindering BIPD^{39, 40} and further highlight the critical absence of basic awareness among many BEPs regarding the existence of ecological data and methodologies. Consequently, our findings emphasize the necessity of strategies that promote positive changes by empowering BEPs with a deeper understanding of advancements in ecological knowledge and improving the practical applicability of these methodological advancements from ecologists.

Having discussed the three identified challenges and their coping strategies, we find promising opportunities for realizing BIPD by learning from the perspectives of a broader

profile of BEPs. First, BEPs exhibit positive attitudes toward biodiversity despite their varying value patterns associated with nature. Their professional norms facilitate adaptive changes by involving biodiversity in their practices. They are willing to overcome structural regulatory barriers and bridge gaps in values and attitudes with stakeholders through public engagement and consensus-building initiatives. If equipped with better biodiversity knowledge, particularly through evidence-based and readily applicable tools, BEPs may experience improved perceived control in communicating effectively with their stakeholders during these initiatives regarding competing structural-physical conflicts, facilitating a collaborative transition towards BIPD.

A consensus among all perspectives indicates that BEPs will not overlook biodiversity data if it is available to them. Specifically, BEPs are likely to act quickly when they are aware of advancements in biodiversity knowledge, informed on how to access such data, employ relevant methods, or understand whom to consult or collaborate with. *Pluralists* and *Enthusiasts* demonstrate a greater willingness to acquire more knowledge, proposing various Knowledge-related suggestions, including increasing data availability and methodological awareness, drawing inspiration from successful case studies, and pursuing collaborations with other disciplines.

Learning from BEPs' perspectives, not all challenges are equally difficult. The more pressing barrier impeding BIPD lies in the fact that biodiversity data and methods have not yet been made available and applicable for BEPs. This echoes similar claims in related fields emphasizing disciplinary silos and knowledge gaps^{16,26,39,42}. However, in addition to this, primary efforts should not only focus on raising awareness and understanding of biodiversity knowledge among BEPs, as emphasized by ecologists^{16,39}, but also on providing accessible biodiversity data and methods to BEPs, especially those urgently in need and those that are practically applicable. In our findings, for a broader profile of BEPs across sectors, professional backgrounds, and geographical regions globally, the vast majority have very limited awareness of the existence of biodiversity data, tools, and knowledge advances made by ecologists. Furthermore, those few BEPs with experience in BIPD expressed concern that the tools developed by ecologists are not easily applicable in urban planning and design practices. In this study, BEPs from various perspectives indicate that a key direction for the much-needed advances is the development of applicable evidence-based tools to facilitate effective communications in engaging with urban stakeholders for a collective transformative shift toward biodiverse cities.

This is hardly a single disciplinary effort. An imperative step forward is to collaboratively advance biodiversity knowledge and build multidisciplinary evidence^{51,52} to empower BEPs

with accessible data and applicable tools. Our findings suggest that the common ground between the two disciplinary perspectives may already exist⁴⁰. A noteworthy example is the *Pluralist* perspective identified in our study, which is widely shared among BEPs and aligns well with the value turn recently promoted within the conservation ecology community^{4,52}, transitioning from “nature for itself” to “nature for people”⁵³. Another example is the *Enthusiast* perspective, characterized by a propensity for ecocentric values. These practitioners may radically approach a biodiverse urban future and exhibit greater openness to adapting new methods and collaborating with ecologists. Additionally, we have identified some novel research endeavors along this line in urban ecology, such as incorporating urban ecology data and methodological advances into the standard planning and design framework^{12,24}, balancing scientific measures and community meaningfulness in selecting target species and developing biodiversity objectives in an urban renewal project³⁷. Still, further research is needed to better understand how to facilitate transdisciplinary knowledge advancement and awareness. For instance, further studies could explore the methods and tools that BEPs consider applicable in BIPD, strategies to transfer the knowledge advance and narrow gaps between urban ecologists and BEPs, and the role of biodiversity in setting objectives for BIPD.

In conclusion, our research challenges the notion that BEPs resist incorporating biodiversity into their practices by broadly exploring their viewpoints. Conversely, BEPs appreciate biodiversity and demonstrate both the desire and ability to overcome legislative structural barriers to implement BIPD. Insights from their perspectives reveal that the primary challenge hindering BIPD is the unavailability and inapplicability of biodiversity data and methodologies for BEPs. To fully leverage their potential and reshape urban environments, it is vital to equip BEPs with accessible biodiversity information and collaborate with them to create pragmatic, applicable solutions, especially in developing evidence-based tools for effective communication with urban stakeholders. This is particularly crucial in more challenging regions, such as the Global South, where contextualized strategies through stakeholder co-production are necessary. Transdisciplinary collaboration, with increased partnerships between ecologists and BEPs from diverse geographic areas and professional backgrounds, could elevate biodiversity considerations from advocacy to essential elements within comprehensive plans and urban renewal initiatives. This could lead to meaningful changes and potentially mainstream BIPD to transform cities into biodiversity-rich areas.

Methods

2.1 Q methodology

We employ Q methodology, a mixed quantitative and qualitative research technique⁵⁴, to illustrate BEPs' typology of viewpoints on BIPD. This methodology has been increasingly utilized in conservation and sustainability research^{55,56}. Q methodology employs factor analysis to statistically identify patterns of perspectives based on participants' rank-sorting of items, allowing for interpretation and comparison of these perspective patterns⁵⁷. While Q methodology is typically applied to understand viewpoints within a single geographical location, it can also be used to analyze viewpoints across multiple locations⁵⁴.

To involve BEPs from both the Global North and South, we selected the United States, Spain, China, and Ethiopia as our case study countries, each characterized by distinctive levels of national urbanization rate⁴⁷ and national GDP per capita, purchasing power parity (PPP)⁴⁸. We also purposively sampled BEPs in these four countries to ensure diversity (Table 1), engaging those who may not typically have an interest in the topic of urban biodiversity across built-environment disciplines, including ecological-environmental and socioeconomic focus areas, and public, private, and non-profits sectors. We recruited 36 participants with professional experience ranging from 6 to over 30 years, yielding an average of 14.2 years of experience. Considering the diverse profile of the participants and the scarcity of BIPD practice, the vast majority of the recruited BEPs may not have knowledge or experience of BIPD.

To facilitate specific and concrete interviews, we briefly introduced BIPD and utilized examples of species distribution modeling and mapping^{31,34} to present a vivid illustration and enhance understanding. This research received ethical approval from the Universidad Politecnica de Madrid (UPM) (reference No. UAPGIAAESO-JAM-DATOS-20231114) before commencing, and all participants signed informed consent to participate.

2.2 Q statements

We initially conducted thirteen semi-structured interviews from December 2023 to February 2024 to develop a concourse of 340 statements⁵⁷, reflecting BEPs' intentions to incorporate BIPD in their practices. We inductively coded the interview transcripts using NVivo 12⁵⁸ and categorized the statements into four themes: Environmental Concerns, Attitudes, Subjective Norms, and Perceived Behavioral Control (TPB)^{44,46}. The last theme of TPB included Understanding Silos and Lock-in Effects⁴¹.

From this coded concourse, we selected 25 representative statements to match with the P-sample of 23 participants for Q-sorting interviews⁵⁹. These statements were edited for clarity and relevance across countries and cultures while retaining the original meaning (Table 3). The statements were translated into Chinese and Spanish, and the translations were

validated by both ecologists and BEPs native in these languages for use in China and Spain. For participants in Ethiopia, we communicated in English, having consulted their language preferences. English is widely used alongside their federal working language, Amharic, across all sectors in Ethiopia; for example, the nation's Constitution is written in both English and Amharic⁶⁰. We tested the Q-set with two respondents to ensure the statements were clear, comprehensive, and suitable to conduct for both face-to-face and online settings.

2.3 Conducting Q sorts

The Q sorts and post-sort interviews took place between March and April 2024. Each interview lasts between 60 and 90 minutes. We carried out all Q sorts using the Q-Tip platform (<https://qtip.geography.wisc.edu/>), a free online tool for conducting Q-method research developed by the University of Wisconsin-Madison. Participants were asked to sort the 25 statements onto a nine-column distribution board from Q-Tip (Fig. 1) based on their opinions regarding the extent to which they agreed or disagreed with each statement relative to others. During the post-sort interviews, we first discussed the participants' sorts and then posted two follow-up questions. The first question aimed to capture BEPs' proposed strategies by asking for their top three suggestions for approaches that they believe would help integrate BIPD into urban practice. The second question sought to gauge their intentions for change by having them select from a five-point Likert scale to rate how BIPD should be incorporated into the legal framework, ranging from "not necessary," "conceptual," "non-statutory" to "statutory" (Table 4).

2.4 Q analysis

Following standard analytical processes in Q Method⁵⁷ and recommendations to minimize bias⁶¹, we analyzed the Q sorts using the R package 'qmethod' version 1.8.4.⁶² and Ken-Q Analysis software version 2.0.1⁶³. After computing intercorrelations among individual Q sorts, we extracted four factors using Principal Components Analysis with eigenvalues greater than 1.77 and applied Humphrey's rule to test the retention of these factors. The cumulative explanatory variance of these four factors was 70.8% (Table 2). We used the default Varimax rotation and retained the automatically flagged defining sorts for each factor, with the resulting minimum factor loading exceeding 0.60.

To aid in interpretation, we consulted the composite ideal sorts (Table 3 and Fig. 1), as aggregated by Ken-Q Analysis software⁶³, which represent a shared viewpoint for each factor. Further, we employed NVivo 12⁵⁸ to organize each factor's post-sort interview transcripts and gain insights into participants' perspectives through illustrative quotes.

Data Availability: All data generated or analyzed during this study are provided where possible in this paper, though individual responses and comments have not been provided to maintain confidentiality. The corresponding author can be reached for reasonable requests.

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