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Participation and co-production in climate adaptation: Scope and limits identified from a meta-method review of research with European coastal communities

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Abstract

As climate change impacts increase, there are growing calls for strengthening relationships between researchers and other stakeholders to advance adaptation efforts. Participation and co-production are widely held to be key to such relationships, both intended to open substantive engagement in science and research to non-experts. Gains commonly attributed to participation and co-production include improved understanding of user needs and contexts, enhanced trust, creating actionable knowledge for adaptation planning and decision-making, and other new outcomes and practices supporting adaptation progress. At the same time, scrutiny of existing efforts to use participation and co-production reveals limits and gaps in understanding the conditions and processes required to undertake them in meaningful, appropriate, and effective ways. This review assesses such limitations and gaps across the growing volume of research focused on adapting coastal and island communities within Europe. We systematically reviewed 60 peer-reviewed papers, drawing on a novel meta-method review approach to synthesize patterns in participation and co-production implementations, types of outcomes, and the latter's associations with study research designs. We identify a propensity toward using more simplistic definitions of community, more conventional, extractive research methods in working with study communities, and emphasizing knowledge generation over other outcomes. These issues are all limits on participation and co-production effectiveness, and we make recommendations to reduce them. We also recommend further recourse to systematic review methods to aid the development of participation and co-production knowledge for adaptation.

This article is categorized under:
Assessing Impacts of Climate Change > Evaluating Future Impacts of Climate Change
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adaptation, climate change, coastal and island communities, co-production, Europe, meta-method, participation, systematic review methods

1 | INTRODUCTION

Science and research can inform societal adaptation to climate change but face increased calls for their processes and outputs to be made more accessible to and actionable by adaptation stakeholders (Arnott et al., 2020; Hall et al., 2019; Moss et al., 2019; Rasmussen et al., 2017). Participation and co-production are similarly associated with a view of opening science and research to the input and influence of "outside" non-experts in substantive ways (Chambers et al., 2021; Wyborn et al., 2019; Wynne-Jones et al., 2015), for example with increased interactions and trust-building between researchers and stakeholders shown to be key drivers of knowledge generation and use among the latter (Fritz & Binder, 2018). However, even as such congruence has unsurprisingly led to growing interest in the possibilities for participation and co-production for climate adaptation (e.g., Bennett et al., 2016; Conway et al., 2019; Few et al., 2006; Ford et al., 2016; Wyborn, 2015), the preconditions and processes for effective adaptation-focused applications of participation and co-production remain poorly understood (Lemos, 2015; Lemos et al., 2018; Mach et al., 2020), having received modest critical treatment to date (e.g., Bamzai-Dodson & McPherson, 2022; Bremer & Meisch, 2017; Turnhout et al., 2019), and in a limited number of contexts (e.g., the Arctic [Flynn et al., 2018], Pacific island states [Ensor et al., 2018], and North America [Bremer & Meisch, 2017]). As the effects of climate change are becoming increasingly apparent and widespread, the gap between interest in and critical appraisal of participation and co-production uses supporting climate adaptation grows more urgent to address and extend to other contexts.

Our goal with this review is to contribute toward closing this gap, by reviewing published empirical studies involving participation and co-production uses to advance climate adaptation of coastal and island communities located in Europe. We identified 60 in-scope studies, linked by their positioning between terrestrial and marine systems and processes. This introduces a basic degree of commonality regarding the range of climate-related risks under consideration, although we acknowledge that these settings do not delimit an area where climate risks or impacts are entirely uniform (Bednar-Friedl et al., 2022). Other studies highlight an array of engagement approaches used in coastal adaptation planning across Europe (Bednar-Friedl et al., 2022; Begg, 2018; Edelenbos et al., 2017; van den Hurk et al., 2022), and many countries in Europe have integrated the principles of the Aarhus Convention, requiring public participation in climate adaptation (Perlaviciute & Squintani, 2020), including some countries where involvement of communities in development and implementation of adaptation measures is now promoted by national-level legal and policy frameworks (Edelenbos et al., 2017; Gram et al., 2016; Lee et al., 2013). As the studies selected for review reflect various of these developments, they constitute a robust sample of adaptation settings in which participation and co-production are employed. Our reference to Europe further enables us to hold the number of studies under consideration at a manageable level, as in tandem, we sought to explore the value of a novel review approach (see below). In the following, we examine the selected in-scope studies for their similarities, differences and limits associated with interpretations and implementations of participation and co-production, and in terms of outcomes pursued and which we assessed as having been achieved.

Systematic review methods are increasingly drawn in the broader climate studies field (Ara Begum et al., 2022; Berrang-Ford et al., 2015). However, our review makes novel use of guidance on systematic "meta-method" review of qualitative research created outside of the climate change arena (Finfgeld, 2003; Paterson et al., 2001; Zimmer, 2006). Supplementing our use of this guidance, we employed two additional review tools: a set of criteria designed to assist standardized appraisal of qualitative studies, adapted from the Critical Skills Appraisal Tool (CASP, 2018), and a

typology adapted from Chambers et al. (2021), supporting the classification and assessment of participation and co-production outcomes. Fusing these elements enabled us to extend comparative analysis across multiple participation and co-production characteristics and subsequently to distil broader implications for outcomes from their application in our chosen study domain. Section 2 provides our rationale for bracketing participation and co-production and an additional overview of the meta-method review approach. Section 3 then details our literature search and the primary review methods. Section 4 opens with contextual characteristics of the included studies before turning to the main review results. Section 5 distills the limits identified in the reviewed studies to discuss and make recommendations around four clusters of issues: (a) engagements with the concept of community, (b) research methods employed in working with communities, (c) the scope of outcomes from participation and co-production, and (d) further exploring systematic review methods. Finally, section 6 considers wider implications emerging from this review.

2 | REVIEW BACKGROUND

We view participation and co-production as commonly used descriptors for a range of aspirations and strategies collectively associated with bridging a conventional divide between researchers and stakeholders. Broadly, the common denominators include the following: an emphasis on developing reciprocal research designs and relationships between researchers and stakeholders, enabling the latter to play an active role in the specification and direction of a research project; harnessing their perspectives and experience; in such a way that research outcomes and impacts are more likely to be relevant and positive from their perspective (Kesby et al., 2005). Normatively, enhanced and sustained interactions with stakeholders are regarded to foster trusted relationships and provide a keystone for social learning, sharing, and developing iterative cycles of usable knowledge (Mach et al., 2020), or what some have labeled as a "science of actionable knowledge" (Arnott et al., 2020).

At the same time, the processes and relationships subsumed under the heading of "interaction" are only now gaining critical attention in relation to knowledge creation and the generation and use of other outcomes. For example, there is heightening awareness that interactions relating to knowledge production may encompass both interactions between multiple forms of knowledge (including both knowledge produced through participation and co-production and that which is held or generated separately) and between knowledge and other influences on users' decision-making contexts (Lemos, 2015; Moss et al., 2019; Rasmussen et al., 2017), which may not align in terms of supporting effective knowledge utilization. Closer attention to such complexities is increasingly required given a disjuncture between, on the one hand, the scope of ambition with which participation and co-production are frequently associated—as indicated above—compared, on the other hand, to growing evidence for relatively more modest achievements and outcomes resulting from their application, according to other recent reviews (Chambers et al., 2021; Jagannathan et al., 2020; Turnhout et al., 2019). Our perspective on participation and co-production as deeply interwoven approaches is consistent with such reviews and the position adopted in other highly cited papers (e.g., Kirchhoff et al., 2013; Miller & Wyborn, 2020). Such overlap is also evident in the common view of co-production as being about "participatory modes of knowledge production" (Turnhout et al., 2019). However, as already indicated, knowledge production is one of the multiple objectives both approaches can deliver. At the same time, the growing emphasis on knowledge actionability also highlights a need for them to engage with processes beyond solely knowledge generation.

We also recognize efforts to uphold key dividing points between participation and co-production, for example, reflecting disciplinary-specific histories and engagements with one or both approaches (Fritz & Binder, 2018; Holt et al., 2019; Matthews et al., 2015; Wynne-Jones et al., 2015), and we are further mindful of other potential influences (e.g., journal norms) favoring of referencing one or other term. Nevertheless, for the present review, there is sufficient evidence to permit treating participation and co-production as key approaches indexing an intent to realize benefits from working closely with stakeholders—in this case, with coastal communities—to progress their adaptation to climate change. As detailed in the next section, our literature search was specified carefully to ensure the capture of all relevant studies with this intent (within Europe and our study period).

Meanwhile, our recourse to meta-method guidance reflects broader calls for strengthened methods for reviewing climate adaptation research (Ara Begum et al., 2022; Berrang-Ford et al., 2015; Ford et al., 2012). Designed for reviewing qualitative studies, the meta-method we employed is classed as a qualitative review framework (thus, it is also distinct from statistically based "meta-analysis" reviews) (Paterson et al., 2001). The core purposes of the meta-method are to analyze the suitability of qualitative research methods for a phenomenon under study and to interpret the influences of methodological characteristics and developments on the related body of results. In the following sections, we apply this

meta-method framework to critically examine interpretations and implementations of participation and co-production across the included European coastal community adaptation studies. While the studies were selected systematically, the range of settings and characteristics they encompass suggests that participation and co-production are relevant to tackling multiple problems and challenges. Participation and co-production are not synonymous with qualitative research, but the centrality of interpersonal and intersubjective relations and processes warrants our use of the meta-method review framework.

3 | REVIEW METHODOLOGY

3.1 | Search strategy and selection process

Our literature search strategy followed established systematic processes (Liberati et al., 2009; McKibbon et al., 2006), commencing with a broadly defined search and narrowing down the set of within-scope results in successive stages. At the initial stage, we searched across eight academic citation databases (Scopus, SAGE, ScienceDirect, JSTOR, ProQuest, Web of Science, PubMed, and GreenFile) plus Google Scholar. These database searches began from an exact phrase search (namely for "climate change"), with the results then further limited using a succession of approximate phrase combinations covering all core terms (adaptation, participation, and co-production) and their main relevant synonyms (Figure 1). Our search focused on peer-reviewed journal articles published between January 2002 (the earliest article matching the search criteria) and April 2021, giving almost 20 years of coverage. Specification of the search parameters was a collective effort by the co-authors, with the database searching itself undertaken by the lead author. A further search was done within the same timeframe using additional keywords with the two databases delivering the greatest number of relevant results in the initial search which did not result in any additional in-scope papers. Supporting Information (SI) 1 provides further details on our database searches and search term variants.

We identified 2009 records through this database search, supplemented by five papers added from our personal reference lists selected using the same criteria. Subsequently, we excluded the following: studies focused outside of Europe including extraterritorial jurisdictions and dependencies, those at a national or international scale only; papers not in English; and those adjudged as not directly relating to climate adaptation. As a result, the number of papers retained for consideration was reduced by around a factor of 10, then further narrowed based on a full reading of their titles and abstracts, followed by an inspection of their full-text content (Figure 2). Of the final set of studies going forward for detailed review, the majority was confirmed to have attempted to utilize a participatory approach and/or co-production for adaptation with European coastal communities. Two papers were also included which analyzed data from empirical research which had not been previously published.

3.2 | Review framework: Meta-study analysis

The meta-method analysis commenced with generating information from each selected paper. From an iterative process involving working between the selected papers and the meta-method guidance (Paterson et al., 2001), we catalogued meta-data consistently along four axes: (1) main contextual characteristics of study locations (geographic, demographic, and socio-economic, and associated climate impacts); (2) community characteristics and definitions; (3) study research designs and research methods; and (4) outcomes (as interpreted by the review authors, see below).

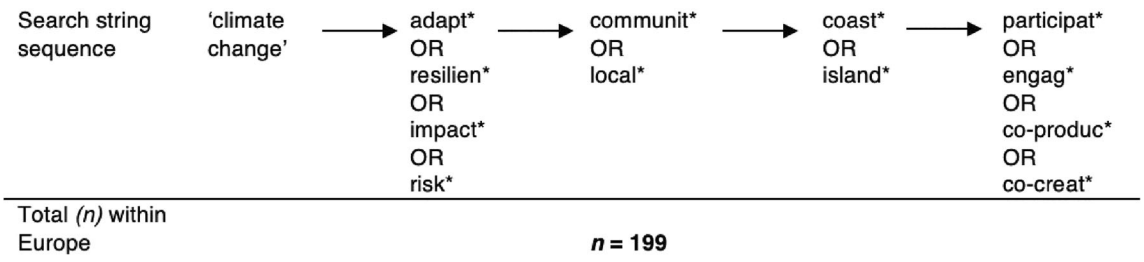

FIGURE 1 The database search process summarized showing search term sequence for initial listings. (*) denotes use of wildcards.

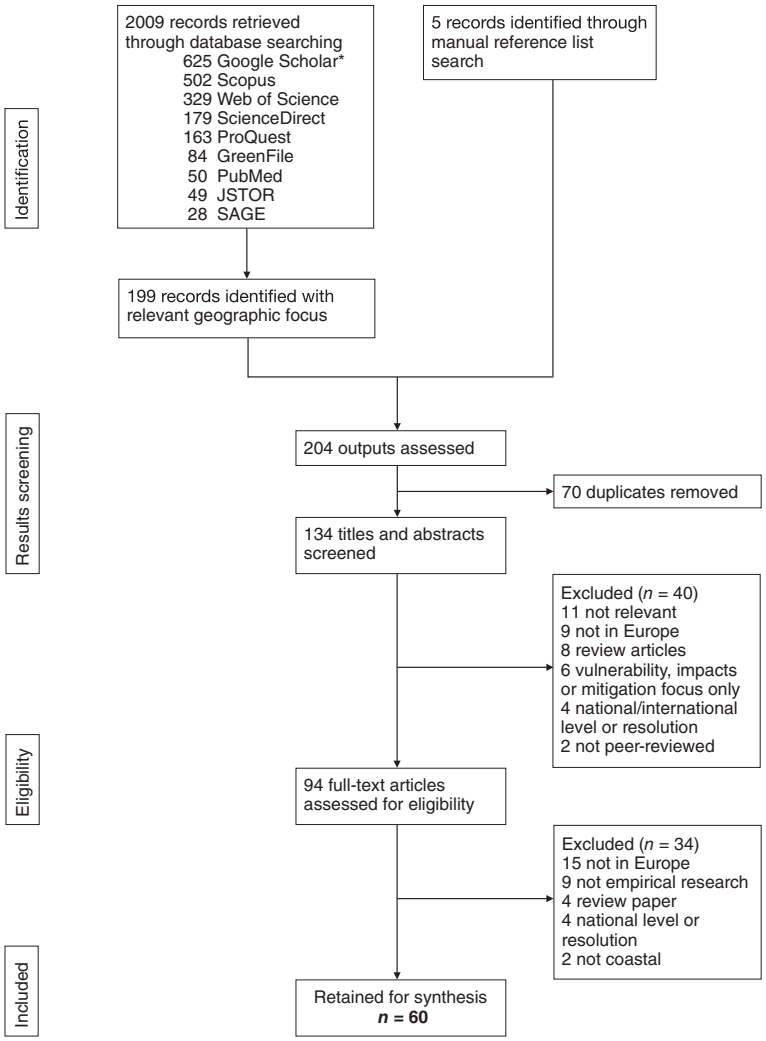

FIGURE 2 The methodology used for the systematic search process, including exclusion criteria applied to identify in-scope papers and the number of articles (n) reviewed (Liberati et al., 2009). (*) Included from Google Scholar were the results from the first 25 pages, sorted by relevance.

The generation of paper-level information along these axes also informed the development of more tailored synthesis questions (see right-side of Figure 3).

In addition, we applied a meta-analysis tool, namely the Qualitative Studies Checklist produced by the Critical Appraisal Skills Programme (CASP), to assist in evaluating the methodological soundness of qualitative research (CASP, 2018). The checklist includes 10 questions, each representing a different criterion related to the validity or utility of qualitative research results (Table 1). The questions are structured to enable assessments of whether all the criteria being considered are met, with a choice between three simple responses ("yes," "no," or "can't tell") for each one (see SI 2). We also added four additional criteria to the pre-existing checklist focused more on appraising participation and co-production characteristics, including community participation in research, use of research, framing of research problems, and incorporation of monitoring and evaluation. This checklist tool aided our initial assessment of the papers and the development of the detailed questions for the meta-method review noted above. Two of the authors independently applied this full set of appraisal criteria to each paper included in the review. We resolved conflicting interpretations of the reading of each paper through discussion among the full author team. Following valid precedents (Brennan et al., 2013; Honein-AbouHaidar et al., 2016), for each paper, we then summed the number of positive ("yes") responses to use in the meta-method synthesis stage (see below).

To interpret the outcomes from the reviewed studies, we also turned to a typology developed recently by Chambers and colleagues (Chambers et al., 2021). This typology spans 14 distinct "outcome dimensions" identified from a

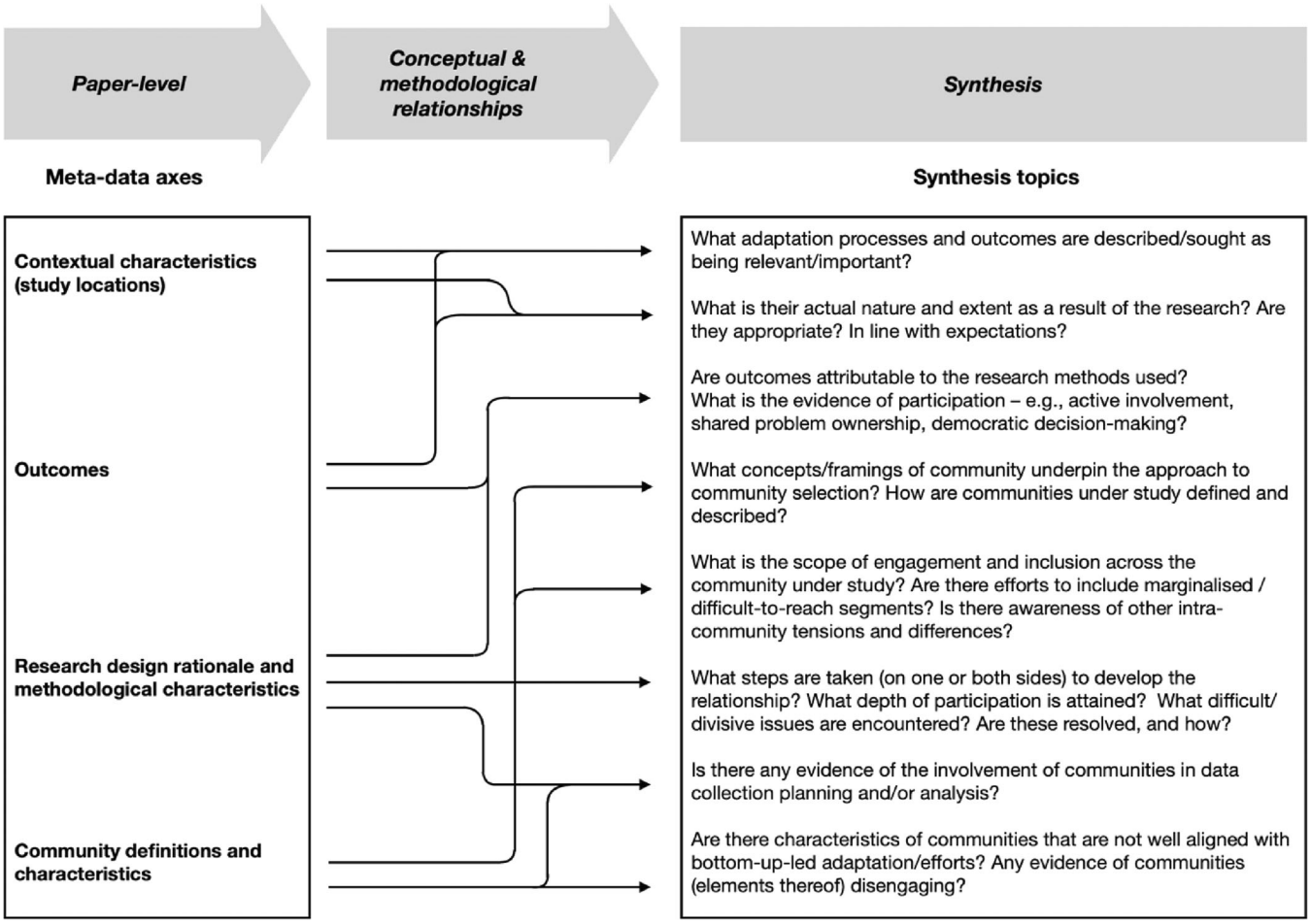

FIGURE 3 Meta-method analysis framework.

maximum-variation sample of co-production applications. We mapped each paper in our review against this typology, with instances of nine different outcome types from the latter identified in this way across the entire set of papers. However, we assessed some papers as having outcomes that could not match to any types in the original typology. Consequently, to capture these outcomes, we inserted three additional types (third column of Table 1). For each study included in our review, from our close reading of the papers, we then identified and tallied the outcomes that had been achieved, as distinct from others (e.g., outcomes discussed but not a focus for a given study). Furthermore, we tallied outcomes with evidence of actual implementation, that is, having been put into action with stakeholders of the study communities, with this assessment also informed by the definition of different "scopes" of outcomes offered by Jagannathan et al. (2020). We recognize the subjectivity in the process of delineating, verifying and classifying study outcomes as described here and that evidence of implemented outcomes may be difficult to capture due to timeframes/lags involved and attribution challenges (Mach et al., 2020). To mitigate these challenges, two authors separately classified each paper against the outcome typology. We resolved differences between the initial author assessment through discussions involving the other authors, toward ensuring consistent calibration. The results from this were subsequently compared and used to arrive at a single, final set of outcomes identified with each paper. Separately to the outcome mapping, we also catalogued the main reasons the papers gave for turning to participation and co-production so that the focus of the former was maintained on interpreting achieved outcomes. We further acknowledge potential bias among the papers toward reporting more positive findings (as opposed to those concerning unmet or undesirable outcomes). However, as all were peer-reviewed, we relied on the integrity of several reviewers and editors to ensure that reporting was accurate and critical.

Our synthesis of the information produced at the individual paper level was aided by the set of guiding questions noted above (Figure 3), answers to which were, in turn, refined to the final review results reported next. This synthesis

TABLE 1 Multi-assessment list used for the meta-analysis.

Adapted CASP checklist tool	Meta-analysis of outcomes	
1. Was there a clear statement of the aims of the research? *Is it worth continuing?* 2. Is an empirical methodology appropriate? 3. Was the research design appropriate to address the aims of the research? 4. Was the data collected in a way that addressed the research issue? 5. Have ethical issues been taken into consideration?	Chambers et al. outcome dimensions	Customised outcomes
	1. Knowledge (co-) production	1. Knowledge generation
	2. Knowledge transfer	2. Knowledge exchange
	3. Capacity development	
	4. Networks	3. Networks
6. Is there evidence participants were involved in developing research aims, research design? * 7. Was the recruitment strategy appropriate to the aims of the research? 8. Has the relationship between researchers and participants been adequately considered? 9. Is there evidence that findings or recommendations were shared with community members and local stakeholders? *	5. Process learning	4. Process learning
	6. Process quality	5. Process quality
	7. Reframing	6. (Re)framing
	8. Empowerment	7. Empowerment
	9. Social equitability	
	10. Enhancing policy uptake	8. Policy development
	11. Management practices	9. Management processes
	12. Institution building	
10. Was the data analysis sufficiently rigorous? 11. Is there a clear statement of findings? 12. How valuable is the research? (Is there a discussion of the contribution the study makes to existing knowledge?) 13. Are considerations of multiple or shifting types of framings taken into account? * 14. Is monitoring and evaluation of research processes or results implemented? *	13. Ecological outcomes	
	14. Social outcomes	
		10. Adaptation outcomes
		11. Shared understanding
		12. Transformation
		Implemented outcomes for communities

Note: Checklist questions/criteria adapted from the Critical Appraisal Skills (CASP) appraisal tool (www.casp-uk.net). Core participation and co-production criteria 6 to 9 are highlighted. (*) Signifies checklist questions originated by the authors (first column). Original outcome dimensions developed by Chambers et al. (2021) (second column) and customized outcomes by authors (third column) (see SI 3 for outcome definitions).

phase was directed at generating a new appraisal of the state of development in interpretations, uses and outcomes of participation and co-production within our chosen study context.

4 | RESULTS

4.1 | Contextual characteristics of reviewed studies

After applying the search process described earlier, we were left with 60 papers published over the two-decade study period, with the majority being multi-authored, lasting more than a year (see SI 4) and published since 2012 (Figure 4). Almost all papers stemmed from research involving study locations in Western Europe, with the largest number being focused on the United Kingdom ($n = 20$), followed by Germany ($n = 9$) and Portugal ($n = 8$), and the remainder scattered across countries in both northern and southern Europe. In a smaller number of papers ($n = 7$), multiple study locations were selected, in some cases in different countries, such as coastal areas of France, Portugal, and Greece (Luís et al., 2018). Studies with multiple sites were most notably clustered among southern European countries and the United Kingdom. The included study locations spanned diverse settings (Figure 5). For example, they ranged from more peripheral northern areas in studies with smaller communities of a few hundred inhabitants (e.g., Baztan et al., 2017; Sugiyama, 2020) to large urban municipalities with multiple hundred thousand inhabitants in the Iberian

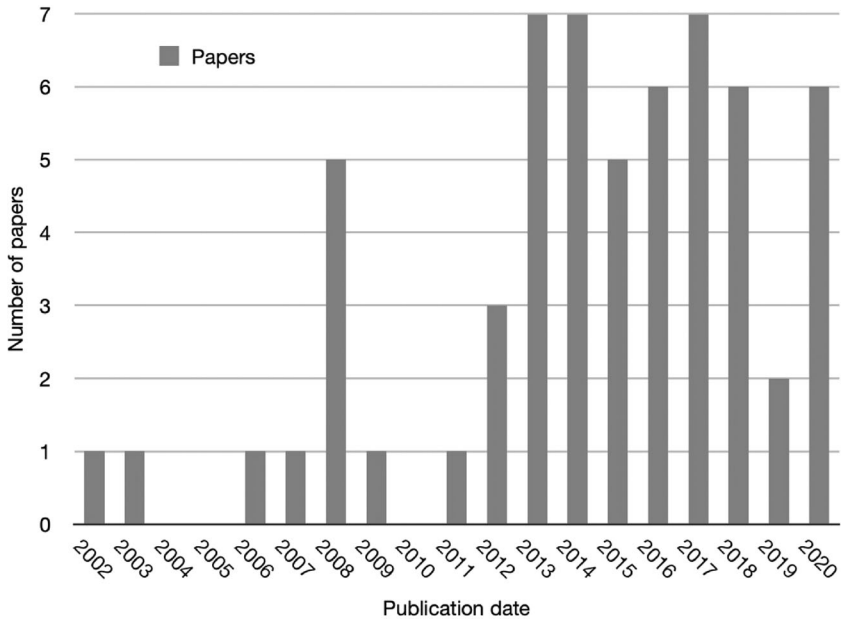

FIGURE 4 Numbers of retained studies published per year over the last two decades.

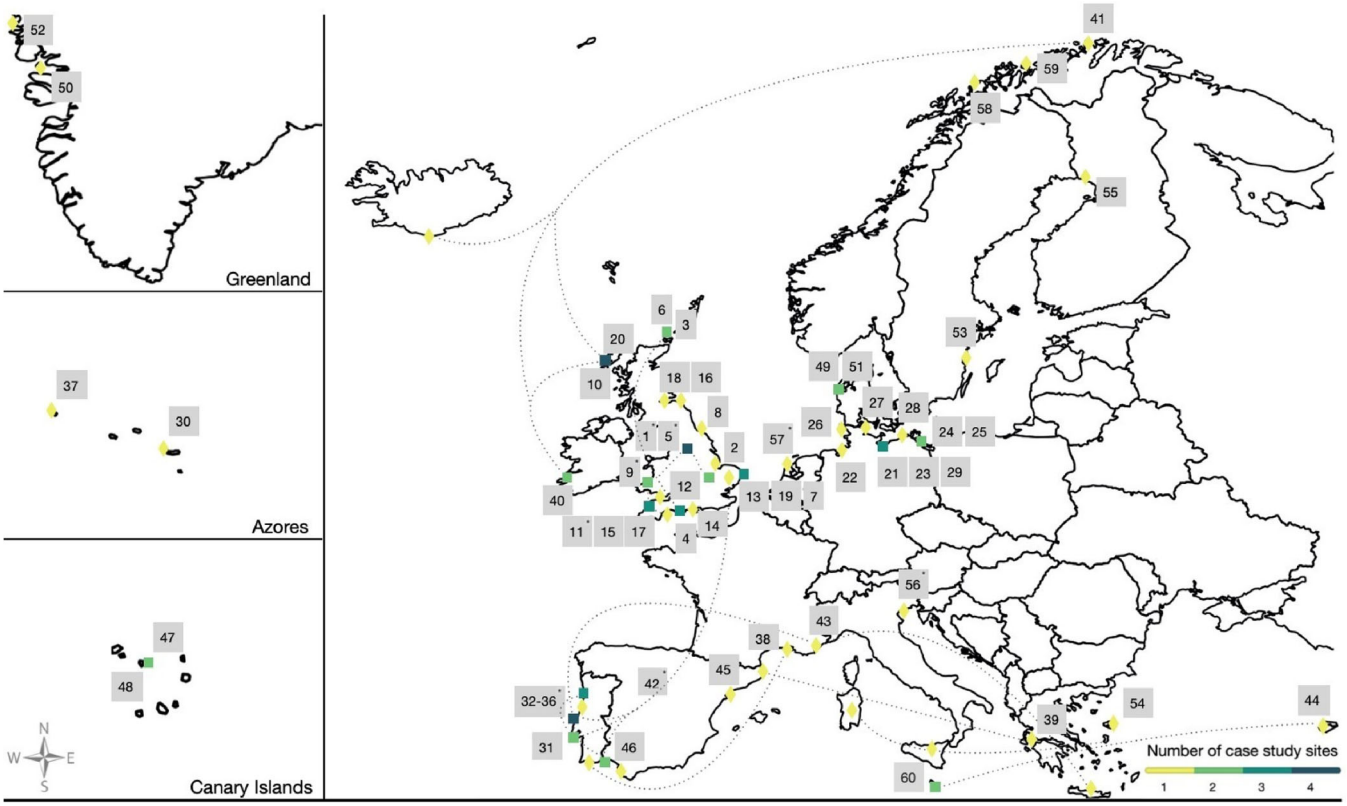

FIGURE 5 Geographic distribution of study areas included in the reviewed papers. Marker properties: (a) color shows the number of times a study area was included, summed across all papers; (b) square shapes (as opposed to diamonds) denote study areas that were included in papers where there was more than one single study area. Additionally, dotted lines connect those study areas that were included within the same (multi-area) study. Numbers from 1 to 60 correspond with paper numbering employed in SI 4. (*) Study sites encompass larger coastal regions. Map not to scale. Boundaries shown were sourced from webvectormaps (used under Creative Commons License CC BY 4.0; https://creativecommons.org/licenses/by/4.0/).

Peninsula (e.g., Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016; Iglesias et al., 2015). Overall, 35 papers (58%) reported research focused solely on rural locations or small urban areas with less than 10,000 inhabitants, while five articles (8%) originated from studies in larger urban settings. The remaining 20 papers (33%) were from research where study locations included large regions encompassing both rural and urban characteristics, such as research in England's south-west and East Anglia regions (Benson et al., 2015), in Portugal (Schmidt et al., 2013; Schmidt et al., 2014), and along part of the Dutch coast (Brand et al., 2014). Half of the papers included locations along the mainland European coastline, whereas the other papers included work in non-mainland island locations, mainly including study areas along the UK's mainland coastline. Fewer papers ($n = 10$; 17%) were from research on smaller and more remote islands (e.g., Angus & Hansom, 2020; Muir et al., 2013; Royuela et al., 2020).

The study locations also varied in their demographic and socio-economic characteristics. For example, several rural and smaller urban study locations reported population decreases and aging demographics linked to out-migration and low birth rates (Amundsen, 2015; Faulkner et al., 2018; Süsser, 2016). In contrast, others had experienced an influx of in-migration, especially retirees (e.g., Schmidt et al., 2013). Some locations had experienced economic stagnation and loss of livelihoods (e.g., Faulkner et al., 2018; Young et al., 2014), while others had seen rapid growth in development (e.g., Gray et al., 2014; Schmidt et al., 2014). Some larger areas and urban locations under study were identified as a base for major economic activities, such as international shipping and commerce, particularly those in the European south (e.g., Luís et al., 2018).

Adverse impacts related to climate change were reported across all study locations. The most frequently cited biophysical impacts were increased flooding ($n = 45$; 75%), coastal erosion ($n = 40$; 67%), sea level rise ($n = 36$; 60%), increased storminess ($n = 32$; 53%), increased variability in precipitation patterns ($n = 24$; 40%), loss of habitat and biodiversity ($n = 14$; 23%) and extreme weather events ($n = 13$; 22%) (see SI 5). Arctic locations studied were described as experiencing or projected to face milder winters resulting in loss of (sea) ice (e.g., Amundsen, 2015; Sugiyama, 2020), as well as increased precipitation (e.g., Muir et al., 2013), flooding and landslides (e.g., Sugiyama, 2020). Papers from work conducted in locations along the North Sea and Baltic Sea commonly noted changes in eutrophication frequency and intensity due to higher temperatures (Andersson et al., 2008; Haller et al., 2011; Turner et al., 2016) as well as changes in biodiversity and marine ecosystems (Schernewski, Schumacher, et al., 2018; Shackley & Deanwood, 2002). Studies in locations in the North Atlantic frequently highlighted impacts related to increased winter precipitation (e.g., Benson et al., 2015; Faulkner et al., 2018), changes in biodiversity and ecosystems, including the introduction of invasive species (e.g., Bentz et al., 2013; Gray et al., 2014), and increased wave activity (Angus & Hansom, 2020; Schmidt et al., 2014). In studies focused in the south of Europe (including Mediterranean Sea, Aegean Sea and Canary Islands locations), changes in the quality of water due to increased saline intrusion (e.g., D'Agostino et al., 2019; Faysse et al., 2012; Luis et al., 2017) were indicated, as well as droughts and greater rainfall uncertainty (e.g., D'Agostino et al., 2019; Fatorić & Morén-Alegret, 2013), and, to a lesser extent, heatwaves (Fatorić et al., 2014; Hernandez et al., 2018a; Hernandez et al., 2018b), and wildfires (Kalabokidis et al., 2008).

Reported existing and anticipated future socio-economic impacts included damage to and loss of property and infrastructure (e.g., Few et al., 2007; Liski et al., 2019; Thomas et al., 2015) and various classes of health impacts, for example, due to heat waves (Hernandez et al., 2018a; Hernandez et al., 2018b). Disruption to essential transport and services was a common theme among cases with communities in remote island locations (e.g., Angus & Hansom, 2020; Thomas et al., 2015). Although some studies in tourism-dependent areas reported an anticipated increase in tourism due to projected warmer summer temperatures (e.g., Gray et al., 2014; Tiller et al., 2016; Turner et al., 2016), many found that coastal communities expected climate change to adversely impact on local economic activity and industry, including tourism and recreation (e.g., Few et al., 2007; Schmidt et al., 2013). These characteristics suggest that participation and co-production are considered relevant to researching adaptation challenges and responses across a wide array of contexts and settings.

4.2 | Definitions and descriptions of study communities

Across the entire set of papers, we identified eight different ways the communities in focus were being delineated (Table 2), with most papers ($n = 52$; 88%) employing multiple of these framings. Seven of these definitional framings were relational in nature, delimiting community with reference to common climate-related risks (found in most papers), common policy-related impacts, co-location with particular spatial units and divisions, adjacency to other areas or schemes, and through ties to a specific economic sector. This set of definitions tends to support a view of

TABLE 2 Approaches used to define/frame "community."

Definition/framing	Percentage of papers[a]	Examples
Climate risk or vulnerability (e.g., coastal hazards)	87	Few et al., 2007; Schmidt et al., 2014; Campos, Vizinho, et al., 2016
Administrative, municipal and other spatial units and boundaries	48	Brown et al., 2017; Myatt et al., 2003; Süsser, 2016
Government project or policy scheme (e.g., managed realignment schemes, regional flood risk management)	27	Bormann et al., 2012; Benson et al., 2015; Liski et al., 2019
Geographic proximity (e.g., small islands, littoral coasts, estuary)	23	Angus & Hansom, 2020; Bentz et al., 2013; Gray et al., 2014
Protected area (e.g., coastal wetland, freshwater habitat)	17	Fatorić and Morén-Alegret, 2014; Iglesias et al., 2015; Milligan et al., 2009
Sectoral interests (e.g., agriculture, fisheries, tourism)	13	Faysse et al., 2012; Haller et al., 2011; Tiller et al., 2016
Concept (e.g., place attachment, resilience, nature-based solutions)	8	Kaján, 2013; Amundsen, 2015; Faulkner et al., 2018
Response to local climate action	3	Andersson et al., 2008; Duffy et al., 2019
Multiple of the above	88	Few et al., 2006; Milligan et al., 2009; Turner et al., 2016

[a]$n = 60$ for each row; row percentages are independent and do not sum to 100.

communities as possessing similar attributes and mutual interests tied to a particular place (i.e., an implicit localism). Attempts to engage more critically with conceptualizations of "community" were rare, including Few et al. (2006), who observed that communities are rarely "consensual, homogeneous entities" (p. 5), and three other papers where attempts at community self-definition in relation to resilience (Faulkner et al., 2018), place attachment (Amundsen, 2015), or adaptive capacity (Kaján, 2013) were included.

4.3 | Community engagement and involvement

We also discerned several aspects of community identity and membership which were being drawn on to engage and develop community involvement (Table 3). More than half the papers reported efforts to progress such engagement via contacts with community representatives holding official roles and responsibilities and/or by attempts to engage "ordinary" community members, such as local residents. In addition, in around a quarter to around half of the papers, community involvement was sought based on the possession of specific kinds of knowledge and experience, including in specific business/economic sectors or scientific or other forms of expertise. Engagement with communities through membership in voluntary groupings and organizations was less commonly used. Three-quarters of the papers referred to multiple elements of community identity and belonging. Frequently, this was aligned with a view of achieving breadth of coverage and inclusivity across the study communities. However, in many papers, a detailed rationale was not provided as to why drawing on a range of elements of community membership was desirable. Further, consideration of more basic identity characteristics, such as socio-economic status, gender, or ethnic group, was also often cursory or absent. A small fraction of papers ($n = 3$; 5%) made efforts to include groups or segments deemed marginalized or difficult to reach, such as members of immigrant organizations (Fatorić & Morén-Alegret, 2013). However, in these cases, the virtues of including "hard to reach" was more usually couched in terms of meeting an objective of wide community participation, rather than addressing positive implications of the research for the former, or vice versa.

Around two-thirds of papers added information on other methods used to widen engagement and involvement across the study communities. Methods considered in this regard included using existing contacts and connections, referrals (snowball sampling), and other forms of non-probability sampling based on willingness to be involved (Table 4). Perhaps reflecting the disciplinary norms of their authors, one-tenth of papers referred to using random sampling and attainment of "representative" samples, suggestive of an aspiration to produce data to be analyzed

TABLE 3 Designations of community membership employed to engage communities in research.

Participant identity	Percentage of papers[a]	Examples
Administrative or functional role	65	Local authority councilors (e.g., Benson et al., 2015); maritime police (Bentz et al., 2013); civil servants (e.g., Bormann et al., 2012); mayors and spatial planners (e.g., Campos, Vizinho, et al., 2016)
Local resident	55	Local resident associations (e.g., Campos, Vizinho, et al., 2016); resident groups (e.g., Few et al., 2007)
Sectoral (e.g., agriculture, fishing, tourism)	45	Fisheries and aquaculture associations (Bentz et al., 2013; Grace et al., 2021; Tiller et al., 2016); land owning interests (e.g., Liski et al., 2019; Milligan et al., 2009)
Business (e.g., local investors, business owners, entrepreneurs)	37	Associations of local business owners (e.g., Campos, Vizinho, et al., 2016); trade unions (Hernandez et al., 2018a; Hernandez et al., 2018b)
Expert group (e.g., farm advisors, water managers, engineers)	33	Coastal defense planners, coastal engineers (e.g., de la Vega-Leinert et al., 2018)
Scientific (e.g., climate change, conservation, biodiversity)	23	Local university scholars (e.g., Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016); regional/national research centers (e.g., Fatorić et al., 2014)
NGOs or civil society	15	Environmental protection associations (e.g., Bormann et al., 2012; Hernandez et al., 2018a; Hernandez et al., 2018b)
Non-professional and/or voluntary	5	Active in operating sports clubs and other recreational activities (Amundsen, 2015); engaged in voluntary fire brigade (Kalabokidis et al., 2008; Süsser, 2016)
Insufficient detail	5	Regional stakeholders (Haller et al., 2011); community leaders (Duffy et al., 2019); local interest groups and members of the public (Cooper & Dolan, 2012)
Multiple of the above	75	National coastal authority, local municipalities, local water and port authorities (Sorensen et al., 2016); civil servants, farmers, engineers, trade unionists, immigrant organizations (Fatorić & Morén-Alegret, 2013)

[a]$n = 60$ for each row; row percentages are independent and do not sum to 100.

TABLE 4 Methods referenced or described for engaging study participants.

Recruitment method	Percentage of papers[a]	Examples
Insufficient detail	33	
Prior contact	22	Kalabokidis et al., 2008; Campos, Vizinho, et al., 2016; Tiller et al., 2016
Snowball sampling (qualitative)	15	Baztan et al., 2017; Few et al., 2007; Vizinho et al., 2017
Probability-type sampling (e.g., simple random sampling, systematic, stratified)	10	Faulkner et al., 2018; Myatt et al., 2003; O'Riordan et al., 2014
Other non-probability-type sampling (e.g., opportunistic, quota, purposive, convenience)	10	Luís et al., 2017; Muir et al., 2013; Royuela et al., 2020
Self-recruitment (e.g., word of mouth recruitment, not covered by snowball sampling)	8	Milligan et al., 2009; Sorensen et al., 2018; Turner et al., 2016
Power versus interest grid (Eden & Ackermann, 1998)	2	Iglesias et al., 2015
More than one of the above	28	Few et al., 2007; Bormann et al., 2012; D'Agostino et al., 2019

[a]$n = 60$ for each row; row percentages are independent and do not sum to 100.

statistically, although evidence of data produced subsequently appropriate for statistical analysis was uncommon. One study sought to adopt a sampling approach grounded in social theory (Iglesias et al., 2015).

4.4 | Research approaches and methods adopted

We assessed methods used in the reviewed papers to collect and analyze information from and with communities, an important input to knowledge generation and integration. More papers referred to employing participation ($n = 54$; 90%) than to co-production ($n = 6$; 10%) (despite inclusion of variations of both terms in our search), with few considering similarities and differences between them or with other related approaches (e.g., co-creation). Around 40% of the papers reported research using a single primary type of research method, whereas around 60% were from studies where multiple different research methods had been employed (Table 5). The use of semi-structured interviews and workshops was reported in over half of the papers, questionnaire surveys in one-third, and various other unspecified forms of meetings in about one-fifth of the papers. Even fewer studies employed focus groups and participant observations. Seven papers (12%) reported research involving the formation of a dedicated working or liaison group involving researchers, communities and other stakeholders (e.g., Milligan et al., 2009; Sorensen et al., 2018; Turner et al., 2016).

4.5 | Outcomes from participation and co-production research

We interpreted 12 outcome types as being attained, although with quite uneven frequencies across the papers (Table 6). All papers provided evidence of knowledge generation, and around one-third included evidence of knowledge exchange and sharing. Common instances of knowledge-related outcomes included producing a scientific-based understanding of local adaptation processes and risk perceptions (e.g., Myat et al., 2003; Schmidt et al., 2013, 2014) or advancing knowledge to inform local and regional policy or management processes (e.g., Schernewski, Bartel, et al., 2018; Schernewski, Schumacher, et al., 2018; Grace et al., 2021). One-fifth of papers had evidence of research where process learning has occurred, while "adaptation processes," relating to strategies, scenarios and pathways for adaptation, were similarly often indicated. Evidence of six other outcome types was less commonly found. "Shared understanding" builds on but goes beyond knowledge sharing by finding common ground among different actors, which was identified in 8 (13%) papers. Meanwhile, a few papers discussed "transformation," referring to outcomes involving substantial fundamental change beyond incremental adaptation. However, only two papers (Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016) provided evidence of attaining such outcomes (see SI 3 for all outcome definitions).

TABLE 5 Data collection and analysis methods employed.

Research method	Percentage of papers[a]	Examples
Interviews	55	Few et al., 2006; Kalabokidis et al., 2008; Schmidt et al., 2014
Workshops	52	Tompkins et al., 2008; Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016; Liski et al., 2019
Surveys/ questionnaires	33	Myatt et al., 2003; D'Agostino et al., 2019; Royuela et al., 2020
Meetings (various)	22	Cooper & Dolan, 2012; Muir et al., 2013; Young et al., 2014
Working/liaison group	12	Milligan et al., 2009; Turner et al., 2016; Sorensen et al., 2018
Focus groups	10	Bormann et al., 2012; Turner et al., 2016; Faulkner et al., 2018
Participant observation	5	Few et al., 2007; Baztan et al., 2017; Sugiyama, 2020
Single method	38	Bentz et al., 2013; Benson et al., 2015; Royuela et al., 2020
Multiple methods	62	Faysse et al., 2012; Pasquier et al., 2020; Grace et al., 2021

Note: Types of research methods employed across all papers and the number of papers using one or multiple methods.
[a]$n = 60$ for each row; row percentages are independent and thus do not sum to 100.

TABLE 6 Outcomes identified from the studies.

Outcome type	Percentage of papers[a]	Examples
Knowledge generation	100	Produced new knowledge on socio-environmental dynamics and resilience (Angus & Hansom, 2020)
Knowledge exchange	30	Facilitated cross-scale dialogue between stakeholders and experts on local water management (Andersson et al., 2008)
Adaptation processes[b]	22	Developed coastal adaptation design strategies (Brand et al., 2014)
Process learning	20	Evaluated participant knowledge acquisition (Benson et al., 2015)
Networks	18	Established new modes of connecting social actors previously disengaged in planning (Campos, Alves, et al., 2016)
(Re)framing	17	Developed future visioning exercise (Milligan et al., 2009)
Policy development	17	Developed priority knowledge needs for policy on nature-based solutions (Grace et al., 2021)
Process quality	15	Reflected on participatory approach, factors inhibiting research outcomes and implications for future research (Faysse et al., 2012)
Shared understanding[b]	13	Co-created common framework to address combined water-related impacts (Sorensen et al., 2018)
Management practices	12	Provided decision-support for local resource management processes (Santoro et al., 2013)
Empowerment	12	Involved marginalized communities (Brown, et al., 2017)
Transformation	3	Applied Participatory Action Research tool to support transformational adaptation processes (Campos, Alves, et al., 2016)
Implemented outcomes for communities resulting from research[b]	20	Uptake of locally developed eutrophication remedy plan in local water management (Andersson et al., 2008); implemented locally developed adaptation plan in municipalities' coastal zone management program (Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016)

[a] $n = 60$ for each row; row percentages are independent and thus do not sum to 100.
[b] Originated by the authors (not from Chambers et al., 2021).

We found that only a few studies ($n = 12$; 20%) reported implemented community outcomes, albeit with examples ranging from the implementation of locally developed adaptation plans across coastal zone management programs (Campos, Alves, et al., 2016) to the uptake of locally developed scenarios as decision-support tools (e.g., Andersson et al., 2008).

Of all papers, some 70% ($n = 42$) explicitly gave one or more reasons for turning to participation or co-production for adaptation efforts with the communities they worked with. Among these, we identified 12 kinds of reason, clustered around developing, integrating, and sharing knowledge and facilitating various processes such as developing adaptation strategies and plans (Table 7). The reasons focused most closely on knowledge generation were to enhance local knowledge and to contribute to scientific knowledge, with these reasons given by 60% and 57% of papers, respectively, even though all papers were assessed separately to have achieved some form of knowledge generation outcome (cf. Table 6). Conversely, 40% of papers stated reasons relating to facilitating the exchange of views and experiences and integrating local and scientific knowledge, which was a higher percentage than the 30% of papers assessed as actually achieving knowledge exchange. Further, we found that very few of the studies, which stated an intent of develop and facilitate adaptation strategies and processes reported implemented adaptation outcomes. Overall, the percentages of papers stating reasons for utilizing participation or co-production were generally higher than those with evidence of achieving other outcomes beyond knowledge generation (compare Tables 6 and 7).

4.6 | Research appraisal (checklist-based)

We assessed most papers as satisfying the majority of criteria included in the CASP-based research appraisal checklist tool (see SI 2). On average, papers met eight out of the 14 checklist criteria, with a detailed breakdown highlighting

TABLE 7 Reasons for turning to participation and co-production uses.

Reason	Percentage of papers[a]	Examples
Develop local adaptation strategies	75	Haller et al., 2011; Brand et al., 2014; Hernandez, Barbosa, et al., 2018
Facilitate adaptation processes	64	Tompkins et al., 2008; Andersson et al., 2008; Schmidt et al., 2013
Enhance local knowledge	60	Shackley & Deanwood, 2002; Kaján, 2013; Schwab et al., 2017
Contribute to scientific understanding and knowledge production	57	Kalabokidis et al., 2008; Faulkner et al., 2018; Pasquier et al., 2020
Inform/educate local actors	45	Iglesias et al., 2015; Sugiyama, 2020; Young et al., 2014
Investigate the usefulness of the methodological approach	43	Gray et al., 2013; Schwab et al., 2017; Wadey et al., 2015
Facilitate engagement between local actors	43	Faysse et al., 2012; Santoro et al., 2013; Krauß, 2020
Facilitate the exchange of experiences or views	40	Santoro et al., 2013; Duffy et al., 2019; Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016
Integrate local and scientific knowledge	40	Few et al., 2006; Bormann et al., 2012; Schmidt et al., 2013
Facilitate social learning processes	38	Benson et al., 2015; Bormann et al., 2012; O'Riordan et al., 2014
Facilitate effective co-management and collaborative planning	15	Schmidt et al., 2013; Vizinho et al., 2017; Sorensen et al., 2016; Sorensen et al., 2018
Develop sustainable management practices	10	Fatorić & Morén-Alegret, 2013; Kaján, 2013; D'Agostino et al., 2019
Lacking any clear statement of reason	30	

Note: Themes emerged from the iterative analysis process and are grouped based on the frequency of appearance. $n = 60$ for each row.
[a]Row percentages are independent and do not sum to 100.

differences in un/met criteria (Figure 6). Notably, we assessed most papers as lacking adequate information about community involvement or the relationship between professional researchers and community participants (criteria 6 and 8). Also, it was often impossible to assess from the paper content if ethical issues such as seeking and obtaining informed consent were handled adequately (criterion 5) (although this information may have been included as supplementary material, which was not searched). Separately, we also considered results for only a subset of the checklist criteria, which we regarded as a core group most relevant to assessing the practices of participation and co-production in the reviewed papers. This core subset (criteria 6 to 9) focused on community involvement and selection, researcher-participant relationships, and results dissemination. Only a minority of papers had positive responses to all four or at least three of these criteria in this subset ($n = 4$ and $n = 7$, respectively), with these papers also assessed as meeting at least three-quarters (11 or more) of all the criteria in the full checklist (e.g., Andersson et al., 2008; Campos, Alves, et al., 2016; Campos, Vizinho, et al., 2016; Faysse et al., 2012).

Given the open and dynamic character of participation and co-production, and of adaptation, continuous and iterative monitoring and evaluation are held to be desirable (Harvey et al., 2019; Van Epp & Garside, 2019). For this reason, we included an additional criterion on whether or not monitoring and evaluation processes were evident in the reviewed research (criterion 14). However, we identified only six papers with positive responses to this question, in other words, to have incorporated means enabling monitoring and evaluation (e.g., Andersson et al., 2008; Santoro et al., 2013; Tompkins et al., 2008). In addition, 11 papers (18%) met another of our own criteria, focused on uses of participation and co-production where existing beliefs and practices were re-framed (criterion 13).

We also compared the number of appraisal criteria each paper was assessed to meet against the number of outcome types they were assessed to produce (referring to the same outcome types in Section 4.5). For these comparisons, we grouped papers according to whether they met three-quarters or more of all 14 criteria, met at least three of the four in the "core" subset of criteria defined above, and met our monitoring and evaluation criterion. On average, there were just over three outcome types per paper (Table 8), with substantial differences between the three groups just specified. Notably, for papers meeting three-quarters or more of all criteria and for papers meeting three-quarters of the "core" criteria, the average number of outcome types was much higher than the average (around eight). That these averages are similar is unsurprising, given that both groups included many of the same papers. In these groups, there were also

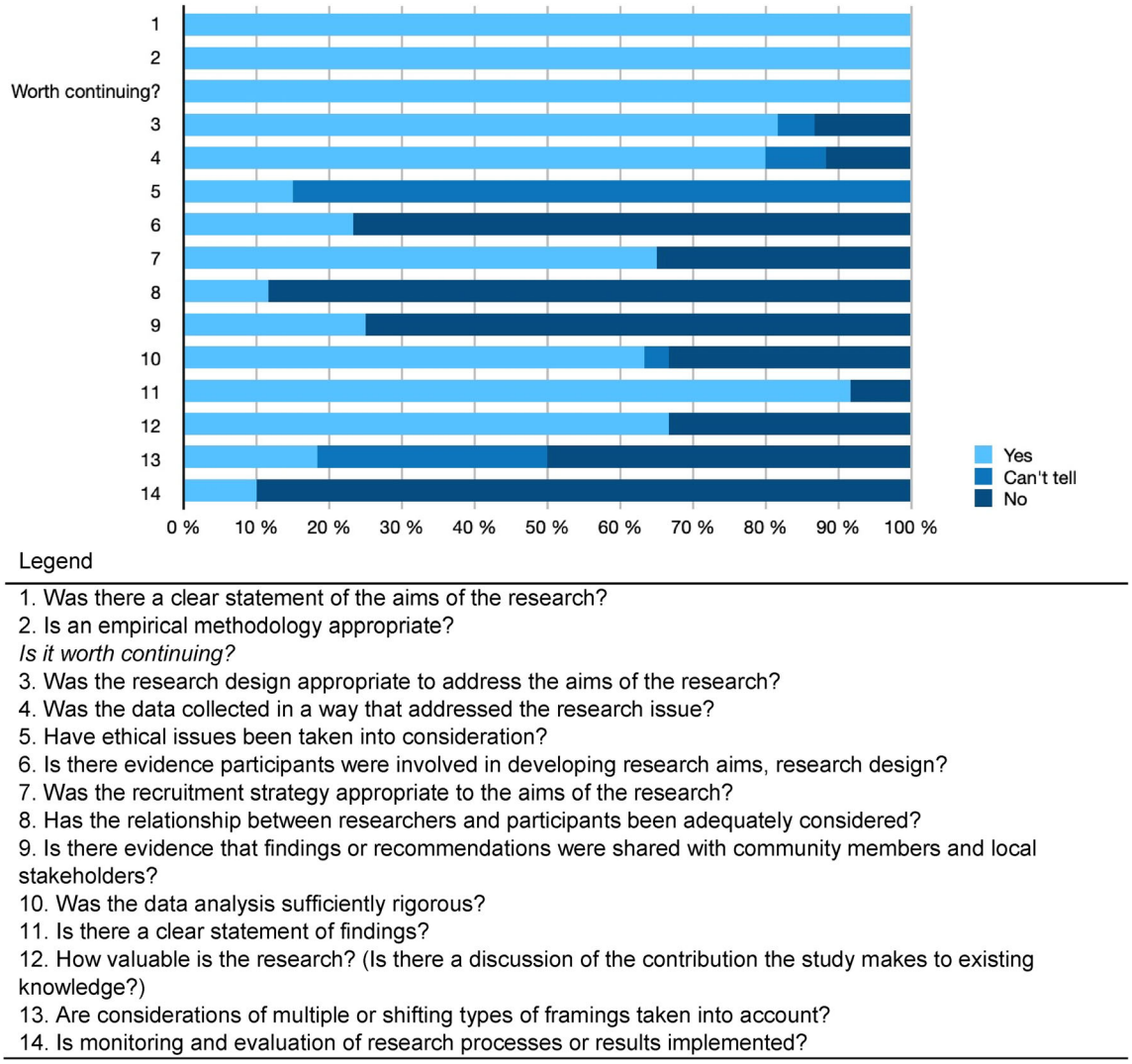

FIGURE 6 Results profile for individual checklist questions/criteria adapted from the Critical Appraisal Skills (CASP) appraisal tool. Percentages out of 60.

TABLE 8 Average participation and co-production outcomes for papers grouped by research appraisal criteria.

	Outcome categories	
Appraisal criteria	**Types of outcome (mean)**	**Implemented community outcomes**
Overall (all 14 criteria)		
≥11 positive "yes" responses; ($n = 13$)	7.8	77%
<10 positive "yes" responses; ($n = 47$)	1.8	9%
Core participation and co-production subset (4 criteria)		
Mean score 3–4; ($n = 11$)	8.3	82%
Mean score 0–2; ($n = 49$)	1.9	8.2%
Monitoring and evaluation (1 criterion) ($n = 6$)	6.8	50%
Overall	3.1	20%

high percentages of papers with evidence of implemented community outcomes (using the same definition of implemented community outcomes as earlier). For papers meeting less than three-quarters of either the total or the core criteria, the average number of outcome types was lower (around two), with similarities in these averages

explicable as above, with small percentages with implemented outcomes. The difference was wider between the group of papers which met the monitoring and evaluation criterion and the overall mean, with around seven and three, respectively.

5 | DISCUSSION

Recent years have witnessed a growing number of studies making recourse to participation and co-production to develop and support climate adaptation of European coastal communities. These studies encompass diverse locations, contexts, climate impacts, and communities. Together, they illustrate that much is being pinned on participation and co-production in terms of their capacity to support meaningful and effective interaction and collaboration between researchers and stakeholders. Such level of expectation has also been noted elsewhere, notably in relation to ways in which participation and co-production are anticipated to enhance the production and use of knowledge, action and change (e.g., Fritz & Binder, 2018; Jagannathan et al., 2020; Mach et al., 2020). However, expectations around participation and co-production may risk obscuring gaps and limits in understanding the requirements for effective design and conduct within specific settings. Likewise, there is a lack of clarity regarding outcomes that could or should be possible. In the discussion, we focus on further distilling a clear view of such limits as they arise in our particular study domain and provide recommendations on how they may be addressed. The discussion is organized under headings where there are clusters of issues emerging from the preceding analysis, including (1) engagements with "community," (2) research methods used, (3) outcomes from participation and co-production, and (4) the use of systematic review methods.

5.1 | Engagements with "community"

Community involvement is a central theme across the studies under review, indicated by the wide range of framings used to define community. In one sense, this is logical; "community" is not straightforward but rather a more multi-dimensional, layered construct. Yet, across these framings, there has been a tendency to rest on more pragmatic bases to represent, describe, and communicate the composition, extent, location, or other characteristics of communities included in the research. In contrast, there is much more limited evidence of awareness and use of (let alone contributions to) the more theoretically informed literature and debate on conceptualizing community. Attention to this substantial latter literature is valuable in gaining purchase on key issues such as intra-community differences, tensions, and dynamics. Without such attention, there are risks to the various attempts to build relationships with communities under the heading of participation and co-production; for example, risks of remaining too narrow, being co-opted by particular interest groups, and (re-)creating or heightening inequalities. We thus recommend further engagement with this more critically informed discourse on community to reduce the risks of inadequate, wasted and maladaptive efforts and toward planning participation and co-production that remains alive to considerations of social justice, power dynamics and differences within communities. Separate reviews (e.g., Crow & Mah, 2012; Turnhout et al., 2019; Walkerdine & Studdert, 2015) provide starting points for this engagement.

5.2 | Methods for working with communities

The reviewed papers employed several methods for working with communities to produce, interpret and implement knowledge and services. We found that most papers used multiple methods, which is unsurprising given the complexities of adaptation planning. However, the choice of more often-used methods is more surprising, including surveys, interviews and focus groups, which are more associated with conventional social inquiry modes that seek to uphold a divide of science from society instead of fording that divide through developing collaborative practices. Using these methods within a participation and co-production setting might be explicable differently. For example, it might reflect constraints on turning to other methods more in step with working collaboratively with non-researchers. More positively, it might be to gain supplementary insights from other "main" methods in novel multi-method and integrated research designs. Alternatively, the effectiveness of standard-type research methods may be increased when co-designed and deployed by "community researchers" or "peer researchers" drawn from within the included communities, with the status and reach of the latter within their communities enabling involvement and responses that could otherwise

prove unattainable. However, the studies reviewed here gave limited attention to these latter possibilities, the links between research methods, and the epistemological and theoretical foundations of participation and co-production more widely. We argue that more attention on these fronts is necessary to foster well-grounded methodological innovation capable of meeting the complex and varied demands of developing robust and appropriate adaptation knowledge and services.

5.3 | Outcomes clarity

The reviewed papers provide evidence of achieving multiple outcome types. However, these outcomes vary quite substantially in their prevalence. We found that all papers lead to knowledge generation, whereas we assessed smaller percentages as achieving other outcomes. Additionally, we discerned some mismatches between outcomes achieved on the one hand and stated reasons given for using participation and co-production on the other. We further found that, on average, studies assessed as having greater evidence of methodological soundness—so far as it was possible to evaluate with the CASP-based set of appraisal criteria—were also associated with more outcomes, compared to other studies which were adjudged to meet fewer of the same criteria. This suggests that the studies within the former group might have been more thorough in looking for and monitoring outcomes. We also found that, on average, more outcomes were associated with the group of papers that met the subset of criteria we deemed as being core to participation and co-production, compared to other papers. However, both groups only constituted a small fraction of the total review set. These findings indicate that researchers may lack full awareness of the scope of possible outcomes.

Consequently, increased familiarity with the spectrum of outcome types is recommended, drawing on recent valid classification efforts (e.g., Chambers et al., 2021; Wall et al., 2017) and considering potential synergies and trade-offs between specific outcomes. For example, while knowledge generation was evidenced in all the studies in the present review, it is likely to possess affinities with certain outcome types (e.g., knowledge exchange or policy development). In contrast, it could inhibit opportunities or progress for others (e.g., reframing attitudes, views and positions among stakeholders). Further, enhanced awareness among researchers should be coupled with efforts to enhance interactive, socially engaged research cultures within communities (Jagannathan et al., 2020; Owen, 2021). In other words, processes are required for defining and monitoring what outcomes are possible and important with specific communities. Improved knowledge is also needed to create processes, changes, and actions to achieve actionable, targeted and agreed outcomes (e.g., to safeguard against false expectations).

5.4 | Systematic review methods to advance participation and co-production evidence

Our review indicates rising interest in participation and co-production uses for adaptation among European coastal and island communities, with the paper publication rate increasing over time. This trend will likely continue with rising interest in their uses more widely across the climate change and sustainability spheres. Thus, comparing different studies to identify and weigh developments in best practices to inform future planning and choice sets becomes more important but potentially more challenging. Against this background, the creation and implementation of systematic review principles, which are themselves "science-like" in their methodological quality, rigor and reproducibility, take on heightening importance (Ara Begum et al., 2022; Arnott et al., 2020; Berrang-Ford et al., 2015). However, the concept of "systematic" assessment and synthesis is not confined to one single approach; rather, multiple frameworks originated in various research and disciplinary fields and consequently carried different perspectives and emphases. The potential to draw more widely from these various frameworks has been noted previously (e.g., Fazey et al., 2004; Haddaway et al., 2018; Pullin & Stewart, 2006). The differences in foci are more so relevant here, in so far as participation and co-production are being drawn on to enhance multiple intersecting links, for example, between those who are inside and outside professional research, between the production and use of research knowledge, between the integration of such knowledge with other forms of knowledge and decision-making, and between knowledge and action. Different approaches stand to yield varying critical insights on developments across this web of links (while it might be expecting much of one single review approach alone to be able to encompass all such links satisfactorily). We hope that our recourse to a meta-method-based review framework and the supplementary review tools prompt other researchers to investigate the range of available systematic review and knowledge synthesis tools. Creating additional guidance for selecting different review frameworks for different purposes and questions would also be a welcome development.

6 | CONCLUSIONS

Participation and co-production attract interest within a wider evolving context for science and research. Growing attention is being paid to ways to change the latter to enhance productive engagement in tackling pressing societal issues, most notably through benefits from the generation of actionable knowledge. Both participation and co-production are regarded to be important to advancing these changes due to their emphases on models and practices for working in appropriate, meaningful collaboration with those conventionally outside science. However, increasing and diversifying attempts to use them as open, overlapping collections of perspectives, principles, and methodologies also present challenges in identifying, evaluating and informing best practices. Hence, methods for reviewing the empirical evidence base in rigorous ways are also increasingly important. Climate adaptation of European coastal communities is one of the aforementioned pressing issue domains. For this review, we sought to critically assess developments in interpretations and implementations of participation and co-production within this domain, drawing primarily on qualitative research meta-method review methods previously unused within climate research. Meta-method is among several systematic review frameworks available, and we encourage further consideration of the utility of different frameworks for improving evidence-based planning.

While interaction and collaboration between science and user communities are seen as central to the above shifts, the review findings and recommendations call for devoting more attention to the realities of working with and through participation and co-production processes. As others note, enhanced descriptions of actual processes involved would be beneficial, considering inequalities, power, politics, motivations, and other structuring influences (Fritz & Binder, 2018; Mach et al., 2020; Turnhout et al., 2019), including scalar dimensions as well (Lemos, 2015). Further, these factors are a reminder that participation and co-production with different groups are dynamic and uncertain, hence efforts on processes of (co-)experimentation, learning, and management of specific initiatives and changes also require documentation (Lemos, 2015; Moss et al., 2019; Turnhout et al., 2019). Finally, although various outcomes are shown to be possible from participation and co-production, planning for specific outcomes needs to be improved. This must also entail building stronger connections with transformation ideas and principles for participation and co-production to meet the high expectations they are frequently held (Fritz & Binder, 2018; Jagannathan et al., 2020; Scoones et al., 2020).

AUTHOR CONTRIBUTIONS

Julian V. Sartorius: Conceptualization (equal); data curation (lead); formal analysis (lead); investigation (lead); methodology (equal); validation (lead); visualization (lead); writing – original draft (lead); writing – review and editing (equal). **Alistair Geddes:** Conceptualization (equal); formal analysis (supporting); funding acquisition (equal); investigation (supporting); methodology (equal); project administration (lead); supervision (lead); writing – original draft (supporting); writing – review and editing (equal). **Alexandre S. Gagnon:** Conceptualization (equal); formal analysis (supporting); funding acquisition (equal); investigation (supporting); methodology (supporting); project administration (supporting); supervision (supporting); writing – original draft (supporting); writing – review and editing (supporting). **Kathryn A. Burnett:** Conceptualization (supporting); funding acquisition (equal); methodology (supporting); supervision (supporting); writing – original draft (supporting).

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Certain meta-data created and analysed by this study beyond those in the reported results may be shared on request. However, we reserve the right not to share detailed meta-data for individual studies included in the review.

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