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Communication and Deliberation for Environmental Governance

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Abstract

Environmental governance occurs through and is shaped by communication. We propose a typology of public communication, classifying it by directionality (one-way or two-way) and objective (informational or operational). We then review how communication types influence individuals' conceptual frames, values, and environmental behaviors. Though one-way communication is common, its impact is often limited to influencing conceptual frames. Research on two-way informational communication demonstrates a greater ability to align conceptual frames and values among individuals, and research on two-way operational communication demonstrates the greatest impact on conceptual frames, values, and environmental behaviors. Factors that affect the impact of communication include the medium through which it occurs, trust, timing, and social-material context. Among these, our review considers new directions in public communication research that focus on the role of digital platforms, misinformation, and disinformation. We conclude by synthesizing research on deliberative communication, a case of communication among citizens guided by democratic ideals.

Contents

1. INTRODUCTION

Within a set of material possibilities, communication structures the form and limits of environmental governance. Communicative actions create, implement, or respond to rules and norms that constitute governance (1–4) and thus guide human activity and outcomes related to the environment (5). Who communicates, who holds decision-making authority, and the context in which communication occurs shape citizens, the institutions they create, and human–environment interactions (6). This review synthesizes literature from a broad range of disciplines to identify relationships between public communication, environmental governance, and the outcomes they produce.

A famous though controversial line from media studies claims, "the medium is the message" (7, p. 7). Research from environmental disciplines finds that how actors communicate messages affects the perception and comprehension of information (8, 9). Similarly, the social processes through which individuals communicate about environmental institutions can shape the rules and norms that guide interactions between people and the environment (6). The broad range of environmental governance studies incorporating public communication attests to its central role in understanding broader patterns of human–environment interactions and processes for sustainable management. It also reveals a tendency to see information as something that individuals exchange and can modify to produce more efficient environmental outcomes.

Public communication: the provision of information to and dialogue among the public to disseminate knowledge or establish institutions and their associated actions

Cheap talk: informational communication that does not produce binding agreements

Research on public communication and environmental governance is a field of active inquiry across the social sciences, including economics, geography, political science, psychology, and sociology. For example, scholarship on climate communication suggests that messengers must address emotional barriers, such as confirmation bias, before overcoming informational deficits to improve comprehension of climate change (10–13). Studies from economics and political science analyze how nonbinding communication, sometimes labeled cheap talk, influences the use and management of common-pool resources (14–16). And scholarship on deliberative or participatory democracy assesses how discourse and social choice combine to generate collective action among citizens (17–19). This multidisciplinary body of work emphasizes the important relationship between communication and environmental governance, and it highlights challenges to effective citizen communication necessary for robust and fair environmental governance. It

further demonstrates that the structure and form of communication are critical to understanding how individuals change as a result of governance (20–23). This reflexive turn encourages investigation into the role of communication in the transformation of conceptual frames and personal values.

Our review advances a typology to organize this extensive literature and its findings on the relationship between communication and environmental governance. We then consider recent research on how digital platforms, as well as misinformation and disinformation, shape citizen communication for environmental governance. Finally, we consider the promise of deliberation to overcome contemporary challenges to effective public communication, and we review empirical research that examines deliberation, deliberative democracy, and environmental governance. Throughout this review, we draw attention to the critical role of communication, its relationship to decision-making authority, and outcomes related to human–environment interactions.

2. PUBLIC COMMUNICATION AND ENVIRONMENTAL GOVERNANCE

Research on public communication in environmental governance emphasizes the actors and processes through which information flows, as well as the governance objectives and impacts of communication (24). In this review, we define the public as individuals who consume or produce information, discuss, deliberate, vote, or otherwise participate in activities related to procedures that shape human–environment interactions. We define citizens as members of the public who have the right to determine the rights they hold (25). In contrast to environmental governance scholarship, which uses a broader understanding of citizenship (26, 27), we distinguish between the public and citizens to highlight how types of communication are available only to those who have the right to institutional self-determination. Though all members of the public may participate in environmental governance by reading the newspaper or engaging in the everyday talk of politics (9), forms of communication that influence rules or their implementation directly are reserved for citizens. Examples may include serving on a jury, voting, or participating in a citizens' assembly (28–31).

We classify communication related to environmental governance on the basis of the directionality of information exchanged and if communication is complemented with a decision-making mechanism (**Figure 1**). Though this typology is novel, differentiating communication based on symmetry or directionality as well as intent or objective has precedent in communication and political communication research (10, 32).

Assessing public communication by directionality and objective distinguishes how communication unfolds and why. Directionality refers to the flow of information, and objective refers to the relationship between communication and environmental governance. One-way communication pertains to the provision of information without reciprocal exchange. Two-way communication involves two or more participants who exchange information among themselves. Though we use the term two-way, this form of communication may be between two actors (bidirectional) or multiple actors (multidirectional). We conceptualize the objective of citizen communication as informational or operational. Informational communication aims to share information related to the environment and its governance, while operational communication focuses on the use of language aimed at directly informing, deciding upon, or implementing a rule or norm related to human–environment interactions.

Public communication aims to inform perceptions, shape values, guide behaviors, and produce governance. For example, one-way informational communication includes reading the newspaper, listening to a political leader, or watching a movie that discusses environmental policy. Two-way informational communication includes conversation, gossip, exchanging emails or letters, and debate. One-way operational communication refers to when individuals or groups gather and

Conceptual frames: the mental structures that individuals use to structure and organize information and experiences

Misinformation: false information that people accept as true

Disinformation: false information designed with the intention to deceive or mislead

Deliberation: two-way or multiway communication that occurs in line with the ideals of respect, noncoercion, equality, consideration, orientation for the common good, publicity, accountability, and sincerity

Deliberative democracy: a theory of democracy that centers deliberative communication as the foundation of democratic participation, often in contrast to theories that center voting or aggregate selection

One-way communication: communication that is asymmetrical; it includes a source and a receiver

Two-way communication: communication that is symmetrical; individuals exchange and may be both source and receiver

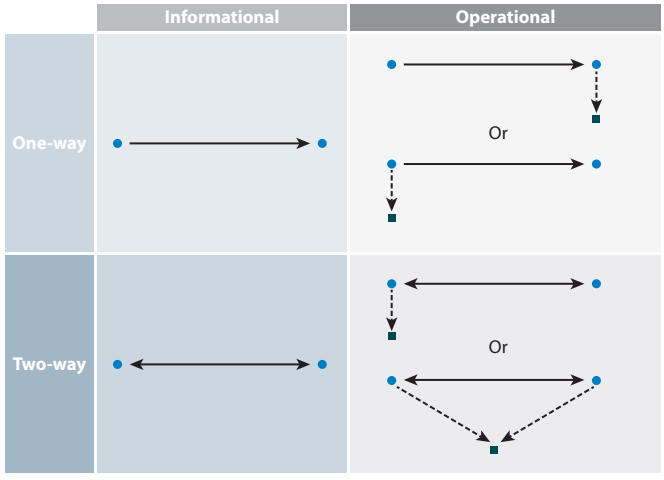

Figure 1

Diagrams of communication type defined by directionality and objective. Circles represent individuals or groups, and solid lines represent communication processes. Squares represent rules, and dashed lines represent decision-making processes. One-way communication refers to unidirectional communication between individuals or groups. Two-way communication represents bidirectional or multidirectional communication between individuals or groups. Informational communication refers to the act of communicating to share information. Operational communication refers to the act of communicating to share information in the service of making or implementing a rule. All communication types may occur only once, or they may be repeated over time.

provide information about a predetermined environmental rule or process. Examples include a statement by an elected official or polling citizens to inform legislation. Operational communication that is two-way can occur when only one individual or group has decision-making authority and mutual exchange is bidirectional or multidirectional with an actor(s) who does not have such authority. Townhall events, where an official discusses a platform or a specific rule, may fall into this category. Two-way operational communication can also occur when all actors have decision-making authority, as in models of direct, open, or deliberative democracy. Each of these communication types often repeat over time.

Differentiating between types of public communication provides a helpful framework for synthesizing scholarship on information, conversation, and deliberation in environmental governance. However, this typology simplifies the reality of daily communication. Dense networks of repeated communication, characterized by shifting directionality and objective, shape human–environment interactions. Further, actors within a network of communication are dynamic over time. The very human act of sharing information, and engaging in discussion or deliberation, can influence the conceptual frames with which individuals organize information and their personal values that guide goals and behaviors (33, 34).

Informational communication: communication that seeks only to exchange information

Operational communication: communication that seeks to exchange information in service to the creation of institutions and their associated actions

Predispositions and mental models influence how citizens comprehend and act in response to informational or operational communication (35). An individual's conceptual frames determine how social information is organized, and these frames are formed through interaction (36). Framing is an active process "that implies agency and contention at the level of reality construction" (37, p. 614). Conceptual frames guide how citizens understand and relate to communication about the norms, rules, and actions that compose environmental governance (38). It is the combination of conceptual frames and communication that shapes and is shaped by personal values (39). Values, in the environmental governance context, refer to the normative positions individuals hold or

express in relationship to human–environment interactions (40). These values, in turn, translate into behavioral intentions, the actions individuals take, and the environmental outcomes they produce (35, 41). To evaluate research on citizen communication and environmental governance, we consider the relationship between communication type, the conceptual frames and personal values of actors, and environmental behaviors and their outcomes.

2.1. One-Way Informational and Operational Communication: Providing, Receiving, or Exchanging Information

One-way communication about the environment and its governance is widespread. Consuming media about the environment and its governance represents one-way informational communication. One-way operational communication includes signs and other messages detailing regulations, letters and emails citizens may write to political representatives, and statements made by political representatives or their offices. The literature on one-way communications often examines how informational interventions change attitudes, motivations, actions, and resource outcomes (42). In general, one-way information alone has limited broadscale impacts on environmental outcomes (43), in part because the impact of communication on citizen behavior is mediated by numerous factors. For example, conceptual frames and personal values mediate the influence information has on behaviors and can affect the perceived importance of information or interest in the subject material (44). Other factors, such as trust, comprehension, and timing of information, can moderate the impact one-way information may have on influencing conceptual frames, personal values, or environmental behaviors (45). The source and medium of one-way information further influence its reception and impact.

One-way informational interventions include a variety of strategies that provide information to influence individuals or groups before they act. Such interventions, sometimes called antecedent strategies, are common in studying perceptions about climate change (42). A meta-analysis of 396 effect sizes from 76 independent experiments found that one-way informational interventions (**Table 1**) had a small positive impact on attitudes about climate change ($g = 0.08$, $p < 0.05$).

Table 1 One-way informational intervention types (adapted from 46)

Theory of change	Intervention	Description
Information-deficit theory	Scientific information	Provides scientific information about the effects of climate change to increase support for addressing it (215)
Gateway belief model	Scientific consensus	Provides information about scientific consensus regarding climate change to motivate changes in other climate change attitudes (216)
Appeal to fear or hope	Emotion	Uses fear- or hope-based messaging to provide information about climate change to increase support for addressing climate change (217, 218)
Construal level theory	Psychological distance	Provides information that emphasizes tangible, relatable, and proximate impacts and effects of climate change to decrease psychological distance with which individuals experience it (219)
Appeal to safety and national identity	National security	Provides information about climate change and methods for addressing it to promote national security and identity (220)
Appeal to economic benefits	Economy	Provides information on the economic costs of climate change and the (potential) benefits of mitigation (221)
Appeal to values and beliefs	Religion	Provides information that links climate change effects and scriptural or moral precedents in a given religion (222)
Appeal to values and beliefs	Morality	Provides information that frames climate change as a moral issue to drive support for addressing it (223)

However, preexisting attitudes moderated this impact, and attitudes related to policy changed less than attitudes related to belief in climate change. This indicates that one-way informational communication generated changes in policy or value-related attitudes less often than attitudes related to beliefs (46). The impact of public information campaigns on preferences for proenvironmental behaviors reveals a similar pattern, with improvements in citizen awareness of environmental harms and an increased willingness to pay for the conservation of ecosystem services following the campaign. These effects declined in the period following the campaign (47). Other studies find a similar impact, where one-way informational communication appears to alter conceptual frames especially as they relate to stated preferences, but there is a lack of evidence for, or mixed impact on, longer-lasting values (43, 48, 49).

The influence of one-way informational communication on environmental behaviors is highly contextual. The communication medium, audience, and the type of environmental behavior combine to mediate environmental outcomes. An analysis of pseudopanel data from the Eurobarometer surveys (years 2008, 2011, and 2014) found that different sources of information influenced eco-behaviors differently across age cohorts (45). In general, however, the use of web-based information sources predicted greater reductions in waste production and energy use, but it did not influence recycling. D'Amato et al. (45) posit that web-based information is useful for complex behaviors, such as waste and energy reduction, whereas recycling is commonplace and requires little additional information to implement. Similarly, a randomized control trial that measured the impact of information on appliance energy usage found that messages about negative environmental and health externalities of energy production outperformed information on savings in reducing appliance usage. This impact was particularly pronounced among families with children (50). Aligning the message and medium with the conceptual frames and values of citizens appears to be critical for influencing short-term behaviors through one-way communication.

Research indicates that the influence of one-way operational communication on the conceptual frames and values of individuals is minimal, with the impact of such communication dependent on audience and incentives. For example, a randomized control trial in Uganda that measured improvements in citizen reporting on solid waste services found that local recognition of citizen reporters did not increase reporting, but communication from the government about how citizen reporters' information influenced waste services did (51). In this context, citizen reporters valued influencing outcomes rather than providing information or recognition to citizens.

Research on behavioral impacts from one-way operational communication similarly demonstrates mixed findings that highlight the importance of how communication occurs and who receives it. A growing body of empirical evidence finds that information by itself can influence individuals' conceptual frames and values, but it neither improves accountability between the public and the political decision-makers nor induces individuals to take advantage of public programs (52–57). In contrast to these findings, the watchdog role that citizens or citizen-groups can play using one-way communication does seem to alter the behavior of authorities. Multiple examples from China found that communicating information about local government compliance with the enforcement of pollution mandates improved accountability for both in-person and digital communications (58, 59). Further, third-party information on water quality and littering provided to government authorities improved water quality in China, though providing the same information to citizens had no impact (60). Finally, an example from the international stage also reflects the ability of one-way operational communication to influence environmental behaviors. Monitoring of World Bank lending by nongovernmental organizations (NGOs) representing public interests demonstrated that when greater oversight for lending was in place, and when international organizations can submit complaints, fewer environmentally risky development projects were funded (61).

In general, there is growing evidence that one-way informational communication can influence citizens' conceptual frames, with less evidence of its impact on their values. Similarly, well-conceived one-way operational communication influences decision-maker behaviors in certain contexts, but it seems to have little impact on the public. However, the importance of message construction, audience, and trust moderate these and other one-way information impacts. For example, research on messaging about eco-friendly products and conceptual framing highlights the importance of matching how a message is communicated with preexisting audience perceptions or environmental awareness (49). Moreover, different age cohorts relate differently to the medium through which communication occurs (45). Both the trust with which communicators receive information and the ease with which they can decode and make sense of a message moderate the influence of one-way communication (62). The timing and location of one-way communication further influence audience perceptions, values, and behaviors. Research examining the use and content of signs to communicate restrictions or closures related to wildlife protection found that they are most effective when they provide instructions or reference to formal regulations and when they are placed in locations that are strategic and proximate to the protected areas (63–65). Thus, there is broad evidence that one-way communication has the potential to shape the conceptual frames of the public or the actions of decision-makers. However, the variation of impacts stemming from the interplay between the message, medium, and communicators remains particularly important. Carefully identifying the impact of one-way communication on different members of the public in the context of environmental governance remains a growing and important body of research, especially considering the rise of digital platforms.

2.2. Two-Way Informational Communication: The Role of Conversation

Arguments from the tragedy of the commons follow, in part, from one of two invalid assumptions about public communication. For the tragedy to occur, it must be the case that resource users will not communicate about resource degradation or that their communication will not produce collective action to address resource degradation. However, assuming that resource users cannot or will not be persuaded to change their behavior through communicative action bears little resemblance to empirical observation (66). The importance of two-way communication has served as a cornerstone for investigating the role of informational exchange in environmental governance (67, 68). Alternative labels for such communication about the environment and related governance include everyday talk and cheap talk. In political science and democracy studies, everyday political talk refers to political conversations citizens typically engage in with family, peers, and community (69). Cheap talk, a term often used in economics and game theory, refers to communication that neither affects payoffs nor creates binding commitments (70, 71). We do not differentiate between everyday talk and cheap talk; two-way informational communication about rules and the environment encompasses both terms. However, cheap talk is also used to describe one-way informational communication (72). Thus, two-way informational communication refers broadly to everyday talk but includes only two-way instances of cheap talk. Keeping this caveat in mind, studies of everyday talk as well as cheap talk identify the importance of communication in shaping conceptual frames, personal values, and environmental behaviors.

Two-way informational communication can help coordinate conceptual frames and personal values. A review of environmental education impacts evaluated 103 changes in behavioral antecedents, with 101 (98%) studies documenting positive changes in environmental awareness or stated preferences for more sustainable environmental outcomes (73). Though Ardoin et al. (73) point to the possible impact of publication bias in favor of significant and positive results, disciplines and studies beyond the realm of environmental education recognize the foundational

Public participation: when formal government processes include citizens by listening to their perspectives, allowing them to make governance decisions, or both

importance of two-way informational communication about environment and its governance in the coordination of conceptual frames and personal values. Such communication provides citizens information about the institutional contexts that shape human–environment interactions and can change how participants consider their own behaviors as well as their perceptions about the behaviors of others (14, 74, 75). For example, this may occur if new households join a community with rights to manage a forest and, in discussions with neighbors, learn about rules and practices associated with its use and management. Communication that coordinates perceptions and values also serves to promote group solidarity (76).

A large body of evidence concludes that two-way informational communication among citizens influences environmental behaviors. Evidence from laboratory and field-based games demonstrates that communication can influence users to contribute to public goods (77, 78), so long as trust is in place (79). Game-based research also finds that the content and repetition of communication is important for understanding cooperation related to resource use. For example, a field-based game in Colombia found that when two-way communication included statements related primarily to sharing information, players were less likely to cooperate, but when statements sought to increase group solidarity, cooperation increased (76). Comparisons between one-off versus repeated communication demonstrate the importance of two-way informational communication over time for promoting cooperation (80–83).

Despite the role that communication plays in coordinating conceptual frames, personal values, and environmental behaviors, collective action problems persist. This points to the costs associated with communication, which can influence both the extent to which citizens are able to engage with one another and the degree to which such communication influences environmental policy (84, 85). In addition, two-way informational communication occurs in social and environmental contexts. Citizens with similar conceptual frames and values often share information with one another, reflecting and leading to polarization (86, 87). Carefully identifying how different forms of two-way informational communication influence citizens and their environmental behaviors, conditional upon social and ecological contexts, will remain important for better understanding the process and outcomes of environmental governance (88).

2.3. Two-Way Operational Communication: Shaping Governance Through Communication

In public policy research, two-way operational communication is often termed public participation (89). We differentiate between settings where citizens hold mutual decision-making authority and settings where the public communicates with individuals (often citizens communicating with their representatives) who hold asymmetrical authority. Across both settings, individuals actively participate in environmental governance, communicating to shape the creation of rules and their implementation. Authority and power are thus a central concern in this form of communication. A strong foundation of experimental and observational research attests to the role of public participation in changing conceptual frames, personal values, and environmental behaviors in settings characterized by both asymmetrical and mutual political authority.

Under certain conditions, public participation enhances the trust and legitimacy individuals afford governance, but its influence on conceptual frames and personal values related to environmental governance is unclear. Participating in the governance process, either by communicating with decision-makers or by communicating as a decision-maker, can enhance trust between individuals, as well as between citizens and representatives (90, 91). It can also enhance the legitimacy of regulations and their related implementation in the eyes of citizen participants (92, 93), as well as change how citizens view their own role and ability to influence governance (94). However,

the evidence for understanding the extent to which citizens change their perceptions or values in relation to the role, need, or importance of environmental governance is limited. Numerous studies focus on the role of preexisting perceptions or values in shaping participatory outcomes (6), but few studies examine how two-way operational communication changes perceptions and stated preferences for environmental policy. Research on the commons finds that two-way operational communication, among citizens who hold rights to use and manage forest resources, aligns conceptual frames and values with sustainable resource use (22). Investigating how two-way operational communication influences citizens' perceptions and values for environmental goods and services will be essential for enacting sustainable transitions.

Cross-disciplinary evidence provides support that two-way operational communication affects environmental governance decisions. A meta-analysis of 305 studies of public participation and conservation and environmental health outcomes in 22 western democracies found that proenvironmental outcomes are best predicted by greater delegation of authority, the representation of environmental and economic interests, and (to a lesser extent) the intensiveness of communication (6). This review underscores results from other studies, which found that empowering citizens with increased decision-making authority in participatory processes results in governance outcomes that support climate adaptation and mitigation (95). However, the organization and structure of the participatory process, as well as the conceptual frames and values of citizens who communicate, are key to understanding the role of public participation in shaping outcomes (6, 95).

The participatory process, stakeholder interests, and accountability are important moderating factors affecting the relationship of two-way operational communication for environmental governance (96). Public participation is a method that can be used to empower or disempower citizens (91). Disempowerment may result through artificial or expedient participatory processes meant to legitimize governance actions without incorporating the voice and values of citizen participants (97, 98). Disempowering public participation can have lasting effects. A study evaluating citizens' support for receiving operational information about river restoration in China found that because preexisting two-way communication was ineffective, citizens preferred one-way communication about river restoration to two-way communication (48). Accountability, either through the delegation of decision-making power to the citizens or through transparent methods of incorporating public voices and values, is essential for realizing improvements in equity, efficiency, and legitimacy (99–101).

3. NEW DIRECTIONS IN CITIZEN COMMUNICATION AND ENVIRONMENTAL GOVERNANCE

The decentralization of communication and the rise of digital platforms have altered citizen communication. In this section, we first consider the role of digital platforms in providing information, facilitating conversation, and mediating operational communication (102, 103). Though digital platforms expand the possibilities of citizen communication, such an expansion is not always constructive for providing useable information or promoting participation (104, 105). Reviewing the literature on the relationship between digital information and environmental governance, we assess the extent to which such platforms improve access to information and for whom (106, 107). We then consider the definition, spread, and impacts of misinformation and disinformation. We assess how misinformation and disinformation relate to legitimacy and trust, criteria that influence whether and how scientific findings inform citizen communication and environmental governance (62). Misinformation alone, however, does not generate misperceptions. We again evaluate the role of conceptual frames and personal values in linking misinformation

to misperceptions (108). Throughout this section, we draw on literature dedicated to climate change, citizen communication, and environmental governance.

Crowdsourcing: a method for obtaining information or labor contributed or created by a large, diffuse public online

3.1. Digital Platforms

Digital platforms have evolved rapidly and offer a new set of communication modalities with which the public can discuss environmental issues (109–111). The means of communication range from private text messaging applications to more public broadcasting in the form of blogs or public social media (109, 112). Private or semiprivate messaging applications, such as WhatsApp, WeChat, or Telegram, enable one- and two-way informational communication, typically used among individuals with social ties or shared interests. Individuals can also communicate through more public channels. Blogs and social media have the common feature of publicly accessible information (113). Across these different types of digital platforms, individuals share information about environmental issues, endorse established or emerging social norms around environmental conservation, and mobilize one another to take collective action (110, 114, 115).

Digital tools such as massive online open courses (MOOCs) or platforms such as eBird and iNaturalist foster environmental education and engagement (116, 117) and enable public participation in large-scale efforts to track changes to the biosphere (118, 119). Such tools may also provide a deeper sense of belonging or proenvironmental identity formation (116, 120, 121). Through crowdfunding platforms such as Kickstarter or experiment.com, individuals can provide or seek financial support for environmental research, technologies that can positively impact the environment, or conservation initiatives (122–124). Crowdfunding and crowdsourcing information can democratize access to resources for projects that may not be eligible for traditional funding sources (123). Through social media, social networking, messaging applications, or blogging sites, citizens can influence public opinion, signal their support for environmental causes, or coordinate to take action, such as environmental or climate protests (109, 125).

Digital tools and platforms offer the promise of democratizing access to information and catalyzing public mobilization. One of the most important ways that digital platforms have transformed communication is by removing barriers to reaching other members of the public (103, 126). Traditional channels of information dissemination were often limited to social elites or entities with substantial resources to generate and transmit content widely. Now, with access to the Internet, individuals have the ability to reach a global audience (111). This broader access to information empowers a wider diversity of voices, such that more grassroots initiatives or marginalized perspectives can gain visibility and social support. Compared with legacy media firms, recent research has argued that digital-first news outlets cover issues like climate change at a higher frequency or with different narrative frames, such as emphasizing civic action rather than policy deliberations (127). Additionally, as described above, digital platforms can provide new sources of financial support or informational resources that may enhance environmental literacy and engagement more generally (128, 129); whether it is through MOOCs or more specialized tools such as eBird or iNaturalist, citizens have unprecedented access to learning about the natural world and crowdsourcing information about their local environments (130, 131).

The Climate March, #FridaysForFuture, and #NoDAPL campaigns are examples of how digital advocacy—in this case, through social media, specifically the platform X (formerly known as Twitter)—can contribute to environmental advocacy (126, 132). The Climate March and #FridaysForFuture inspired the public to participate in climate strikes and have made climate change a more mainstream political issue in representative democracies (133, 134). #NoDAPL, led by Indigenous activists, used social media to decry pollution impacts associated with the Dakota Access Pipeline and rallied public support against proposed infrastructure (126, 135). As with the campaigns we discuss here, digital communication about environmental issues often features

discussion by different stakeholders that can transform into different constituency groups (136, 137). Despite concerns that political polarization drives the formation of isolated digital communities (138), recent work has argued that some online communities instead exhibit patterns consistent with debate and deliberation (139). Environmental movements from low-income and lower-middle-income countries have used digital organizing across multiple social media platforms; examples include the Yaqui people using social media to combat water pollution and excessive freshwater withdrawal (140), citizens in Malaysia coordinating online to protest a proposed rare earth mineral refinery (141), and protests across multiple Chinese cities driven by digital posts in opposition to paraxylene chemical factories (142, 143). These examples illustrate how members of the public can leverage digital platforms to spark regional action and, in some cases, global awareness. Recognizing the power of social media to spur collective action, authoritarian regimes, such as the government of the People's Republic of China, prioritize censoring posts that can mobilize the public over posts that criticize the government but have no persuasive or broader appeal (144). Perhaps unsurprisingly, social media usage positively covaried with youth participation in environmental activism in a set of surveyed countries, including Chile, Canada, France, the United Kingdom, and the United States (145, 146). Movements spurred or amplified by online discourse underscore how digital platforms can, at best, lead to cross-border solidarity for environmental causes, providing global reach for concerned members of the public, including those in geographically remote or highly marginalized groups.

Clicktivism: using the Internet to perform relatively low-cost actions in terms of time and money, such as sharing or consuming content

Though digital mechanisms may democratize information, a critical question remains: Does this lead to meaningful action, or does it primarily result in mere clicktivism? Cliktivism has been defined as the limited engagement of liking, sharing, and reposting without any impact outside of digital platforms. While digital platforms can mobilize large numbers of people to show support for environmental causes through clicks and shares, it is unclear whether, how, and when citizens translate digital communications to meaningful actions that address environmental challenges. Recent findings indicate mixed success for environmental collective action. While digital platforms may offer novel ways of reaching the public that translate to success for relatively cheap or free actions (147), in other cases, digital campaigns failed to persuade broader social media user populations (148) or even recoup the costs of running ads as a means to message to the public online (149).

It is uncertain whether digital platforms can ultimately democratize environmental information. Inequalities in access to technology and the lack of transparency surrounding algorithmic recommendation systems mean that some messages may be disproportionately amplified while others are suppressed (150, 151). Such imbalances can hinder the equitable dissemination of knowledge and environmental advocacy. When platforms are owned privately, their governance can change suddenly and without public accountability, negatively affecting the environmental publics that they serve (152). Government censorship and coordinated campaigns by powerful interests can also hinder the free and fair exchange of online information by suppressing or manipulating certain messages (153–155). Moreover, the quality of information that the public may encounter online may be low, threatening public understanding of climate science (156). Despite the exciting promise of large-scale crowdsourcing of ideas, any digital platform—even one with egalitarian communication features—remains embedded in larger systems and ideologies that shape possibilities and constraints of environmental governance (157, 158).

3.2. Misinformation and Disinformation

The spread of false information (misinformation) and information intentionally designed to deceive citizens (disinformation) has risen in tandem with the use of digital platforms. In 2021, nearly half of Americans stated they consumed news from social media platforms "often" or "sometimes,"

Table 2 Climate delay discourses (adapted from 163, p. 2)

Discourse	Logic	Subdiscourses
Emphasize the downsides	Disruption from taking action will be wasteful or costly	Policy perfectionism Appeal to well-being Appeal to social justice
Push nontransformative solutions	Transformative change is not necessary	Technological optimism All talk, little action Fossil fuel solutionism No sticks, just carrots
Redirect responsibility	Others have an obligation for climate action	Individualism Whataboutism The "free rider" excuse
Surrender	Mitigating climate change is not possible	Change is impossible Doomism

with Facebook serving as the social media platform that they used most (159). Misinformation and disinformation related to climate change and climate science are especially prevalent (154, 160). A recent analysis found that 16 of the world's biggest polluters produced advertisements that garnered over 150 million impressions (161). Given the recent proliferation of large language models and platforms that harness them, such as ChatGPT, the cost of producing misinformation and disinformation is likely to drop, while the time and expense of producing careful journalism and replicable science will not. Thus, the amount of misinformation and disinformation is likely to increase (162).

Two cases present useful insights into how misinformation and disinformation affect environmental governance. First, misinformation and a number of disinformation campaigns seek to impede or delay climate action. Messaging that emphasizes redirecting responsibility, advocates for nontransformative solutions, stresses downsides, and amplifies surrender are common strategies to undermine trust and legitimacy of climate change information and policy proposals for climate action (163). These "discourses of delay" are summarized in **Table 2** as tactics that delegitimize information that supports addressing climate change (163, p. 2; 164, p. 7). In another example, there are documented cases where WhatsApp has served as a powerful tool to spread disinformation to undermine trust in ongoing environmental crises. In Brazil, WhatsApp was used to implement a misinformation campaign about the origins of smoke from the Amazon into cities such as São Paulo, where environmental NGOs and activists were falsely blamed for the fires (165). Though the impacts of misinformation and disinformation efforts are challenging to estimate, the growing abundance of false information presents a challenge to honest, objective debate around environmental governance issues.

Individuals use traditional media, in addition to digital platforms, to communicate false and deceptive information. Rhetorical devices include creating doubt around scientific consensus, emphasizing scientific uncertainty, attacking the credibility of scientists and experts, raising doubts about the legitimacy of established processes and institutions, and spreading questionable alternative ideas (166–168). These tactics can be amplified to a greater extent on digital platforms compared to traditional outlets such as print media, television, or in-person communications, and the ways in which they influence beliefs, values, and behaviors are similar to those of nondigital communications. For example, misinformation and disinformation may reinforce cognitive biases, such as familiarity bias (i.e., frequency of information can increase its legitimacy), availability bias (i.e., information that is easily recalled), and confirmation bias (i.e., seeking information that supports existing beliefs), and several other cognitive and socio-affective factors that can shape

a person's susceptibility to misinformation and disinformation (169, 170). Yet when misinformation and disinformation are spread across communication modes, they reinforce falsehoods and threaten good environmental governance by undermining trust and legitimacy. Indeed, whether or not digital communication is coordinated by bad faith actors, the sheer volume and frequency of these messages can overwhelm digital platforms as a means of public communication for environmental governance.

Many studies of digital platforms and environmental governance focus on the role of one-way informational communication. For example, actors can post misleading or false information on YouTube through educational material or ads, as shown by the creation of front groups that post ads against recent efforts for climate change legislation in the United States on platforms such as Facebook (171). The emphasis on studying misinformation and disinformation through one-way informational communication may be a function of the comparative advantage that digital communications have for this type of communication. For example, there are practical challenges for scaling two-way communications, whether it be for informational or operational purposes. More work is needed to assess the extent, type, and impact of digital misinformation and disinformation on public communication for environmental governance.

Solutions to combat misinformation and disinformation focus on education, sanctioning, and transparency (168, 172, 173). Inoculating the public against misinformation exposes citizens to arguments common among misinformation and disinformation campaigns related to climate science so that people will be less susceptible to believing unreliable information (174–176). Providing evidence of intentional falsification of deceit, and seeking to sanction those who intentionally produce and spread false information, is another tactic to address misinformation and disinformation (177). Research to date highlights variation in the types of people who are more susceptible to misinformation and disinformation, as well as the efficacy of various methods to slow its spread and influence. Methods to combat misinformation and disinformation include digital literacy education, prompts to reflect on informational accuracy, and enhancing the transparency of funding and sources of information (172). Scientific misinformation may be uniquely challenging to correct (178), suggesting a particular difficulty for environmental governance, which often relies on scientific evidence to inform policies and practice. In response to the contemporary promise of digital platforms, and the related challenges of misinformation and disinformation, a growing body of research highlights the importance of collective intelligence and citizen deliberation (19, 30).

4. DELIBERATIVE DEMOCRACY AND ENVIRONMENTAL GOVERNANCE

Deliberative democracy refers to an aspirational form of two-way operational communication. A minimal definition defines deliberation as two-way communication where citizens sincerely examine their preferences, perceptions, and values concerning issues of public concern. Deliberative democracy, therefore, is "any practice of democracy that gives deliberation a central place" (28, p. 2). Deliberation depends upon a set of ideals that promote collective reasoning. Though there is no consensus on these ideals, they often include some combination of respect, noncoercion, equality, consideration, orientation for the common good, publicity, accountability, and sincerity (**Table 3**). Assessing the extent to which two-way operational communication unfolds in the context of democratic ideals differentiates strong deliberation from weak deliberation.

Strong deliberation addresses many issues that reduce the usefulness of public communication for environmental governance. Issues surrounding anonymity and dishonesty when using digital platforms (179) are addressed through ideals of publicity and sincerity (180). Concerns about misinformation (164) are mitigated through the ideals of respect, sincerity, and the transparent

Table 3 The democratic ideals to which deliberative processes aspire and their description

Democratic ideal	Description
Accountability	Communication leads to decision-making (consensus or aggregation), and decisions lead to impacts on institutions or their implementation
Equality	Equal opportunity for inclusion across demographic subgroups, as well as the equal opportunity to speak, listen, and understand
Noncoercion	The ability for citizens to speak and listen without coercion
Publicity	Communication occurs transparently, either being observable directly or faithfully recorded
Reasons/relevant considerations	Communication centers on the sharing of considerations relevant to institutions or their implementation
Respect	Citizens recognize their rights, and the rights of others, to speak, listen, and understand

As theory and research on deliberation has progressed, these ideals have been reinterpreted. This list seeks to represent the set of democratic ideals that guide contemporary deliberative theory and research (28, 29, 32, 187).

presentation of information. Ideals such as equality, noncoercion, and respect promise inclusive, equitable, and transparent communication (181).

Deliberative communication among citizens also promises to address challenges presented by democratic systems for addressing environmental problems. These challenges include democratic deficits, such as unclear or unstable citizen preferences, inaccurate communication of citizen interests through voting alone, and a lack of representative accountability to citizens (182). In addition to these traditional deficits, deliberative methods seek to address contemporary challenges in environmental governance, such as lack of representation and consideration of future generations and their needs (183), the politization of technical information and related polarization (86), and the influence and power of elite or special interests (184, 185). Deliberative communication addresses these issues by incorporating ideals of equality and inclusivity, noncoercion, publicity, relevance, and respect. These ideals demonstrate a large overlap with the main principles associated with the measurement and evaluation of good governance, which include inclusivity, fairness, transparency, accountability, legitimacy, direction, performance, and capability (186).

However, strong deliberation is an ideal form. Empirical studies seek to facilitate or otherwise create deliberative settings, but such settings are necessarily imperfect. Deliberation that is good (if not strong or ideal) comprises three dimensions. First, it enables participants to reach mutual decisions or better understand an issue. Second, deliberation unfolds among equals and does not reproduce inequalities that exist elsewhere. And third, deliberation generates impacts on the conceptual frames or values of individuals, the decisions being reached by representatives, or on human behavior (31).

Empirical research uses the ideals of deliberative democracy to design studies that examine how citizens who disagree can reach a collective decision they define as legitimate (187). The science of deliberation is receiving attention, especially as it responds to concerns about misinformation, growing recognition of inequitable political processes, and the pressing need for improved environmental governance (19). Deliberative research provides citizens with a strong base of information, facilitates inclusive and respectful discussion, ensures fair participation, and uses a selection mechanism to decide on a course of action (32). Such research can focus on deliberation in person or through digital platforms (188, 189). It may include all members of a group seeking to make a decision, a purposively selected set of individuals, or a mini-public of randomly selected citizens (190, 191). Some form of decision-making is often central to understanding the impacts of deliberation, and research often differentiates between public and private decision-making, as

well as consensus-based aggregative decisions. Though consensus-based decision-making has a long precedent in deliberative theory (192), alternative decision-making forms are not mutually exclusive and can work together (28).

A large body of evidence demonstrates the ability of deliberation to alter stated preferences and opinions related to environmental governance. We use the term deliberative surveys to refer to research methods that measure how citizens' conceptual frames and values change due to deliberative communication. Standard methods in this field of inquiry include deliberative polling; surveys amid deliberative juries, assemblies, or mini-publics; the combination of deliberation and discrete choice experiments; and other techniques that evaluate changes in citizens' conceptual frames and beliefs after participation in deliberation or compared with citizens who do not deliberate (193–195). Researchers have studied the impact of deliberation on polling results for several decades and find that deliberation often coordinates debate and preferences around a similar set of dimensions for a given issue. This meta-agreement helps clarify differences in opinion, even when consensus or preference aggregation is not the focus of deliberative communication (17). An experiment that examined the impact of deliberation on climate polarization in the United States found that, among six highly polarized issues, deliberation significantly reduced polarization for three issues related to climate change and the Paris Agreement, and for all six issues the most extreme participants demonstrated significant depolarization (86). Beyond altering conceptual frames so that citizens are better able to understand one another and discuss governance issues, there is a growing body of evidence that deliberation coordinates preferences and social choice. Research involving a game-based experiment in Kenya found that deliberation increased prosocial preferences and that individuals within a deliberative and consensus-based decision treatment were more likely to change their individual preferences to reflect group selection when compared with control or voting-based decision treatments (196). This coordination of individual preferences with the group decision also occurred in a deliberative experiment in New Hampshire focused on the valuation of different ecosystem services, where participants' ecosystem service rankings ultimately converged and trended toward the group's deliberative ranking (197).

In addition to coordinating stated preferences, there is growing evidence that deliberation influences the governance decisions that citizens make. Deliberative fora are increasing in scale and scope as the evidence base for their impact on citizen decision-making grows, especially related to environmental governance (30). Such fora include deliberative citizen juries and citizen assemblies, sometimes termed deliberative mini-publics. Citizens are randomly selected to participate in mini-publics, with assemblies typically including more citizens than juries (198). This selection process aims to recreate demographic patterns in the general population, thus reflecting the distribution of age, gender, race, and other demographic qualities from the sampled population. Citizens within mini-publics are presented with information in a learning phase. In the case of citizen climate assemblies that occurred in Ireland, France, and the United Kingdom, this included materials for citizens to read and presentations from climate scientists and from individuals representing interest groups (199). Citizens are further able to ask questions and exercise the right to understand (32). Following the learning phase, citizens deliberate and make group decisions related to proposals and policy recommendations (30, 190, 200). Recent research on successful deliberation using social media found that mechanisms used for in-person interactions, such as acknowledging the values of the other parties in a conversation or mirroring their language, are key to successfully persuading other parties to adopt shared opinions (201).

Deliberation also provides a suite of benefits beyond improved communication for environmental governance. For example, deliberation can improve the perceived legitimacy of procedures and policies. Before-and-after surveys of citizens who participate in citizen assemblies found that facilitated deliberation garners greater procedural legitimacy (93). However, after adjusting for

different conceptual frames and personal values, perceptions of legitimacy are often more strongly tied to how well a particular instrument or policy reflects an individual's preferences. The more a participant agrees with a policy or instrument under discussion, the more likely they are to perceive procedures and policies as legitimate (93). Additionally, there is evidence for depolarization (86), improved scientific awareness, and improved understanding, as well as greater trust in some modes of governance and distrust in other, less democratic modes (3). Future research on the spillover effects from deliberation about environmental governance will be important for determining the social benefits and potential trade-offs such communication provides.

Commoning: social practices that create community-based rules, collective identities, and commonly shared resources

Though the evidence for understanding the impact of deliberative communication on environmental governance is growing, important research gaps remain. First, empirical studies of deliberation and deliberative democracy often focus on high-income nations home to liberal democracies (202). Though rich traditions of deliberation exist across the Global South, and though there is a growing interest in the power and importance of civil society in the democracies of low- and middle-income countries, evidence related to deliberation and environmental governance draws primarily on research on the Global North (3, 203). Comparing deliberative impacts across democracies around the world will be essential to understanding the potential for this form of communication to promote individual and environmental change (204). Second, more research is necessary to theorize and examine the relationships between commoning and deliberative communication (205, 206). Commoning refers to social processes that maintain collective governance, as well as the experiences of citizens involved in such processes (207). Assessing how emerging and collective processes of environmental governance incorporate elements of deliberation and deliberative democracy promises to better inform research of the commons and deliberative democracy. Finally, rigorous assessment of the relationship between different ideals and how deliberation is facilitated can provide critical operational insights for guiding deliberative communication about environmental governance (208).

5. CONCLUSION

Communicating is foundational to living socially and is a basic feature of being human (33, 67). Through communication, citizens learn about or create rules, their implementation, and their outcomes (32). Reviewing literature on different types of public communication and their relationship to environmental governance demonstrates the importance of assessing how governance unfolds. Much research evaluates and compares different governance mechanisms, such as payments for ecosystem services or tenure reform, but comparatively little research examines the conditions and realities of implementation (209). This tendency can overlook the way that communication defines objectives, constitutes implementation, and determines how mechanisms of governance are talked about and evaluated. In contrast, our review examines different forms of public communication as the processes by which individuals comprehend, value, discuss, construct, and evaluate the rules or norms of human–environment interactions. It advances public communication as an essential element of environmental governance.

Public communication is crucial for environmental governance, but it does not determine governance outcomes alone. In this review, we consider the role of communication and deliberation for environmental governance within a given social-material context. This prioritizes the evaluation and comparison of empirical research, but it does not include theoretical insights related to how communication functions to create social structures or reinforce systems of power. For example, theory that relates communication and social context claims that verbal communication reflects the social structure in which it occurs, regulating who can speak and with what level of authority (210). The reproduction of social structure through communication influences unconscious beliefs individuals hold (*doxa*) and their everyday behaviors (*habitus*) (211).

Theory related to communication and governing power considers the role of discourse and how the ability to determine what counts as knowledge or truth relates to broader systems of authority and legitimacy (212, 213). Though such theories are not antithetical to the types of public communication we identify, they emphasize how communication functions to produce social and material realities. They also highlight how communication occurs and is shaped within broader power relations. Thus, while this review attends to the types and impacts of public communication, future research that evaluates theories of communication and environmental governance can provide useful insights into the history, formation, and reproduction of social-material contexts that enable and limit the range of possibilities for environmental governance.

Attending to the processes of public communication demands attention to how individuals comprehend information, who is sharing it, and how they share it. Thus, throughout this review we focus on how different types of communication—defined by directionality and objective—influence the conceptual frames and values of individuals, as well as the behaviors and environmental impacts that result. This focus is especially prescient, as recent analyses highlight the importance of citizen communication for legitimating and taking action to mitigate climate change, conserve biodiversity, and support sustainable development (19, 203). The modern era of public communication for environmental governance presents challenges as well as enormous opportunities. Digital platforms can connect individuals around the world to provide global arenas for discussion and deliberation (86, 214). However, these platforms can also alienate certain parts of the population, increase polarization, and promote misinformation or disinformation (164). Researchers and practitioners who promote deliberation and deliberative democracy facilitate communication according to a set of ideals that address contemporary challenges. They provide a strong base of evidence to show that under certain circumstances and with appropriate facilitation, citizen communication can improve understanding, increase perceived legitimacy of governance, and advance prosocial outcomes for collective action. As environmental governance gains prominence in contemporary policy agendas, the need to realize transparent, equitable, and legitimate solutions to environmental problems becomes increasingly important. Promoting free and fair public communication is both a method and a goal for addressing environmental governance challenges of the twenty-first century.

SUMMARY POINTS

1. Communication structures the possibilities and limits of environmental governance. It differs in type by directionality (one-way or two-way) and objective (informational or operational).
2. One-way communication is widespread, but research finds its influence on environmental governance is minimal. The impact of one-way informational and operational communication is often limited to influencing individuals' conceptual frames.
3. There is strong support for the importance of two-way informational communication for coordinating conceptual frames, personal values, and environmental behaviors related to environmental governance and the use of natural resources.
4. Two-way operational communication represents the costliest but most impactful form of public communication. Also known as public participation, this type of communication is further differentiated on the basis of whether citizens share decision-making authority among themselves or whether it is vested in a specific individual or group without being extended to all communicating members of the public.

5. Digital platforms are reshaping public communication. Thus far, they have had the greatest impact on one-way communication types and two-way informational communication.
6. The rapid rise of misinformation and disinformation has occurred in tandem with the increase in access to digital platforms. With the amount of misinformation and disinformation projected to rise, public communication based on information created transparently will be essential.
7. Deliberation refers to a specific form of two-way communication that upholds a set of ideals to promote respectful exchange between equal communicants that enables sincere reflection on preferences considering the public good.
8. A growing body of evidence focused on citizen juries and citizen assemblies (i.e., deliberative mini-publics) finds that deliberation is an impactful method for promoting fair and sustainable environmental governance.

FUTURE DIRECTIONS

1. Research on the impact of one-way communication on conceptual frames and personal values surrounding climate change will remain critical for implementing climate mitigation and adaptation. Better understanding how medium, message, and preexisting perceptions mediate communication impacts will remain an important field of research.
2. Assessing how digital platforms can facilitate two-way operational communication promises to advance public participation, particularly if such digital communications result in more than low-stakes, minimal-effort activities such as sharing content.
3. More work is needed to understand the effects of misinformation and disinformation on public communication and environmental governance, as well as what forms of communication effectively address it.
4. Ensuring public communication is fair and equitable demands greater attention in terms of who can engage with different information and who is able to participate publicly.
5. Assessing the relationship between deliberative ideals and how they moderate impacts of deliberative communication on citizens, behaviors, and environmental outcomes can provide valuable insights for environmental organizations.
6. As deliberative mini-publics become more common, implementation science focused on their facilitation, impact, and outcomes can contribute research on how they are best scaled.

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LITERATURE CITED

1. Irvin RA, Stansbury J. 2004. Citizen participation in decision making: Is it worth the effort? *Public Adm. Rev.* 64(1):55–65
2. Newell P, Pattberg P, Schroeder H. 2012. Multiactor governance and the environment. *Annu. Rev. Environ. Resour.* 37:365–87
3. Sanyal P, Rao V. 2018. *Oral Democracy*. Cambridge, UK: Cambridge Univ. Press
4. Schmidt VA. 2008. Discursive institutionalism: the explanatory power of ideas and discourse. *Annu. Rev. Political Sci.* 11:303–26
5. Lemos MC, Agrawal A. 2006. Environmental governance. *Annu. Rev. Environ. Resour.* 31:297–325
6. Newig J, Jager NW, Challies E, Kochskämper E. 2023. Does stakeholder participation improve environmental governance? Evidence from a meta-analysis of 305 case studies. *Global Environ. Chang.* 82:102705
7. McLuhan M. 1964. *Understanding Media: The Extensions of Man*. New York: McGraw-Hill
8. Boykoff MT. 2009. We speak for the trees: media reporting on the environment. *Annu. Rev. Environ. Resour.* 34:431–57
9. Boykoff MT, Boykoff JM. 2007. Climate change and journalistic norms: a case-study of US mass-media coverage. *Geoforum* 38(6):1190–204
10. Akin H, Scheufele DA. 2017. Overview of the science of science communication. In *The Oxford Handbook of the Science of Science Communication*, ed. KH Jamieson, DM Kahan, DA Scheufele, pp. 25–33. Oxford, UK: Oxford Univ. Press
11. Maibach EW, Uppalapati SS, Orr M, Thaker J. 2023. Harnessing the power of communication and behavior science to enhance society's response to climate change. *Annu. Rev. Earth Planet. Sci.* 51:53–77
12. Masuda YJ, Scharks T. 2017. Science communication is receiving a lot of attention, but there's room to improve. In *Effective Conservation Science: Data Not Dogma*, ed. P Kareiva, M Marvier, B Silliman, pp. 115–20. Oxford, UK: Oxford Univ. Press
13. Scheufele DA. 2013. Communicating science in social settings. *PNAS* 110(suppl_3):14040–47
14. Janssen MA, Holahan R, Lee A, Ostrom E. 2010. Lab experiments for the study of social-ecological systems. *Science* 328(5978):613–17
15. Masuda YJ, Waterfield G, Castilla C, Kang S, Zhang W. 2022. Does balancing gender composition lead to more prosocial outcomes? Experimental evidence of equality in public goods and extraction games from rural Kenya. *World Dev.* 156:105923
16. Ostrom E. 2005. *Understanding Institutional Diversity*. Princeton, NJ: Princeton Univ. Press
17. List C, Luskin RC, Fishkin JS, McLean I. 2013. Deliberation, single-peakedness, and the possibility of meaningful democracy: evidence from deliberative polls. *J. Politics* 75(1):80–95
18. Goodin RE, Dryzek JS. 2006. Deliberative impacts: the macro-political uptake of mini-publics. *Politics Soc.* 34(2):219–44
19. Dryzek JS, Bächtiger A, Chambers S, Cohen J, Druckman JN, et al. 2019. The crisis of democracy and the science of deliberation. *Science* 363(6432):1144–46
20. Erbaugh JT. 2019. Responsibilization and social forestry in Indonesia. *Forest Policy Econ.* 109:102019
21. Soneryd L, Uggla Y. 2015. Green governmentality and responsibilization: new forms of governance and responses to 'consumer responsibility.' *Environ. Politics* 24(6):913–31
22. Agrawal A. 2005. *Environmentality*. Durham, NC: Duke Univ. Press. 326 pp.
23. Hammett D. 2018. Engaging citizens, depoliticizing society? Training citizens as agents for good governance. *Geogr. Ann. Ser. B Human Geogr.* 100(2):64–80
24. Fox JA. 2015. Social accountability: What does the evidence really say? *World Dev.* 72:346–61
25. Ribot J. 2022. Violent silence: framing out social causes of climate-related crises. *J. Peasant Stud.* 49(4):683–712
26. Kiss B, Sekulova F, Hörschelmann K, Salk CF, Takahashi W, Wamsler C. 2022. Citizen participation in the governance of nature-based solutions. *Environ. Policy Gov.* 32(3):247–72

27. Kymlicka W, Norman W. 2000. Citizenship in culturally diverse societies: issues, contexts, concepts. In *Citizenship in Diverse Societies*, ed. W Kymlicka, W Norman, pp. 1–42. Oxford, UK: Oxford Univ. Press
28. Bächtiger A, Dryzek JS, Mansbridge J, Warren M. 2018. Introduction. In *The Oxford Handbook of Deliberative Democracy*, ed. A Bächtiger, JS Dryzek, J Mansbridge, M Warren, pp. 1–32. Oxford, UK: Oxford Univ. Press
29. Dryzek JS. 2002. *Deliberative Democracy and Beyond: Liberals, Critics, Contestations*. Oxford, UK: Oxford Univ. Press. 306 pp.
30. Landemore H. 2020. *Open Democracy: Reinventing Popular Rule for the 21st Century*. Princeton, NJ: Princeton Univ. Press
31. Polletta F, Gardner B. 2018. The forms of deliberative communication. In *The Oxford Handbook of Deliberative Democracy*, ed. A Bächtiger, JS Dryzek, J Mansbridge, M Warren, pp. 69–85. Oxford, UK: Oxford Univ. Press
32. Gastil J. 2008. *Political Communication and Deliberation*. Thousand Oaks, CA: Sage
33. Newell A, Simon HA. 1972. *Human Problem Solving*. Englewood Cliffs, NJ: Prentice-Hall
34. Simon HA. 2000. Bounded rationality in social sciences. *Mind Soc*. 1(1):171–89
35. Newell BR, McDonald RI, Brewer M, Hayes BK. 2014. The psychology of environmental decisions. *Annu. Rev. Environ. Resour.* 39:443–67
36. Goffman E. 1974. *Frame Analysis? An Essay on the Organization of Experience*. Boston: Northeastern Univ. Press
37. Benford RD, Snow DA. 2000. Framing processes and social movements: an overview and assessment. *Annu. Rev. Sociol.* 26:611–39
38. Lakoff G. 2010. Why it matters how we frame the environment. *Environ. Commun.* 4(1):70–81
39. Dietz T, Fitzgerald A, Shwom R. 2005. Environmental values. *Annu. Rev. Environ. Resour.* 30:335–72
40. Palmer C, McShane K, Sandler R. 2014. Environmental ethics. *Annu. Rev. Environ. Resour.* 39:419–42
41. Maund PR, Irvine KN, Lawson B, Steadman J, Risely K, et al. 2020. What motivates the masses: understanding why people contribute to conservation citizen science projects. *Biol. Conserv.* 246:108587
42. Steg L, Vlek C. 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. *J. Environ. Psychol.* 29(3):309–17
43. Nisa CF, Bélanger JJ, Schumpe BM, Faller DG. 2019. Meta-analysis of randomised controlled trials testing behavioural interventions to promote household action on climate change. *Nat. Commun.* 10(1):4545
44. Bolderdijk JW, Gorsira M, Keizer K, Steg L. 2013. Values determine the (in)effectiveness of informational interventions in promoting pro-environmental behavior. *PLOS ONE* 8(12):e83911
45. D'Amato A, Giaccherini M, Zoli M. 2019. The role of information sources and providers in shaping green behaviors. Evidence from Europe. *Ecol. Econ.* 164:106292
46. Rode JB, Dent AL, Benedict CN, Brosnahan DB, Martinez RL, Ditto PH. 2021. Influencing climate change attitudes in the United States: a systematic review and meta-analysis. *J. Environ. Psychol.* 76:101623
47. Bithas K, Latinopoulos D, Mentis C, Chatzivasileiadis T. 2023. Reshaping preferences over coastal and marine environment. Evaluating temporal effects on preferences raised by information campaigns. *Ocean Coast. Manag.* 243:106740
48. Chen W, Cho FHT. 2019. Environmental information disclosure and societal preferences for urban river restoration: latent class modelling of a discrete-choice experiment. *J. Clean. Prod.* 231:1294–306
49. Kikuchi-Uehara E, Nakatani J, Hirao M. 2016. Analysis of factors influencing consumers' proenvironmental behavior based on life cycle thinking. Part I: effect of environmental awareness and trust in environmental information on product choice. *J. Clean. Prod.* 117:10–18
50. Asensio OI, Delmas MA. 2015. Nonprice incentives and energy conservation. *PNAS* 112(6):E510–15
51. Buntaine MT, Nielson DL, Skaggs JT. 2021. Escaping the disengagement dilemma: two field experiments on motivating citizens to report on public services. *Br. J. Political Sci.* 51(2):685–705
52. Banerjee AV, Banerji R, Duflo E, Glennerster R, Khemani S. 2010. Pitfalls of participatory programs: evidence from a randomized evaluation in education in India. *Am. Econ. J. Econ. Policy* 2(1):1–30

53. Buntaine MT, Daniels B, Devlin C. 2018. Can information outreach increase participation in community-driven development? A field experiment near Bwindi National Park, Uganda. *World Dev.* 106:407–21
54. Jablonski RS, Buntaine MT, Nielson DL, Pickering PM. 2022. Individualized text messages about public services fail to sway voters: evidence from a field experiment on Ugandan elections. *J. Exp. Political Sci.* 9(3):346–58
55. Keefer P, Khemani S. 2012. *Do informed citizens receive more. . .or pay more? The impact of radio on the government distribution of public health benefits*. Policy Res. Work. Pap. Ser. 592, World Bank Group, Washington, DC
56. Lieberman ES, Posner DN, Tsai LL. 2014. Does information lead to more active citizenship? Evidence from an education intervention in rural Kenya. *World Dev.* 60:69–83
57. Ravallion M, van de Walle D, Dutta P, Murgai R. 2013. *Testing information constraints on India's largest antipoverty program*. Policy Res. Work. Pap. 6598, World Bank, Washington, DC
58. Anderson SE, Buntaine MT, Liu M, Zhang B. 2019. Non-governmental monitoring of local governments increases compliance with central mandates: a national-scale field experiment in China. *Am. J. Political Sci.* 63(3):626–43
59. Buntaine MT, Greenstone M, He G, Liu M, Wang S, Zhang B. 2024. Does the squeaky wheel get more grease? The direct and indirect effects of citizen participation on environmental governance in China. *Am. Econ. Rev.* 114(3):815–50
60. Buntaine MT, Zhang B, Hunnicutt P. 2021. Citizen monitoring of waterways decreases pollution in China by supporting government action and oversight. *PNAS* 118(29):e2015175118
61. Buntaine MT. 2015. Accountability in global governance: civil society claims for environmental performance at the World Bank. *Int. Stud. Q.* 59(1):99–111
62. Gundersen T, Alinejad D, Branch TY, Duffy B, Hewlett K, et al. 2022. A new Dark Age? Truth, trust, and environmental science. *Annu. Rev. Environ. Resour.* 47:5–29
63. Allbrook DL, Quinn JL. 2020. The effectiveness of regulatory signs in controlling human behaviour and Northern gannet (*Morus bassanus*) disturbance during breeding: an experimental test. *J. Nat. Conserv.* 58:125915
64. Marschall S, Granquist SM, Burns GL. 2017. Interpretation in wildlife tourism: assessing the effectiveness of signage on visitor behaviour at a seal watching site in Iceland. *J. Outdoor Recreation Tour.* 17:11–19
65. Weston MA, Dodge F, Bunce A, Nimmo DG, Miller KK. 2012. Do temporary beach closures assist in the conservation of breeding shorebirds on recreational beaches? *Pac. Conserv. Biol.* 18(1):47–55
66. Ostrom E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK: Cambridge Univ. Press. 289 pp.
67. Agrawal A. 2014. Studying the commons, governing common-pool resource outcomes: some concluding thoughts. *Environ. Sci. Policy* 36:86–91
68. Ostrom E, Gardner R, Walker J. 1994. *Rules, Games, and Common-Pool Resources*. Ann Arbor: Univ. Mich. Press
69. Mansbridge J. 1999. Everyday talk in the deliberative system. In *Deliberative Politics: Essays on Democracy and Disagreement*, ed. S Macedo, pp. 211–39. Oxford, UK: Oxford Univ. Press
70. Duffy J, Feltovich N. 2002. Do actions speak louder than words? An experimental comparison of observation and cheap talk. *Games Econ. Behav.* 39(1):1–27
71. Farrell J, Rabin M. 1996. Cheap talk. *J. Econ. Perspect.* 10(3):103–18
72. Bingler JA, Kraus M, Leippold M, Webersinke N. 2022. Cheap talk and cherry-picking: What ClimateBert has to say on corporate climate risk disclosures. *Financ. Res. Lett.* 47:102776
73. Ardoin NM, Bowers AW, Gaillard E. 2020. Environmental education outcomes for conservation: a systematic review. *Biol. Conserv.* 241:108224
74. Weber JM, Kopelman S, Messick DM. 2004. A conceptual review of decision making in social dilemmas: applying a logic of appropriateness. *Personal. Soc. Psychol. Rev.* 8(3):281–307
75. Liebrand WBG, Messick DM, Wilke HAM, eds. 1992. *Social Dilemmas: Theoretical Issues and Research Findings*. London: Garland Science. 242 pp.

76. Lopez MC, Villamayor-Tomas S. 2017. Understanding the black box of communication in a common-pool resource field experiment. *Environ. Sci. Policy* 68:69–79
77. Balliet D. 2010. Communication and cooperation in social dilemmas: a meta-analytic review. *J. Confl. Resolut.* 54(1):39–57
78. Koessler A-K, Page L, Dulleck U. 2021. Public cooperation statements. *J. Econ. Interact. Coord.* 16(4):747–67
79. Andersson KP, Cook NJ, Grillos T, Lopez MC, Salk CF, et al. 2018. Experimental evidence on payments for forest commons conservation. *Nat. Sustain.* 1(3):128–35
80. Gardner R, Ostrom E, Walker J. 1994. *Social capital and cooperation: communication, bounded rationality, and behavioral heuristics*. Paper presented at Inequality and the Commons, the Third Biennial Conference of the International Association for the Study of Common Property, Washington, DC, Sep. 17–20
81. Oprea R, Charness G, Friedman D. 2014. Continuous time and communication in a public-goods experiment. *J. Econ. Behav. Organ.* 108:212–23
82. Palfrey T, Rosenthal H, Roy N. 2017. How cheap talk enhances efficiency in threshold public goods games. *Games Econ. Behav.* 101:234–59
83. Travers H, Clements T, Keane A, Milner-Gulland EJ. 2011. Incentives for cooperation: the effects of institutional controls on common pool resource extraction in Cambodia. *Ecol. Econ.* 71:151–61
84. Brzezinski DT, Wilson J, Chen Y. 2010. Voluntary participation in regional fisheries management council meetings. *Ecol. Soc.* 15(3):2
85. Hoffmann P, Villamayor-Tomas S, Lopez MC. 2023. Analyzing group communication dynamics and content in a common-pool resource experiment. *PLOS ONE* 18(5):e0283196
86. Fishkin J, Siu A, Diamond L, Bradburn N. 2021. Is deliberation an antidote to extreme partisan polarization? Reflections on "America in One Room." *Am. Political Sci. Rev.* 115(4):1464–81
87. Mason L. 2015. "I disrespectfully agree": the differential effects of partisan sorting on social and issue polarization. *Am. J. Political Sci.* 59(1):128–45
88. Anderies JM, Janssen MA, Bousquet F, Cardenas J-C, Castillo D, et al. 2011. The challenge of understanding decisions in experimental studies of common pool resource governance. *Ecol. Econ.* 70(9):1571–79
89. Newig J, Fritsch O. 2009. Environmental governance: participatory, multi-level – and effective? *Environ. Policy Gov.* 19(3):197–214
90. Marlin-Tackie FA, Polunci SA, Smith JM. 2020. Fracking controversies: enhancing public trust in local government through energy justice. *Energy Res. Soc. Sci.* 65:101440
91. Saif O, Keane A, Staddon S. 2022. Making a case for the consideration of trust, justice, and power in conservation relationships. *Conserv. Biol.* 36(4):e13903
92. Birnbaum S. 2016. Environmental co-governance, legitimacy, and the quest for compliance: When and why is stakeholder participation desirable? *J. Environ. Policy Plann.* 18(3):306–23
93. Birnbaum S, Bodin Ö, Sandström A. 2015. Tracing the sources of legitimacy: the impact of deliberation in participatory natural resource management. *Policy Sci.* 48(4):443–61
94. Knobloch KR, Gastil J. 2015. Civic (re)socialisation: the educative effects of deliberative participation. *Politics* 35(2):183–200
95. Cattino M, Reckien D. 2021. Does public participation lead to more ambitious and transformative local climate change planning? *Curr. Opin. Environ. Sustain.* 52:100–10
96. Ribot J, Agrawal A. 1999. Accountability in decentralization: a framework with South Asian and West African cases. *J. Dev. Areas* 33(4):473–502
97. Ece M, Murombedzi J, Ribot J. 2017. Disempowering democracy: local representation in community and carbon forestry in Africa. *Conserv. Soc.* 15(4):357–70
98. Ribot JC. 1995. From exclusion to participation: turning Senegal's forestry policy around? *World Dev.* 23(9):1587–99
99. Ribot JC. 1999. Decentralisation, participation and accountability in Sahelian forestry: legal instruments of political-administrative control. *Africa* 69(1):23–65
100. Ribot JC. 2004. *Waiting for Democracy: The Politics of Choice in Natural Resource Decentralization*. Washington, DC: World Resources Inst.

101. Przeworski A, Stokes SC, Manin B, eds. 1999. *Democracy, Accountability, and Representation*. Cambridge, UK: Cambridge Univ. Press
102. Camilleri S, Agius MR, Azzopardi J. 2020. Analysis of online news coverage on earthquakes through text mining. *Front. Earth Sci.* 8:141
103. Martin C, MacDonald BH. 2020. Using interpersonal communication strategies to encourage science conversations on social media. *PLOS ONE* 15(11):e0241972
104. Dilling L, Lemos MC. 2011. Creating usable science: opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environ. Chang.* 21(2):680–89
105. Lemos MC, Kirchhoff CJ, Ramprasad V. 2012. Narrowing the climate information usability gap. *Nat. Clim. Chang.* 2(11):789–94
106. Shyamsundar P, Sauls LA, Cheek JZ, Sullivan-Wiley K, Erbaugh JT, Krishnapriya PP. 2021. Global forces of change: implications for forest-poverty dynamics. *Forest Policy Econ*. 133:102607
107. Vu HT, Blomberg M, Seo H, Liu Y, Shayesteh F, Do HV. 2021. Social media and environmental activism: framing climate change on Facebook by global NGOs. *Sci. Commun.* 43(1):91–115
108. Nyhan B. 2020. Facts and myths about misperceptions. *J. Econ. Perspect.* 34(3):220–36
109. Ballew MT, Omoto AM, Winter PL. 2015. Using Web 2.0 and social media technologies to foster proenvironmental action. *Sustainability* 7(8):10620–48
110. Bergman JN, Buxton RT, Lin H-Y, Lenda M, Attinello K, et al. 2022. Evaluating the benefits and risks of social media for wildlife conservation. *FACETS* 7:360–97
111. Pearce W, Niederer S, Özkula SM, Sánchez Querubín N. 2019. The social media life of climate change: platforms, publics, and future imaginaries. *WIREs Clim. Chang.* 10(2):e569
112. Bayer JB, Triệu P, Ellison NB. 2020. Social media elements, ecologies, and effects. *Annu. Rev. Psychol.* 71:471–97
113. Ellison NB, Boyd DM. 2013. *Sociality Through Social Network Sites*, Vol. 1. Oxford, UK: Oxford Univ. Press
114. Chang CH, Armsworth PR, Masuda YJ. 2022. Twitter data reveal six distinct environmental personas. *Front. Ecol. Environ.* 20(8):481–87
115. Newell R, Dale A. 2015. Meeting the Climate Change Challenge (MC3): the role of the internet in climate change research dissemination and knowledge mobilization. *Environ. Commun.* 9(2):208–27
116. Peter M, Diekötter T, Höffler T, Kremer K. 2021. Biodiversity citizen science: outcomes for the participating citizens. *People Nat.* 3(2):294–311
117. Schuttler SG, Sorensen AE, Jordan RC, Cooper C, Shwartz A. 2018. Bridging the nature gap: Can citizen science reverse the extinction of experience? *Front. Ecol. Environ.* 16(7):405–11
118. Crain R, Cooper C, Dickinson JL. 2014. Citizen science: a tool for integrating studies of human and natural systems. *Annu. Rev. Environ. Resour.* 39:641–65
119. McKinley DC, Miller-Rushing AJ, Ballard HL, Bonney R, Brown H, et al. 2017. Citizen science can improve conservation science, natural resource management, and environmental protection. *Biol. Conserv.* 208:15–28
120. Bonney R, Phillips TB, Ballard HL, Enck JW. 2016. Can citizen science enhance public understanding of science? *Public Underst. Sci.* 25(1):2–16
121. Chase SK, Levine A. 2018. Citizen science: exploring the potential of natural resource monitoring programs to influence environmental attitudes and behaviors. *Conserv. Lett.* 11(2):e12382
122. Byrnes JEK, Ranganathan J, Walker BLE, Faulkes Z. 2014. To crowdfund research, scientists must build an audience for their work. *PLOS ONE* 9(12):e110329
123. Gallo-Cajiao E, Archibald C, Friedman R, Steven R, Fuller RA, et al. 2018. Crowdfunding biodiversity conservation. *Conserv. Biol.* 32(6):1426–35
124. Wheat RE, Wang Y, Byrnes JE, Ranganathan J. 2013. Raising money for scientific research through crowdfunding. *Trends Ecol. Evol.* 28(2):71–72
125. Ladle RJ, Correia RA, Do Y, Joo G-J, Malhado AC, et al. 2016. Conservation culturomics. *Front. Ecol. Environ.* 14(5):269–75
126. Hopke JE, Paris L. 2021. Environmental social movements and social media. In *The Handbook of International Trends in Environmental Communication*, ed. B Takahashi, J Metag, J Thaker, SE Comfort, pp. 357–72. Abingdon, UK: Routledge

127. Painter J, Kristiansen S, Schäfer MS. 2018. How 'digital-born' media cover climate change in comparison to legacy media: a case study of the COP 21 summit in Paris. *Global Environ. Chang.* 48:1–10
128. Nulman E, Özkula SM. 2016. Environmental nongovernmental organizations' digital media practices toward environmental sustainability and implications for informational governance. *Curr. Opin. Environ. Sustain.* 18:10–16
129. Soroye P, Edwards BPM, Buxton RT, Ethier JP, Frempong-Manso A, et al. 2022. The risks and rewards of community science for threatened species monitoring. *Conserv. Sci. Pract.* 4(9):e12788
130. Niemiller KDK, Davis MA, Niemiller ML. 2021. Addressing 'biodiversity naivety' through project-based learning using iNaturalist. *J. Nat. Conserv.* 64:126070
131. Sullivan BL, Wood CL, Iliff MJ, Bonney RE, Fink D, Kelling S. 2009. eBird: a citizen-based bird observation network in the biological sciences. *Biol. Conserv.* 142(10):2282–92
132. Segerberg A. 2017. Online and social media campaigns for climate change engagement. In *Oxford Research Encyclopedia of Climate Science*, ed. H von Storch. **https://doi.org/10.1093/acrefore/9780190228620.013.398**
133. Fisher DR. 2019. The broader importance of #FridaysForFuture. *Nat. Clim. Chang.* 9(6):430–31
134. Marris E. 2019. Why young climate activists have captured the world's attention. *Nature* 573(7775):471–72
135. Estes N. 2019. *Our History Is the Future: Standing Rock Versus the Dakota Access Pipeline, and the Long Tradition of Indigenous Resistance*. Brooklyn, NY: Verso. 310 pp.
136. Hodges HE, Stocking G. 2016. A pipeline of tweets: environmental movements' use of Twitter in response to the Keystone XL Pipeline. *Environ. Politics* 25(2):223–47
137. Collins L, Nerlich B. 2015. Examining user comments for deliberative democracy: a corpus-driven analysis of the climate change debate online. *Environ. Commun.* 9(2):189–207
138. Williams HTP, McMurray JR, Kurz T, Hugo Lambert F. 2015. Network analysis reveals open forums and echo chambers in social media discussions of climate change. *Global Environ. Chang.* 32:126–38
139. Treen K, Williams H, O'Neill S, Coan TG. 2022. Discussion of climate change on Reddit: polarized discourse or deliberative debate? *Environ. Commun.* 16(5):680–98
140. Duarte ME. 2017. Connected activism: Indigenous uses of social media for shaping political change. *Australas. J. Inform. Syst.* 21. **https://doi.org/10.3127/ajis.v21i0.1525**
141. Kaur K. 2015. Social media creating digital environmental publics: case of Lynas Malaysia. *Public Relat. Rev.* 41(2):311–14
142. Liu J. 2016. Digital media, cycle of contention, and sustainability of environmental activism: the case of anti-PX protests in China. *Mass Commun. Soc.* 19(5):604–25
143. Sun X, Huang R. 2020. Spatial meaning-making and urban activism: two tales of anti-PX protests in urban China. *J. Urban Aff.* 42(2):257–77
144. King G, Pan J, Roberts ME. 2013. How censorship in China allows government criticism but silences collective expression. *Am. Political Sci. Rev.* 107(2):326–43
145. Boulianne S, Ohme J. 2022. Pathways to environmental activism in four countries: social media, environmental concern, and political efficacy. *J. Youth Stud.* 25(6):771–92
146. Scherman A, Valenzuela S, Rivera S. 2022. Youth environmental activism in the age of social media: the case of Chile (2009–2019). *J. Youth Stud.* 25(6):751–70
147. Coppock A, Guess A, Ternovski J. 2016. When treatments are tweets: a network mobilization experiment over Twitter. *Political Behav.* 38(1):105–28
148. Foos F, Kostadinov L, Marinov N, Schimmelfennig F. 2021. Does social media promote civic activism? A field experiment with a civic campaign. *Political Sci. Res. Methods* 9(3):500–18
149. Kubo T, Yokoo H-F, Veríssimo D. 2023. Conservation fundraising: evidence from social media and traditional mail field experiments. *Conserv. Lett.* 16(1):e12931
150. Freelon D, Marwick A, Kreiss D. 2020. False equivalencies: online activism from left to right. *Science* 369(6508):1197–201
151. Sankaranarayanan A, Hemberg E, O'Reilly U-M. 2023. The Facebook algorithm's active role in climate advertisement delivery. arXiv:2308.03191 [cs.HC]
152. Chang CH, Deshmukh NR, Armsworth PR, Masuda YJ. 2023. Environmental users abandoned Twitter after Musk takeover. *Trends Ecol. Evol.* 38(10):893–95

153. King G, Pan J, Roberts ME. 2014. Reverse-engineering censorship in China: randomized experimentation and participant observation. *Science* 345(6199):1251722
154. Supran G, Oreskes N. 2021. Rhetoric and frame analysis of ExxonMobil's climate change communications. *One Earth* 4(5):696–719
155. Treen K, Williams H, O'Neill SJ. 2020. Online misinformation about climate change. *WIREs Clim. Chang.* 11(5):e665
156. Schäfer MS. 2012. Online communication on climate change and climate politics: a literature review. *Wiley Interdiscip. Rev. Clim. Chang.* 3(6):527–43
157. Bennett WL. 2012. The personalization of politics: political identity, social media, and changing patterns of participation. *Ann. Am. Acad. Political Soc. Sci.* 644(1):20–39
158. Friel S, Arthur M, Frank N. 2022. Power and the planetary health equity crisis. *Lancet* 400(10358):1085–87
159. Walker M, Matsa KE. 2021. News consumption across social media in 2021. *Pew Research Center*, Sep. 20. **https://www.pewresearch.org/journalism/2021/09/20/news-consumption-across-social-media-in-2021/**
160. Marlow T, Miller S, Roberts JT. 2021. Bots and online climate discourses: Twitter discourse on President Trump's announcement of U.S. withdrawal from the Paris Agreement. *Clim. Policy* 21(6):765–77
161. Eco-bot.net. 2021. Data archive. *Eco-bot.net.* **https://eco-bot.net/archive**
162. Aïmeur E, Amri S, Brassard G. 2023. Fake news, disinformation and misinformation in social media: a review. *Soc. Netw. Anal. Min.* 13(1):30
163. Lamb WF, Mattioli G, Levi S, Roberts JT, Capstick S, et al. 2020. Discourses of climate delay. *Global Sustain.* 3:e17
164. King J, Janulewicz L, Arcostanzo F. 2022. *Deny, Deceive, Delay: Documenting and Responding to Climate Disinformation at COP26 and Beyond*. London: Institute for Strategic Dialogue
165. Ozawa JVS, Woolley SC, Straubhaar J, Riedl MJ, Joseff K, Gursky J. 2023. How disinformation on WhatsApp went from campaign weapon to governmental propaganda in Brazil. *Soc. Media Soc.* 9(1):20563051231160632
166. Dunlap RE, McCright AM. 2011. *Organized Climate Change Denial*. Oxford, UK: Oxford Univ. Press
167. Farrell J. 2019. The growth of climate change misinformation in US philanthropy: evidence from natural language processing. *Environ. Res. Lett.* 14(3):034013
168. Lewandowsky S. 2021. Climate change disinformation and how to combat it. *Annu. Rev. Public Health* 42:1–21
169. Ecker UKH, Lewandowsky S, Cook J, Schmid P, Fazio LK, et al. 2022. The psychological drivers of misinformation belief and its resistance to correction. *Nat. Rev. Psychol.* 1(1):13–29
170. Farrell J. 2016. Corporate funding and ideological polarization about climate change. *PNAS* 113(1):92–97
171. Tabuchi H. 2021. In your Facebook feed: oil industry pushback against Biden climate plans. *The New York Times*, Sep. 30. **https://www.nytimes.com/2021/09/30/climate/api-exxon-biden-climate-bill.html**
172. Arechar AA, Allen J, Berinsky AJ, Cole R, Epstein Z, et al. 2023. Understanding and combatting misinformation across 16 countries on six continents. *Nat. Hum. Behav.* 7(9):1502–13
173. Hansson SO. 2018. Dealing with climate science denialism: experiences from confrontations with other forms of pseudoscience. *Clim. Policy* 18(9):1094–102
174. Cook J, Lewandowsky S, Ecker UKH. 2017. Neutralizing misinformation through inoculation: exposing misleading argumentation techniques reduces their influence. *PLOS ONE* 12(5):e0175799
175. van der Linden S, Leiserowitz A, Rosenthal S, Maibach E. 2017. Inoculating the public against misinformation about climate change. *Global Chall.* 1(2):1600008
176. van der Linden S, Maibach E, Cook J, Leiserowitz A, Lewandowsky S. 2017. Inoculating against misinformation. *Science* 358(6367):1141–42
177. Farrell J, McConnell K, Brulle R. 2019. Evidence-based strategies to combat scientific misinformation. *Nat. Clim. Chang.* 9(3):191–95
178. Chan MS, Albarracín D. 2023. A meta-analysis of correction effects in science-relevant misinformation. *Nat. Hum. Behav.* 7(9):1514–25

179. Drouin M, Miller D, Wehle SMJ, Hernandez E. 2016. Why do people lie online? "Because everyone lies on the internet." *Comput. Hum. Behav.* 64:134–42
180. Semaan BC, Robertson SP, Douglas S, Maruyama M. 2014. Social media supporting political deliberation across multiple public spheres: towards depolarization. In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing*, pp. 1409–21. New York: Assoc. Comput. Mach.
181. Alexander M, Doorn N, Priest S. 2018. Bridging the legitimacy gap—translating theory into practical signposts for legitimate flood risk governance. *Reg. Environ. Chang.* 18(2):397–408
182. Fung A. 2008. Democratizing the policy process. In *The Oxford Handbook of Public Policy*, ed. R Goodin, M Moran, M Rein, pp. 669–86. Oxford, UK: Oxford Univ. Press
183. Dryzek JS, Bowman Q, Kuyper J, Pickering J, Sass J, Stevenson H. 2019. *Deliberative Global Governance*. Cambridge, UK: Cambridge Univ. Press
184. Tesler M. 2018. Elite domination of public doubts about climate change (not evolution). *Political Commun.* 35(2):306–26
185. Wilfahrt M. 2018. The politics of local government performance: elite cohesion and cross-village constraints in decentralized Senegal. *World Dev.* 103:149–61
186. Pomeranz EF, Stedman RC. 2020. Measuring good governance: piloting an instrument for evaluating good governance principles. *J. Environ. Policy Plann.* 22(3):428–40
187. Thompson DF. 2008. Deliberative democratic theory and empirical political science. *Annu. Rev. Political Sci.* 11:497–520
188. el-Wakil A, Strebel MA. 2022. Participatory processes and their outcomes: comparing assembly and popular vote decisions. *Eur. Political Sci. Rev.* 14(3):441–58
189. Kersting N. 2021. Participatory democracy and sustainability. Deliberative democratic innovation and its acceptance by citizens and German local councilors. *Sustainability* 13(13):7214
190. Giraudet L-G, Apouey B, Arab H, Baeckelandt S, Bégout P, et al. 2022. "Co-construction" in deliberative democracy: lessons from the French Citizens' Convention for Climate. *Humanit. Soc. Sci. Commun.* 9(1):207
191. Warren ME, Gastil J. 2015. Can deliberative minipublics address the cognitive challenges of democratic citizenship? *J. Politics* 77(2):562–74
192. Habermas J. 1984. *The Theory of Communicative Action*. Boston: Beacon Press
193. Gastil J. 2022. Survey methods. In *Research Methods in Deliberative Democracy*, ed. SA Ercan, H Asenbaum, N Curato, RF Mendonça, pp. 204–17. Oxford, UK: Oxford Univ. Press
194. Grönlund K, Herne K. 2022. Experimental methods. In *Research Methods in Deliberative Democracy*, ed. SA Ercan, H Asenbaum, N Curato, RF Mendonça, pp. 163–74. Oxford, UK: Oxford Univ. Press
195. Kingzette J, Neblo M. 2022. Deliberative field experiments. In *Research Methods in Deliberative Democracy*, ed. SA Ercan, H Asenbaum, N Curato, RF Mendonça, pp. 175–88. Oxford, UK: Oxford Univ. Press
196. Grillos T. 2022. Participation improves collective decisions (when it involves deliberation): experimental evidence from Kenya. *Br. J. Political Sci.* 52(4):1728–47
197. Murphy M, Mavrommati G, Mallampalli V, Howarth R, Borsuk M. 2017. Comparing group deliberation to other forms of preference aggregation in valuing ecosystem services. *Ecol. Soc.* 22(4):17
198. Wells R, Howarth C, Brand-Correa LI. 2021. Are citizen juries and assemblies on climate change driving democratic climate policymaking? An exploration of two case studies in the UK. *Clim. Chang.* 168(1–2):5
199. Knowledge Network on Climate Assemblies. 2021. Summaries of national climate assemblies. *KNOCA*. **https://www.knoca.eu/climate-assemblies#Summaries-of-national-climate-assemblies**
200. Willis R, Curato N, Smith G. 2022. Deliberative democracy and the climate crisis. *WIREs Clim. Chang.* 13(2):e759
201. Tan C, Niculae V, Danescu-Niculescu-Mizil C, Lee L. 2016. *Winning arguments: interaction dynamics and persuasion strategies in good-faith online discussions*. Paper presented at the Proceedings of the 25th International Conference on World Wide Web, Montreal, Apr. 11–15
202. Chandrashekeran S, Morgan B, Coetzee K, Christoff P. 2017. Rethinking the green state beyond the Global North: a South African climate change case study. *WIREs Clim. Chang.* 8(6):e473
203. Heller P, Rao V. 2015. Deliberation and development. In *Deliberation and Development: Rethinking the Role of Voice and Collective Action in Unequal Societies*, ed. P Heller, V Rao, pp. 1–26. Washington, DC: World Bank

204. Dryzek JS, Nicol D, Niemeyer S, Pemberton S, Curato N, et al. 2020. Global citizen deliberation on genome editing. *Science* 369(6510):1435–37
205. Chatterton P, Featherstone D, Routledge P. 2013. Articulating climate justice in Copenhagen: antagonism, the commons, and solidarity. *Antipode* 45(3):602–20
206. Leitheiser S, Trell E-M, Horlings I, Franklin A. 2022. Toward the commoning of governance. *Environ. Plann. C Politics Space* 40(3):744–62
207. Partelow S, Manlosa AO. 2023. Commoning the governance: a review of literature and the integration of power. *Sustain. Sci.* 18(1):265–83
208. Gastil J, Black L. 2018. Deliberation in communication studies. In *The Oxford Handbook of Deliberative Democracy*, ed. A Bächtiger, JS Dryzek, J Mansbridge, M Warren, pp. 502–17. Oxford, UK: Oxford Univ. Press
209. Hering JG. 2018. Implementation science for the environment. *Environ. Sci. Technol.* 52(10):5555–60
210. Bourdieu P, Passeron J-C, Bourdieu P, Bourdieu P. 2000. *Reproduction in Education, Society and Culture*. London: Sage Publ. 254 pp. 2nd ed.
211. Bourdieu P. 1977. *Outline of a Theory of Practice*. Cambridge, UK: Cambridge Univ. Press
212. Foucault M. 1978. Governmentality. In *The Foucault Effect: Studies in Governmentality, with Two Lectures by and an Interview with Michel Foucault*, ed. G Burchell, C Gordon, P Miller, pp. 87–104. Chicago: Univ. Chicago Press
213. Lemke T. 2001. "The birth of bio-politics": Michel Foucault's lecture at the Collège de France on neo-liberal governmentality. *Econ. Soc.* 30(2):190–207
214. Gastil J, Richards RC. 2017. Embracing digital democracy: a call for building an online civic commons. *Political Sci. Politics* 50(3):758–63
215. Suldovsky B. 2017. The information deficit model and climate change communication. In *Oxford Research Encyclopedia of Climate Science*, ed. H von Storch. **https://doi.org/10.1093/acrefore/9780190228620.013.301**
216. van der Linden S, Leiserowitz A, Maibach E. 2019. The gateway belief model: a large-scale replication. *J. Environ. Psychol.* 62:49–58
217. Reser JP, Bradley GL. 2017. Fear appeals in climate change communication. In *The Oxford Research Encyclopedia of Climate Change Communication*, ed. MC Nisbet, SS Ho, E Markowitz, S O'Neill, MS Schäfer, J Thaker. Oxford, UK: Oxford Univ. Press
218. Smith N, Leiserowitz A. 2014. The role of emotion in global warming policy support and opposition. *Risk Anal.* 34(5):937–48
219. Maiella R, La Malva P, Marchetti D, Pomarico E, Di Crosta A, et al. 2020. The psychological distance and climate change: a systematic review on the mitigation and adaptation behaviors. *Front. Psychol.* 11:568899
220. Wolsko C. 2017. Expanding the range of environmental values: political orientation, moral foundations, and the common ingroup. *J. Environ. Psychol.* 51:284–94
221. Albertson B, Busby JW. 2015. Hearts or minds? Identifying persuasive messages on climate change. *Res. Politics* 2(1). **https://doi.org/10.1177/2053168015577712**
222. Shin F, Preston JL. 2021. Green as the gospel: the power of stewardship messages to improve climate change attitudes. *Psychol. Relig. Spiritual.* 13(4):437–47
223. Markowitz EM, Shariff AF. 2012. Climate change and moral judgement. *Nat. Clim. Chang.* 2(4):243–47