Referee Comment 2

General Comments

Comments	Responses
This MS addresses an important and timely question and is supported by a valuable field dataset. The integration of carbon stocks, sources, and stability into a single framework is interesting, and the finding that shifts in carbon sources and stability may precede carbon stock losses is potentially important. Generally the MS is well written	We sincerely thank you for your positive evaluation of our manuscript.
However, some aspects of the conceptual framing and interpretation could be strengthened, particularly regarding the attribution of observed patterns to urbanization and the consideration of alternative explanations.	We sincerely thank you for raising this important comment. Following your suggestion, we further refined the overall logic of the manuscript, with particular emphasis on clarifying the conceptual boundaries of our framework and avoiding overinterpretation of causal relationships. Specifically, we clarified the conceptual relationships among the three core dimensions of the triad framework, namely carbon stocks, organic carbon source contributions, and carbon stability, and emphasized that their coordinated variations collectively represent the integrated responses of blue carbon ecosystems along urbanization gradients. In the Discussion, we further considered the potential influence of regional environmental differences, including tidal characteristics, hydrodynamic conditions, and sediment supply, on the interpretation of our observations. Accordingly, we moderated statements implying direct causal effects of urbanization on carbon dynamics and clarified that our conclusions primarily reflect associations identified from a natural gradient comparison design. Furthermore, we clarified that “carbon anchors” and “instability fronts” do not represent universally applicable ecosystem states or classifications, but rather conceptual scenarios summarizing the observed combinations of habitat types and urbanization levels within our study system. These revisions have improved the

	applicability and interpretative rigor of our conceptual framework.
2. Introduction: This part does a good job of motivating the study. The authors clearly identify two important gaps: (1) stock, source and stability components of blue carbon have largely been studied separately, and (2) we still know relatively little about how these components vary across habitats along urbanization gradients. However, I think several aspects of the conceptual development could be strengthened.	We sincerely appreciate your recognition and positive comments regarding the conceptual framework and underlying motivation of this study. Following your suggestion, we further clarified the conceptual relationships among the three core dimensions of the triad framework, namely carbon stocks, organic carbon source contributions, and carbon stability. We also further clarified the relationship between urbanization gradients and ecosystem types by explicitly stating that urbanization levels represent gradients of anthropogenic disturbance intensity at the regional scale, whereas natural mangroves, restored mangroves, and unvegetated tidal flats represent distinct habitat states. In addition, we refined the study hypotheses to better reflect habitat-specific responses. Specifically, H3 has been revised as follows: "Soil-carbon stability is expected to be higher under lower urbanization pressure, but this effect should be strongest in natural mangroves and weaker or more variable in restored mangroves and tidal flats because of differences in belowground development, geomorphic maturity, and source stability." These revisions have improved the conceptual clarity of our framework and strengthened the alignment between our hypotheses, and study design. We appreciate your constructive suggestion and hope that the revised manuscript will be suitable for publication.

Specific Comments

Comments	**Responses**
1. Abstract: The same underlying concepts are introduced using several different expressions (e.g., "how much carbon is stored, who supplies it, and how long it persists", "stocks, sources, and stability", and the "triad framework"). While these terms appear to refer to the same ideas, switching	We sincerely appreciate the valuable comment. We have carefully reviewed and revised the relevant statements in the Abstract of the revised manuscript. Specifically, we have further clarified the conceptual relationships among the three core dimensions of soil organic carbon

terminology within a short abstract makes the narrative harder to follow. I suggest introducing the preferred terminology early and using it consistently throughout.	characteristics, including carbon stocks, carbon sources, and carbon stability. At the beginning of the Abstract, we introduced consistent terminology definitions to improve the connections among different expressions, avoid potential ambiguity, and enhance the overall logical coherence and readability. Meanwhile, we have retained the term "triad framework" as the name of the conceptual framework to emphasize that it integrates three complementary dimensions of soil organic carbon characteristics: stocks, sources, and stability. This revision improves the clarity and consistency of the conceptual description throughout the Abstract.
1. Abstract: L22–25 The transition from the main findings to the introduction of the framework feels somewhat abrupt. A brief linking sentence explaining how the findings led to the development of the framework would help improve the logical flow.	Thank you very much for your valuable comment. We have revised the Abstract to improve its logical coherence and readability by adding transitional statements between the main findings and the conceptual framework. Specifically, the original sentence "We introduced a triad framework that treats stocks, sources, and stability as coupled state variables along the urbanization gradient and identified two reproducible system states: carbon anchors in low urbanization natural mangroves and instability fronts in restored stands and tidal flats." has been revised to "These concurrent changes motivated the development of a triad framework that treats stocks, sources, and stability as coupled state variables along the urbanization gradient. Within this framework, we identified two representative ecosystem scenarios: carbon anchors in low urbanization natural mangroves and instability fronts in restored stands and tidal flats.". These additions will clarify how the results support the proposed framework, thereby strengthening the overall flow and clarity of the Abstract.
1. Abstract: L25–27 The terms "connectivity" and "accretion" are introduced only in the final sentence of the abstract. Because they have not been mentioned previously, their role in the proposed framework is not immediately clear. Consider introducing them earlier or briefly explaining how they contribute to the diagnostic framework.	Thank you very much for your valuable comment. Considering the word limit of the Abstract and that the core focus of this framework is to integrate three dimensions of soil organic carbon characteristics, namely organic carbon stocks, organic carbon sources, and organic carbon stability, we have retained "connectivity" and

	"accretion" within the framework application section rather than introducing these auxiliary concepts earlier in the Abstract. Following your suggestion, we have revised the related descriptions to improve the logical transitions and overall readability of the Abstract. These modifications help clarify the relationships among the framework components while avoiding unnecessary conceptual complexity, thereby enhancing the accessibility and coherence of the Abstract.
2. Introduction: One issue is that the Introduction discusses several specific stabilization mechanisms (e.g. MAOM and Fe/Al-bound carbon), but these mechanisms are not clearly linked to the hypotheses. As a result, the hypotheses feel somewhat disconnected from the framework developed in the preceding paragraphs. It would be helpful to add a short mechanistic explanation of why urbanization is expected to affect these stabilization pathways, and how this leads to the predictions being tested	We sincerely thank you for raising this important point. We agree that the original manuscript did not sufficiently clarify the link between the discussion of stabilization mechanisms, such as mineral-associated organic matter (MAOM) and Fe/Al-bound carbon, and the hypotheses proposed in this study, which may have weakened the logical connection between the theoretical background and our predictions. Following your suggestion, we have added further explanations of these mechanisms in the revised Introduction. Specifically, human disturbances may influence organic matter–mineral interactions by altering organic matter inputs, sedimentary environmental conditions, and redox states, thereby regulating carbon preservation and turnover processes. These potential stabilization processes may affect SOC turnover dynamics and provide a theoretical basis for interpreting the SOC turnover rate variations assessed using the β parameter in this study.
2. Introduction: I also found the relationship between the urbanization gradient (low, moderate and high) and the habitat categories (natural, restored and tidal flat) somewhat unclear. These represent different ecological dimensions, and it would be useful to explain more explicitly how they fit together within the conceptual framework of the study. Related to this, the three study regions are located in different parts of the Guangdong coastline and may differ in important environmental characteristics such as tidal regimes, hydrodynamics and sedimentation processes. A brief discussion of	Thank you very much for this important comment. We agree that urbanization intensity and habitat type represent two distinct ecological dimensions and that their relationship required clearer explanation. We have therefore revised the Introduction to clarify that urbanization represents the regional intensity of anthropogenic pressure, whereas natural mangroves, restored mangroves, and unvegetated tidal flats represent contrasting habitat states. Our conceptual framework evaluates how soil-carbon stocks, source composition, and stability vary among these habitat types

why these locations can be treated as an urbanization gradient, and how potential geographic confounding is addressed, would strengthen the rationale of the study.	under different levels of urban pressure, rather than treating habitat type as a component of the urbanization gradient. We have also expanded the rationale for selecting Zhanjiang, Shantou, and Huizhou as representatives of low, moderate, and high urbanization, respectively. Urbanization intensity was quantified using four socioeconomic indicators: the proportion of the urban population, the proportion of the non-agricultural population, per capita disposable income of urban residents, and built-up area. These indicators consistently distinguished the three cities along an increasing urbanization gradient. We nevertheless recognize that the three cities occupy different sections of the Guangdong coastline and may differ in tidal regime, hydrodynamics, sediment supply, and other environmental characteristics. Because each urbanization level is represented by one city, geographic variation cannot be completely separated from urbanization in this observational design. We have now stated this limitation explicitly and have revised the manuscript to avoid interpreting the observed patterns as effects of urbanization independent of all regional environmental differences. Instead, we interpret them as habitat-specific soil-carbon responses associated with contrasting levels of urban development across subtropical coastal settings. Where available, measured local environmental variables were incorporated into the analyses and interpretation to reduce the influence of site-level heterogeneity. These revisions clarify how the two dimensions fit within the study design and provide a more transparent account of the strengths and limitations of treating the three regions as an urbanization gradient.
2. Introduction: I found H3 to be relatively broad compared with the mechanistic framework presented earlier in the Introduction. The prediction that lower urban	We sincerely thank you for this valuable suggestion. We agree that the original formulation of H3 was relatively broad and did not sufficiently emphasize the habitat-

pressure leads to greater stability is intuitively reasonable, but it does not fully exploit the habitat-specific framework developed in Paragraph 4) I think the hypothesis would be more interesting if it made a more specific prediction about how different habitat types are expected to respond to urbanization, particularly whether restored habitats are expected to converge towards natural reference systems under lower levels of urban pressure.	specific responses implied by our conceptual framework. In response, we have revised H3 to make the prediction more explicit across habitat types. The revised hypothesis now states that soil-carbon stability is expected to be higher under lower urbanization pressure, but that this effect should be strongest in natural mangroves and weaker or more variable in restored mangroves and tidal flats because of differences in belowground development, geomorphic maturity, and source stability. We also carefully considered the suggestion regarding whether restored mangroves converge toward natural reference systems under lower urbanization pressure. We agree that this is an important and interesting question. However, testing convergence would require a sampling design with comparable natural and restored mangroves across all urbanization levels, particularly including natural mangroves under moderate urbanization. Because such sites were not available in the present dataset, we cannot robustly test convergence toward natural reference conditions without exceeding the scope of our study. Accordingly, we have revised the hypothesis and the corresponding text in the Introduction to better reflect habitat-specific expectations, while avoiding an unsupported convergence claim. We have also noted in the Discussion that future studies with balanced natural and restored reference systems across urbanization gradients would be valuable for directly testing restoration convergence.
2. Introduction: L50-55 it's better to add the references.	References have been added.
3. Discussion: Throughout Section 4, many paragraphs begin with phrases such as "Our results suggest...", "Our data show...", or "Our results indicate...". While not problematic individually, their repeated use becomes noticeable and can make it difficult to identify which analyses support a given conclusion. Given the diverse evidence presented in this study (SOC stocks, ^{210}Pb	Thank you very much for your valuable and constructive comment. We have systematically revised the relevant sections of the Discussion in the manuscript by reducing the repetitive use of generic expressions such as "our results suggest/indicate," and by explicitly linking each statement to its corresponding evidence to improve clarity and readability.

dating, stable isotopes, and turnover metrics), I encourage the authors to refer more directly to the relevant indicators or analytical approaches when discussing specific findings.	For example, "Our results suggest…" has been revised to "Results of soil organic carbon stocks and burial rates suggest…," while "Our results indicate…" has been revised to "Soil organic carbon turnover rate results indicate…". These revisions enhance the precision of interpretation and improve the logical flow between different analytical results.
3. Discussion: In Sections 4.1 and 4.2, the discussion links the stronger decline in carbon stocks and the shift towards more labile carbon sources in restored stands and tidal flats largely to urbanization. However, some of the mechanisms invoked, such as young substrates, lower structural complexity, and underdeveloped root systems, are also characteristic of these habitats regardless of urban pressure. The discussion would benefit from more clearly distinguishing habitat maturity effects from urbanization effects	Thank you very much for your valuable comment. In response, we have revised the Discussion section of the manuscript to further distinguish between the effects of habitat maturity (or successional stage) and urbanization on soil organic carbon stocks and carbon source composition.
3. Discussion: The study design captures a clear urbanization gradient across the three regions. However, these locations also differ in their geographic and geomorphic settings and may vary in hydrodynamics, sediment characteristics, and natural accretion processes. Some observed differences in carbon burial and stability may therefore reflect regional environmental variation in addition to urbanization. A brief discussion of these potentially confounding factors would strengthen the interpretation of the results.	Thank you very much for this important comment. We agree that the three study regions differ not only in urbanization intensity but also in geographic and geomorphic setting, including tidal regime, hydrodynamics, sediment supply, sediment properties, and natural accretion processes. Because each urbanization level is represented by a single region, these regional differences cannot be fully separated from urbanization in the present observational design. We have therefore revised the Discussion to acknowledge this potential geographic confounding and to temper causal interpretations of the observed patterns. Specifically, we now interpret the differences in carbon burial and stability as responses associated with contrasting urbanization contexts rather than as effects attributable exclusively to urbanization. We also discuss how variation in hydrodynamics, sediment characteristics, and natural accretion may have contributed to the differences among regions.

	This limitation does not negate the consistent changes observed across carbon stocks, sources, and stability, but it constrains the extent to which the relative contribution of urbanization can be isolated from regional environmental variation. Future studies should replicate multiple independent coastal systems within each urbanization category and incorporate direct measurements of tidal dynamics, sediment supply, and geomorphic setting to separate urbanization effects from geographic heterogeneity more robustly.
3. Discussion: Section 4.4 introduces the concepts of "carbon anchors" and "instability fronts" as contrasting system states. While these categories provide a useful synthesis of the observed patterns, their broader applicability may currently be overstated. The study includes multiple habitat types and urbanization levels, and other combinations not represented by these end-members could potentially produce different responses. I suggest presenting these states as scenarios identified within this study system rather than broadly transferable categories.	Thank you very much for your valuable comment. In response, we have revised the Discussion section to clarify that “carbon anchors” and “instability fronts” are defined as typical scenarios identified within the framework of this study, used to summarize the key response patterns observed across different habitat types and urbanization levels, rather than representing universally applicable system states or broadly generalizable classifications. This revision further clarifies the scope of the conceptual framework and avoids overextending its general applicability.
3. Discussion: The proposed framework is built around responses across habitat types and urbanization levels. However, the absence of natural mangroves at the moderate urbanization level leaves one part of the conceptual matrix unrepresented. It would be helpful to acknowledge this limitation and discuss how it affects interpretation of the proposed framework and its generality.	Thank you very much for this important comment. We agree that the absence of natural mangroves at the moderate urbanization level leaves the habitat by urbanization matrix incomplete. We have therefore revised the Discussion to acknowledge that the present design cannot fully characterize the continuous response of natural mangrove soil carbon across the entire urbanization gradient or determine whether the carbon anchor state weakens gradually or shifts abruptly at intermediate levels of urban pressure. This limitation does not invalidate the observed contrasts among the sampled habitat and urbanization combinations, but it restricts our ability to estimate habitat by urbanization interactions and to generalize the proposed framework as a fully resolved response model. We now clarify that the framework should be interpreted as a conceptual diagnostic derived from the

	available observational evidence, rather than as a complete factorial representation of all habitat states across all urbanization levels. Future studies should adopt a fully crossed design that includes natural and restored mangroves and tidal flats at each urbanization level, ideally with multiple independent regions within each category. Such replication would allow the continuity, thresholds, and generality of the proposed carbon anchor and instability front states to be tested more rigorously.