Environmental Science and Policy 154 (2024) 103688

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

ICT-based environmental participation in China: Same, same but digital?

Maria Bondes [a,*], Genia Kostka [a], Wiebke Rabe [b]

[a] Institute of Chinese Studies, Freie Universität Berlin, Germany
[b] Institute of Intercultural and International Studies, University of Bremen, 28359 Bremen, Germany

ARTICLE INFO

Keywords:
Digital governance
ICTs
Public participation
Environmental activism
Environmental governance
China

ABSTRACT

Information and communication technologies (ICTs) have been credited with the potential to alter the dynamics of environmental governance by empowering citizens, enhancing accountability and improving government efficiency. However, in non-democratic contexts the link between ICTs and public participation is far from clear. Taking the case of China, this study investigates urban Chinese citizens' use of digital technologies for environmental participation and the factors explaining (non)engagement. Drawing on an online survey with 2912 participants in 2021, we find surprisingly high levels of participation that is not hampered by regime-related factors such as trust in governmental institutions or concerns about the risks of taking action online. This shows that digital technologies have significant participatory potential also under restrictive conditions. However, our findings also show several major limitations of ICTs. Participation in our study is driven by citizens who are digitally skilled, environmentally concerned and also active in the offline sphere. This points, first, to a digital participation opportunity gap that could exclude the less digitally skilled and tech-savvy. Second, this supports the "reinforcement hypothesis" that ICTs are used by the already active and do not suffice to draw new social groups into the policy process. Third, in our study digital environmental participation is limited by citizens' attribution of responsibility to the government, an unintended consequence of China's "environmental authoritarianism" that curtails ICTs from unfolding their full potential. Together, our findings contribute to the debate on digital authoritarianism and the opportunities and limitations of ICTs for environmental participation in non-democratic contexts.

1. Introduction

Information and communication technologies (ICTs) have in recent years boosted the opportunities for environmental public participation with the potential to fundamentally alter the dynamics of environmental governance (He et al., 2017). Digital technologies have been credited with the potential to enhance transparency and close accountability gaps between governments and the public by providing new means of accessing and producing information (Gigler and Bailur, 2014; Peixoto and Fox, 2016), through digital governance initiatives (Schulz and Newig, 2015; United Nations, 2020), and by providing new tools for the mobilization of collective action (Bennett and Segerberg, 2011; Earl and Kimport, 2011). However, while ICTs provide a range of new opportunities for environmental citizen engagement, empirical evidence on the impact of digital technologies on public participation is far from conclusive, especially in authoritarian countries where participatory dynamics diverge widely from democratic regimes (Grönlund and Wakabi, 2015; Ji et al., 2018; Kostka et al., 2020).

In the debate about digital authoritarianism, concerns have been raised that rather than promoting public participation and transparency, digital technologies may primarily serve as instruments of state surveillance, control and propaganda (Creemers, 2017; King et al., 2013; Qiang, 2019). Moreover, in an authoritarian context, regime-related factors such as lacking trust in governmental institutions and the risks of taking action online in a restrictive political environment have been found to hamper digital engagement (Alrashedi et al., 2015; Grönlund and Wakabi, 2015). While ICTs enhance the access to environmental information, existing research on China further shows that environmental awareness does not necessarily translate into greater preferences for environmental protection, leave alone increased participation (Brombal, 2020; Flatø, 2020; Xu, 2014). An evaluation of ICTs' participatory potentials in environmental governance in a non-democratic setting thus requires a thorough understanding of the factors explaining digital environmental participation.

This study takes the case of China and gauges urban Chinese citizens' use of ICTs for environmental participation across a broad range of

* Corresponding author.
E-mail address: maria.bondes@fu-berlin.de (M. Bondes).

https://doi.org/10.1016/j.envsci.2024.103688
Received 1 May 2022; Received in revised form 25 April 2023; Accepted 23 January 2024
Available online 16 February 2024

activities. In China, arguably the world's leading country in digital authoritarianism, both state and non-state actors have embraced digital technologies to leverage environmental participation for addressing the country's environmental crisis (Hsu et al., 2017; Kostka et al., 2020; Kostka and Zhang, 2018). China thus provides for an interesting case to study ICT-based environmental participation in an authoritarian regime. We develop a framework to explain varying levels of digital environmental participation based on citizens' environmental attitude and behavior, digital skills and attitude, political attitude, and on socio-demographic characteristics. Drawing on an online survey conducted in August 2021 with 2912 respondents across China, we first document the scope and frequency of Chinese citizens' digital environmental participation. Second, we assess factors that explain different levels of engagement. The survey resembles the Chinese internet-connected population by age and gender, as well as region.

We find surprisingly high levels of ICT-based citizen engagement in environmental governance that is not hampered by regime-related factors such as matters of trust or concerns about the risks of taking action online. However, the extent of engagement varies across social groups and points to two major limitations of ICTs. We find that digital technologies are most used for environmental engagement by the digitally skilled and those with a higher technological affinity, and those who are environmentally concerned and already active offline. This suggests that a digital participation opportunity gap exists that might exclude the less digitally skilled from participating, supporting concerns about a "digital divide." Moreover, the finding that ICTs are used mostly by those already environmentally active offline suggests that rather than expanding citizen environmental engagement, ICTs may not suffice to draw in new social groups into the policy process, supporting the "reinforcement hypothesis." Finally, our findings highlight a problem inherent in China's top-down system of environmental governance. Digital environmental participation in our study is significantly limited by citizens attributing the responsibility for environmental problem-solving to the government. This is an unintended side effect of China's "environmental authoritarianism" that hinders digital technologies from unfolding their full potential in a restrictive political setting.

Our study contributes to existing research in several ways. First, by highlighting the "digital divide" and "reinforcement hypothesis," our findings contribute to a more nuanced understanding of the participatory potentials and limitations of ICTs for environmental governance in a non-democratic political framework and speak to the debate on digital authoritarianism (Gohdes, 2020; Gueorguiev, 2021; Howells and Henry, 2021; Xu, 2021). Second, our findings contribute to the literature on digital environmental governance and the digital recalibration of state-society relations under Xi Jinping. While there has been significant academic interest in the role of ICTs for environmental participation in China, existing studies have largely focused on the use of ICTs by Chinese environmental organizations (Ji et al., 2018; Liu, 2011; Sima, 2011), the role of digital technologies for the mobilization of collective action (Cai and Zhou, 2016; Huang and Yip, 2012; Sullivan and Xie, 2009), or investigated specific initiatives or types of ICT such particular apps or websites (Balla, 2012; Goron and Bolsover, 2020; Hsu et al., 2020). While He et al. (2017) assess the use of different digital tools for environmental participation by Beijing residents, their survey is restricted to the capital and does not explain variation in digital participation. By focusing on ordinary urban Chinese citizens' full range of digital environmental participation and the factors for (non)engagement, our study sheds more light on the potentials and hindrances for digital participation in China's top-down system of (environmental) governance.

2. Literature review and analytical framework

2.1. ICTs and environmental participation

The spread of ICTs has greatly enhanced citizen's options to engage in environmental governance and produced new forms of digital participation (He et al., 2017). Such digital or e-participation is defined by the United Nations as the "process of engaging citizens through ICT in policy, decision-making, and service design and delivery in order to make it participatory, inclusive and deliberative" (United Nations, 2020). Digital participation encompasses both top-down initiated forms of participation and bottom-up participation initiated by non-state actors (Wimmer et al., 2017). Digital environmental participation, then, is ICT-mediated participation in matters of environmental governance, understood as "regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes" (Lemos and Agrawal, 2006, p. 298).

In environmental governance, where informational processes play a key role, ICTs have in particular been credited with providing citizens with new possibilities for accessing, producing, verifying, monitoring and controlling information that can empower citizens and enhance transparency (Hsu et al., 2020; Mol, 2010; Soma et al., 2016). Citizen participation can also be integrated directly into the governance process through digital governance initiatives and ICT-based feedback mechanisms with the potential of enhancing communication between governments and citizens, improving service delivery, and increasing efficiency and accountability (Gigler and Bailur, 2014; Vij and Gil-Garcia, 2017). Moreover, digital technologies have facilitated the public expression of opinion and framing of environmental issues, contributed to the creation of an online "green public sphere" (Sima, 2011), and proven to be key tools for the mobilization and organization of collective action (Bennett and Segerberg, 2011; Earl and Kimport, 2011).

The effect of digital technologies on participation is far from clear, however, especially in a non-democratic political setting like China that leaves limited room for civil society and strictly controls political participation. While some studies have found a positive correlation between the development and use of ICTs and public participation (Gil de Zúñiga et al., 2012; Jho and Song, 2015), the literature also suggests that digital technologies per se may not suffice to overcome barriers to participation such as matters of trust, lacking political efficacy, or privacy concerns (Hsu et al., 2017; Hsu et al., 2020; Wakabi, 2016; Xenos and Moy, 2007) – factors likely to weigh in particularly heavy in a restrictive political context. Moreover, while it has been widely assumed that enhanced access to environmental information and increased transparency lead to intensified participation (Mol, 2010), this assumption cannot readily be transferred to an authoritarian context (Kostka et al., 2020). Existing research on China shows that environmental information alone does not necessarily translate into greater preferences for environmental protection, leave alone active participation (Brombal, 2020; Flatø, 2020; Goron and Bolsover, 2020; Xu, 2014). The relationship between ICTs and environmental participation is thus complex, even more so in a non-democratic regime (Kostka et al., 2020; United Nations and Le Blanc, 2020).

2.2. ICTs and environmental participation in China

In China, a formerly information-poor country with severe limitations to public engagement and a top-down command-and-control system of environmental governance (Kostka and Zhang, 2018; Mol and Carter, 2006), both state and non-state actors have in recent years leveraged digital technologies to foster citizen participation in environmental governance. In line with a broader trend to strengthen institutionalized participation channels (Fu and Distelhorst, 2018; Göbel, 2021; Lorentzen, 2017), and drawing on ICTs and big data approaches for addressing the country's implementation gap in environmental governance (Kostka and Mol, 2013; Kostka and Zhang, 2018), the Chinese government has in recent years digitally revamped the country's environmental monitoring system and set up a wealth of ICT-based communication channels with the public (Hsu et al., 2017; Kostka and Zhang, 2018; Schlæger and Zhou, 2019). These include

public complaint websites, platforms and social media channels both inside the environmental bureaucracy and beyond (Distelhorst and Hou, 2017; Göbel and Li, 2021; Wang and Zhong, 2020), as well as a growing number of mobile applications, some of them directly linked into (smart) city's digital urban management systems (Hsu et al., 2017; Schlæger and Zhou, 2019).

Despite continuing data problems (Hsu et al., 2017; Kostka et al., 2020; Tarantino, 2020), these governmental channels provide Chinese citizens access to an unprecedented amount of official information, including both information published as part of the government's transparency and data disclosure initiatives and such acquired through information disclosure requests (Goron and Bolsover, 2020; Seligsohn et al., 2018; Tarantino, 2020; Wang, 2016; Zhang et al., 2016, 2017). Moreover, citizens can leverage the new digital channels for public consultation in the form of feedback and suggestions (Hsu et al., 2017), and for the online submission of environmentally-related complaints and petitions (Fu and Distelhorst, 2018; Hsu et al., 2017; Wang and Zhong, 2020). Acknowledging the value of citizen-generated data for narrowing the center's informational deficits and limited monitoring capacities, the Chinese government has also started to engage citizens in the collection of (mostly pollution) data and the monitoring of local government responses (Brombal, 2020; Hsu et al., 2020), as well as for improving public service delivery (Schlæger and Zhou, 2019). Chinese citizens can further leverage digital technologies for participating in environmental impact assessments, e.g. by submitting opinions online, or for stepping up legal action, for instance by using ICTs to file lawsuits or to submit or collect evidence (Bondes, 2019; Johnson, 2020).

Outside these state-sanctioned channels, digital technologies have opened an array of informal pathways for environmental participation. ICTs have enhanced Chinese citizens' access to a range of alternative information sources, producing an "information-complex" environment (Zhang et al., 2017). This includes data processed or collected by environmental organizations, some of whom actively engage citizens in data collection (Brombal, 2020; Tarantino, 2020; Xu, 2014), as well as information sought from fellow citizens, domestic experts or international actors (Huang, 2020). Digital technologies further provide Chinese citizens with new opportunities to share or discuss environmentally-related information or news, contributing to what has been termed a green "online public sphere" (Ji et al., 2018; Sima, 2011), and have been found to facilitate the organization and mobilization of more or less contentious forms of collective action (Bondes, 2019; Cai and Zhou, 2016; He et al., 2017; Huang and Yip, 2012; Yang and Wu, 2022). This encompasses "e-movements" that unfold entirely online; digital versions of offline or "e-tactics" such as online letter-writing, signature collections or opinion surveys; and "e-mobilization," i.e. the use of digital tools for the mobilization of collective action (Earl and Kimport, 2011). Chinese citizens can also participate in a growing number of environmental protection initiatives set up by corporate actors, such as the Alipay Ant Forest program launched in 2016 that permits users of the Alipay application to translate "low-carbon activities" into planted trees (UNFCCC, n.d.). Up to date, there is little systematic evidence about how ordinary Chinese citizens make use of these new digital opportunities, however.

2.3. *Explaining digital environmental participation in a non-democratic political setting*

Bringing together the literatures on political, environmental and digital participation, we develop a framework for assessing digital environmental participation in a non-democratic political setting (see Fig. 1). We group the factors into four categories: 1) environmental attitude and behavior, 2) digital skills and attitude, 3) political attitude, and 4) sociodemographic control variables.

2.3.1. *Environmental attitude and behavior*

The literatures on political and environmental participation and on ICTs' impact on citizen engagement have widely assumed that enhanced access to information increases knowledge and awareness, which then translates into higher levels of participation (Barrios-O'Neill and Schuitema, 2016; He et al., 2017; Mol, 2010; Xenos and Moy, 2007). In the environmental realm, higher levels of environmental awareness and concern, i.e. the extent to which an individual not only acknowledges but is concerned about environmental issues, have been found to correlate with higher levels of environmental participation (Eom et al.,

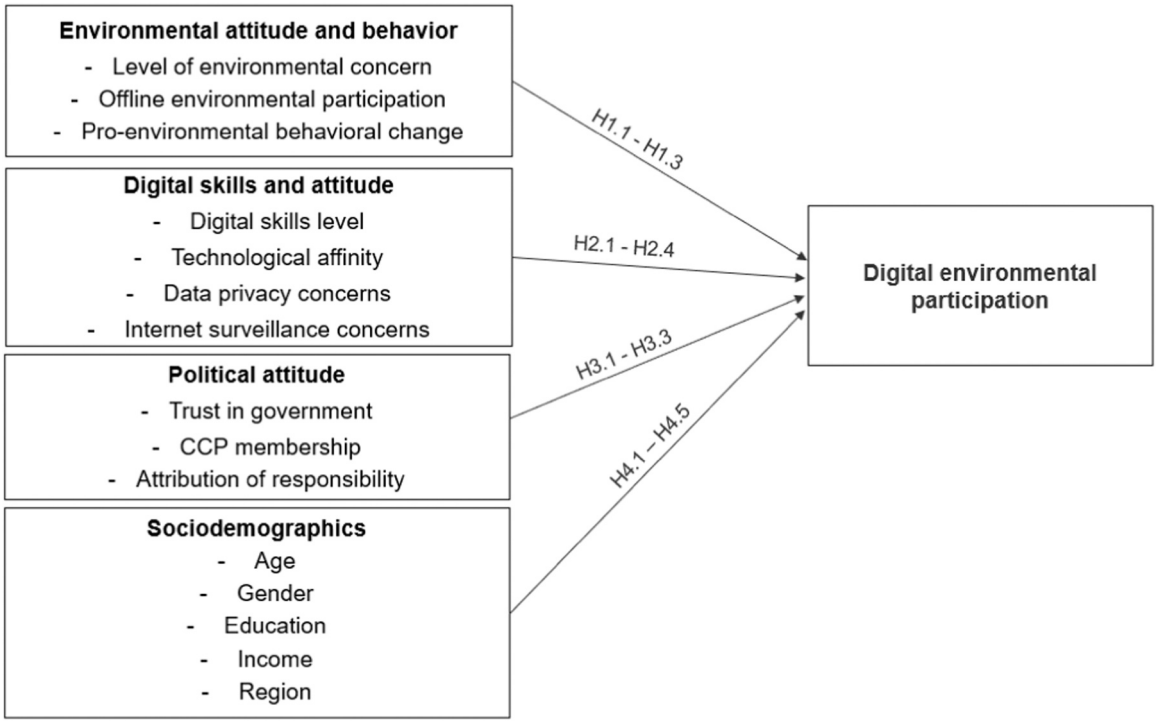

Fig. 1. Conceptual framework for explaining digital environmental participation.

2016; O'Connor et al., 1999; Stern, 2000). This link has largely been examined in Western democratic contexts, however. In non-Western and non-democratic societies, the relation between environmental awareness or concern and citizen participation is not clear (Eom et al., 2016; Kostka et al., 2020). Albeit showing regional, sociodemographic and issue variation, surveys among Chinese residents have overall found significant or rising levels of environmental awareness and concern (Flatø, 2020; He et al., 2017; Liu and Mu, 2016; Wong, 2010; Xu et al., 2017; Yu, 2014). This does not necessarily translate into greater preferences for environmental protection, "willingness to pay," or higher levels of participation, however (Flatø, 2020; Wang et al., 2016; Xu et al., 2017; Zhang et al., 2020). While some studies show that high levels of environmental concern correspond with environmental participation (He et al., 2017; Johnson et al., 2017), others have shown that factors such as lacking resources, economic dependencies and lacking political efficacy hamper participation (Deng and Yang, 2013; Lora-Wainwright, 2017). To assess the relationship between environmental concern and digital environmental participation (DigEnPa), we test the hypothesis that *DigEnPa is higher among individuals that report higher levels of environmental concern* (H1.1).

Also the relationship between online and offline participation has been widely debated. While the "mobilization hypothesis" holds that digital technologies can "inform, organize and engage those who are currently marginalized from the existing political system," the "reinforcement hypothesis" suggests that ICTs are used primarily by already active citizens (Norris, 2001, p. 218). In China, digital participation has largely been found to be a plus for total engagement. According to previous research, most citizens use a combination of online and offline activities, suggesting, first, that digital means are not crowding out offline forms of (environmental) participation and, second, that ICTs may facilitate public participation but are not in themselves sufficient (Cai and Zhou, 2016; He et al., 2017; Huang and Yip, 2012; Su and Meng, 2016; Tai et al., 2020). Existing studies have also investigated the relationship between digital participation and other forms of environmental activity. Research on the public response to air pollution in China have found that many citizens resort to individualized pro-environmental behavior such as the use of more sustainable means of transport or self-protective strategies like buying air purifiers (Johnson et al., 2017; Wang et al., 2016; Xu et al., 2017). While Johnson et al. (2017) find that Chinese citizens do not necessarily regard such private action as an alternative to public participation, they argue that it might be seen as a more realistic strategy in a political context that provides limited opportunities for civic engagement. To investigate the relationship between DigEnPa and other forms of environmental activity, we hypothesize that *DigEnPa is higher among individuals who also engage in offline environmental participation* (H1.2), *and among those who have increased their individualized pro-environmental behavior* (H1.3).

2.3.2. Digital skills and attitude

Second, digital participation cannot be explained by only examining traditional participation-related variables, but needs to take into account factors relating to digital technologies (Hoffmann and Lutz, 2021; Norris, 2001; Sylvester and McGlynn, 2010). The literature on digital participation has widely acknowledged that using ICTs for citizen participation requires specific knowledge in the form of digital skills (Gil de Zúñiga et al., 2012; Vicente and Novo, 2014; Xenos and Moy, 2007). Attitudes towards the technology itself as captured by the "technology acceptance model" (TAM) have also been found to impact the use of ICTs for participation (Lee and Kim, 2012; Lin et al., 2011). We thus expect that *DigEnPa is higher among individuals with a higher digital skills level* (H2.1) *and those who make extensive use of their smart phone as proxy for technological affinity* (H2.2). In addition, technology-related data privacy and internet surveillance concerns can be a major barrier to participation, particularly in authoritarian contexts (Alrashedi et al., 2015; Grönlund and Wakabi, 2015; Hsu et al., 2020). We thus hypothesize that *DigEnPa is higher among individuals with lower levels of data privacy concerns* (H2.3) *and internet surveillance concerns* (H2.4).

2.3.3. Political attitude

A third group of factors that might help explain digital environmental participation relate to citizens' political attitudes. More specifically, existing research has identified citizens' trust in governmental institutions and political efficacy (i.e. a sense of agency and empowerment and the belief that one's actions can have an impact) as central motivational factors for political, environmental and digital participation (Eom et al., 2016; Johnson and Scicchitano, 2000). Particularly in authoritarian political contexts, lacking trust in government and low political efficacy have been found to be major barriers to digital participation (Alrashedi et al., 2015; Grönlund and Wakabi, 2015; Lee-Geiller, 2020; Wakabi, 2016), which play a crucial role in impeding both online and offline environmental participation also in the case of China (Hsu et al., 2017; Lora-Wainwright, 2017). Moreover, in top-down systems of governance such as China, also a lack of feeling responsible can hamper environmental participation when citizens attribute the responsibility for environmental problem-solving mainly to the government (Li and Shapiro, 2020; Wong, 2010; Xu et al., 2017). We thus assume *DigEnPa is higher among individuals with higher levels of trust in governmental institutions* (H3.1), and *among individuals that are members of the Communist Party of China* (H3.2), while expecting *lower digital environmental participation among individuals that attribute the responsibility for managing environmental problems mainly to the government* (H3.3).

2.3.4. Sociodemographics

We further include socioeconomic factors. First, in traditional theories of political participation, socioeconomic status (SES) is a central explanatory factor. Resource models of political participation regard particularly education and income as important resources for engagement (Brady et al., 1995; Verba and Nie, 1987). This has also been applied to digital participation, where SES is additionally seen to directly affect both access to and the skills for using digital technologies (Norris, 2001; United Nations, 2020; Vicente and Novo, 2014). SES also plays a central role in the literature on environmental participation. Hierarchy-of-needs-based approaches and some of the environmental inequality literature suggest that citizens' demands for environmental protection and participation rise with increasing socioeconomic resources when there is no longer a crowding out by more pressing "life concerns" (Baumol and Oates, 1988; Flatø, 2020; Inglehart, 1997). This is supported by empirical research on China, which has shown that while environmental awareness is also prevalent among individuals with lower SES, the demand for environmental protection, pro-environmental behavior, and environmental participation is higher among higher classes and can be hampered by lacking resources and economic dependencies, showing a "knowledge-behavior gap" (Flatø, 2020; Shao et al., 2018; Wang et al., 2016; Xu et al., 2017; Zhang et al., 2020). We thus expect *higher levels of DigEnPa among citizens with higher levels of education and income* (H4.1 and H4.2). Second, studies have shown that younger citizens are more likely to engage in pro-environmental behavior and demands for environmental protection (Chen et al., 2011; Wang et al., 2016; Zhang et al., 2020) and it is also younger citizens who are more likely to use the Internet and frequently conduct online activities with 70 % of social media users under the age of 35 (Spencer, 2022). For both reasons, *we expect higher levels of DigEnPa among younger citizens* (H4.3). Third, the relationship between gender and environmental activities outside the home is unclear. Studies on environmental behavior in China have found an "environmental gender gap" with regards to private pro-environmental behavior, however. Activities such as recycling and green consumer behavior are higher among Chinese women (Shields and Zeng, 2012; Xiao and Hong, 2018). There is no gender difference with regards to Internet use in China (CNNIC, 2022). Inferring from pro-environmental behavior, *it is thus possible that women engage more in digital environmental participation*

(H4.4). We have further included geographic controls. While the gap in both Internet penetration rate and economic development across regions in China has narrowed down in recent years, Western and Central China still lacks behind Eastern China in both regards (Lin et al., 2017). We thus hypothesize that *DigEnPa is higher among respondents from Eastern China* (H4.5).

Fig. 1 summarizes our framework for explaining digital environmental participation in a non-democratic political setting.

3. Methodology

We conducted an online public opinion survey in August 2021 throughout China. Online surveys allow for accessing a larger sample population and broader parts of a society across regions and across socio-demographic dimensions than this would be the case for conducting fieldwork and in-depth interviews. Especially for our research interest, which inspects digital environmental participation across multiple dimensions, the access to a larger sample population is paramount to increase representativeness. Furthermore and importantly, given the severe obstacles to current in-person research in China due to both the pandemic and the political climate, an online survey presents itself as an alternative to collect information about Chinese society under these difficult conditions despite having its own methodological limitations. Due to the nature of the survey, our population is limited to the Internet-connected population, which has implications for the interpretation of results as discussed further in the limitations section below. However, the share of Internet users among China's urban population has reached 82.2 %. While not being representative of the urban Chinese population, we thus capture a large part of it. We decided to focus on urban residents and exclude rural residents from our analysis, since including rural residents would have further increased the existing selection bias towards the Internet-connected population. By early 2022, only 58.8 % of the rural population use the Internet (CNNIC, 2022). Internet Including the rural population will require the use of further survey techniques once this is feasible again in the future. (Table 1).

We worked with an international survey company. The company recruits respondents via panel and intercept sampling. Registered participants can access surveys via the company website and receive invitation reminders per email. The panel size for China encompasses 5,203,000 citizens. Furthermore, the company works with a broad range of websites, social media applications and mobile apps. Users are invited to participate in surveys and are rewarded points to redeem for cash and prizes. In total, we garnered 5999 answers based on quota for age, gender and region that resemble the Chinese population for gender and region. The sample is biased towards the younger population, however (see Table A1 in the Appendix). After data cleaning which removed respondents from the sample who abandoned the survey or have not passed consistency checks, our final sample includes 2912 valid respondents, thus leaving us with a valid response rate of 48.45 %. 1485 respondents in our sample identified with 'male', 1427 respondents with 'female'. Our survey consisted of a total of 25 questions which were grouped in several dimensions: sociodemographics (6 questions); digital skills and affinity (4 questions); environmental attitude and behavior (8 questions); political attitude (5 questions); motivation and hindrances for digital environmental participation (2 questions). Tables A2 and A3 provide an overview of the respondents' main characteristics and summary statistics.

The dependent variable of interest in our study is "digital environmental participation," which we assess in two dimensions: frequency and scope. We first examined how frequent respondents took different kinds of activities related to environmental issues via governmental or nongovernmental online channels. Second, we assessed the scope of activities, i.e. how many types of activity people engaged in. To assess the dependent variable we asked two questions. To capture DigEnPa via governmental channels, respondents were asked: "*In the last five years, how often have you used an online channel by government actors (*e.g. *website or microblog of local government or EPB) for the following activities related to environmental issues?"* (在过去五年中, 您通过政府的线上渠道(例如, 环保或其他政府部门的官网或微博) 就环境问题采取过下列行动的频率如何?). For examining DigEnPa via nongovernmental channels, respondents were asked "*In the last five years, how often have you used an online channel by non-government actors (such as a website, microblog or other social media by friends, other citizens, NGOs* etc.*) for the following activities related to environmental issues?*" (在过去5年中, 您通过非政府的线上渠道 (例如, 朋友, 其他个人或非政府组织的网站, 微信, 微博等社交媒体) 就环境问题采取过下列行动的频率如何?).[1] For both questions, respondents could select the frequency (*1* =从来没有(*never*), *2* = 几乎没有(*almost never*), *3* = 偶尔 (*from time to time*), *4* = 频繁 (*often*), *5* = 非常频(*very often*)) for seven types of activity, with never and almost never regarded as low level of participation, from time to time regarded as medium level, and often and very often regarded as high level. The seven types of activities reflect the main pathways for digital environmental participation via both governmental and nongovernmental channels, which we derived from the literature on Chinese environmental participation and our knowledge based on extensive prior research in this issue field. We decided to include information-seeking, since this is a crucial aspect of the new opportunities for public engagement provided by digital technologies. While China used to be an information-poor society with severely limited access to environmental information (Mol, 2010), ICTs have opened up new pathways to an unprecedented amount of governmental and alternative environmental information, which can be a prerequisite for other forms of public engagement (Goron and Bolsover, 2020; Seligsohn et al., 2018; Tarantino, 2020; Zhang et al., 2016, 2017). However, thus far it is unclear whether Chinese citizens make use of these new informational opportunities.

To analyze our dependent variable, we developed an *accumulated* digital environmental participation index that combines the frequency and scope of activities across both governmental and nongovernmental online channels. We added up recoded frequency scores (ranging from 1 to 4) across all individual types of activity. This leaves us with index scores ranging between 0 (no digital environmental participation) and 56 (very high digital environmental participation). We used multivariate regression to analyze the factors explaining variation in DigEnPa levels. Table 1 summarizes our variables, their measurements, and the corresponding hypotheses. In order not to distort results too much by summing up scores across types of activities that vary significantly with regards to the amount of related effort and risk, we further created two subsamples for "higher effort" and "higher risk" activities.

4. Results and discussion

4.1. High levels of digital environmental participation

The findings show that the vast majority of respondents have engaged in DigEnPa in the last five years. Overall, 96 % of participants report having participated in one or more types of activity at least from time to time. Only 4 % report never or almost never having participated in any kind of activity. This suggests that Chinese citizens make overall good use of the opportunities for environmental participation provided

[1] We selected a time period of five years, because we regard this as a suitable length for studying a recent topic while minimizing recall errors and decrease in information. Choosing a time period is a trade-off between the amount of recall errors and information that can be provided. Recall errors usually increase with an increase of the recall period, since longer time periods can lead to "under-reporting" and, hence, inaccurate data (Kjellsson et al., 2014, p. 44). Moreover, since we are interested in a recent phenomenon, expanding the time frame too much would risk receiving answers that are no longer up to date. By contrast, shorter periods might provide less information (ibid., pp. 34–35), since they can exclude respondents who are usually active, but for some reasons have not been so in the most recent past.

Table 1
Measurement and expected outcomes of key variables.

Variable	Specification	Measurement	Hypothesis
Dependent variables			
Digital environmental participation	Via governmental channels: Seek information; give feedback or suggestion; make complaint or file petition; participate in environmental impact assessment; file information request to government or corporation; take legal action (e.g. lawsuit, administrative redress); contribute to pollution map or environmental data project (e.g. Black and Smelly Waters Initiative); other (open box) Via nongovernmental channels: Seek information; share or discuss information or news; donate money; participate in signature collection, letter writing or opinion survey; share information about collective activities (e.g. letter writing, protest); contribute to pollution map or environmental data project (e.g. IPE Blue Map); participate in corporate environmental protection project (e.g. Alipay Ant Forest program); other (open box)	*Frequency (1 = never, 2 =almost never, 3 =from time to time, 4 =often, 5 =very often)* *Recode: 0 =never, 1 =almost never, 2 =from time to time, 3 =often, 4 =very often* *Aggregated into index: accumulated frequency across activities (0 =never conducted any type of activity to 56 =very often conducted all types of activity)*	
Environmental attitude and behavior			
Level of environmental concern	Air pollution; water pollution; soil pollution; desertification or soil erosion; water shortage; climate change; biodiversity loss; resource depletion; waste; food safety	*Select 1 (not concerned at all) to 6 (very concerned)* *Aggregated into index: accumulated level of concern across issues (10 =not concerned at all across all issues to 60 =very concerned across all issues)*	H1.1: DigEnPa is higher among individuals that report higher levels of environmental concern.
Offline environmental participation	Via governmental channels: Seek information; give feedback or suggestion; make complaint or file petition; participate in environmental impact assessment; file information request to government or corporation; take legal action (e.g. lawsuit, administrative redress); other (open box) Via nongovernmental channels: Seek information; share or discuss information or news; donate money, volunteer, participate in signature collection, letter writing or opinion survey; participate in public collective activities (e.g. stroll, protest); share information about collective activities (e.g. signature collection, protest); other (open box)	*Frequency (1 = never, 2 =almost never, 3 =from time to time, 4 =often, 5 =very often)* *Recode: 0 =never, 1 =almost never, 2 =from time to time, 3 =often, 4 =very often* *Aggregated into index: accumulated frequency across activities (0 =never conducted any type of activity to 52 =very often conducted all types of activity)*	H1.2 DigEnPa is higher among individuals that also engage in offline environmental participation.
Pro-environmental behavioral change	Buy more environmentally friendly products; more sustainable transport; eat more organic or fewer animal products; less waste and/or better waste sorting; save water or electricity; adapt to pollution (e.g. buy air filters, check air quality)	*Select all that apply* *Dummy: "not selected"= 0, "selected"= 1* *Aggregated into index: range of pro-environmental behavioral change, adding number of selected option (0 =reported change in no category to 6 =reported change in all categories)*	H1.3: DigEnPa is higher among individuals that have increased their individualized pro-environmental behavior.
Digital skills and attitude			
Digital skills level[a]	Familiarity with the following items: PDF; JPG; computer virus; wiki; blog; tag/hashtag; advanced search option; firewall	*Select 1 (no understanding) to 6 (full understanding)* *Aggregated into index: accumulated digital skills level (8 =no understanding of any item to 48 =full understanding of all items)*	H2.1: DigEnPa is higher among individuals with a higher digital skills level.
Technological affinity	Use of mobile phone for all aspects of life	*Select 1 (strongly disagree) to 6 (strongly agree)*	H2.2: DigEnPa is higher among individuals with higher technological affinity.
Data privacy concerns	Reason for not addressing environmental issues online more often	*Select 1 (reason not relevant at all) to 6 (reason very relevant)*	H2.3: DigEnPa is higher among individuals with lower levels of data privacy concerns.
Internet surveillance concerns	Reason for not addressing environmental issues online more often	*Select 1 (reason not relevant at all) to 6 (reason very relevant)*	H2.4: DigEnPa is higher among individuals with lower levels of Internet surveillance concerns.
Political attitude			
Trust in government	Trust in governmental institutions	*Select 1 (no trust at all) to 6 (full trust), 7 (prefer not to answer)*	H3.1: DigEnPa is higher among individuals with higher levels of trust in governmental institutions.
Chinese Communist Party membership		*Dummy: 0 =not selected; 1 =selected*	H3.2: DigEnPa is higher among individuals that are a member of the Chinese Communist Party.
Attribution of responsibility	Most responsible for managing environmental problems: central government; local government; private companies; non-governmental organizations; international organizations; individual citizens; scientific expert community; other (open box); none of the above (exclusive option)	*Select top three* *Dummy: 0 = "local government" or "central government" not selected; 1 = "local government" or "central government" selected*	H3.3: DigEnPa is higher among individuals that don't attribute the responsibility for managing environmental problems mainly to the government.
Sociodemographics			
Education level		*1 =I don't have a formal education; 2 =primary school or middle school, 3 =high school, 4 =bachelor's degree or vocational training*	H4.1: DigEnPa is higher among individuals with higher levels of education.
Income level (monthly in RMB)		*1 = 999 or less; 2 = 1000-2999; 3 = 3000-4999; 4 = 5000-6999; 5 = 7000-8999; 6 = 9000-10999;*	H4.2: DigEnPa is higher among individuals with higher levels of income.

(*continued on next page*)

Table 1 (*continued*)

Variable	Specification	Measurement	Hypothesis
		7 = 11,000-12999; 8 = 13,000-14999; *9 = 15,000-16999; 10 = 17,000 or above* *96 =Prefer not to say*	
Age		*In years (open box)* *Recoded to capture age group: 1 = 18-24, 2 = 25-34, 3 = 35-44, 4 = 45-54, 5 = 55-64*	H4.3: DigEnPa is higher among younger citizens.
Gender		*0 = male, 1 = female*	H4.4: DigEnPa is higher among female citizens.
Region[b]		*1 =Eastern, 2 =Central, 3 =Western,* *4 =Northeastern*	H4.5: DigEnPa is higher among citizens in Eastern China.

[a] This follows the measurement developed for surveys by Hargittai and Hsieh (2012).
[b] We have used the criteria by the National Bureau of Statistics of China to divide the country into four regions. In our analysis, the Eastern region is the baseline for the other regions.

by digital technologies. On average, respondents report having participated at least from time to time in 12.94 (*SD = 2.27*) out of the 14 types of activity across governmental and nongovernmental channels. The average frequency of participation sets around medium across the different types of activity, with an average of 2.15 (*SD = 0.76*) on the recoded scale from 0–4, i.e. ranging between "from time to time" and "often." Combining the frequency and scope of participation, the average *accumulated* digital environmental participation index, which adds up both governmental and nongovernmental types of activity is 30.11 out of 56 (ranging from 0 =never having conducted any type of activity to 56 = very often having conducted all 14 types of activity).

When looking at governmental and nongovernmental channels separately, digital environmental participation via nongovernmental channels is slightly higher than via governmental channels both in terms of frequency and scope (see Fig. 1). The average frequency of participation is 2.06 (*SD=0.85*) for governmental and 2.23 (*SD = 0.76*) for nongovernmental channels on the recoded scale from 0–4, i.e. both also ranging between "from time to time" and "often." The average *accumulated* digital environmental participation index is 14.4 and 15.6 out of 28 each for governmental and nongovernmental channels, respectively (ranging from 0 =never having conducted any governmental or nongovernmental type of activity, respectively, to 28 =very often having conducted all types of governmental or nongovernmental activities, respectively). (Fig. 2).

With regards to the specific kinds of activity, Figs. 3 and 4 show the reported frequency for individual types of participation. The findings show that urban Chinese citizens' ICT-based environmental participation in the last five years encompasses the full range of both institutionalized and extra-institutional types of activity. While the vast majority of citizens report they have used the informational function of ICTs by seeking environmental information via governmental or nongovernmental channels at medium or high levels of participation, i.e. from time to time (41 %), or often and very often (46 %), digital civic participation goes well beyond this informational aspect. Using online governmental channels (Fig. 3), the majority of respondents report to have engaged in consultation, i.e. giving feedback or making suggestions (39 % with medium, 35 % with high levels of participation), filed complaints and petitions (33 % medium, 29 % high levels), participated in environmental impact assessments (38 % medium, 41 % high levels), filed an information request (32 % medium, 31 % high levels), taken legal action (29 % medium, 31 % high levels), or contributed to a pollution map or environmental data project such as the Black and Smelly Waters Initiative (33 % medium, 36 % high levels).

A similar picture is given for participation via nongovernmental online channels (Fig. 4). The majority of respondents report they have used the deliberative function of the Internet by sharing and discussing environmental information and news (38 % with medium, 43 % with high levels of participation). A similarly high share of respondents reports to have used unofficial online channels to donate money (44 % medium, 47 % high levels), participate in "e-tactics," i.e. digital versions of offline tactics (37 % medium, 35 % high levels), or "e-mobilization," i.e. using digital tools to share information about collective activities (38 % medium, 36 % high levels). The vast majority of respondents also report to have contributed to a pollution map or environmental data project such as the IPE Blue Map app via nongovernmental channels (36 % both medium and high levels), or participated in a corporate environmental protection project such as the Alipay Ant Forest program (36 % medium, 47 % high levels). The findings suggest that, overall, Chinese citizens make full use of the new digital opportunities for environmental participation both via governmental and nongovernmental channels. This encompasses the full range of state-sanctioned and more informal and potentially contentious types of activity, with a slight overall preference for nongovernmental channels.

4.2. Explaining digital environmental participation

In order to measure the power of different predictor variables and explain why some respondents participate more frequently and via a wider scope of activities, we undertook a multivariate regression (Table A4 in the Appendix). We ran a regression that includes the effects of environmental attitude and behavior (model 1), digital skills and attitude (model 2), political attitude (model 3), and sociodemographic variables(model 4) on both the combined DigEnvPa index that adds up governmental and nongovernmental activities, as well as the separate governmental and nongovernmental indexes. Fig. 5 illustrates the results of the regression analysis.

First, we find that citizens' environmental attitude and behavior are important factors that help explain DigEnPa. In particular, offline environmental participation is positively and significantly associated with levels of DigEnPa, both via governmental and nongovernmental channels. Also levels of environmental concern matter, albeit with a lower effect. These findings confirm H.1.1 and H1.2 that *DigEnPa is higher among individuals that report higher levels of environmental concern* and *among individuals that also engage in offline environmental participation.* Individualized pro-environmental behavior is positively correlated with nongovernmental action, but negatively associated with activities via governmental channels. We thus confirm H1.3, which hypothesized that *DigEnPa is higher among individuals that have increased their individualized pro-environmental behavior* (H1.3), for nongovernmental channels, but reject it for governmental channels.

Second, we assessed citizens' digital skills and attitude and how these factors are related to DigEnPa. The analysis shows that digital skills levels are positively and significantly associated with DigEnPa, albeit with a low effect, thus confirming H2.1, which reads as *DigEnPa is higher among individuals with a higher digital skills level*. With a stronger association, we find that technology affinity is significant, at least for nongovernmental channels We thus confirm H2.2 *that DigEnPa is higher among individuals with higher technological affinity* for nongovernmental types of activity. By contrast, the variable on data privacy concerns is not associated with citizens' DigEnPa. Counterintuitively, Internet

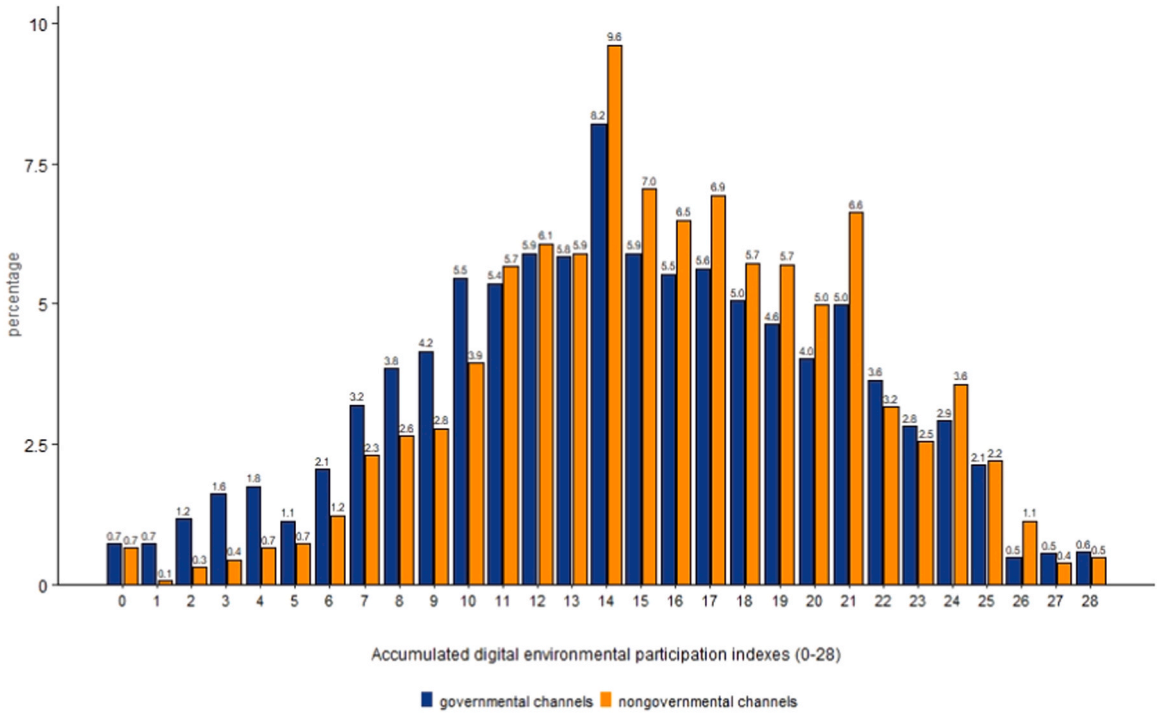

Fig. 2. Accumulated digital environmental participation indexes for governmental and nongovernmental channels (N = 2912).

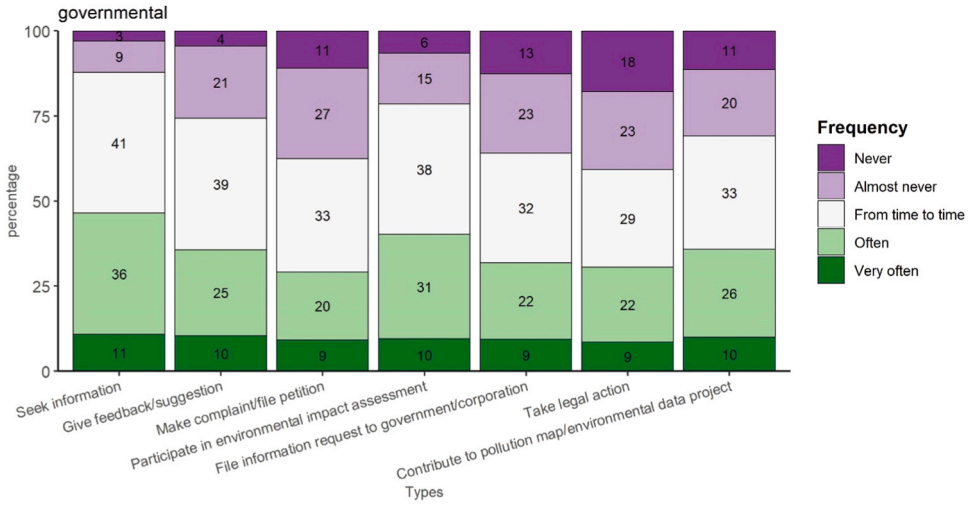

Fig. 3. Frequency of participation by type of activity via governmental channels (N = 2912).

surveillance concerns are even positively correlated with DigEnPa via governmental channels. Together, the results show that concerns over data privacy and Internet surveillance are not a significant hindrance for citizens' digital environmental engagement. Instead, citizens, who have concerns over Internet surveillance are even more engaging in governmental digital environmental participation. We therefore reject both hypotheses H2.3 and H2.4, namely *DigEnPa is higher among individuals with lower levels of data privacy concerns* (H2.3) *and Internet surveillance concerns* (H2.4).

Third, we assessed whether citizens' political attitude is related to DigEnPa. Our results show that trust in governmental institutions has limited explanatory power for DigEnPa, hence leading us to reject H3.1 which assumed that *DigEnPa is lower among individuals with lower levels of trust in governmental institutions.* CCP members are more likely to engage in governmental action, hence confirming H3.2 for governmental channels that *DigEnPa is higher among individuals that are a member of the Chinese Communist Party*. However, we find a high and significant negative association between the attribution of responsibility to the government and DigEnPa, in particular via governmental channels. This means that citizens who attribute the responsibility for environmental problem-solving to the government are less likely to engage in digital environmental participation and confirms H3.3 that *DigEnPa is higher among individuals that don't attribute the responsibility for managing environmental problems to the government.*

Last, we find that female and higher educated citizens, as well as those with a lower income engage more in nongovernmental action, albeit the latter to a small effect. This confirms H4.1 and H4.4 that citizens with a higher level of education and female citizens show higher levels of DigEnPa, but does not confirm H4.2 that higher levels of income are associated with higher levels of DigEnPa. These sociodemographic variables only play a significant role for nongovernmental channels, however, which points to an interesting difference between

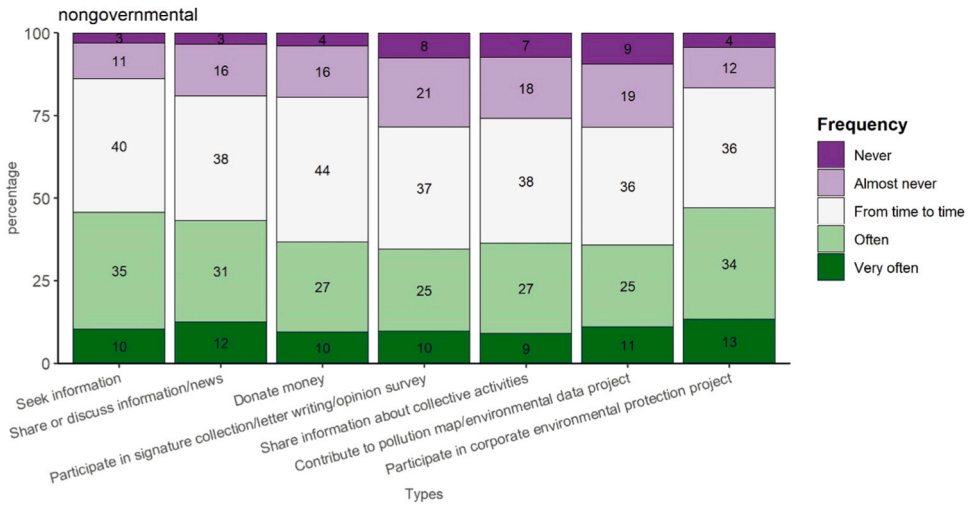

Fig. 4. Frequency of participation by type of activity via nongovernmental channels (N = 2912).

the two types of channels. Regarding regional differences, we find that citizens in Western China are more likely to use governmental channels for DigEnPa. Region is not significant in the combined index for governmental and nongovernmental channels, however, hence not confirming H4.5. In our study, digital environmental participation is further not explained by age, we thus reject hypothesis H4.3 that DigEnPa is higher among younger citizens. This could be attributed to the sample bias towards the younger population.

In order not to obscure results too much by summing up scores across different types of activity with regards to the level of related effort and risk, in particular given the surprisingly high shares of participation across all types of activity, we ran an additional set of regressions on two subsamples of "higher effort" and "higher risk" types of activities across governmental and nongovernmental channels. With regards to "higher effort" activities, we classified simple information seeking and sharing as low-key types of activities, since most other activities could require more or less effort depending on their exact manifestation – a kind of information we did not collect in the survey.[2] With regards to "higher risk" types of activities, we included taking legal action, since this can be rather sensitive in China, as well as participating or passing on information about collective action, which has become even more sensitive under Xi Jinping. The results of these subsample regressions are provided in Table A5 in the Appendix. Overall, the subsamples reflect the regression results for the full sample. The only notable results are that pro-environmental behavioral change has a negative effect on higher risk types of activities (as it does on all governmental activities), and that Internet surveillance concerns are positively linked with higher effort activities (again, as are all governmental activities). Moreover, counter to expectation, trust in government is negatively associated with higher risk activities, albeit with a very small effect. That means that more trust in governmental institutions actually leads to less risky action, rather than lacking political trust keeping people from becoming active. Last, higher income is positively associated with risky action, but also with a very small effect. The other variables wither have no effect or the same effect as on the full sample.

4.3. Discussion

Our results show surprisingly high levels of citizens' digital environmental participation. Respondents in our survey embrace the new ICT-provided opportunities for participation in environmental governance with the majority reporting medium or high levels of participation across a broad range of activities. This encompasses all key areas in which ICTs have been found to alter the dynamics of environmental governance in the context of democratic regimes. The respondents in our study, overall, reported to make good use of the important informational function of digital technologies (Mol, 2010) by accessing a diversified range of environmental information. They also actively engage in environmental data collection and monitoring as suggested in the literature on digital environmental participation in democratic countries (Gigler and Bailur, 2014; Peixoto and Fox, 2016; Soma et al., 2016).

Moreover, citizens engage both via governmental and nongovernmental channels. The majority of our respondents use the new digital communication channels with the government for top-down initiated forms of participation such as public consultation and institutionalized forms of environmental claims-making as suggested in the literature on environmental e-governance (Schulz and Newig, 2015; United Nations, 2020). At the same time, respondents draw on ICTs for bottom-up and potentially more contentious forms of participation such as for the expression of personal opinions in a deliberative online public sphere (Sima, 2011), for participation in the activities of environmental organizations, or for the digital mobilization of both online and offline collective action as described in the contentious politics literature (Bennett and Segerberg, 2012; Earl and Kimport, 2011). Despite a small overall preference for nongovernmental activities, both governmental and nongovernmental channels are used to a similar extent in our study, which suggests that both top-down and bottom-up initiated forms of participation are regarded as viable and complementary forms of DigEnPa.[3]

Despite the overall high levels of digital environmental participation, the extent of participation varies among social groups and points to several hindrances to digital engagement. Our findings indicate that digital environmental participation among urban Chinese citizens is

[2] For instance, making a complaint or filing a petition could describe either making a simple online complaint via a complaint platform or setting up a more comprehensive online petition involving more people. In a similar vein, participating in an environmental impact assessment could mean briefly posting an online comment during the public opinion collection phase or being more involved in the public participation process. Also sharing information about collective activities could encompass forwarding a picture or post or actually setting up collective activities such as a motorcade, meeting or "stroll" and sharing this information.

[3] This is confirmed by a significant positive correlation ($r = 0.87$, $p < 0.000$) between participation through governmental and nongovernmental channels, which suggests that participants who use one type of channel also tend to use the other.

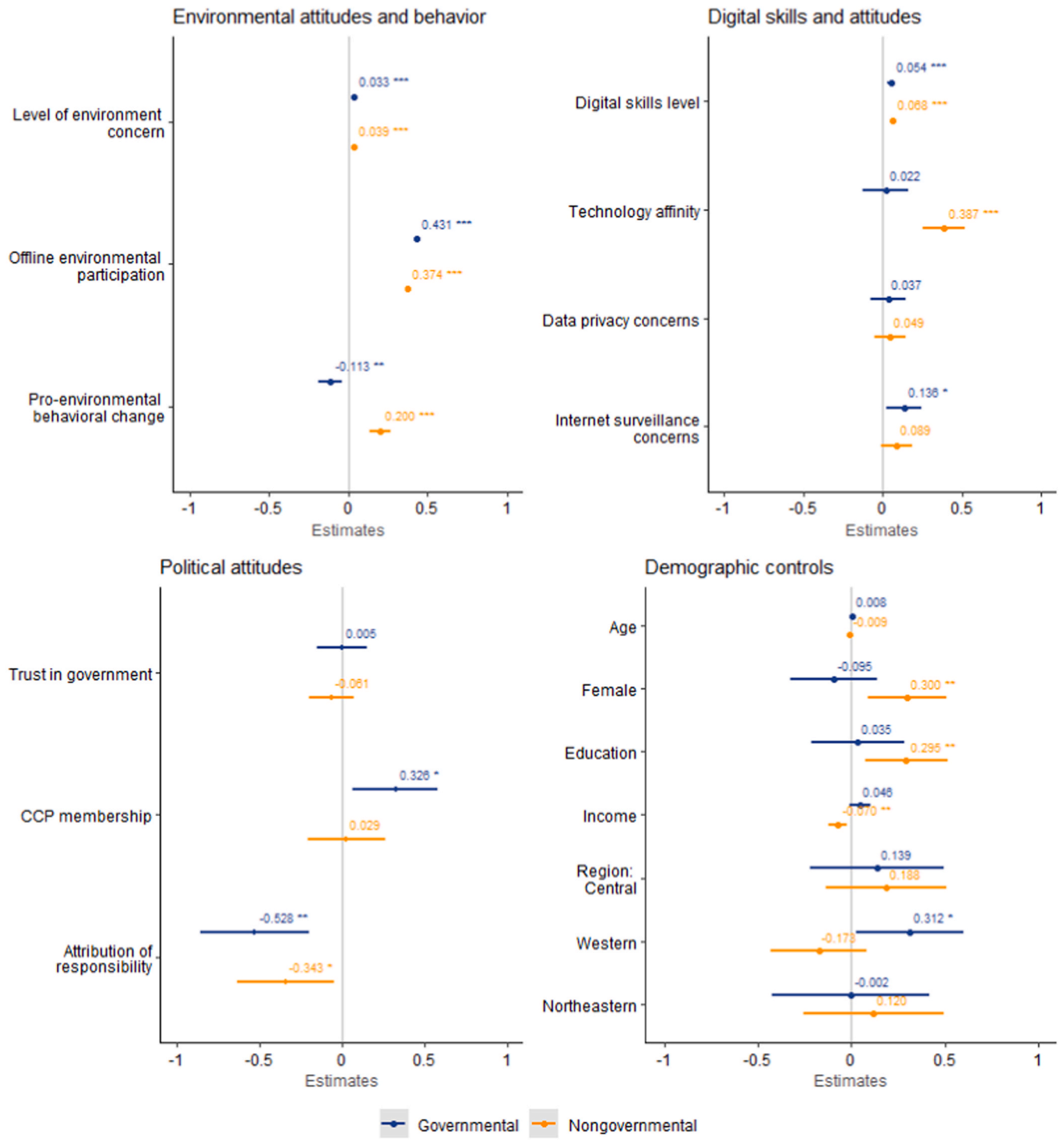

Fig. 5. Estimates of effects of environmental attitude and behavior, political attitude, digital skills and attitude, and sociodemographic factors on digital environmental participation.

driven primarily by those with higher levels of environmental concern and those who are already environmentally active offline, as well as by the more digitally skilled and those with a higher technological affinity. Our findings permit several conclusions about digital environmental participation in China.

First, the fact that citizens who use ICTs for environmental participation are, generally, citizens with higher levels of environmental concern and those active offline supports the "reinforcement hypothesis" (Norris, 2001, p. 218). It suggests that ICTs are mainly used by those already environmentally active and it is questionable whether ICTs in fact expand citizen environmental participation or bring politically marginalized groups into the policy process. Whether ICTs can encourage citizens that have thus far not become environmentally active to do so would be an interesting point for future research. The finding confirms existing studies that have found that most Chinese citizens use a combination of online and offline activities (Cai and Zhou, 2016; He et al., 2017; Huang and Yip, 2012; Su and Meng, 2016). With regards to individualized pro-environmental behavior, the data show a first interesting difference between governmental and nongovernmental channels. The findings show that urban residents who privately adjust their

behavior in a more environmentally friendly way are also more likely to become active via nongovernmental channels such as environmental organizations or in the online "green sphere". This shows that also in a repressive political context, individualized pro-environmental activity does not seem to be regarded as a more feasible alternative to environmental public participation as suggested by Johnson et al. (2017), at least in the nongovernmental realm. Rather, both forms of environmental action seem to be complementary. A small negative effect can be seen with regards to governmental action, though, suggesting that those who adjust their private activities take less state-led environmental action. This points to an interesting difference in citizens' understanding and use of both types of channels and matches the authors' finding in a second paper that citizen action via nongovernmental channels is more based on broader environmental concerns, while governmental action is more driven by personal grievances (Guo et al., forthcoming).[4]

Second, digital skills and technological affinity matter for digital environmental participation. This points to a digital participation opportunity gap where mostly the already digitally active make use of ICTs for digital participation and confirms studies that associate a higher use of digital technologies and social media with higher levels of participation, also in China (Gil de Zúñiga et al., 2012; Jho and Song, 2015; Wang & Shi, 2018). Supporting the "digital divide" literature, the finding suggests that digital environmental participation requires a certain degree of digital know-how and technological affinity that could reinforce socio-political inequalities by excluding the digitally unskilled and less tech-savvy population from political engagement (Elliott and Earl, 2018; He et al., 2017; Hoffmann and Lutz, 2021). Again, we find an interesting difference between governmental and nongovernmental channels, though. While participation via both types of channels hinges on digital skills, higher levels of technological affinity are only correlated with nongovernmental channels. This can be explained by the fact that the main nongovernmental forms of activity – participation in the online green public sphere, environmental campaigns or the activities of environmental organizations – tend to have a strong social media component (Bondes, 2019; Cai and Zhou, 2016; He et al., 2017; Y. Huang, 2020, pp. 70–71). This suggests that becoming active outside the state domain might require a higher degree of tech-savviness than participation via governmental channels, presenting an interesting form of "digital divide" effect that could be particular to authoritarian political contexts. While the "digital divide" effect is relatively small in our study, the actual effect is likely to be much bigger since our sample includes only the Internet-connected urban population. Overall, this points to another major hindrance of the participatory potentials of ICTs.

Third, we find that potential regime-related hindrances to digital participation such as lacking trust in governmental institutions, data privacy or Internet surveillance concerns, which have been found to hamper digital engagement in other restrictive political contexts (Alrashedi et al., 2015; Grönlund and Wakabi, 2015; Lee-Geiller, 2020; Wakabi, 2016), do not seem to constitute a significant barrier for DigEnPa, at least for the respondents in our sample. Rather, citizens who engage via governmental channels are more likely to believe Internet surveillance is a risk of DigEnPa. This finding can be explained with the "privacy paradox" according to which citizens engage in a cost-benefit calculus of their online engagement and ultimately believe the benefits to outweigh the risks (Barth and de Jong, 2017). Since the risks for taking action have increased for nongovernmental channels under Xi Jinping, the higher perceived costs could neutralize the effect there.[5] Together, this shows that ICTs can unfold significant participatory potential in environmental governance even under repressive political circumstances without being curbed by matters of trust and the risks associated with taking action online. Moreover, as expected, we find that members of the Chinese Communist Party tend to take more governmental action, again pointing to a difference in the types of activities and suggesting that participation via governmental channels is at least partly mobilized from above. However, we find that Chinese citizens' believes in the government's responsibility for environmental problem-solving significantly reduce DigEnPa, as has also been reported for offline environmental engagement (Li and Shapiro, 2020; Wong, 2010; Xu et al., 2017). In the offline literature, this effect is twofold. On the one hand, the literature finds that the institutions that represent citizens' interests are weak, thus prompting people to rely on the government for solving environmental problems (Wong, 2010). On the other hand, the predominance of the party-state in China's command-and-control environmental governance system, its self-presentation as main problem-solving authority and the reliance on top-down behavioral campaigns that fail to create or even hamper intrinsic motivations for environment-protective behavior lead to a lack of perceived personal responsibility for addressing environmental issues (Li and Shapiro, 2020; Xu et al., 2017). This is an unintended side effect of China's top-down environmental governance system that hinders ICTs to unfold their full potential for citizen participation in environmental governance.

Last, traditional sociodemographic factors matter also in the digital domain, but only for nongovernmental environmental participation. This points to another interesting difference between the two types of channels. In our sample, digital environmental participation via nongovernmental channels is significantly higher among the female population and those with higher levels of education. This mirrors studies on environmental behavior in China, which find that female, younger and highly educated citizens are more likely to engage in pro-environmental behavior and demands for environmental protection (Chen et al., 2011; Y. Wang et al., 2016; Y. Zhang et al., 2020). That education levels matter confirms resource- and hierarchy-of-needs-based approaches that regard environmental engagement as dependent on higher socioeconomic status and attribute environmental participation mainly to China's urban "middle class" (Flatø, 2020; Shao et al., 2018; Wasserstrom, 2009; Yu, 2014). Income in our study has a slight negative effect on participation via nongovernmental channels. This could be related to the "gender pay gap" in China, given the larger share of active female respondents (Bai et al., 2022). However, it has also been found by others that education matters for environmental attitudes and behavior in China, but income does not (Chen et al., 2011; Yu, 2014). That female respondents in our sample show higher levels of DigEnPa confirms studies on the "environmental gender gap" in China (Shields and Zeng, 2012; Xiao and Hong, 2018), which find higher levels of private pro-environmental behavior, such as recycling and green consumer behavior, among Chinese women. Our

[4] The paper focuses specifically on the different preferences for and motivations behind the use of governmental versus nongovernmental channels among urban Chinese residents. The paper assesses the motivation behind becoming environmentally active in the last five years in the survey, including "I am personally affected," "for my friends and family," "for future generations," or "for the environment." The results show that being motivated by personal grievances, especially having concerns for one's family and friends, is positively and significantly correlated with a higher individual use of governmental channels vis-à-vis nongovernmental channels, and negatively correlated with the use of nongovernmental channels. On the contrary, acting out of environmental concerns is positively correlated with higher use of nongovernmental channels vis-á-via governmental channels (Guo et al.).

[5] Amid the Chinese government's intensified efforts to channel participation into governmental venues and so-called "citizens' orderly participation" under Xi Jinping, nongovernmental channels have come under increasing pressure in recent years with a higher associated risk of adverse state responses. This includes increased online surveillance and (self-)censorship outside official state communication channels, especially on social media, intensified control of social organizations and environmental activists, and low tolerance of collective activities such as protests (Fu and Distelhorst, 2018; Göbel, 2021; Lorentzen, 2017; O'Brien, 2023; Yang and Wu, 2022).

study suggests that this could also be the case with regards to nongovernmental digital environmental participation. Interestingly, these socioeconomic factors do not matter for participation via governmental channels. Moreover, citizens in Western China are more likely to engage in governmental channels compared to citizens in the other regions. This could be linked to the fact that social organizations are more advanced in Central and Western China and that the opportunities for nongovernmental engagement, but also trust in nonstate actors may hence be more limited in Western China. Overall, this suggests that there is a notable difference between citizens' use of the two types of channels and that different social groups could have diverging preferences for the different types of channels – an area that requires further investigation and has been studied in more detail in Guo et al. (forthcoming) . That age does not have a significant effect in our study could partially be explained by the bias towards younger respondents in our sample.

With regards to the two "higher effort" and "higher risk" subsamples, the most notable result is that the overall results do not significantly change for the two subsamples. Most importantly, political variables like trust in political institutions but also Internet surveillance concerns do not seem to obstruct participation also via more risky types of activities. Moreover, the results do not seem to be obscured by low-key types of activity such as seeking or sharing information.

4.4. Research limitations

Our findings need to be considered against a few noteworthy limitations. The major limitation relates to assessing online behavior through an online survey. As mentioned above, our sample only captures the Internet-connected urban population. The survey is thus limited to citizens who have access to the Internet and the relevant devices, namely desktop computers, smartphones, and tablets, and who might use digital technologies more frequently per se. In different words, our online survey could not capture opinions of citizens without access to the Internet and digital technologies, hence resulting in a "coverage bias" (van Dijk, 2005). The remarkably high share of respondents that report to have used online channels for environmental participation across the different types of channels needs to be considered in light of this. While it is hard to assess the magnitude of this effect, it is very likely that the numbers are inflated due to the nature of the online survey. Our Internet-connected respondents may either enjoy objectively more convenient conditions for online participation, or be more prone to using digital means of participation as compared to people without Internet connection. We also do not know whether non-Internet-connected citizens prefer using offline channels, whether they are less active in expressing their opinions on environmental issues in general, or whether they might hold different risk perceptions than citizens of our sampled population. Nonetheless, given the high urban Internet penetration rate of 82.2 % (CNNIC, 2022), our sample captures the majority of urban residents and the bias does not prevent us from exploring the relationship between digital environmental participation and multiple sets of explanatory variables based on the group heterogeneity of our sample. To avoid this bias and capture also the rural population, future research will have to include other methodological means once this is feasible again in China.

Moreover, our sample population is biased towards younger citizens (see Table A4 in the appendix) and includes only those living in urban areas. While age is not associated with citizens' participation in our study, empirical research in China supports resource- and hierarchy-of-needs-based approaches and shows that China's new urban "middle class" has been most outspoken when it comes to making environmental demands (Flatø, 2020; Lora-Wainwright, 2017; Shao et al., 2018; Xu et al., 2017). Moreover, a large number of digitally-enhanced environmental campaigns have been staged in China's major cities (Bondes, 2019; Cai and Zhou, 2016; He et al., 2017; Huang, 2020, pp. 70–71). This sample bias is also likely to bias the results in a similar direction, i.e. that citizens in our sample are more actively engaged in environmental governance than is the case for China's general population.

Finally, our results share the limitations inherent in all survey data. To minimize the risk that respondents misunderstood our questions, we sent out the survey to pilot respondents and, subsequently, discussed it with them and adjusted our survey. Another problem relates to the risk of citizens providing answers that do not reflect their true opinion or randomly answering questions. This could be either based on a perceived sensitivity of questions or related to the rewards-based nature of the survey. In order to receive the reward (such as a voucher), respondents might have completed to survey without providing sincere answers due to time-constraints and limited interest. We included several consistency checks to limit this risk, such as consistency questions in the beginning and end of the survey, checks during the data cleaning phase on whether respondents used the same login-ID more than once, or whether the survey was completed within an unrealistically short time period. Respondents were excluded if answers did not pass these checks. For instance, 41 respondents were removed from the final data set due to a comparatively short survey completion time.

5. Conclusion

Our study contributes to understanding the participatory potentials of ICTs in environmental governance in the context of non-democratic political regimes. By studying citizens' digital environmental participation in China, one of the world's leading countries in digital authoritarianism, our analysis brings new insights to the potentials and limitations of digital environmental governance in authoritarian regimes and the debate on digital authoritarianism more broadly.

Our study shows that also in an authoritarian political setting, digital technologies can unfold significant participatory potential without being impeded by matters of political trust and perceived regime-related risks to digital engagement such data privacy and Internet surveillance concerns. This encompasses a broad range of activities via both governmental and nongovernmental channels. The findings suggest that also in non-democratic regimes, digital technologies have the potential to alter the dynamics of environmental governance by enhancing transparency, accountability, citizen-government communication, efficiency and service delivery as found in democratic countries (Brombal, 2020; Gigler and Bailur, 2014; Hsu et al., 2020; Vij and Gil-Garcia, 2017).

Nonetheless, we find that the extent of participation varies across social groups and identify several hindrances to DigEnPa. First, in China, it is the environmentally concerned and those also active offline that take most environmentally-related digital action. This supports the "reinforcement hypothesis." Rather than expanding the scope of civic actors in China's environmental governance, ICTs are mostly used by those already involved and do not suffice to draw new social groups into the governance process, for instance by reducing the risks of participation in an authoritarian political framework. Second, we find a digital participation opportunity gap. Digital environmental participation in our study is driven by the digitally skilled and those with a higher technological affinity. This supports the "digital divide" literature that cautions us that digital technologies might reinforce socio-political inequalities by excluding the less digitally skilled and tech-savvy from engagement (Elliott and Earl, 2018; Hoffmann and Lutz, 2021; Vicente and Novo, 2014b). Third, regime-related factors such as matters of political trust or data privacy and Internet surveillance concerns do not seem to hamper DigEnPa in China. However, our findings show that digital engagement is impeded by the tendency of Chinese citizens to attribute the responsibility for environmental problem-solving to the government, hence shedding personal responsibility. This is a problem inherent in China's model of "environmental authoritarianism" also reported offline, which hinders ICTs to unfold their full participatory potential.

In sum, our findings show that digital technologies can unfold significant participatory potential also in an autocratic context. However,

this potential is driven mostly by those already digitally and environmentally active. Digital technologies appear to fail to draw new social groups into the policy process. Moreover, in China, as in many other non-democratic countries, digital participation continues to take place amid an instrumental approach to public participation that seeks to integrate institutions and mechanisms of citizen engagement into an autocratic system of governance in order to enhance political stability and effective policy-making without promoting democracy (Gueorguiev, 2021). The participatory potential thus is a potential with clear limitations.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Genia Kostka reports financial support was provided by German Research Foundation.

Data availability

Data will be made available on request.

Appendix

Higher effort subsample: governmental activities (give feedback or suggestion; make complaint or file petition; participate in environmental impact assessment; file information request; take legal action; contribute to pollution map or environmental data project); nongovernmental activities (donate money; participate in signature collection, letter writing or opinion survey; share information about collective activities; contribute to pollution map or environmental data project; participate in corporate environmental protection project).

Higher risk subsample: governmental activities (take legal action); nongovernmental activities (participate in signature collection, letter writing or opinion survey; share information about collective activities).

Table A1
Chinese population and sample population by age group.

	Chinese population (%, 2020)	Urban Chinese (%, 2021) population	Sample (%)
18–24	10 (15-24)	16 (15–24)	17
25–34	15	12	25
35–44	14	18	27
45–54	17	16	19
55–64	12	11	12
65+	14	11	0

Source: National Bureau of Statistics of China (2021).

Table A2
Summary of respondents' sociodemographic characteristics.

Variable	N	Percentage %
Age group		
18-24	503	17
25-34	736	25
35-44	772	27
45-54	555	19
55-64	346	12
Gender		
Male	1485	51
Female	1427	49
Monthly income		
<1000	61	2.1
1000-2999	98	3.4
3000-4999	190	6.5
5000-6999	275	9.4
7000-8999	371	13
9000-10,999	349	12
11,000–12,999	449	15
13,000–14,999	384	13
15,000–16,999	372	13
>=17,000	326	11
Prefer not to say	37	1.3
Education level		
Primary or middle school	44	1.5
High school	519	18
Bachelor's degree or vocational training	2214	76
Master's degree or PhD degree	135	4.6
City size		
Other cities	942	32
First-tier and capital cities	1970	68
Region		
Eastern China	1607	55
Central China	342	12

(*continued on next page*)

Table A2 (*continued*)

Variable	N	Percentage %
Western China	724	25
Northeastern China	239	8.2

Table A3
Summary statistics.

Variable	N	Mean or %	SD	Median (IQR)	Range
Environmental attitude and behavior					
Level of environmental concern	2912	45	8	46 (41, 51)	10, 60
Pro-environmental behavioral change	2912	3	2	3 (2, 4)	0, 6
Offline environmental participation (combined)	2912	27	11	27 (19, 34)	0, 52
Political attitude					
Trust in government	2889	5	1	6 (5, 6)	1, 6
CCP membership					
Yes	787	27	-	-	-
Attribution of responsibility					
Others	404	14	-	-	-
Government	2508	86	-	-	-
Digital skills and attitude					
Digital skills level	2912	35	7	36 (31, 41)	8, 48
Technological affinity	2912	5	1	5 (5, 6)	1, 6
Data privacy concerns	2912	4	1	4 (3, 5)	1, 6
Internet surveillance concerns	2912	4	1	4 (3, 5)	1, 6

Table A4
Regression of environmental attitudes and behavior, political attitude, digital skills and attitude, and sociodemographics on digital environmental participation, combining governmental and nongovernmental channels.

Predictors	M1 Estimates	M2 Estimates	M3 Estimates	M4 Estimates	M1-4, combined Estimates	M1-4, governmental Estimates	M1-4, nongovernmental Estimates
Level of environmental concern	0.107***				0.071***	0.033***	0.039***
	(0.011)				(0.011)	(0.007)	(0.007)
Offline environmental participation	0.852***				0.805***	0.431**	0.374***
	(0.009)				(0.010)	(0.007)	(0.006)
Pro-environmental behavioral change	0.092				0.087	0-.113**	0.200***
	(0.055)				(0.057)	(0.038)	(0.034)
Digital skills level		0.611***			0.122***	0.054***	0.068***
		(0.027)			(0.015)	(0.010)	(0.009)
Technological affinity		0.063			0.409***	0.022	0.387***
		(0.194)			(0.111)	(0.074)	(0.066)
Data privacy concerns		1.011***			0.086	0.037	0.049
		(0.158)			(0.085)	(0.057)	(0.050)
Internet surveillance concerns		1.217***			0.224**	0.136*	0.089
		(0.158)			(0.086)	(0.057)	(0.051)
Trust in government			2.002***		-0.056	0.005	-0.061
			(0.228)		(0.116)	(0.077)	(0.069)
CCP membership			4.360***		0.355	0.326*	0.029
			(0.419)		(0.199)	(0.133)	(0.118)
Attribution of responsibility [government]			-3.696***		-0.871***	-0.528**	-0.343*
			(0.528)		(0.253)	(0.169)	(0.150)
Age	-0.002	0.014	0.015	0.019	-0.000	0.008	-0.009
	(0.008)	(0.015)	(0.017)	(0.018)	(0.008)	(0.005)	(0.005)
Female	0.178	-0.331	-0.347	-0.490	0.205	-0.095	0.300**
	(0.182)	(0.334)	(0.383)	(0.397)	(0.178)	(0.119)	(0.106)
Education level	0.563**	0.098	0.445	1.004*	0.330	0.035	0.295**
	(0.194)	(0.356)	(0.409)	(0.419)	(0.191)	(0.127)	(0.114)
Income level	0.102*	0.516***	1.193***	1.392***	-0.024	0.046	-0.070**
	(0.042)	(0.079)	(0.086)	(0.088)	(0.043)	(0.029)	(0.025)
Region (baseline group: Eastern)							
Central	0.264	1.031*	0.734	1.051	0.327	0.139	0.188
	(0.282)	(0.519)	(0.594)	(0.616)	(0.276)	(0.184)	(0.164)
Western	0.122	0.762	0.916	1.113*	0.139	0.312*	-0.173
	(0.223)	(0.412)	(0.470)	(0.487)	(0.219)	(0.146)	(0.130)
Northeastern	0.190	0.674	2.796***	2.692***	0.118	-0.002	0.120
	(0.327)	(0.600)	(0.685)	(0.709)	(0.321)	(0.214)	(0.190)
Intercept	-0.672	-5.320**	11.063***	16.237***	-2.870**	-1.321	-1.550*
	(0.923)	(1.801)	(2.167)	(1.854)	(1.070)	(0.713)	(0.635)

(*continued on next page*)

Table A4 (*continued*)

Predictors	M1 Estimates	M2 Estimates	M3 Estimates	M4 Estimates	M1-4, combined Estimates	M1-4, governmental Estimates	M1-4, nongovernmental Estimates
Observations	2875	2875	2858	2875	2858	2858	2858
R^2/R^2 adjusted	0.814/ 0.813	0.370/ 0.367	0.175/ 0.172	0.109/ 0.107	0.824/0.823	0.750/0.748	0.747/0.746

* $p < 0.05$ **$p < 0.01$ *** $p < 0.001$.

Table A5
Regression of environmental attitudes and behavior, political attitude, digital skills and attitude, and sociodemographics on "higher effort" and "higher risk" subsamples.

Predictors	Higher effort Estimates	Higher risk Estimates
Level of environment concern	0.047***	0.010**
	(0.010)	(0.004)
Pro-environmental behavioral change	-0.096	-0.100***
	(0.050)	(0.019)
Offline environmental participation	0.703***	0.212***
	(0.009)	(0.003)
Digital skill level	0.061***	0.012*
	(0.014)	(0.005)
Technology affinity	0.201*	0.017
	(0.097)	(0.037)
Data privacy concerns	0.041	-0.010
	(0.074)	(0.028)
Internet surveillance concerns	0.190*	0.036
	(0.075)	(0.028)
Trust in government	-0.097	-0.081*
	(0.101)	(0.038)
CCP membership	0.483**	0.100
	(0.174)	(0.066)
Attribution of responsibility	-0.915***	-0.280***
	(0.222)	(0.084)
Age	0.005	0.002
	(0.007)	(0.003)
Female	-0.009	0.027
	(0.156)	(0.059)
Education level	0.037	-0.090
	(0.168)	(0.063)
Income level	0.022	0.031*
	(0.037)	(0.014)
Central	0.195	0.132
	(0.242)	(0.091)
Western	0.244	0.139
	(0.192)	(0.072)
Northeastern	0.222	0.075
	(0.281)	(0.106)
Intercept	9.882***	3.288***
	(0.938)	(0.354)
Observations	2858	2858
R^2/R^2 adjusted	0.814/0.813	0.726/0.725

*$p < 0.05$ **$p < 0.01$ ***$p < 0.001$.

References

Alrashedi, R., Persaud, A., Kindra, G., 2015. Drivers of eParticipation: Case of Saudi Arabia. J. Bus. Inq. 14 (1), 1–22. ⟨https://journals.uvu.edu/index.php/jbi/article/view/120⟩.

Bai, W., Lee, Y.-L., Liao, J., Wu, L., Xie, M., & Zhou, T., 2022. The Gender Pay Gap in China: Insights from a Discrimination Perspective (arXiv:2206.09306). arXiv. https://doi.org/10.48550/arXiv.2206.09306.

Balla, S.J., 2012. Information technology, political participation, and the evolution of Chinese policymaking. J. Contemp. China 21 (76), 655–673. https://doi.org/10.1080/10670564.2012.666835.

Barrios-O'Neill, D., Schuitema, G., 2016. Online engagement for sustainable energy projects: a systematic review and framework for integration. Renew. Sustain. Energy Rev. 54, 1611–1621. https://doi.org/10.1016/j.rser.2015.10.084.

Barth, S., de Jong, M.D.T., 2017. The privacy paradox – investigating discrepancies between expressed privacy concerns and actual online behavior – a systematic literature review. Telemat. Inform. 34 (7), 1038–1058. https://doi.org/10.1016/j.tele.2017.04.013.

Baumol, W.J., & Oates, W.E. , 1988. The Theory of Environmental Policy (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9781139173513.

Bennett, W.L., Segerberg, A., 2011. Digital media and the personalization of collective action. Inf. Commun. Soc. 14 (6), 770–799. https://doi.org/10.1080/1369118X.2011.579141.

Bennett, W.L., Segerberg, A., 2012. The logic of connective action. Inf. Commun. Soc. 15 (5), 739–768. https://doi.org/10.1080/1369118X.2012.670661.

Bondes, M. , 2019. Chinese Environmental Contention: Linking Up against Waste Incineration. Amsterdam University Press.

Brady, H.E., Verba, S., Schlozman, K.L., 1995. Beyond SES: a resource model of political participation. Am. Political Sci. Rev. 89 (2), 271–294. https://doi.org/10.2307/2082425.

Brombal, D., 2020. Is fighting with data enough? Prospects for transformative citizen science in the Chinese anthropocene. J. Environ. Plan. Manag. 63 (1), 32–48. https://doi.org/10.1080/09640568.2019.1641071.

Cai, Y., Zhou, T., 2016. New information communication technologies and social protest in China: INformation as Common Knowledge. Asian Surv. 56 (4), 731–753. https://doi.org/10.1525/as.2016.56.4.731.

Chen, X., Peterson, M.N., Hull, V., Lu, C., Lee, G.D., Hong, D., Liu, J., 2011. Effects of attitudinal and sociodemographic factors on pro-environmental behaviour in Urban China. Environ. Conserv. 38 (1), 45–52. https://doi.org/10.1017/S037689291000086X.

CNNIC (2022). 第50次中国互联网络发展状况统计报告The 50th Statistical Report on China's Internet Development, ⟨http://www.cnnic.cn/NMediaFile/2022/0926/MAIN1664183425619U2MS433V3V.pdf⟩.
Creemers, R., 2017. Cyber China: upgrading propaganda, public opinion work and social management for the twenty-first century. J. Contemp. China 26 (103), 85–100. https://doi.org/10.1080/10670564.2016.1206281.
Deng, Y., Yang, G., 2013. Pollution and protest in China: environmental mobilization in context. China Q. 214, 321–336. https://doi.org/10.1017/S0305741013000659.
van Dijk, J., 2005. The Deepening Divide: Inequality in the Information Society. Sage. https://doi.org/10.4135/9781452229812.
Distelhorst, G., Hou, Y., 2017. Constituency service under nondemocratic rule: evidence from China. J. Polit. 79 (3), 1024–1040. https://doi.org/10.1086/690948.
Earl, J., & Kimport, K., 2011. Digitally Enabled Social Change: Activism in the Internet Age. MIT Press.
Elliott, T., Earl, J., 2018. Online protest participation and the digital divide: modeling the effect of the digital divide on online petition-signing. N. Media Soc. 20 (2), 698–719. https://doi.org/10.1177/1461444816669159.
Eom, K., Kim, H.S., Sherman, D.K., Ishii, K., 2016. Cultural variability in the link between environmental concern and support for environmental action. Psychol. Sci. 27 (10), 1331–1339. https://doi.org/10.1177/0956797616660078.
Flatø, H., 2020. Socioeconomic status, air pollution and desire for local environmental protection in china: insights from national survey sata. J. Environ. Plan. Manag. 63 (1), 49–66. https://doi.org/10.1080/09640568.2019.1630373.
Fu, D., Distelhorst, G., 2018. Grassroots participation and repression under Hu Jintao and Xi Jinping. China J. 79, 100–122. https://doi.org/10.1086/694299.
Gigler, B.S., Bailur, S., 2014. Closing the Feedback Loop: Can Technology Bridge the Accountability Gap? World Bank. ⟨https://gsdrc.org/document-library/closing-the-feedback-loop-can-technology-bridge-the-accountability-gap/⟩. last accessed 26 April 2022.
Gil de Zúñiga, H., Jung, N., Valenzuela, S., 2012. Social media use for news and individuals' social capital, civic engagement and political participation. J. Comput. -Mediat. Commun. 17 (3), 319–336. https://doi.org/10.1111/j.1083-6101.2012.01574.x.
Göbel, C., 2021. The political logic of protest repression in China. J. Contemp. China 30 (128), 169–185. https://doi.org/10.1080/10670564.2020.1790897.
Göbel, C., Li, J., 2021. From bulletin boards to big data: the origins and evolution of public complaint websites in China. J. Curr. Chin. Aff. 50 (1), 39–62. https://doi.org/10.1177/1868102621992144.
Gohdes, A.R., 2020. Repression technology: internet accessibility and state violence. Am. J. Political Sci. 64 (3), 488–503. https://doi.org/10.1111/ajps.12509.
Goron, C., Bolsover, G., 2020. Engagement or control? The impact of the chinese environmental protection bureaus' burgeoning online presence in local environmental governance. J. Environ. Plan. Manag. 63 (1), 87–108. https://doi.org/10.1080/09640568.2019.1628716.
Grönlund, Å., Wakabi, W., 2015. Citizens' use of new media in authoritarian regimes: a case study of Uganda. Electron. J. Inf. Syst. Dev. Ctries. 67 (1), 1–23. https://doi.org/10.1002/j.1681-4835.2015.tb00479.x.
Gueorguiev, D., 2021. Retrofitting Leninism: Participation Without Democracy in China. Oxford University Press USA.
Guo, D., Bondes, M., Kostka, G., Rabe, W., forthcoming. Between institutionalized and non-institutionalized channels: Explaining citizens' environmental participation and preferences in China (under review).
Hargittai, E., Hsieh, Y.P., 2012. Succinct survey measures of web-use skills. Soc. Sci. Comput. Rev. 30 (1), 95–107. https://doi.org/10.1177/0894439310397146.
He, G., Boas, I., Mol, A.P.J., Lu, Y., 2017. E-participation for environmental sustainability in transitional urban China. Sustain. Sci. 12 (2), 187–202. https://doi.org/10.1007/s11625-016-0403-3.
Hoffmann, C.P., Lutz, C., 2021. Digital divides in political participation: the mediating role of social media self-efficacy and privacy concerns. Policy Internet 13 (1), 6–29. https://doi.org/10.1002/poi3.225.
Howells, L., Henry, L.A., 2021. Varieties of digital authoritarianism: analyzing Russia's approach to internet governance. Communist Post-Communist Stud. 54 (4), 1–27. https://doi.org/10.1525/j.postcomstud.2021.54.4.1.
Hsu, A., Weinfurter, A., Yan, C., & Cheng, Y. , 2017. *From Citizens to Satellites: Third-Wave Data Approaches in China*. Yale Data-Driven Lab. ⟨http://datadrivenlab.org/china-sights/third-wave-data-approaches-in-china/⟩ (Last Accessed 14 March 2022).
Hsu, A., Weinfurter, A., Tong, J., Xie, Y., 2020. Black and smelly waters: how citizen-generated transparency is addressing gaps in china's environmental management. J. Environ. Policy Plan. 22 (1), 138–153. https://doi.org/10.1080/1523908X.2019.1654365.
Huang, R., Yip, N., 2012. Internet and activism in urban China: a case study of protests in Xiamen and Panyu. J. Comp. Asian Dev. 11 (2), 201–223. https://doi.org/10.1080/15339114.2012.720125.
Huang, Y. , 2020. Toxic politics: China's environmental health crisis and its challenge to the Chinese state. Cambridge University Press.
Inglehart, R., 1997. Modernization, postmodernization and changing perceptions of risk. Int. Rev. Sociol. 7 (3), 449–459. https://doi.org/10.1080/03906701.1997.9971250.
Jamie Spencer, 2022. 2022 Chinese Social Media Statistics And Trends Infographic. Make A Website Hub. ⟨https://makeawebsitehub.com/chinese-social-media-statistics/⟩.
Jho, W., Song, K.J., 2015. Institutional and Technological Determinants of Civil e-Participation: Solo or duet? Gov. Inf. Q. 32 (4), 488–495. https://doi.org/10.1016/j.giq.2015.09.003.
Ji, Q., Harlow, S., Di, C., Zihan, Wang, 2018. Discussing environmental issues in Chinese social media: an analysis of greenpeace china's weibo posts and audience responses. J. Soc. Media Soc. 7 (1), 37–60. ⟨https://thejsms.org/index.php/JSMS/article/view/314⟩.
Johnson, R.J., Scicchitano, M.J., 2000. Uncertainty, risk, trust, and information: public perceptions of environmental issues and willingness to take action. Policy Stud. J. 28 (3), 633–647. https://doi.org/10.1111/j.1541-0072.2000.tb02052.x.
Johnson, T., 2020. Public participation in China's EIA process and the regulation of environmental disputes. Environ. Impact Assess. Rev. 81, 106359 https://doi.org/10.1016/j.eiar.2019.106359.
Johnson, T., Mol, A.P.J., Zhang, L., Yang, S., 2017. Living under the dome: individual strategies against air pollution in Beijing. Habitat Int. 59, 110–117. https://doi.org/10.1016/j.habitatint.2016.11.014.
King, G., Pan, J., Roberts, M., 2013. How censorship in China allows government criticism but silences collective expression. Am. Political Sci. Rev. 107 (2), 326–343. ⟨https://www.jstor.org/stable/43654017?seq=1⟩.
Kjellson, G., Clarke, P., Gerdtham, U., 2014. Forgetting to remember or remembering to forget: A study of the recall period length in health care survey questions. J. Health Economics. 35, 34–46. https://doi.org/10.1016/j.jhealeco.2014.01.007.
Kostka, G., Mol, A.P.J., 2013. Implementation and participation in China's local environmental politics: challenges and innovations. J. Environ. Policy Plan. 15 (1), 3–16. https://doi.org/10.1080/1523908X.2013.763629.
Kostka, G., Zhang, C., 2018. Tightening the grip: environmental governance under Xi Jinping. Environ. Polit. 27 (5), 769–781. https://doi.org/10.1080/09644016.2018.1491116.
Kostka, G., Zhang, X., Shin, K., 2020. Information, technology, and digitalization in china's environmental governance. J. Environ. Plan. Manag. 63 (1), 1–13. https://doi.org/10.1080/09640568.2019.1681386.
Lee, J., Kim, S., 2012. E-participation in the Era of Web 2.0: factors affecting citizens' active e-participation in local governance. ICEGOV. https://doi.org/10.1145/2463728.2463739.
Lee-Geiller, S. , 2020. Conditions Influencing E-participation: a cross-country comparative mixed methods analysis. In: Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance, 754–761. https://doi.org/10.1145/3428502.3428615.
Lemos, M.C., Agrawal, A., 2006. Environmental governance. Annu. Rev. Environ. Resour. 31 (1), 297–325. https://doi.org/10.1146/annurev.energy.31.042605.135621.
Li, Y., & Shapiro, J. , 2020. China Goes Green: Coercive Environmentalism for a Troubled Planet. Polity Press.
Lin, F., Fofanah, S.S., Liang, D., 2011. Assessing citizen adoption of e-government initiatives in gambia: a validation of the technology acceptance model in information systems success. Gov. Inf. Q. 28 (2), 271–279. https://doi.org/10.1016/j.giq.2010.09.004.
Lin, J., Yu, Z., Wei, Y.D., Wang, M., 2017. Internet access, spillover and regional development in china. Art. 6 Sustainability 9 (6). https://doi.org/10.3390/su9060946.
Liu, J., 2011. Picturing a green virtual public apace for social change: a study of internet activism and web-based environmental collective actions in China. Chin. J. Commun. 4 (02), 137–166.
Liu, X., Mu, R., 2016. Public environmental concern in China: determinants and variations. Glob. Environ. Change 37, 116–127. https://doi.org/10.1016/j.gloenvcha.2016.01.008.
Lora-Wainwright, A. , 2017. Resigned Activism: Living with Pollution in Rural China. MIT Press.
Lorentzen, P., 2017. Designing contentious politics in Post-1989 China. Mod. China 43 (5), 459–493. https://doi.org/10.1177/0097700416688895.
Mol, A., Carter, N., 2006. China's environmental governance in transition. Environ. Polit. 15 (2), 149–170. https://doi.org/10.1080/09644010600562765.
Mol, A.P.J., 2010. The future of transparency: power, pitfalls and promises. Glob. Environ. Polit. 10 (3), 132–143. https://doi.org/10.1162/GLEP_a_00018.
National Bureau of Statistics of China , 2021. 中国统计年鉴China Statistical Yearbook 2021. ⟨http://www.stats.gov.cn/tjsj/ndsj/2021/indexch.htm⟩.
Norris, P. , 2001. Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide. Cambridge University Press.
O'Brien, K.J., 2023. Neither withdrawal nor resistance: adapting to increased repression in China. Mod. China 49 (1), 3–25. https://doi.org/10.1177/00977004221119082.
O'Connor, R.E., Bord, R.J., Fisher, A., 1999. Risk perceptions, general environmental beliefs, and willingness to address climate change. Risk Anal. 19 (3), 461–471. https://doi.org/10.1023/A:1007004813446.
Peixoto, T., Fox, J., 2016. When does ICT-enabled citizen voice lead to government responsiveness? IDS Bull. 41 (1), 23–39. https://doi.org/10.19088/1968-2016.104.
Qiang, X., 2019. The road to digital unfreedom: president Xi's surveillance state. J. Democr. 30 (1), 53–67. https://doi.org/10.1353/jod.2019.0004.
Schlæger, J., Zhou, J., 2019. Digital environmental monitoring in urban China. In: Delman, J., Ren, Y., Luova, O., Burell, M., Almén, O. (Eds.), Greening China's Urban Governance: Tackling Environmental and Sustainability Challenges. Springer, pp. 131–149. https://doi.org/10.1007/978-981-13-0740-9_7.
Schulz, D., Newig, J., 2015. Assessing online consultation in participatory governance: conceptual framework and a case study of a national sustainability-related consultation platform in Germany. Environ. Policy Gov. 25 (1), 55–69. https://doi.org/10.1002/eet.1655.
Seligsohn, D., Liu, M., Zhang, B., 2018. The sound of one hand clapping: transparency without accountability. Environ. Polit. 27 (5), 804–829. https://doi.org/10.1080/09644016.2018.1452522.
Shao, S., Tian, Z., Fan, M., 2018. Do the rich have stronger willingness to pay for environmental protection? New evidence from a survey in China. World Dev. 105, 83–94. https://doi.org/10.1016/j.worlddev.2017.12.033.

Shields, T., Zeng, K., 2012. The reverse environmental gender gap in China: evidence from 'The China survey'. Soc. Sci. Q. 93 (1), 1–20. https://doi.org/10.1111/j.1540-6237.2011.00802.x.
Sima, Y., 2011. Grassroots environmental activism and the internet: constructing a green public sphere in China. Asian Stud. Rev. 35 (4), 477–497. https://doi.org/10.1080/10357823.2011.628007.
Soma, K., Onwezen, M.C., Salverda, I.E., van Dam, R.I., 2016. Roles of citizens in environmental governance in the information age—four theoretical perspectives. Curr. Opin. Environ. Sustain. 18, 122–130. https://doi.org/10.1016/j.cosust.2015.12.009.
Stern, P.C., 2000. Toward a coherent theory of environmentally significant behavior. J. Soc. Issues 56 (3), 407–424. https://doi.org/10.1111/0022-4537.00175.
Su, Z., Meng, T., 2016. Selective responsiveness: online public demands and government responsiveness in authoritarian China. Soc. Sci. Res. 59, 52–67. https://doi.org/10.1016/j.ssresearch.2016.04.017.
Sullivan, J., Xie, L., 2009. Environmental activism, social networks and the internet. China Q. 198, 422–432. https://doi.org/10.1017/S0305741009000381.
Sylvester, D.E., McGlynn, A.J., 2010. The digital divide, political participation, and place. Soc. Sci. Comput. Rev. 28 (1), 64–74. https://doi.org/10.1177/0894439309335148.
Tai, K.-T., Porumbescu, G., Shon, J., 2020. Can e-participation stimulate offline citizen participation: an empirical test with practical implications. Public Manag. Rev. 22 (2), 278–296. https://doi.org/10.1080/14719037.2019.1584233.
Tarantino, M., 2020. Navigating a datascape: challenges in automating environmental data disclosure in China. J. Environ. Plan. Manag. 63 (1), 67–86. https://doi.org/10.1080/09640568.2019.1659132.
UNFCCC. (n.d.). Alipay Ant Forest: Using Digital Technologies to Scale up Climate Action. UNFCCC. ⟨https://unfccc.int/climate-action/momentum-for-change/planetary-health/alipay-ant-forest⟩ (Last Accessed 12 December 2021).
United Nations, 2020. UN E-Government Survey 2020. United Nations. ⟨https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2020⟩ (Last Accessed 14 January 2022).
United Nations, & Le Blanc, D. , 2020. E-participation: A Quick Overview of Recent Qualitative Trends. https://doi.org/10.18356/0f898163-en.
Verba, S., & Nie, N.H. , 1987. Participation in America: Political Democracy and Social Equality. University of Chicago Press.
Vicente, M.R., Novo, A., 2014. An empirical analysis of e-participation. The role of social networks and e-government over citizens' online engagement. Gov. Inf. Q. 31 (3), 379–387. https://doi.org/10.1016/j.giq.2013.12.006.
Vij, N., & Gil-Garcia, R., 2017. Digital governance and individuals' empowerment. Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance, 136–139. https://doi.org/10.1145/3047273.3047313.
Wakabi, W., 2016. When Citizens in Authoritarian States Use Facebook for Social Ties but Not Political Participation. In Y. Ibrahim (Ed.), Politics, Protest, and Empowerment in Digital Spaces (pp. 192–214). Information Science Reference. https://doi.org/10.4018/978-1-5225-1862-4.ch012.
Wang, X., 2016. Requests for environmental information disclosure in China: an understanding from legal mobilization and citizen activism. J. Contemp. China 25 (98), 233–247. https://doi.org/10.1080/10670564.2015.1075712.
Wang, Y., Sun, M., Yang, X., Yuan, X., 2016. Public awareness and willingness to pay for tackling smog pollution in China: a case study. J. Clean. Prod. 112, 1627–1634. https://doi.org/10.1016/j.jclepro.2015.04.135.
Wang, Z., Zhong, Y., 2020. What were residents' petitions in Beijing: based on text mining. J. Urban Manag. 9 (2), 228–237. https://doi.org/10.1016/j.jum.2019.11.006.
Wasserstrom, J.N., 2009. Middle-class mobilization. J. Democr. 20 (3), 29–32. https://doi.org/10.1353/jod.0.0090.
Wimmer, J., Wallner, C., Winter, R., & Oelsner, K., 2017. Introduction. In (Mis) Understanding Political Participation: Digital Practices, New Forms of Participation and the Renewal of Democracy (pp. 1–14). Taylor & Francis Group.
Wong, K., 2010. Environmental awareness, governance and public participation: public perception perspectives. Int. J. Environ. Stud. 67 (2), 169–181. https://doi.org/10.1080/00207231003683424.
Xenos, M., Moy, P., 2007. Direct and differential effects of the internet on political and civic engagement. J. Commun. 57 (4), 704–718. https://doi.org/10.1111/j.1460-2466.2007.00364.x.
Xiao, C., Hong, D., 2018. Gender differences in environmental behaviors among the chinese public: model of mediation and moderation. Environ. Behav. 50 (9), 975–996. https://doi.org/10.1177/0013916517723126.
Xu, J., Chi, C.S.F., Zhu, K., 2017. Concern or apathy: the attitude of the public toward urban air pollution. J. Risk Res. 20 (4), 482–498. https://doi.org/10.1080/13669877.2015.1071869.
Xu, J.H., 2014. Communicating the right to know: social media in the do-it-yourself air quality testing campaign in Chinese cities. Int. J. Commun. 8 (0), 20. ⟨https://ijoc.org/index.php/ijoc/article/view/2413/0⟩.
Xu, X., 2021. To repress or to co-opt? Authoritarian control in the age of digital surveillance. Am. J. Political Sci. 65 (2), 309–325. https://doi.org/10.1111/ajps.12514.
Yang, S., Wu, F., 2022. From online mass incidents to defiant enclaves: political dissent on China's internet. China J. 87, 20–39. https://doi.org/10.1086/717610.
Yu, X., 2014. Is environment 'a City Thing' in China? Rural–urban differences in environmental attitudes. J. Environ. Psychol. 38, 39–48. https://doi.org/10.1016/j.jenvp.2013.12.009.
Zhang, L., Mol, A.P., He, G., 2016. Transparency and information disclosure in China's environmental governance. Curr. Opin. Environ. Sustain. 18, 17–24. https://doi.org/10.1016/j.cosust.2015.03.009.
Zhang, L., Mol, A.P., Yang, S., 2017. Environmental information disclosure in China: in the era of informatization and big data. Front. Law China 12 (1), 57–75. https://doi.org/10.3868/s050-006-017-0004-3.
Zhang, Y., Yu, C.-H., Li, D., Zhang, H., 2020. Willingness to pay for environmental protection in China: air pollution, perception, and government involvement. Chin. J. Popul. Resour. Environ. 18, 229–236. https://doi.org/10.1016/J.CJPRE.2019.10.003.

Maria Bondes is a Senior Lecturer at the Institute for Near Eastern and East Asian Languages and Civilizations at Friedrich-Alexander-Universität Erlangen-Nürnberg. Her research centers on state-society relations, contentious politics, environmental governance and the digital transformation in China, with a focus on environmental and digital participation. Her book "Chinese Environmental Contention: Linking Up Against Waste Incineration" (Amsterdam University Press, 2019) explores the network of contention that has emerged against waste incineration in China.

Genia Kostka is a Professor of Chinese Politics at the Freie Universität Berlin. Her research focuses on digital transformation, environmental politics, and political economy with a regional focus on China. Her most recent research project explores how digital technologies are integrated into local decision-making and governance structures in China (ERC Starting Grant 2020–2025).

Wiebke Rabe is Assistant Professor of International Relations at the Institute of Intercultural and International Studies (InIIS) at the University of Bremen . She works on China's digital governance, foreign investment, and global resource politics. Her most recent work focuses on China's provinces' integration into the world economy and China's investments into the digital economy and into soft power resources in Southeast Asia and Africa.