Ocean and Society
2025 • Volume 2 • Article 10319
https://doi.org/10.17645/oas.10319

cogitatio

ARTICLE

Open Access Journal

Transformation Across Land-Sea Governance: Future Research Opportunities

Tegan Evans [1], Gianluca Ferraro [1], and Pierre Failler [2]

[1] Centre for Blue Governance, University of Portsmouth, UK
[2] UNESCO Chair in Ocean Governance

Correspondence: Tegan Evans (tegan.evans@port.ac.uk)

Submitted: 13 March 2025 **Accepted:** 14 May 2025 **Published:** 21 July 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Transformation is heralded as a solution to the diverse and interconnected crises threatening natural environments and the livelihoods of those who depend on them. Coastal governance does not exist in a vacuum, and integrated land-sea governance systems are a potential solution to the triple planetary threat of climate change, increasing pollution and biodiversity loss. A systematic literature review was undertaken to identify whether transformation is understood in a consistent manner across land-sea governance systems and to identify the status of knowledge regarding transformation across these scales to identify future research priorities. The results suggest that transformation is an emerging concept in freshwater governance compared to the well-established discussions of saltwater governance transformations. Of the 135 articles identified, 26 explicitly identified transformation, with only one article not positioning transformation as a radical social change, suggesting that a shared definition is emerging across the land-sea interface. A total of 62 case studies of transformation were identified across saltwater and freshwater environments, with articles detailing case study analyses of tools and approaches for transformation numbering 34, suggesting that place-based knowledge and analyses of transformation are well established in the literature, but that the tools or approaches to change are fragmented. These findings suggest a growing but uncoordinated body of work, which emphasises the need for future research into shared definitions, the role of transitional waters such as estuaries, and the governance landscapes that create transformation.

Keywords

blue governance; coastal governance; land-sea governance; marine governance; ocean governance; transformation; water governance

© 2025 by the author(s), licensed under a Creative Commons Attribution 4.0 International License (CC BY).

1. Introduction

Coastal environments are where global crises such as climate change, biodiversity loss, and increasing pollution are felt most tangibly through impacts such as coastal erosion, sea level rise, and the degradation of ecosystems that communities are reliant on (Armitage et al., 2017; Elliott, 2013). Solutions to such crises are called for across the land-sea interface, with governance often identified as the scale at which change should take place (Hulme, 2009). Coastal governance is an arena where multiple actors, interests, institutions, and processes co-exist and interact through various scales, sectors, and governance domains. It is the frontline where global agendas, local priorities, and resource constraints compete and coalesce into action and are experienced by local communities (Clement et al., 2024; Gerhardinger et al., 2020). Governance provides a crucial link between both social and ecological systems and represents a considerable leverage point for change, given its influence over planning and management (Clement et al., 2024). The challenges and limitations of coastal governance are well-defined in the literature, including ineffective and sectorally fragmented governance structures (Bausero-Jorcin et al., 2024; Blythe et al., 2021). The result of these deficiencies enable the continuing over-exploitation of diverse resources, habitat destruction, and species loss in critical estuarine, coastal, and marine resources at national, regional, and international levels (Elliott, 2013; Kelly et al., 2019; Rudolph et al., 2020).

At a time when the urgency of global crises is driving increased attention to identifying and operationalising solutions for transformation, the need to stocktake and understand the best ways forward is critical. An approach that prioritises and enables multiple wins across holistic systems is necessary. Coastal governance does not exist within a vacuum, and it is well established that the land-sea interface is inherently interconnected and complex, biophysically through the movement of material, organisms, and nutrients (Ensor et al., 2021) and socially through culture, economics, and reliance on resources (Barceló et al., 2024; Singh et al., 2021). These interconnections take place across the continuum of ocean, marine, coastal, water, and riverine environments (Gerhardinger et al., 2018). Land-sea governance is the integration of multiple layers of coastal, marine, and inland governance systems, managing both water and land-based activities.

Coupled with the impact of global crises, the ineffectiveness of governance has led to demands for transformation (Järnberg et al., 2023). The call for transformation in coastal and related ocean spaces has been made at diverse scales, including at the community level (Choudhury et al., 2021) and the national government level (Amundsen et al., 2018). Transformation has been positioned as a solution to global crises increasingly in literature (Bai et al., 2016; Fazey, Moug, et al., 2018; Fazey, Schäpke, et al., 2018; O'Brien, 2012), yet it remains a contested concept, fragmented in meaning and interpretation across diverse disciplines (Evans et al., 2023). Several different conceptualisations of transformation in ocean governance exist. In general, transformation can be defined in two separate ways: a radical, fundamental, and fast change that results in an unrecognisable system; or a slower, shallower, stepwise, and incremental process of change (Evans et al., 2023, 2024; O'Brien, 2012). As such, identifying which definition of transformation is most prevalent across the land-sea interface is important to ensure that future change is not paralysed by different definitions (Evans et al., 2025). Formal reviews by Evans et al. (2023) and Blythe et al. (2021) have led to a well-established understanding of the different characteristics of transformation. As such, transformation can be categorised into different meanings based on their theoretical backgrounds (Evans et al., 2023; Feola, 2015; Nalau & Handmer, 2015; Patterson et al., 2017), resulting in different definitions which in turn lead to opposing methods or principles applied in pursuit of achieving transformative change.

To date, there has been limited engagement between the concept of transformation and land-sea governance, meaning that establishing the baseline status of knowledge across these diverse spatial scales is imperative to direct future research more efficiently. Identifying whether the transformation has a consistent definition across land-sea governance systems is imperative from a theoretical perspective and for several practical reasons. From a theoretical perspective, Wittgenstein (1953) argues that for language to be meaningful, it needs to be consistent despite its need to be grounded within its use. More recently, the importance of consistency has been reasserted by Davelaar (2021), who identifies the importance of a consistent understanding of what transformation is and what it entails across complex scales. From a practical perspective, a common definition of transformation is required to ensure that action is synergistic across diverse spatial scales. In addition, a common definition of transformation is important to prevent greenwashing, whereby unsustainable practices are permitted under the guise of sustainability (Hamilton & Ramcilovic-Suominen, 2023). A common language across diverse spatial and related governance delineations would provide an entry point for change efforts towards a holistic approach to managing across the land-sea interface (Abson et al., 2017). Finally, ambiguity or conflicting definitions would present significant barriers to enacting transformation (Evans et al., 2023).

The aim of this literature review is therefore to identify and evaluate the status of knowledge and practice of transformation across the governance of the land-sea interface by examining how transformation is defined, understood, and operationalised and whether a common understanding of transformation exists. The analysis focuses specifically on how water is governed across the land-sea interface. Understanding how transformation is defined across land-sea governance systems—the what—is critical to understand if a common definition can be leveraged for change (Evans et al., 2025). Secondly, outlining the status of knowledge regarding key methods, tools, or principles used to create transformative change—the how—will provide insight into what approaches or avenues of transformation are common across different geographies and systems (Bentz et al., 2022). By drawing on these comparative insights, the findings of this review are used to recommend a future research agenda for transformation across land-sea governance. Section 2 outlines why exploring transformation across land-sea governance systems is necessary, followed by the methodological approach in Section 3. The results are detailed in Section 4, followed by the discussion and conclusions in Sections 5 and 6.

2. A Justification for Land-Sea Governance

Governing across the land-sea interface is a potentially transformative solution to many challenges facing the health and conservation of environments that are ultimately connected by water from both inland and offshore sources, including rivers and oceans (Tocco et al., 2024). The demand and call for integration in environmental, and particularly coastal governance, is not new, and stems from concerns regarding institutional fragmentation (Smith et al., 2011). Regional legal instruments such as the European Maritime Spatial Planning Directive 2014/89/EU, to some extent, advocate for governing across the land-sea interface through Articles 4(2) and 6(2)(a) and Article 7, although this is deemed insufficient (Zaucha et al., 2025) the Water Framework Directive 2000/60/EC also extends to 3 nautical miles offshore, further suggesting a rationale for land-sea governance. However, what land-sea governance looks like in practice remains poorly defined and characterised (Maragno et al., 2020; Neimane, 2020; Ramieri et al., 2024; Tocco et al., 2024). In practice, approaches that combine land and sea governance are unusual. Land and sea governance are separate, and often conflicting, spheres of governance that include policies, strategies, and

legal instruments to govern diverse activities (O'Hagan et al., 2020; Schlüter et al., 2022). Catalysed by the recognition that the health of a river will ultimately influence the health of coastal and marine environments, it is clear that solutions that promote more holistic governance structures are needed to ensure coherent and coordinated governance (Lawlor & Depellegrin, 2023; Partelow et al., 2020)

However, governance and management across the land-sea interface rarely consider these biophysical and social interdependencies, which instead are mostly considered distinct with unique priorities, approaches, and paradigms. This has previously been justified as necessary, due to the different actors, policies, resources, and conflicts present at each stage. The academic debate surrounding pathways to achieve integration of governance of land-sea governance is evolving (Tocco et al., 2024) along with growing consensus for change in the way oceans, seas, coastlines, and catchment areas are governed (McLaughlin, 2010; Rochette et al., 2015). Research regarding practical approaches to governing and managing the land-sea interface is growing (Pittman & Armitage, 2016). For example, Innocenti and Musco (2023) outline potential spatial approaches for management across the land-sea interface. Additionally, Pittman and Armitage (2016) explore how current institutions govern the land-sea interface, while Morf et al. (2022) explore how existing management approaches could consider the land-sea interface. Given the uncertainty and overlapping priorities and scales at play in land-sea governance (Banikoi et al., 2023), change is usually complex, necessitating a transformative approach (Ramesh et al., 2015).

Opportunity exists here to transform land-sea governance by creating governance systems that incorporate the complexity and overlaps. A promising and innovative way this land-sea interface has been embedded into policy is the African Union's (2019) Blue Economy Strategy, where the blue economy encompasses groundwater, rivers, lakes, coastal, and marine environments. However, examples such as this are scarce due to the complexity of managing such diverse environments holistically. To understand how transformation can be achieved across land-sea governance, it is necessary to outline firstly what transformation means across these domains, and how solutions are idealised.

3. Methods

3.1. Systematic Review Protocol

A systematic literature review was used to understand and outline the divergent interpretations of transformation used across varying spatial dimensions of the land-sea interface. Systematic reviews have been used in transformation literature (Evans et al., 2023) and in literature exploring land-sea governance (Pittman & Armitage, 2016) and are valuable tools in appraising the current status of knowledge and identifying future research needs. This article represents the first attempt at combining the two fields through a systematic review process.

The land-sea interface was segmented into different common spatial dimensions, and Boolean search terms were used, as outlined in Table 1. Search terms from an ocean perspective included "ocean," "marine," "coastal," and "blue," which represent the distinct spatial forms of governance that exist spatially. From a land-based water perspective, "watershed" and "catchment" search terms were used. These terms are deliberately broad, with the assumption that such terms would capture diverse forms of governance within these framings, including riverine—and lake-based governance. Various other land-based water search terms

Table 1. Search terms and justification.

Search term	Justification
Blue	An emerging paradigm related to blue growth, blue carbon, and the blue economy (Auad & Fath, 2022). Although used more commonly in socio-economic discussions, the spatial extent of "blue" differs depending on the context and can just include the ocean or more holistic interpretations of water for example through the inclusion of rivers, lakes, groundwater, marine, and coastal environments (AU-IBR, 2019).
Marine	A general descriptor that can be used to describe coastal areas to oceanic zones. Marine is most often used as a spatial descriptor of national governance and management approaches, such as marine spatial planning (Ramieri et al., 2024).
Ocean	A spatial description that specifically relates to offshore waters. Governance and management approaches can include sustainable ocean plans (Haas et al., 2021; High Level Panel for a Sustainable Ocean Economy, 2022).
Coastal	Coastal areas relate specifically to where land and ocean meet. Coastal governance and management tools include integrated coastal zone management (Pittman & Armitage, 2016).
Watershed	A watershed refers to drainage basins that include rivers, lakes, and streams. Watershed governance and management approaches include integrated water resource management (Volenzo & Odiyo, 2018).
Catchment	A catchment can refer to more specific or smaller watersheds and is often used in governance and management. Catchment governance and management also includes integrated water resource management and catchment plans.

were initially considered and rejected due to the volume of literature that was generated, the analysis of which would have been beyond the scope of this research to explore.

Based on the first search conducted, as evidenced in Table 2, watershed and catchment yielded extensive results and were thus deemed satisfactory for inclusion. It was challenging to identify appropriate search terms that would encompass a variety of governance systems, without being too granular and requiring numerous search terms and searches. The spatial terms outlined in Table 1 were chosen due to their ability to encompass a variety of spatial systems and their well-established governance works of literature. For example, a catchment is often used as a more localised form of governance but is also a part of a watershed, and the terms are often used interchangeably. Search terms were identified to capture literature engaging with governance processes, planning, and dynamics across the land-sea interface, and did not include specific legal terminology such as "foreshore," which would have biased the sample towards legal analyses. From a spatial perspective, blue can generally refer to combined inland and offshore water-based environments or can instead refer to marine and ocean environments. Coastal, ocean, and marine environments exist along the same spatial continuum, but with overlapping spatial and governance considerations. It is acknowledged here that the explicit definitions associated with the search terms in Table 1 may be contested, however, the intent is to illustrate the lack of standardisation in the spatial considerations of these terms. Thus, the research leverages these inherent overlaps and synergies to explore whether transformation can be used as a concept for change across these inherently interconnected environments.

The first search was conducted on Scopus on the 20th of May 2024, and limited to peer-reviewed articles, book chapters, and reviews. It is recognised that the exclusion of "grey" literature, such as independently

published policy, research, and guidance, is a limitation of this research, and it is recommended that this be included in future analyses. Articles were included based on several exclusion and inclusion criteria, for example, articles needed to have been published after 2010 (when transformation first gained prominence in literature, immediately prior to the publication of Gelchich et al., 2010, a critical article in the field of transformation and marine governance), and written in English. The first search per spatial dimension yielded extensive results that needed refinement, as noted in Table 2. A second search for water-related governance was conducted on the 13th of August 2024, using the same search parameters for the search terms outlined in Table 1. Catchment as a search term occasionally returned distinct areas, such as estuaries, with their own complex governance arenas. Based on how these areas were related to the initial search term, decisions were made to include or exclude these papers. For example, Daniell et al. (2020) defined estuarine governance as biophysically belonging to catchments, river basins, and coastal areas, and further discussed and defined estuarine governance in this complex governance context. As such, this paper was included in the analysis as it contributed to the research objectives.

The identified papers were subject to two screening processes. The first focused on the content of the abstract. Papers that did not include "transformation" in the abstract, or did not discuss governance were removed. At this stage, duplicates across the searches were identified and recategorised to the most appropriate spatial category. The second stage of screening included a content search in-text of "transformation" and "governance" to further refine articles for analysis. At this stage, papers were removed depending on the way transformation was described. For example, papers that used transformation as a geophysical descriptor, including describing geomorphology or land use changes, such as Bellaubi et al. (2021), were excluded from the analysis. Papers were also removed depending on how "governance" was used in the paper. For example, if governance was mentioned but not the focus or scope of the article, the paper was removed. Such refinements resulted in more manageable totals across spatial dimensions of transformation.

Table 2. Search terms and the results of the first search, abstract screening, and final content search.

Search terms	First search	Papers accepted following abstract screening and removal of duplicates	Papers accepted following content screening
"Ocean," "governance," and "transformation"	84	25	23
"Marine," "governance," and "transformation"	118	23	22
"Coastal," "governance," and" transformation"	162	46	38
"Blue," "governance," and" transformation"	62	4	4
"Catchment," "transformation," and "governance"	1,091	37	25
"Watershed," "governance," and "transformation"	1,051	40	23
Total	2,568	175	135

3.2. Coding and Analysis

A mixture of deductive and inductive techniques were used for analysis to understand the status of knowledge of transformation across different spatial scales and to understand the character of transformation (Baumann et al., 2023). Firstly, a deductive structured coding framework was initially used, informed by the research questions and similar to the approach used by Zimmermann et al. (2023). In this approach, accepted papers were categorised based on location in the land-sea interface, geographic scale and location, type of paper, keywords, and location of the article. These were later clustered into broader categories, outlined in Table 3, to facilitate comparative analyses based on similar locations in the land-sea interface. These high-level inventory style classifications allowed for an inventory of papers to be created for more targeted deep dives to be undertaken based on paper type and location within the land-sea interface, allowing for comparison across different spatial areas.

Following this initial categorisation, an inductive coding approach was used to explore how transformation was understood and theorised across the different spatial delineations identified (Table 3; Evans et al., 2023; Plummer et al., 2013). In this approach, each definition of transformation was coded inductively and thematically, resulting in codes such as "radical" and "incremental," which allowed for the synthesis of the general characteristics of transformation. The more granular "focus" of each article was also identified using keywords and a general assessment of the article, for example, whether the article was primarily focused on resilience. The tools analysed to create transformation were also explored through clustering and comparison across the different spatial delineations identified.

4. Results

4.1. General Findings

A total of 135 articles were identified for inclusion in the review following the screening protocol identified in Section 3 (a full list can be found in the Supplementary File, Table 1). The results of the final screening yielded diverse papers from different disciplinary domains, with transformation occasionally not being the sole focus of the article but instead a broader implication of the research. Articles were identified between 2010 and May 2024, when the first search began. 2017 marked a turning point in the rate of transformative literature published across all spatial areas identified, where the number of identified published papers in the review doubled and continued to grow (Supplementary File, Figure 1), suggesting that transformation in land-sea governance is still an early and evolving subject.

The review identified a range of articles that discussed transformative change in governance, spanning across diverse disciplines and perspectives (Supplementary File, Table 1). There was a mostly even spread of articles identified across the original spatial descriptions used for the Boolean search, except for "blue," which yielded four papers. This is unsurprising given its relatively recent traction in governance (Table 2). As outlined in Section 3, articles identified were further categorised into the specific location of the article in the land-sea interface addressed to allow for greater nuance and a clearer understanding of the status of literature, resulting in 11 distinct spatial categories across the land-sea governance system (Table 3). These categories were inductively categorised based on the results of the review, and are shown in Table 3. Water (n = 41), coast (n = 32), and ocean (n = 24) were the most popular categories, mostly linked to specific

geographic areas and case studies. For ease of analysis and comparison, they are clustered respectively into "saltwater" environments, transitional waters, and freshwater environments (Table 3).

To understand the types of transformative literature and to outline the status of knowledge, the type of article was categorised. These categories were identified through an inductive coding of the article's purpose and scope. The review identified six types of papers, the most common of which were place-based analyses (case studies) of transformation, which included either general studies of change or studies of specific tools or approaches for change (Table 3). Case studies of specific tools for change (n = 34) were common throughout saltwater environments, and most populous in water governance. Case studies of transformation (n = 62), except for "blue," were present across all land-sea environments. Calls for change (n = 11), which advocated for transformation as a result of conceptual arguments, opinions, or other analyses but did not test any pathways or tools to achieve change, were mostly limited to saltwater environments such as marine, ocean, and blue governance. One theory paper was identified in water governance that instead focused on the theoretical foundations of transformation. Tools for change (n = 23), which proposed different ways of achieving transformation but did not test these in any place-based analyses, were most populous across coast, marine, ocean, and water categories.

Table 3. Areas of land-sea governance against types of paper-coded.

	Specific category	Call for change	Case study	Guidance for transformation	Theory	Tool for change	Tool for change/case study
Saltwater	Blue	3	0	0	0	0	1
	Coast	1	17	2	0	5	7
	Marine	2	9	0	0	2	5
	Ocean	2	7	2	0	9	4
	Marine and coastal	0	2	0	0	1	0
Transitional waters	Water	3	16	0	1	6	15
	Land-sea interface	0	1	0	0	0	1
	Estuary	0	1	0	0	0	0
Freshwater	Catchment	0	1	0	0	0	0
	River basin	0	5	0	0	0	1
	Wetlands	0	3	0	0	0	0
Total		11	62	4	1	23	34

71% of the articles identified were linked to a specific geographic location such as continents, countries, and regions (Supplementary File, Table 1). Most of these papers were specific case studies of change processes, or case studies where tools for transformation were tested (Figure 1). 29 separate countries were identified as case studies or case studies where tools of transformation were explored (Supplementary File, Figure 2 and Table 1). 23 articles included multiple countries. When compared at a continental level, in general, there was a fairly even spread of articles across continents, suggesting a growing field of empirical study of transformation. Europe had nine case studies, and Asia, South America, and North America had seven case studies each. Africa and Oceania had five case studies each (Figure 1). Specific countries with the highest number of articles included Brazil (n = 7), Canada, Australia, and South Africa (n = 6 each). 11 countries had

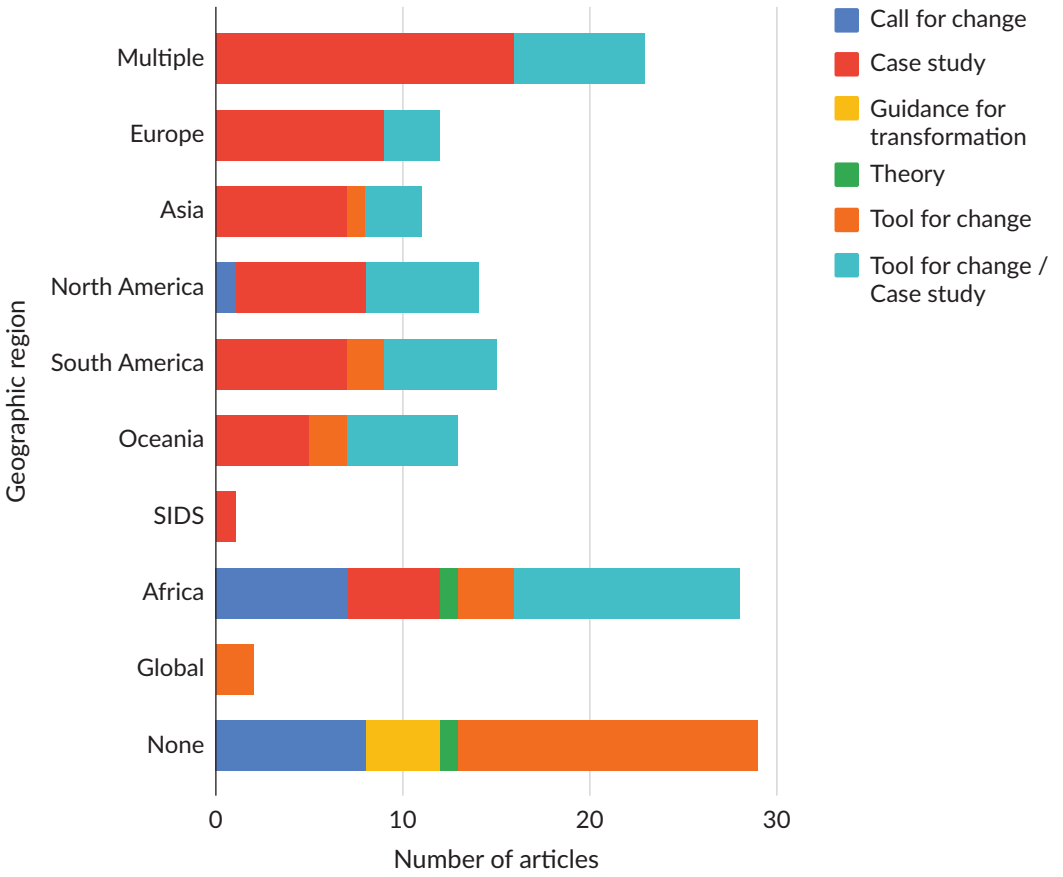

Figure 1. Geographic regions and types of paper identified.

only one article identified each, including Iran, Indonesia, Portugal, and the Maldives (Supplementary File, Table 1). The remaining papers not linked to a geographic location were mostly arguments and conceptualisations of different tools for change that were not linked to a case study (n = 16) and calls for change (n = 8; Supplementary File, Table 1).

In summary, there is a growing body of empirical research regarding transformation across land-sea governance. Water governance was the most popular category, yet difficult to parameterise and define, with the commonality across articles being that they concerned "water." Diverse article types were identified, including case studies of transformation in situ, ranging in scale from communities and sector-specific governance to national and regional approaches, to theoretical articles outlining considerations for transformative change. The high number of case study papers suggests an analytical turn to understanding how transformations occur, yet these tend to be national in scope.

4.2. The "What": Defining Transformation

Of the 135 articles identified in this analysis, only 26 (18%) provided a definition of transformation, representing a significant limitation in asserting which definitions of transformation can be leveraged for change across land-sea governance. Of the 26 articles that did define transformation, one conflated the concepts of transition (Ferguson et al., 2013), meaning that only 25 provided an explicit definition solely of

transformation, as the two concepts are not interchangeable (Hölscher et al., 2018). Of the 25, six were definitions of the author's conception, ranging in detail from institutional change (Dale et al., 2018) to detailed descriptions of the character of transformation (Schlüter et al., 2021). All but one definition of transformation described such change as being radical or fundamental in nature, representing a change that must address deeply entrenched norms, processes, and structures in order to facilitate the depth of change required (Temper et al., 2018). One article contrasted this perspective; Clement et al. (2024) described transformation as being incremental in character, which contrasted the prevailing view, and instead advocated for smaller, stepwise changes.

Of these 25 papers with definitions, 13 were case studies of change, six were evaluations of tools of change in a case study, five were descriptions of tools of change, and one provided guidance for transformation. Eight of the 25 papers with a definition of transformation were coastal, seven focused on water, and five focused on the ocean. Marine and coastal had two articles coded each, and catchment and land-sea interface had one definition each. These findings suggest that a more cohesive and standard understanding of transformation exists in coastal, water, and ocean literature.

These findings indicate that an early common understanding of transformation can be identified across land-sea governance systems, with this understanding of transformation being a radical and wide-ranging change. While the total number of papers that explicitly define transformation is small, areas for future research can be identified, as discussed in Section 5.

4.3. The "How": Understanding Methods, Tools, and Approaches to Transformation

Methods, approaches, or tools for transformation were diverse (Supplementary File, Table 1). In total, 57 articles discussed tools for transformation (including case studies where tools were evaluated). Tools are diverse, ranging from well-established concepts such as legitimacy, justice, and adaptive governance to more niche tools, such as virtualism, hope, and social networks (Supplementary File, Figure 3). Except for water ($n = 19$), most articles were identified in saltwater categories, with ocean ($n = 12$), coast ($n = 11$), and marine ($n = 7$) having the highest number of articles. In general, there were high levels of diversity across the types of tools identified, with 32 unique tools identified (Supplementary File, Figure 3). Only 14 tools had more than one article coded and identified (Figure 2). Resilience and adaptive governance, often linked to climate change adaptation, were the most identified, with resilience being identified in coastal literature ($n = 2$), and ocean and water governance literature ($n = 1$ each). The six most prevalent methods for transformation are all rooted in social science literature and approaches, representing well-established fields such as resilience, adaptation, stakeholder engagement, justice, and knowledge (Figure 2).

In addition to these more nuanced spatial categories, the scale of the article was also categorised to provide deeper insight into the distribution of tools for transformation. For example, national scale studies were most common, with 10 case studies, eight studies of tools of change in case studies, and four articles exploring tools for change. Community-level studies were the second most common with nine case studies and seven analyses of tools for change in specific case studies (Supplementary File, Figure 4).

In summary, diverse methods, tools, and approaches for transformation were identified, with limited consensus regarding the tools identified. Despite this, nearly all tools and approaches identified were

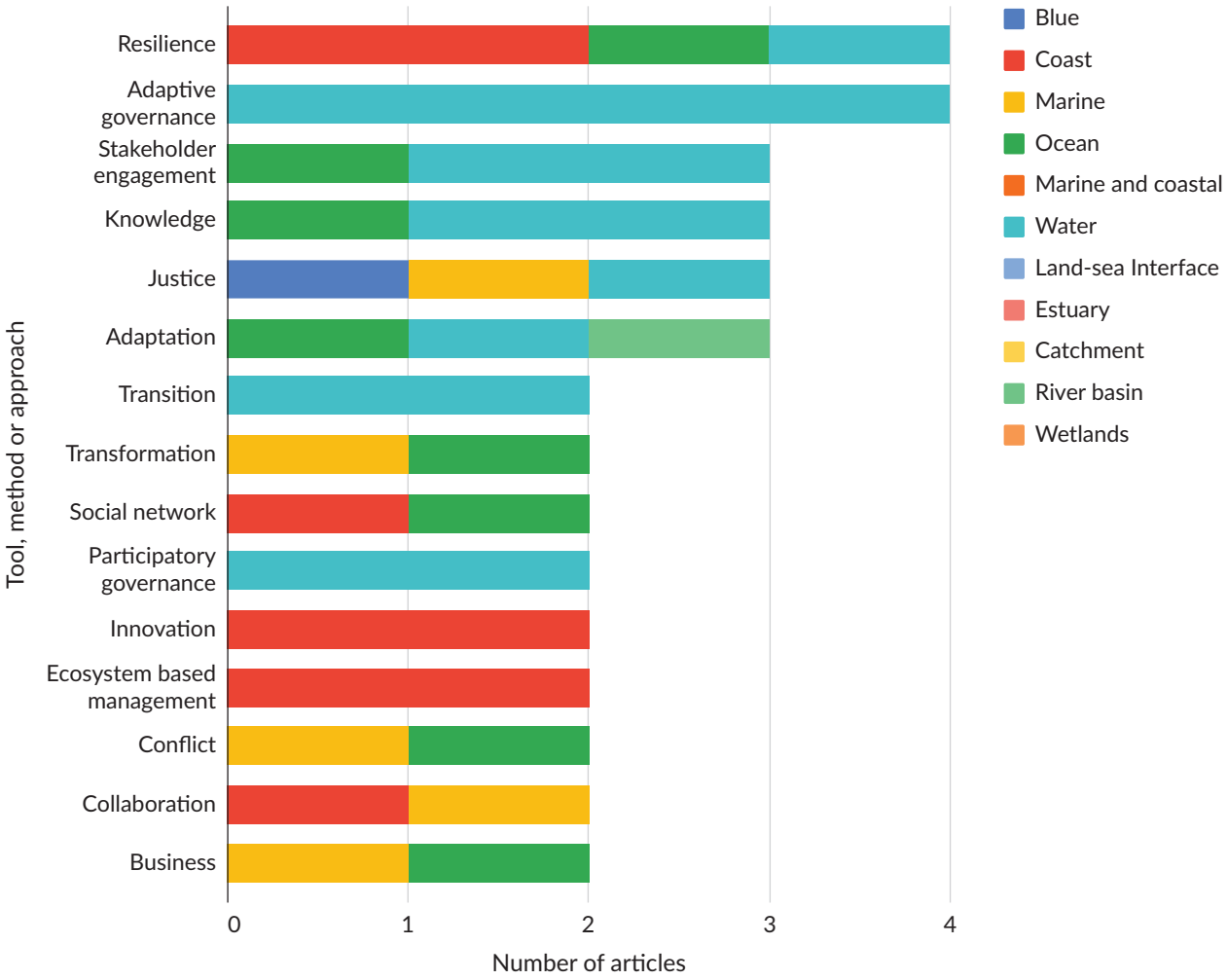

Figure 2. Number of tools, methods, and approaches identified across articles.

fundamentally social in character, suggesting that across land-sea governance systems, social tools can be leveraged to create change. It was also identified that tools for transformation are more established in saltwater governance than in freshwater.

5. Discussion

5.1. The "What": Comparing Definitions of Transformation

To generate a research agenda for transformation across land-sea governance, the status of knowledge and evidence must be appraised and common ground identified. Necessitated by the fact that divergent definitions of transformation can have implications for the nature and character of change that is employed to achieve it (Davelaar, 2021; Evans et al., 2025), this review has sought to identify opportunities for future research. Building on existing theoretical frameworks of transformation (Evans et al., 2023; Nalau & Handmer, 2015), the review identified an emerging common language of transformation across land-sea governance. Transformation was regarded as an inherently "fundamental" and socio-ecological process of change that mirrors existing literature. However, the finding that only 21 papers of 135 explicitly define

transformation suggests that across land-sea governance domains, a common understanding is still nascent. The lack of specific definitions of transformation adds weight to the assertion that definitions of transformation are generally assumed to be a widely agreed-upon concept, which presents major risks and challenges to the creation of transformative solutions (Evans et al., 2024).

Building on these synergies, the social character of transformation was observed across all definitions except one. In freshwater governance, transformation was particularly regarded by several articles as a process that expands beyond governance structures and processes driven by societal dependence on the health of water environments (Jentoft & Chuenpagdee, 2022; Knieper & Pahl-Wostl, 2016). Knieper and Pahl-Wostl (2016) recommend that the transformation of water governance be achieved through broader societal transformations towards sustainable water practices as a "whole of society" approach, including behaviour change, rather than focusing on the mitigation of such pressures. This mirrors approaches advocated for in catchment governance (Pringle et al., 2023) and ocean governance (Bennett et al., 2021). As explored in Section 5.2, this characterisation leads to significant opportunities to explore interconnected social tools and approaches to creating transformation.

Connected to the limited explicit definitions of transformation, are the contradictory calls for transformation across saltwater and environmental governance. Calls for change tended to be saltwater-centric (Bouwer et al., 2022; Jentoft & Chuenpagdee, 2022; Nagy & Nene, 2021) with fewer calls for change across freshwater governance, mirroring the assertion from Albrecht et al. (2023, p. 50) that water governance literature "lacks a nuanced, empirically reasoned, understanding of intentional change…[and] transformation." This suggests that transformation is more regarded as a desired solution in saltwater governance, and recognition of the drivers of transformation remains nascent in freshwater governance. Opportunity exists for a broader reflection of the drivers of change in freshwater governance systems, which will ground truth and contextualise transformative interventions. The review also identified limited articles that provided guidance for transformation, with guidance only identified in coastal governance (Kuhl et al., 2021) and ocean governance (Lombard et al., 2023). Opportunity therefore exists to create specific guidance for transformation across land-sea governance through a more detailed synthesis of the wealth of case studies identified in this research. Such guidance should include identifying common barriers and enablers of transformation, reflecting the practical experiences of transformation in motion.

5.2. The "How": Comparing Methods, Tools, and Approaches to Transformation

Understanding how transformation has been achieved throughout diverse case study contexts and scales is necessary to identify the best practices, potential barriers to change, and to understand potential synergies in approaches across spatial scales in land-sea governance systems. The abundance and diversity of case studies identified in this research, including those evaluating specific tools or approaches to transformation, is surprising, given previous demands for more empirical and localised studies of transformation in governance systems (Blythe et al., 2021; Evans et al., 2023). Case studies were identified across all identified categories of the land-sea interface, except for "blue," which remains an evolving concept. Case studies ranged in scale, with the most common being national-level analyses, but detailed analyses of transformative processes tended to be localised, for example, focusing specifically on marine small-scale fisheries (Chuenpagdee & Jentoft, 2022). Specific gaps exist regarding case studies of transformation in African states, Oceania, the Middle East, and SIDS, where little literature was identified suggesting specific research priorities. In addition, there is a

significant opportunity for greater comparative analysis across case studies to identify regional and contextual conditions shaping transformation. A significant opportunity exists to undertake a large-scale synthesis of these case studies to identify consistent barriers and opportunities to transformation.

A wealth of tools and approaches to achieve transformation were identified, the majority of which were social in character, mirroring the "whole of society" approach often identified. The majority of tools and approaches identified had isolated examples of use, suggesting that tools for transformation remain nascent. This confirms the argument that further research regarding transformation's practical applications is needed to identify how transformation is achieved in land-sea governance, mirroring the demand for practical tools for change in general transformational literature (Bai et al., 2016; Fazey, Schäpke, et al., 2018; O'Brien, 2012). Few tools were identified more than twice in literature, with the most discussed approach being resilience, although only four articles identified it in total, suggesting that this is still a potential niche approach to transformation. Alternatively, it may suggest the tools are not regarded as transferable and are instead tailored for a specific context. In general, no specific tool or approach to transformation can be considered common across land-sea governance, although the social character of the most common tools of change does represent a significant entry point into designing transformative interventions. For example, despite the overarching focus of the articles analysed being distilled into a singular category for the purposes of this research, many categories are interconnected and interdependent. The difficulty in identifying definitive tools for transformation may reflect broader conceptual and terminology inconsistencies in the literature regarding land-sea governance.

The interdependencies of social processes and tools for transformation were also observed. Power and knowledge were positioned by Jentoft and Chuenpagdee (2022) as having the combined potential to transform institutions of governance. For example, justice is positioned by Biancardi Aleu et al. (2022) as a way to reimagine the purpose of participatory governance processes in water governance (Foster et al., 2016). Recognising the interconnections of multiple pathways to transformation is critical in achieving change. A specific opportunity exists to link concepts of justice that were identified across the water, blue, and marine systems and explore how these can relate to freshwater governance systems and is an area for future research. Despite limited examples identified in this study regarding the importance of justice in transformational change, broader literature positions the inclusion and mainstreaming of these approaches as fundamental to achieving transformation.

5.3. Limitations of the Review and Future Research Suggestions

Several challenges were identified in this review of land-sea governance transformations, the most significant being the lack of conceptual clarity surrounding water governance. Reflecting the inherent conceptual challenges of governance, and exacerbated by the additional conceptual challenges of transformation, the ability to clearly articulate the inclusions and exclusions of water governance would be critical to identifying synergies and conflicts across land-sea governance. The growing importance of transformation in water governance, driven by climate change and the importance of water quality and access, represents an imperative for future research (Räsänen et al., 2019). As evidenced in this review, transformation in traditional saltwater governance systems is well-characterised, and its barriers and limitations are well-established. In contrast, only one article explicitly explored the concept of transformation in water governance and appraised the concept and its utility (Pahl-Wostl, 2020; Pahl-Wostl

et al., 2020). Pahl-Wostl (2020) identifies significant barriers to transformation in water governance, regardless of scale or context, that align with the barriers of saltwater governance.

Despite water being the overall most populous category, water was a difficult category of governance to delineate in this study. The scale of water governance is different to discern and depends on the context it is applied to, resulting in very different focuses and priorities, making common ground difficult to identify. For example, whether water governance includes a domestic river basin, transboundary basins, or water supply systems is often not clear (Knieper & Pahl-Wostl, 2016). Water governance, as evidenced in this review, has a similar diversity of scopes and spatial considerations, with limited consensus regarding what falls within or beyond its scope. The broadness of what is considered "water" was challenging to disaggregate into further categories for spatial comparison. Research to date has focused mostly on individual cases of water governance, yielding "substantially different" governance focuses, with limited synthesis of the general characteristics of water governance (Dale et al., 2018, p. 71). Thus, a significant future research opportunity lies in untangling what are the essential scope, characteristics, and parameters of "water" governance, which will provide a comparative baseline for future research.

Meissner and Jacobs (2016) suggest complexity theory as a pathway to understanding water governance, specifically as a way to understand the complicated networks as a way to understand diverse actors across international river basins. Building on the well-established characterisation of traditional saltwater governance as a messy and fragmented arena, with multiple priorities, actors, and perspectives shaping governance at different scales (Banikoi et al., 2023), complexity theory offers a way to understand interconnections between land-sea governance. Complexity theory centralises the dynamic, interconnected nature of both governance systems, and represents a significant pathway for further research (Folke, Carpenter, et al., 2004; Folke, Hahn, et al., 2005). Additionally, complexity theory lends well to adaptive governance, which was identified in this review as a potential tool or approach for change (Chaffin et al., 2016).

Governance of transitional environments, such as estuaries, was less explored in this review due to their lack of identification by the structured search protocol, representing a limitation of the study. Focusing on transitional environmental governance in the land-sea interface, such as estuaries, would be a valuable future research pathway, as land and sea-based governance do not manage these environments effectively (Daniell et al., 2020). Such transitional environments face both land-based and water-based pressures, and there is an urgent need to focus research on the governance of such areas to explore how these transitional areas can inform broader governance transformations.

Finally, the systematic review undertaken has several inherent methodological limitations, such as the potential for selection bias in the initial filtering phase or unintentional bias in reporting (Owens, 2021). The protocols used in this review aim to ensure that the results are transparent and reproducible, particularly through the reporting of the search terms in Table 1 and the full list of accepted articles in Supplementary File, Table 1. The exclusion of grey literature from the search terms is also a limitation of the study, which presents an interesting avenue of further study regarding how transformation and, particularly, the tools of transformation are operationalised.

6. Conclusion

In summary, while there is growing recognition of the need for transformation across land-sea governance systems, challenges remain in defining the concept clearly and developing practical tools for implementation. In particular, water governance remains fragmented as a concept with diverse interpretations and limited consensus regarding scope. Additionally, a more detailed exploration of transitional water environments, such as estuaries, should be prioritised as these were not identified in this study. This review has outlined the status of scientific knowledge surrounding the conceptualisation and operationalisation of transformation across land-sea governance systems, highlighting the challenges of integrated complex governance systems. Future research should address these gaps, with a focus on empirical case studies, the development of common frameworks, and the application of complexity and adaptive governance theories.

The review has identified an early shared understanding of transformation across land-sea governance systems, which, potentially through further research, can be leveraged for future change. While the concept is widely discussed, only a small portion of the literature provides clear definitions, highlighting the need for a more standardised understanding of transformation to guide governance practices effectively. Further research identifying how the shared "social" character of transformation across land-sea governance can be effectively operationalised is needed. In addition, this review has provided an inventory of transformation as a concept across the land-sea interface, providing a geographic, spatial, and analytical catalogue of transformative solutions, theory, and practice. Finally, this review has provided a comprehensive catalogue of transformative tools and approaches across land-sea governance systems, offering valuable geographic, spatial, and analytical frameworks to guide future efforts.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024-2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Conflict of Interests

In this article, editorial decisions were undertaken by Raoul Beunen (Open University of the Netherlands, The Netherlands).

Supplementary Material

Supplementary files are not copy-edited nor proofread by the Editorial Office, and it is the authors' responsibility to guarantee the scientific accuracy of these files.

References

Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C. D., Jager, N. W., & Lang, D. J. (2017). Leverage points for sustainability transformation. *Ambio*, *46*, 30–39. https://doi.org/10.1007/s13280-016-0800-y

AU-IBAR. (2019). *Africa blue economy strategy*. https://faolex.fao.org/docs/pdf/au228027.pdf

Albrecht, E., Lukkarinen, J., Hakkarainen, M., & Soininen, N. (2023). Hydropowering sustainability transformation: Policy frames on river use and restoration in Finland. *Fennia—International Journal of Geography*, *201*(1), 47–64. https://doi.org/10.11143/fennia.120946

Amundsen, H., Hovelsrud, G. K., Aall, C., Karlsson, M., & Westskog, H. (2018). Local governments as drivers for societal transformation: Towards the 1.5°C ambition. *Current Opinion in Environmental Sustainability*, *31*, 23–29. https://doi.org/10.1016/j.cosust.2017.12.004

Armitage, D., Alexander, S., Andrachuk, M., Berdej, S., Brown, S., Nayak, P., Pittman, J., & Rathwell, K. (2017). Communities, multi-level networks and governance transformations in the coastal commons. In D. Armitage, A. Charles, & F. Berkes (Eds.), *Governing the coastal commons* (pp. 231–251). Routledge. https://www.taylorfrancis.com/books/9781317421283/chapters/10.4324/9781315688480-13

Auad, G., & Fath, B. D. (2022). Towards a flourishing blue economy: Identifying obstacles and pathways for its sustainable development. *Current Research in Environmental Sustainability*, *4*, Article 100193. https://doi.org/10.1016/j.crsust.2022.100193

Bai, X., van der Leeuw, S., O'Brien, K., Berkhout, F., Biermann, F., Brondizio, E. S., Cudennec, C., Dearing, J., Duraiappah, A., Glaser, M., Revkin, A., Steffen, W., & Syvitski, J. (2016). Plausible and desirable futures in the Anthropocene: A new research agenda. *Global Environmental Change*, *39*, 351–362. https://doi.org/10.1016/j.gloenvcha.2015.09.017

Banikoi, H., Schlüter, A., & Manlosa, A. O. (2023). Understanding transformations in the marine coastal realm: The explanatory potential of theories of institutional change. *Marine Policy*, *155*, Article 105791. https://doi.org/10.1016/j.marpol.2023.105791

Barceló, M., Tengö, M., Simonetti, J. A., & Gelcich, S. (2024). Exploring links between local knowledge, values and livelihoods in land-sea interface: Insights on emerging tradeoffs and change in Southern Chile. *Ecosystems and People*, *20*(1), Article 2329562. https://doi.org/10.1080/26395916.2024.2329562

Baumann, L., Riechers, M., Celliers, L., & Ferse, S. C. A. (2023). Anticipating and transforming futures: A literature review on transdisciplinary coastal research in the Global South. *Ecosystems and People*, *19*(1), Article 2288957. https://doi.org/10.1080/26395916.2023.2288957

Bausero-Jorcin, S., Gelcich, S., Gianelli, I., Jorge-Romero, G., Lezama, C., & Defeo, O. (2024). Assessing the performance of a participatory governance transformation in small-scale fisheries: A case study from Uruguay. *Marine Policy*, *160*, Article 105964. https://doi.org/10.1016/j.marpol.2023.105964

Bellaubi, F., Mallarach, J. M., & Sardá, R. (2021). A geoethical approach to unlock a social-ecological governance problem: The case of the Tordera River (Catalonia, Spain). *Sustainability*, *13*(8), Article 4253. https://doi.org/10.3390/su13084253

Bennett, N. J., Blythe, J., White, C. S., & Campero, C. (2021). Blue growth and blue justice: Ten risks and solutions for the ocean economy. *Marine Policy*, *125*, Article 104387. https://doi.org/10.1016/j.marpol.2020.104387

Bentz, J., O'Brien, K., & Scoville-Simonds, M. (2022). Beyond "blah blah blah": Exploring the "how" of transformation. *Sustainability Science*, *17*, 497–506. https://doi.org/10.1007/s11625-022-01123-0

Biancardi Aleu, R., Kløcker Larsen, R., & Methner, N. (2022). Participation and marginalization in water governance: Probing the agency of powerholders. *Ecology and Society*, *27*(4), Article 33. https://doi.org/10.5751/ES-13680-270433

Blythe, J., Armitage, D., Bennett, N., Silver, J. J., & Song, A. M. (2021). Conditions and cautions for transforming ocean governance. In J. Baird & R. Plummer (Eds.), *Water resilience: Management and governance in times of change* (pp. 241–261). Springer. https://link.springer.com/book/10.1007/978-3-030-48110-0

Bouwer, L. M., Cheong, S. M., Jacot Des Combes, H., Frölicher, T. L., McInnes, K. L., Ratter, B. M. W., &

Rivera-Arriaga, E. (2022). Risk management and adaptation for extremes and abrupt changes in climate and oceans: Current knowledge gaps. *Frontiers in Climate*, *3*, Article 785641. https://doi.org/10.3389/fclim.2021.785641

Chaffin, B. C., Garmestani, A. S., Gunderson, L. H., Benson, M. H., Angeler, D. G., Tony, C. A., Cosens, B., Craig, R. K., Ruhl, J. B., & Allen, C. R. (2016). Transformative environmental governance. *Annual Review of Environment and Resources*, *41*, 399–423. https://doi.org/10.1146/annurev-environ-110615-085817

Choudhury, M.-U.-I., Haque, C. E., & Hostetler, G. (2021). Transformative learning and community resilience to cyclones and storm surges: The case of coastal communities in Bangladesh. *International Journal of Disaster Risk Reduction*, *55*, Article 102063. https://doi.org/10.1016/j.ijdrr.2021.102063

Clement, S., Jozaei, J., Mitchell, M., Allen, C. R., & Garmestani, A. S. (2024). How resilience is framed matters for governance of coastal social-ecological systems. *Environmental Policy and Governance*, *34*(1), 65–76. https://doi.org/10.1002/eet.2056

Dale, A. P., Vella, K., Gooch, M., Potts, R., Pressey, R. L., Brodie, J., & Eberhard, R. (2018). Avoiding implementation failure in catchment landscapes: A case study in governance of the Great Barrier Reef. *Environmental Management*, *62*, 70–81. https://doi.org/10.1007/s00267-017-0932-2

Daniell, K. A., Plant, R., Pilbeam, V., Sabinot, C., Paget, N., Astles, K., Steffens, R., Barreteau, O., Bouard, S., Coad, P., Gordon, A., Ferrand, N., Le Meur, P.-Y., Lejars, C., Maurel, P., Rubio, A., Rougier, J.-E., & White, I. (2020). Evolutions in estuary governance? Reflections and lessons from Australia, France and New Caledonia. *Marine Policy*, *112*, Article 103704. https://doi.org/10.1016/j.marpol.2019.103704

Davelaar, D. (2021). Transformation for sustainability: A deep leverage points approach. *Sustainability Science*, *16*, 727–747. https://doi.org/10.1007/s11625-020-00872-0

Elliott, M. (2013). The *10-tenets* for integrated, successful and sustainable marine management. *Marine Pollution Bulletin*, *74*(1), 1–5. https://doi.org/10.1016/j.marpolbul.2013.08.001

Ensor, J., Tuhkanen, H., Boyland, M., Salamanca, A., Johnson, K., Thomalla, F., & Lim Mangada, L. (2021). Redistributing resilience? Deliberate transformation and political capabilities in post-Haiyan Tacloban. *World Development*, *140*, Article 105360. https://doi.org/10.1016/j.worlddev.2020.105360

Evans, T., Fletcher, S., Failler, P., & Potts, J. (2023). Untangling theories of transformation: Reflections for ocean governance. *Marine Policy*, *155*, Article 105710. https://doi.org/10.1016/j.marpol.2023.105710

Evans, T., Fletcher, S., Failler, P., Fletcher, R., & Potts, J. (2024). Radical and incremental, a multi-leverage point approach to transformation in ocean governance. *Sustainability Science*, *19*, 1243–1258. https://doi.org/10.1007/s11625-024-01507-4

Evans, T., Fletcher, S., Failler, P., & Potts, J. (2025). Typologies of transformation—Visualizing different understandings of change for sustainability. *Sustainability*, *17*(9), Article 4075.

Fazey, I., Moug, P., Allen, S., Beckmann, K., Blackwood, D., Bonaventura, M., Burnett, K., Danson, M., Falconer, R., Gagnon, A. S., Harkness, R., Hodgson, A., Holm, L., Irvine, K. N., Low, R., Lyon, C., Moss, A., Moran, C., Naylor, L., . . . Wolstenholme, R. (2018). Transformation in a changing climate: A research agenda. *Climate and Development*, *10*(3), 197–217. https://doi.org/10.1080/17565529.2017.1301864

Fazey, I., Schäpke, N., Caniglia, G., Patterson, J., Hultman, J., van Mierlo, B., Säwe, F., Wiek, A., Wittmayer, J., Aldunce, P., Al Waer, H., Battacharya, N., Bradbury, H., Carmen, E., Colvin, J., Cvitanovic, C., D'Souza, M., Gopel, M., Goldstein, B., . . . Wyborn, C. (2018). Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. *Energy Research and Social Science*, *40*, 54–70. https://doi.org/10.1016/j.erss.2017.11.026

Feola, G. (2015). Societal transformation in response to global environmental change: A review of emerging concepts. *Ambio*, *44*, 376–390. https://doi.org/10.1007/s13280-014-0582-z

Ferguson, B. C., Brown, R. R., & Deletic, A. (2013). A diagnostic procedure for transformative change based on transitions, resilience, and institutional thinking. *Ecology and Society*, *18*(4), Article 57. https://doi.org/10.5751/ES-05901-180457

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., & Holling, C. S. (2004). Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics*, *35*, 557–581. https://doi.org/10.1146/annurev.ecolsys.35.021103.105711

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, *30*, 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Foster, N., Collins, K., Ison, R., & Blackmore, C. (2016). Water governance in England: Improving understandings and practices through systemic co-inquiry. *Water*, *8*(11), Article 540. https://doi.org/10.3390/w8110540

Gerhardinger, L. C., Andrade, M. M. D., Corrêa, M. R., & Turra, A. (2020). Crafting a sustainability transition experiment for the brazilian blue economy. *Marine Policy*, *120*, Article 104157. https://doi.org/10.1016/j.marpol.2020.104157

Gerhardinger, L. C., Gorris, P., Gonçalves, L. R., Herbst, D. F., Vila-Nova, D. A., De Carvalho, F. G., Glaser, M., Zondervan, R., & Glavovic, B. C. (2018). Healing Brazil's blue Amazon: The role of knowledge networks in nurturing cross-scale transformations at the frontlines of ocean sustainability. *Frontiers in Marine Science*, *4*, Article 395. https://doi.org/10.3389/fmars.2017.00395

Haas, B., Mackay, M., Novaglio, C., Fullbrook, L., Murunga, M., Sbrocchi, C., McDonald, J., McCormack, P. C., Alexander, K., Fudge, M., Goldsworthy, L., Boschetti, F., Dutton, I., Dutra, L., McGee, J., Rousseau, Y., Spain, E., Stephenson, R., Vince, J., . . . Haward, M. (2021). The future of ocean governance. *Reviews in Fish Biology and Fisheries*, *32*, 253–570. https://doi.org/10.1007/s11160-020-09631-x

Hamilton, R. T. V., & Ramcilovic-Suominen, S. (2023). From hegemony-reinforcing to hegemony-transcending transformations: Horizons of possibility and strategies of escape. *Sustainability Science*, *18*, 737–748. https://doi.org/10.1007/s11625-022-01257-1

High Level Panel for a Sustainable Ocean Economy. (2022). *100% sustainable ocean management: An introduction to sustainable ocean plans*. https://oceanpanel.org/wp-content/uploads/2022/06/21_REP_Ocean-SOP_v10.pdf

Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What's the difference? *Environmental Innovation and Societal Transitions*, *27*, 1–3. https://doi.org/10.1016/j.eist.2017.10.007

Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge University Press.

Innocenti, A., & Musco, F. (2023). Land–sea interactions: A spatial planning perspective. *Sustainability*, *15*(12), Article 9446.

Järnberg, L., Vulturius, G., & Ek, F. (2023). Strategic agency and learning in sustainability initiatives driving transformation: The symphony tool for ecosystem-based marine spatial planning. *Sustainability Science*, *18*, 1149–1161. https://doi.org/10.1007/s11625-022-01286-w

Jentoft, S., & Chuenpagdee, R. (2022). Interactive learning and governance transformation for securing blue justice for small-scale fisheries. *Administration and Society*, *54*(7), 1255–1282. https://doi.org/10.1177/00953997211073947

Kelly, C., Ellis, G., & Flannery, W. (2019). Unravelling persistent problems to transformative marine governance. *Frontiers in Marine Science*, *6*, Article 213. https://doi.org/10.3389/fmars.2019.00213

Knieper, C., & Pahl-Wostl, C. (2016). A comparative analysis of water governance, water management, and environmental performance in river basins. *Water Resources Management*, *30*, 2161–2177. https://doi.org/10.1007/s11269-016-1276-z

Kuhl, L., Rahman, M. F., McCraine, S., Krause, D., Hossain, M. F., Bahadur, A. V., & Huq, S. (2021). Transformational adaptation in the context of coastal cities. *Annual Review of Environment and Resources*, *46*, 449–479. https://doi.org/10.1146/annurev-environ-012420-045211

Lawlor, P., & Depellegrin, D. (2023). Managing land sea interactions: Case studies of coastal governance in four EU member states. In S. Partelow, M. Hadjimichael, & A-K. Hornidge (Eds.). *Ocean governance: Knowledge systems, policy foundations and thematic analyses* (pp. 209–230). Springer.

Lombard, A. T., Clifford-Holmes, J., Goodall, V., Snow, B., Truter, H., Vrancken, P., Jones, P. J. S., Cochrane, K., Flannery, W., Hicks, C., Gipperth, L., Allison, E. H., Diz, D., Peters, K., Erinosho, B., Levin, P., Holthus, P., Szephegyi, M. N., Awad, A., . . . Morgera, E. (2023). Principles for transformative ocean governance. *Nature Sustainability*, *6*, 1587–1599. https://doi.org/10.1038/s41893-023-01210-9

Maragno, D., dall'Omo, C. F., Pozzer, G., Bassan, N., & Musco, F. (2020). Land–sea interaction: Integrating climate adaptation planning and maritime spatial planning in the North Adriatic Basin. *Sustainability*, *12*(13), Article 5319.

McLaughlin, R. J. (2010). A review of coastal governance. *Ocean and Coastal Law Journal*, *16*(2), Article 12.

Meissner, R., & Jacobs, I. (2016). Theorising complex water governance in Africa: The case of the proposed Epupa Dam on the Kunene River. *International Environmental Agreements: Politics, Law and Economics*, *16*, 21–48. https://doi.org/10.1007/s10784-014-9250-9

Morf, A., Moodie, J., Cedergren, E., Eliasen, S. Q., Gee, K., Kull, M., Mahadeo, S., Husa, S., & Vološina, M. (2022). Challenges and enablers to integrate land-sea-interactions in cross-border marine and coastal planning: Experiences from the pan Baltic scope collaboration. *Planning Practice & Research*, *37*(3), 333–354. https://doi.org/10.1080/02697459.2022.2074112

Nagy, H., & Nene, S. (2021). Blue gold: Advancing blue economy governance in Africa. *Sustainability*, *13*(13), Article 7153. https://doi.org/10.3390/su13137153

Nalau, J., & Handmer, J. (2015). When is transformation a viable policy alternative? *Environmental Science and Policy*, *54*, 349–356. https://doi.org/10.1016/j.envsci.2015.07.022

Neimane, L. (2020, April 23–24). *Identifying challenges to implementation of maritime spatial plans in the Baltic States* [Paper presentation]. Proceedings of the 62nd Internafional Scienfific Conference of Daugavpils University, Daugavpils, Latvia.

O'Brien, K. (2012). Global environmental change II: From adaptation to deliberate transformation. *Progress in Human Geography*, *36*(5), 667–676. https://doi.org/10.1177/0309132511425767

O'Hagan, A. M., Paterson, S., & Le Tissier, M. (2020). Addressing the tangled web of governance mechanisms for land-sea interactions: Assessing implementation challenges across scales. *Marine Policy*, *112*, Article 103715. https://doi.org/10.1016/j.marpol.2019.103715

Owens, J. K. (2021). Systematic reviews: Brief overview of methods, limitations, and resources. *Nurse Author and Editor*, *31*(3/4), 69–72.

Pahl-Wostl, C. (2020). Adaptive and sustainable water management: From improved conceptual foundations to transformative change. *International Journal of Water Resources Development*, *36*(2/3), 397–415. https://doi.org/10.1080/07900627.2020.1721268

Pahl-Wostl, C., Knieper, C., Lukat, E., Meergans, F., Schoderer, M., Schütze, N., Schweigatz, D., Dombrowsky, I., Lenschow, A., Stein, U., Thiel, A., Tröltzsch, J., & Vidaurre, R. (2020). Enhancing the capacity of water governance to deal with complex management challenges: A framework of analysis. *Environmental Science & Policy*, *107*, 23–35. https://doi.org/10.1016/j.envsci.2020.02.011

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., Hornidge, A. K., Le Tissier, M., Pittman, J. B., Song, A. M., Sousa, L. P., Văidianu, N., & Van Assche, K. (2020). Environmental governance

theories: A review and application to coastal systems. *Ecology and Society*, *25*(4), Article 19. https://doi.org/10.5751/ES-12067-250419

Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., & Barau, A. (2017). Exploring the governance and politics of transformations towards sustainability. *Environmental Innovation and Societal Transitions*, *24*, 1–16. https://doi.org/10.1016/j.eist.2016.09.001

Pittman, J., & Armitage, D. (2016). Governance across the land-sea interface: A systematic review. *Environmental Science & Policy*, *64*, 9–17. https://doi.org/10.1016/j.envsci.2016.05.022

Plummer, R., Armitage, D. R., & De Loë, R. C. (2013). Adaptive comanagement and its relationship to environmental governance. *Ecology and Society*, *18*(1), Article 21. https://doi.org/10.5751/ES-05383-180121

Pringle, C. B., Meissner, R., Biggs, R., Pahl-Wostl, C., Stuart-Hill, S., & Sitas, N. (2023). Exploring social processes in transformation: The case of a collaborative water partnership in South Africa. *Ecosystems and People*, *19*(1), Article 2213780. https://doi.org/10.1080/26395916.2023.2213780

Ramesh, R., Chen, Z., Cummins, V., Day, J., D'Elia, C., Dennison, B., Forbes, D. L., Glaeser, B., Glaser, M., Glavovic, B., Kremer, H., Lange, M., Larsen, J. N., Le Tissier, M., Newton, A., Pelling, M., Purvaja, R., & Wolanski, E. (2015). Land–ocean interactions in the coastal zone: Past, present and future. *Anthropocene*, *12*, 85–98. https://doi.org/10.1016/j.ancene.2016.01.005

Ramieri, E., Bocci, M., Brigolin, D., Campostrini, P., Carella, F., Fadini, A., & Barbanti, A. (2024). Designing and implementing a multi-scalar approach to maritime spatial planning: The case study of Italy. *Marine Policy*, *159*, Article 105911.

Räsänen, A., Schönach, P., Jurgilevich, A., Heikkinen, M., & Juhola, S. (2019). Role of transformative capacity in river basin management transformations. *Water Resources Management*, *33*, 303–317. https://doi.org/10.1007/s11269-018-2103-5

Rochette, J., Billé, R., Molenaar, E. J., Drankier, P., & Chabason, L. (2015). Regional oceans governance mechanisms: A review. *Marine Policy*, *60*, 9-19.

Rudolph, T. B., Ruckelshaus, M., Swilling, M., Allison, E. H., Österblom, H., Gelcich, S., & Mbatha, P. (2020). A transition to sustainable ocean governance. *Nature Communications*, *11*, Article 3600. https://doi.org/10.1038/s41467-020-17410-2

Schlüter, M., Caniglia, G., Orach, K., Bodin, Ö., Magliocca, N., Meyfroidt, P., & Reyers, B. (2022). Why care about theories? Innovative ways of theorizing in sustainability science. *Current Opinion in Environmental Sustainability*, *54*, Article 101154. https://doi.org/10.1016/j.cosust.2022.101154

Schlüter, M., Lindkvist, E., & Basurto, X. (2021). The interplay between top-down interventions and bottom-up self-organization shapes opportunities for transforming self-governance in small-scale fisheries. *Marine Policy*, *128*, Article 104485. https://doi.org/10.1016/j.marpol.2021.104485

Singh, G. G., Cottrell, R. S., Eddy, T. D., & Cisneros-Montemayor, A. M. (2021). Governing the land-sea interface to achieve sustainable coastal development. *Frontiers in Marine Science*, *8*, Article 709947. https://doi.org/10.3389/fmars.2021.709947

Smith, H. D., Maes, F., Stojanovic, T. A., & Ballinger, R. C. (2011). The integration of land and marine spatial planning. *Journal of Coastal Conservation*, *15*, 291–303.

Temper, L., Kothari, A., Temper, L., Walter, M., Kothari, A., Sangam, V., & Turhan, E. (2018). A perspective on radical transformations to sustainability: Resistances, movements, alternatives. *Sustainability Science*, *13*, 747–746.

Tocco, C. L., Frehen, L., Forse, A., Ferraro, G., & Failler, P. (2024). Land-sea interactions in European marine

governance: State of the art, challenges and recommendations. *Environmental Science & Policy*, *158*, Article 103763. https://doi.org/10.1016/j.envsci.2024.103763

Volenzo, T. E., & Odiyo, J. (2018). Ecological public health and participatory planning and assessment dilemmas: The case of water resources management. *International Journal of Environmental Research and Public Health*, *15*(8), Article 1635. https://doi.org/10.3390/ijerph15081635

Wittgenstein, L. (1953). *Philosophical investigations*. Blackwell Publishing.

Zaucha, J., Gee, K., Ramieri, E., Neimane, L., Alloncle, N., Blažauskas, N., Calado, H., Cervera-Núñez, C., Kuzmanović, V. M., Stancheva, M., Witkowska, J., Schütz, S. E., Zapatero, J. R., & Ehler, C. N. (2025). Implementing the EU MSP Directive: Current status and lessons learned in 22 EU member states. *Marine Policy*, *171*, Article 106425.

Zimmermann, S., Dermody, B. J., Theunissen, B., Wassen, M. J., Divine, L. M., Padula, V. M., von Wehrden, H., & Dorresteijn, I. (2023). A leverage points perspective on Arctic Indigenous food systems research: A systematic review. *Sustainability Science*, *18*(3), 1481–1500. https://doi.org/10.1007/s11625-022-01280-2

About the Authors

Tegan Evans is a research fellow with the University of Portsmouth Revolution Plastics Institute and Centre for Blue Governance. Her research interests include transformation, transition, plastic policy, ocean governance, and the blue economy.

Gianluca Ferraro is associate professor in environmental governance at the University of Portsmouth (Centre for Blue Governance) and visiting professor at the University of Valencia. His research examines policy implementation, public participation, institutional change, and subnational governance. He is the scientific coordinator of the Horizon Europe project BlueGreen Governance.

Pierre Failler is the UNESCO Chair in Ocean Governance and director of the Centre for Blue Governance. His extensive research history spans concepts such as the blue economy, blue governance, blue finance, and economics.