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How are India's State Pollution Control Boards Adapting to Evolving Workloads and Roles?

Issue Brief | September 2025
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Executive summary

The state pollution control boards (SPCBs) of India are key regulatory bodies responsible for controlling environmental pollution. Over the years, their role has been expanded significantly with the evolution of environmental legislation and compliance requirements.

This issue brief examines **how SPCBs are responding to their increasing workload, resource constraints, and operational challenges by adopting innovative practices**. The findings highlight the **positive impact of these innovations on workload management, financial efficiency, and overall performance**, laying the foundation for improved governance in environmental management.

The study adopts a **qualitative approach, combining both primary and secondary research**. A total of 21 retired officials from SPCBs and the Central Pollution Control Board (CPCB) were invited to participate in semi-structured interviews, of whom 9 agreed. They provided valuable insights into the functioning of SPCBs, focusing on challenges and areas for improvement. In parallel, as part of the study, an extensive review of legislative frameworks, including the *Water (Prevention and Control of Pollution) Act, 1974* and the *Air (Prevention and Control of Pollution) Act, 1981*, was conducted to understand the legally mandated responsibilities of SPCBs.

Moreover, **27 annual reports published by 9 selected SPCBs** (Goa, Gujarat, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Tripura, and West Bengal) were comprehensively analysed to identify innovative practices in workload management. These SPCBs were selected through purposive sampling, with the criterion being that they should have published annual reports for at least three consecutive years, starting 2018 or later.

Before 2000, their workload primarily included duties and responsibilities defined by three major laws, namely the *Air Act*, *Water Act*, and the *Environment*

(Protection) Act, 1986. **Since 2000, starting with the Noise Pollution (Regulation and Control) Rules, 2000, 11 new legislations (including acts and rules) have been formulated**. Each of these legislations has expanded SPCBs' range of functions to include monitoring, implementation, maintenance of inventories, and standards setting. To address the substantial increase in their workload—and other challenges such as limited human resources, financial constraints, and limited enforcement powers—SPCBs have adopted myriad innovative practices. These practices are discussed in this study and are grouped under the following categories:

- **Process optimisation:** Several SPCBs have re-engineered their processes to streamline operations. For example, the **Maharashtra Pollution Control Board (MPCB) improved the processing of consent applications by establishing/using templates that were industry specific**, thus reducing delays, enhancing compliance management, and dispensing with earlier methods, which involved issuing consents manually, and redundant steps.
- **Financial innovation:** Tripura SPCB has **leveraged financial incentives to encourage industries to adopt environmentally friendly practices**. These include promoting transitions to cleaner technologies – for example, by encouraging the conversion of conventional kilns to zig-zag kilns. These financial incentives have enabled industries to transition to cleaner fuels and technologies, despite their limited scale of operations.

New environmental laws, complex regulations, and industrial expansion have significantly amplified the responsibilities of SPCBs.

- **Adoption of advanced technologies:** SPCBs are increasingly utilising information technology (IT) tools to enhance operational efficiency. **Online continuous emission monitoring systems (OCEMS), drones, and global positioning system (GPS) tracking are some of the technologies being integrated to automate monitoring processes**, reducing the dependency on manual labour and improving data accuracy. In contrast, conventional approaches have sometimes hindered the fetching and processing of such data.
- **Administrative innovation:** Some SPCBs, like that of Gujarat, have introduced organisational changes to improve internal management. **By establishing dedicated scientific committees, they have streamlined processes related to the procurement and management of scientific instruments, optimising operational efficiency.** In conventional systems, the presence of multiple decision-makers often caused inconsistent decision-making.
- **Public engagement and communication:** Some SPCBs, including Madhya Pradesh, have made considerable strides in public outreach by **developing mobile apps that provide real-time data on air quality.** This enables citizens to make informed decisions and also fosters greater public involvement in environmental protection. These apps have also helped improve the relationship between regulators and the public.
- **Research and development (R&D): Collaborations with academic institutions have enabled SPCBs to integrate cutting-edge research into their monitoring practices.** For instance, the **Goa SPCB has partnered with IIT Goa to integrate machine learning algorithms into air quality forecasting**, enhancing the accuracy of pollution predictions.

While this study primarily focuses on documenting and promoting the positive strides made by SPCBs in terms of governance innovations with a view to promote their uptake, it also provides recommendations to further support their efforts:

- **Expand knowledge-sharing:** Create a centralised platform to facilitate cross-learning

and knowledge exchange on best practices among SPCBs. Such a platform – anchored by the CPCB – will allow states to adopt innovations used by their peers, accelerating improvements nationwide.

- **Encourage continuous innovation:** SPCBs should institutionalise mechanisms that aid continuous process and management innovations. Establishing innovation frameworks that effectively balance risks and benefits will foster an institutional culture of experimentation and adaptability.
- **Enhance resource allocation:** Increasing financial and human resources through public-private partnerships (PPPs) will enable SPCBs to sustain their progress and continue adopting modern technologies, ensuring that they can meet evolving environmental challenges.

This study also has certain limitations, which are listed below:

- Only the workload determined by legislation was captured, not that from judgements, internal protocols, and directions.
- Only those SPCBs that have released three consecutive annual reports were selected.
- We relied on SPCBs' annual reports to identify innovations, which may have led to the omission of innovations not recorded in the reports.
- The categorisation of public-sector innovations is specific to SPCBs and not universal.

SPCBs are central to India's pollution control efforts. The innovative practices documented in this study highlight the capacity of SPCBs to adapt and optimise their operations in the face of significant challenges, including rising workloads and resource constraints. By embracing technological advancements, streamlining processes, and enhancing public engagement, SPCBs are setting a strong precedent for improved environmental governance in India. Through continued cross-learning, resource augmentation, and a commitment to innovation, SPCBs are well-positioned to drive India towards a cleaner, more sustainable future.

1. Introduction

The genesis of pollution control boards in India can be traced back to the United Nations (UN) Conference on the Human Environment convened in Stockholm in 1972. The conference led to the enactment of the *Water Act, 1974*; (MoLJ 1974), under which pollution control boards were established in India. In the following decades, pollution control boards have been assigned additional responsibilities through the *Air Act, 1981*; and the *Environment (Protection) Act, 1986* (hereinafter the EPA) (MoLJ 1981; 1986). These laws position state pollution control boards (SPCBs) as the guardians of a healthy environment in India.

SPCBs operate as state-level entities, nested within the administrative and regulatory control of the Central Pollution Control Board (CPCB) and the Ministry of Environment, Forests and Climate Change (MoEFCC) and execute their statutory responsibilities at a provincial level. The CPCB was established in 1974 with the enactment of the *Water Act, 1974*, with a mandate to coordinate pollution control interventions across India by establishing pollution standards, conducting research, and providing programmatic and technical guidance to the SPCBs. The MoEFCC was established in 1985 to oversee the formulation and implementation of programmes and policies that advance broader environmental conservation and pollution control imperatives.

Thus, the current regulatory architecture for pollution control in India is marked by interdependence and collaboration among these institutions. While SPCBs function as stand-alone bodies for monitoring and regulating pollution within their respective jurisdictions, their effectiveness is intrinsically tied to the coordination and guidance provided by the CPCB as well as the larger policy frameworks that the MoEFCC and/or the government sets out from time to time like the *National Clean Air Programme (NCAP)*, Ease of Doing Business regulations, Environmental Impact Assessment (EIA) notifications, etc.

Given the importance of SPCBs in India's pollution control ecosystem, there is extensive literature on their functioning. The earliest such research was the Bhattacharya Committee Report (1984), followed by the Administrative Staff College of India (1994), the report submitted by the Sub-Group (1994), and the report submitted by the Planning Commission on the functioning of SPCBs (2001) (these reports can be found in CPR (2022)). Recent literature includes an analysis of India's environmental policy and legal framework by the Organisation for Economic Co-operation and Development (OECD 2006), the United States Environmental Protection Agency's (USEPA's) *Environmental Compliance and Enforcement Training Institutions in India* (USEPA 2005), the Indian Institute of Management, Lucknow's (IIM (L) 2010) evaluation of the CPCB, the CPCB's audit reports of SPCBs, the Centre for Science and Environment's (CSE's) Transparency Index: Rating of Pollution Control Boards on Public Disclosure (Verma 2021), the Centre for Chronic Disease Control's (2020) analysis of pollution control boards, and the Centre for Policy Research's (CPR's) *The State of India's Pollution Control Boards – A Series of Papers* (CPR 2022).

Multiple assessments of the pollution control board ecosystem have been carried out. Although the time periods over which these assessments were conducted differ, significant commonalities emerge in the findings. The most common challenges associated with pollution control boards are listed below:

- Inconsistent tenures in leadership roles
- Uneven stakeholder representation within the board
- High vacancy rates
- Limited staff training opportunities
- Limited finances and constraints on expenditure

- Gaps in adoption of advanced pollution control technologies and data systems
- Limited institutional mechanisms for public engagement
- Systems for consistent, periodic reporting are yet to mature

While limitations have been identified, the existing literature does not examine in detail the burden that the rapidly changing Indian environmental governance scenario has placed on SPCBs. As such, there has been little research on the innovative measures and practices that SPCBs have developed to cope with their increasing responsibilities while operating with a persistent paucity of resources.

This issue brief provides an overview of the innovative practices adopted by SPCBs in India to cope with growing environmental challenges and regulatory demands. For this, we analysed existing legislation to identify the functions performed by SPCBs and provided an overview of the innovative measures they routinely employ to manage their workload. Further, we identified areas of improvement and opportunities to enhance the capacity and performance of SPCBs in fulfilling their mandate and included recommendations to address them.



Advancing technologies and rising environmental complexities have sharply expanded SPCBs' regulatory mandate.

2. Methodology

We employed a qualitative approach for this study and invited 21 retired SPCB/CPCB officials to participate in semi-structured interviews. The interviews were held virtually as well as in person. The interviews aimed to obtain perspectives and expert opinions on the functioning of SPCBs, the challenges encountered, and potential areas of improvement. Of the 21 officials invited, 9 agreed to be interviewed. Among these nine interviewees, three had worked at the CPCB previously, while six had worked at SPCBs in Maharashtra, Odisha, and West Bengal. The officials were selected through snowball sampling.

This was followed by secondary research. First, we conducted a longitudinal analysis of environmental laws, rules, and notifications to identify the legally mandated workload of SPCBs.¹ This was done by reviewing the seventh edition of the CPCB's compendium on Pollution Control Acts, Rules, and Notifications (CPCB 2021b).

Following this, we captured the innovative measures adopted by the nine SPCBs based on their annual reports. These reports capture innovations in workload management as they offer a consolidated account of the activities undertaken by an SPCB in a financial year.

Official websites, which are the other predominant source of information, are relevant but are updated only sporadically, and hence, do not offer current information on the activities of SPCBs. Hence, websites were not used to collect data; they were used only to identify publicly available annual reports.

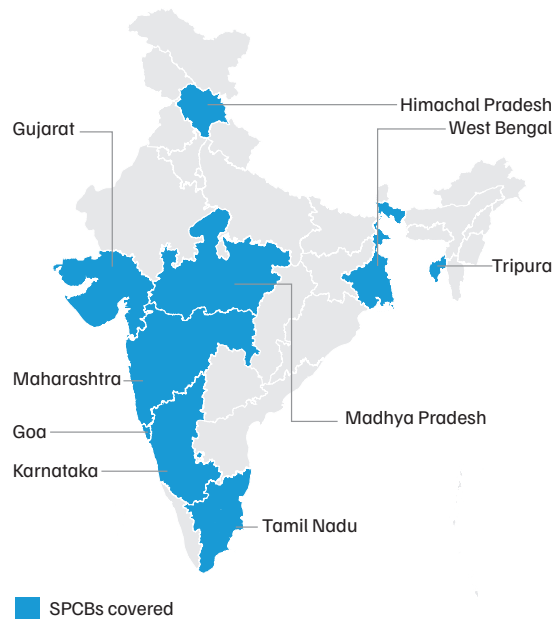
We used purposive sampling to select the SPCBs based on the following criteria:

- The SPCB should have published an annual report for at least three consecutive years, starting 2018 or later. This was done to ensure that we could evaluate SPCBs over a similar period and capture the most current innovative practices.

- Annual reports had to be structurally identical. This was done to ensure consistency in the examined content regardless of the SPCB.

Thus, nine SPCBs were selected, which have jurisdictions in the states shown in Figure 1. A total of 27 annual reports published by these SPCBs were covered under this study.

Figure 1. Nine State Pollution Control Boards (SPCBs) have been covered in this study



Source: Authors' analysis

Finally, we conducted a case study to understand the need for innovation in SPCBs. The Maharashtra Pollution Control Board (MPCB) was selected for this due to the availability of legislation- and application-wise data on the board's services. We reviewed the MPCB's consent and authorisation disposal compliance dashboard to understand the board's workload and drew linkages between the increasing workload and the human resources available.

1. The list of laws reviewed during this study is available as Annexure 1.

3. Evolution of the workload

The *Water Act enacted in 1974* (MoLJ 1974) provided the legal foundation for creating SPCBs. The act enjoined SPCBs to carry out a range of functions pertaining to water pollution, including the following:

- granting industries the consent to establish (CTE) and consent to operate (CTO);
 - inspecting industries and treatment plants to ensure compliance with the act;
 - monitoring pollution in water bodies and setting standards for sewage discharge over land or in water bodies;
 - collecting and disseminating information on water pollution and undertaking mass awareness programmes;
 - establishing effluent standards as well as modifying and annulling them based on regional differences;
 - developing economical and reliable methods to dispose of, treat, and utilise sewage by undertaking research; and
 - advising state governments regarding pollution control.
- The *Air Act (1981)* broadened the SPCBs' functions accorded to them under the Water Act to include the management of air pollution (MoLJ 1981), thus considerably expanding their workload. **In 1987, the law was amended to extend the CTE and CTO requirement** from just "16 types of industrial activities" to "**any industrial activity**," leading to a significant increase in workload caused by the increase in the number of consent applications.

The *Environment (Protection) Act, 1986* (hereinafter EPA), was enacted following the Bhopal Gas Tragedy (Abraham and Abraham 1991). As an umbrella act, the EPA is supplemented by several subordinate legislations that govern a range of functions from environmental protection and prevention of hazards and pollution to the handling and management of different types of waste (MoLJ 1986). The *Environment Protection Rules* (hereinafter EPR), enacted in furtherance of the EPA, assign the following functions to SPCBs:

- identification and demarcation of excessively polluted industrial clusters as critically polluted industrial areas;
- gauging the assimilative capacity of receiving water bodies before permitting the discharge of effluents into them; and
- directing industries to install equipment to treat pollutants if they exceed the stipulated thresholds as provided under Schedules I, III, IV, and VI of the EPR.

A study of the **schedules under the EPR** (provided in Table 1) reveals further significant additions to the SPCBs' workload.

Since 2000, starting with the *Noise Pollution Rules*, 11 new legislations have expanded SPCBs' role in monitoring, implementation, inventory upkeep, and standards setting.

Table 1. Schedules under the Extended Producer Responsibility (EPR) that add to SPCB workloads

Schedule	Function
Schedule I	Specifies standards to be met by industries that discharge effluents and mandates SPCBs to monitor the discharge of effluents from non-ferrous metal industries
Schedule III	Specifies ambient air quality standards with respect to noise and mandates SPCBs to monitor noise levels
Schedule IV	Specifies standards for the emission of smoke, vapour, etc. from motor vehicles
Schedule VI	Specifies general standards for the discharge of environmental pollutants and mandates SPCBs to enforce and monitor the discharge of specified effluents
Schedule VII	Specifies ambient air quality standards and mandates SPCBs to monitor air quality

Source: CPCB. 2021b. *Pollution Control Acts, Rules and Notifications Issued Thereunder*. New Delhi: Central Pollution Control Board.

Notifications under the EPA have also led to a significant increase in the workload of SPCBs. The **EIA Notification of 2006** requires SPCBs to conduct field visits for projects which have requested environmental clearance as well as public hearings to evaluate the impact on local communities (MoEFCC 2006). Similarly, the Coastal Regulation Zone

(CRZ) Notifications² lay down stringent effluent discharge standards and consent-seeking provisions for projects in CRZ-notified areas, increasing the inspection and monitoring workload of SPCBs in coastal states (CPCB 2021b). These have been highlighted in Table 2.

Table 2. Notifications under the EPR that increased SPCB workloads

Notification	Function
EIA 2006	Conduct public hearings Inspect project sites
CRZ notifications	Conduct public hearings for projects requesting environmental clearance in coastal zones Set or modify effluent discharge standards for coastal zones
Environment (Protection) Amendment Rules, 2017	Monitor sewage treatment plants (STPs) based on prescribed effluent discharge standards

Source: CPCB. 2021b. *Pollution Control Acts, Rules and Notifications Issued Thereunder*. New Delhi: Central Pollution Control Board.

2. A comprehensive list of Coastal Regulation Zone (CRZ) Notifications can be found on https://environmentclearance.nic.in/report/CRZ_Notifications.aspx

Furthermore, different notifications released periodically to address specific environmental concerns across states contribute to sporadic additions to the workload of the concerned SPCBs. Some examples include the following:

- the 1997 MoEFCC notification on constituting the Aquaculture Authority of India, which enjoined consultative functions on certain SPCBs;
- the 1999 MoEFCC notification on the utilisation of fly ash from coal-based thermal power plants, which specified monitoring functions for regional officers of SPCBs; and

- the 2010 MoEFCC notification that resulted in the constitution of the Bihar Ganga River Conservation Authority and made the Bihar SPCB chairperson an ex officio member of the body.

As highlighted previously, the EPA is the parent act of various subordinate legislations. These include several rules related to the management and handling of different types of waste, which aim to regulate the generation, collection, storage, transportation, and disposal of waste in an environmentally sustainable manner. The first of these rules was introduced in the form of the *Hazardous Waste (Management and Handling) Rules, 1989*. This grew to six sets of rules, each governing specific types of waste.

Table 3. Introduction of waste management rules

Year	Waste management rules
1989	<i>Manufacture, Storage and Import of Hazardous Chemicals Rules</i>
1989	<i>Hazardous Waste (Management and Handling) Rules</i>
1998	<i>Biomedical Waste (Management & Handling) Rules (hereinafter BWM Rules)</i>
2000	<i>Municipal Solid Wastes (Management & Handling) Rules</i>
2001	<i>Batteries (Management and Handling) Rules (hereinafter Batteries Rules)</i>
2008	<i>Hazardous Waste (Management, Handling and Transboundary Movement) Rules</i>
2009	<i>Plastics (Manufacture, Usage and Waste Management) Rules (hereinafter Plastic Rules)</i>
2011	<i>E-waste (Management and Handling) Rules (hereinafter E-waste Rules)</i>

Source: CPCB. 2021b. *Pollution Control Acts, Rules and Notifications Issued Thereunder*. New Delhi: Central Pollution Control Board.

The year 2016 saw the introduction of new waste management rules by the Indian government, which were enacted in supersession to the earlier regulations mentioned in Table 3. These new rules included the following:

- *Construction & Demolition Waste Management Rules, 2016 (hereinafter C&D Rules)*
- *Solid Waste Management Rules, 2016 (hereinafter SWM Rules)*
- *Plastic Waste Management Rules, 2016*
- *E-Waste Management Rules, 2016*

- *Hazardous Waste Management Rules, 2016*
- *Biomedical Waste Management Rules, 2016*

While each set of waste management rules pertains to a specific kind of waste, the associated workloads are similar and can be grouped as follows:

- granting authorisations, approvals, registrations, no objection certificates, and CTE, CTO, and consent to transport for stakeholders handling waste;
- inspection of compliance and maintaining inventories of waste handlers;

- undertaking third-party audits of treatment plants and regulating the interstate movement of wastes; and
- carrying out programmes to inform citizens of waste management, and publishing compliance and field inspection reports (CPCB 2021b).

However, other than the major functions assigned to SPCBs under these rules and the aforementioned legislations and subordinate legislations, various other laws related to the increasing diversity of waste types have amplified their workload. The *Manufacture, Use/Import/Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells (Rules, 1989)* enjoins upon the member secretaries of SPCBs to be ex officio members of the state committees on biotechnology (CPCB 2021b). Similarly, the *Chemical Accidents Rules, 1996*, makes chairpersons of SPCBs a part of state crisis groups and requires every local crisis group to have an SPCB representative (CPCB 2021b). Furthermore, the *Wetlands (Conservation and Management) Rules, 2017*, require member secretaries of SPCBs to serve as ex officio members of the state committee on biodiversity. Finally, the *Public Liability Insurance Act, 1991*, requires SPCBs to take

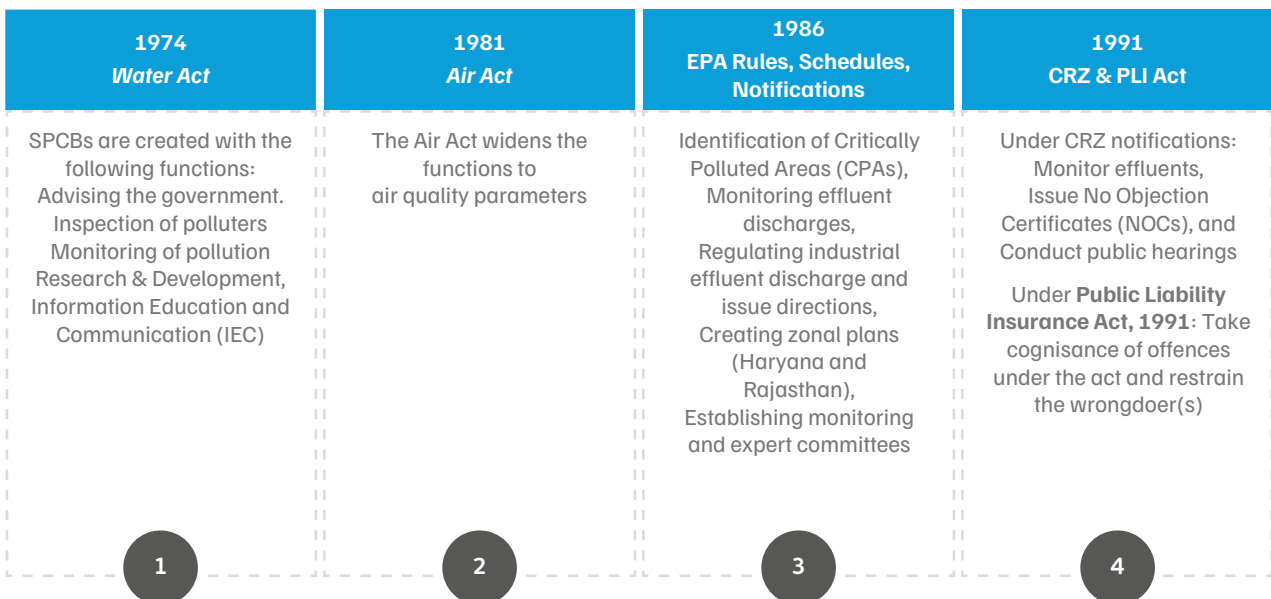
cognisance of chemical-heavy industries in the state that fail to avail insurance under the act (MoEFCC 2015).

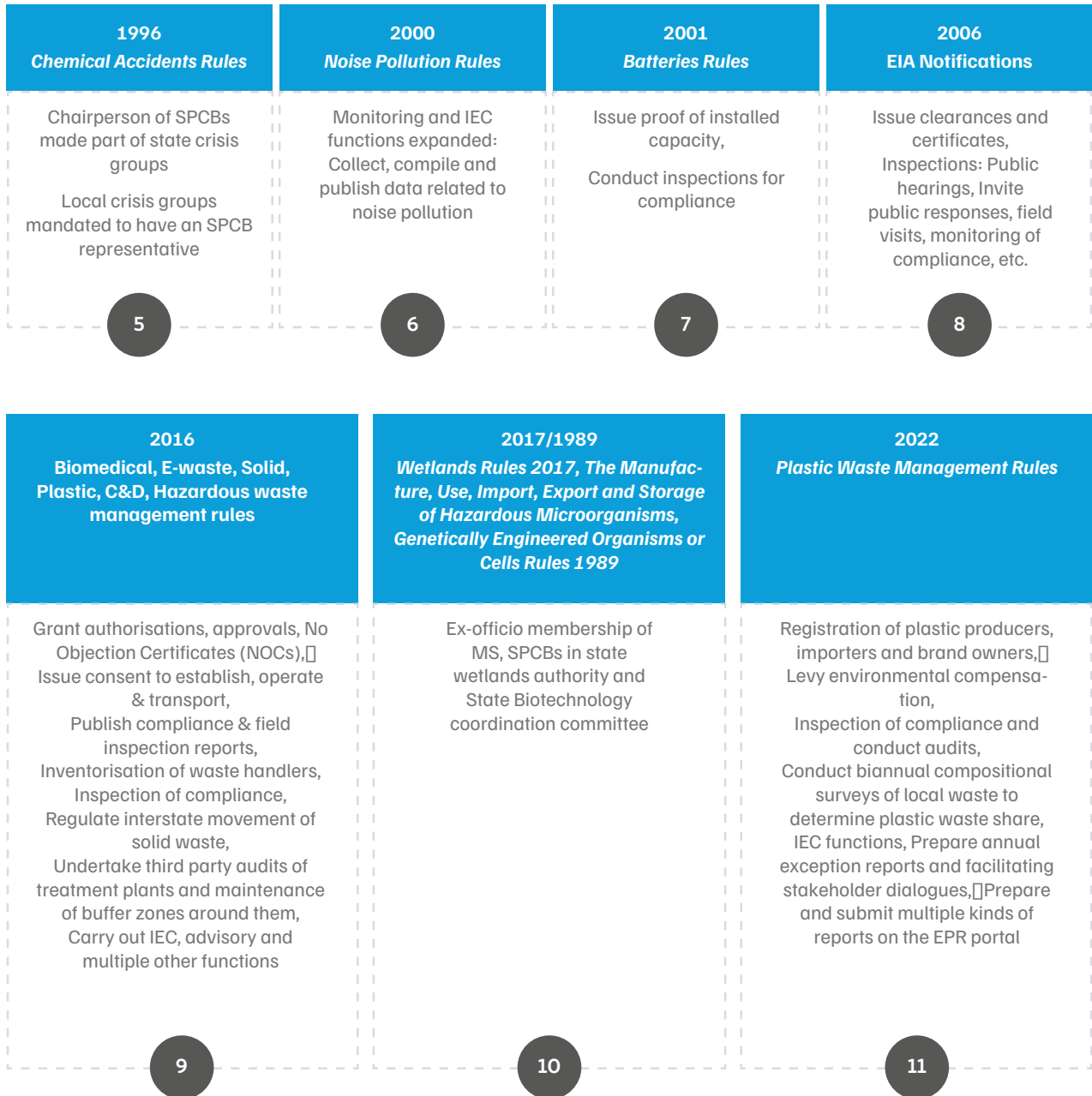
Although such requirements do not contribute to the core functions of SPCBs – which our interviewees identified as being related to consenting, inspection, and monitoring – they do add to the tasks expected to be performed by officials.

“Outsiders cannot know what the SPCBs do. It is very different from the inside. The functions performed by SPCBs derive from the various Rules, Regulations, etc. that have been drafted under the Air Act, Water Act, and the Environmental Protection Act. But the functions are not limited to those things alone, and PCB officials are often involved in responding to queries by the courts, NGT, and responding to questions raised in the Assemblies and the Parliament, RTI queries, etc.”

— ex-official, CPCB

Figure 2. Ever since their inception, the responsibilities of SPCBs have increased substantially





Source: CPCB. 2021b. *Pollution Control Acts, Rules and Notifications Issued Thereunder*. New Delhi: Central Pollution Control Board.

“RTIs and parliamentary/assembly questions and engagement also take time as the questions are data intensive. We are often asked to share data in formats we don't internally maintain. We spend time formatting data for these things. This is more so for lower and mid-level officials. Such requests are considered high priority.”

— *ex-official, Odisha SPCB*

Apart from environmental laws, the *Right to Information Act, 2005* (hereinafter RTI Act), has also added to the workload of SPCBs (MoLJ 2005). One of

the interviewees pointed out, “the range of questions we receive as RTIs is wide. Some can be answered instantly like providing documents. Elaborate RTIs seeking data can take a lot of time because old data has not been digitised. We are trying to put all our documents online to reduce the burden of RTI.”

Similarly, the *National Green Tribunal (NGT) Act, 2010* (hereinafter NGT Act), also adds to the workload of SPCBs (MoLJ 2010). While the act does not prescribe functions for SPCBs, the creation of a dedicated environmental tribunal has led to an increase in cases filed before the NGT where SPCBs are key litigants. Our interviewees pointed out that attending NGT hearings and complying with the tribunal's orders also add to their workload.

4. Innovations in SPCBs

Innovation is usually associated with the private sector due to its entrepreneurial work culture, while public-sector organisations tend to prefer conventional practices when fulfilling their mandates (Teofilovic 2002). As a consequence, most literature on organisational innovations is contextualised in the private-sector setting (Demircioglu and Audretsch 2017). Although public-sector innovations can generate a higher impact when compared to innovations in the private sector, there is limited literature on this (Edler and Yeow 2016).

Our analysis of the existing literature on public-sector innovations identifies several drivers of innovation in public-sector organisations, including economic changes, the emergence of new technologies, and learnings from processes or Doing, Using, and Interacting (DUI) techniques (Hartley, Sørensen, and Torfing 2013; Nählinder and Eriksson 2019). It is not just the emerging new technologies and processes that compel the public sector to innovate. A paucity of resources has also been identified as a key antecedent in the innovation process (Demircioglu and Audretsch 2017; Bekkers, Tummers, and Hanna De Vries 2015). Apart from this, result-focused management in public organisations is also leading to innovative use of resources and facilitating better management of workloads (Teofilovic 2002).

Several of the conditions mentioned above are applicable to SPCBs. Increasing workload – as demonstrated through the analysis of legislation – and the paucity of human resources identified in the existing literature, among other factors, creates the necessary conditions for innovative measures to proliferate (Bhargav Krishna et al 2022). The emergence of information and communication technology tools has further enabled SPCBs to adopt innovations for managing their workload. We have identified several innovations in the annual reports of SPCBs.

However, before delving into the findings, we focus on what constitutes an innovation. Several descriptions of organisational innovations exist in the literature on innovations in the public sector. The most commonly accepted definition of innovation includes the adoption of an idea perceived as new, the first-time adoption of an existing idea, and discontinuity of past processes (Borins 2001; Rogers 2003; Brown 2010). For the purpose of this exercise, we defined innovation as **the adoption of new technologies or practices that lead to improved delivery of legally ascribed functions of SPCBs.**

With this definition in mind, we scrutinised SPCBs' annual reports to identify innovations in workload management. However, cataloguing the innovations required categorising innovations based on their types. This had already been done by Bekkers, Tummers, and De Vries (2015), who reviewed 181 academic publications on innovation in the

public sector to provide a pliable template for such categorisation. These were published in leading journals on public administration around the world between 1990 and 2014. Based on their assessment of the literature, innovation in public-sector settings can be categorised into the types seen in Table 4.

Table 4. Categories of innovations

Type of innovation	Possible characteristics/Outcomes
1. Process innovations	Enhancement in the standards and efficacy of organisational functioning
1A. Administrative process innovations	New management techniques for better resources management
1B. Technological process innovations	Harnessing technological progress to improve service delivery capacity for citizens and other stakeholders
2. Product/Service innovations	Developing new public services or products for better governance and outreach
3. Governance innovations	Addressing civic issues through self-regulation or by enacting regulations
4. Conceptual innovations	New terms of reference for assessing the feasibility of proposed interventions

Source: Bekkers, V., de Vries, H., & Tummers, L. (2015). *Innovation in the public sector: A systematic review and future research agenda*. *Public Administration*, 94(1), 146–166

While the categorisation by Bekkers, Tummers, and De Vries (2015) was useful, we found it necessary to adapt and refine their categories to better suit the context and objectives of this study. Modifications were necessary because of the need to create a framework that not only captured the essence of innovation categories, but also provided scope for inclusion of the challenges and opportunities specific to the SPCBs. We used findings from informational interviews, environmental legislations, and annual reports to remodel the innovation categorisation framework. Categories such as information technology innovation, financial innovation, and information, education, and communication (IEC) innovation, all aim to bridge gaps and enable a more precise analysis of the innovations happening within SPCBs. This remodelling allowed us to align the framework more closely with the unique characteristics and priorities of SPCBs, thereby enhancing the relevance of our study and its applicability to the specific challenges faced by these organisations.

This led us to identify remodelled categories of innovations shown in Figure 3.

Figure 3. Categories of innovative practices employed by SPCBs³



Source: Authors' analysis

3. Descriptions of each category of innovation is available in the corresponding sections under Chapter 4.

While we have used the Bekkers, Tummers, and De Vries (2015) framework to guide our classification of innovations in public-sector organisations, these categories are unique to the Indian pollution regulation ecosystem and are not universally applicable to all public-sector organisations. We created this classification to help in shortlisting innovative practices from annual reports of SPCBs.

In the following chapter, we present category-wise catalogues of innovations adopted by SPCBs along with their ostensible outcomes on the legally ascribed workload of SPCBs. That is, we provide the anticipated outcomes, namely, the outcomes that may be anticipated from the adoption of each innovative measure. This is because our findings merely suggest the potential impact of these innovations, rather than providing verified and quantifiable outcomes that may have occurred from their adoption.

4.1 SPCBs are altering their procedures to improve performance

Bekkers, Tummers, and De Vries (2015) understand process innovations as enhancements in organisational functioning through the adoption of new management techniques and technologies. Bingham and McNaught (1976) define process innovation as an “alteration in the **modus operandi** of a public organisation.” Management techniques often pertain to changes in the way tasks are organised, coordinated, or supervised, whereas technologies refer to new tools, systems, or equipment. Here, we have chosen to differentiate between management techniques (processes) and technologies because while both management techniques and technologies can lead to process improvements, distinguishing between them allows for a more nuanced identification of the innovations observed in SPCBs’ annual reports. This differentiation enables us to explore not only the adoption of new technologies, but also the innovative ways in which SPCBs optimise their internal processes and management practices. Building on these ideas, we have identified process innovations as those decisions that alter existing processes in the organisation in a bid to improve efficiency. The process innovations identified across selected SPCBs are listed in Table 5.



Table 5. Process innovations at SPCBs

State	Process innovation	Anticipated outcome
Maharashtra	Industry- & application-specific templates designed to facilitate online consent issuance	Improved consent management under Air & Water Act
	A <i>Uniform Integrated Enforcement Policy</i> established for consent management (first time by any SPCB)	
	Auto-renewal of consent based on self-certification for red-, orange-, & green-category industries, thereby incentivising compliance	
	Unmanned aerial vehicles (UAVs) used to monitor ambient air quality at line sources	Improved monitoring under Air Act
	Standard bidding document developed to help local bodies in awarding STP contracts	Reduced documentation & enhanced clarity for stakeholders under Waste Management Rules
	Visit scheduler developed to allocate visits to department officers	Improved inspections under Air & Water Act
Gujarat	Seven-year consent & fast-tracked fee payment granted to applicants accredited with Responsible Care Management System	Improved consent management under Air & Water Act
	Industrial associations encouraged to provide waste exchange banks/collection centres and pre-processing facilities for effective waste supply chain management & to promote co-processing	Improved compliance under Waste Management Rules
	Third-party certification for orange-category industries & self-certification for green-category industries to enhance facilitation	Improved compliance under Air & Water Act
West Bengal	Minimum documents mandated for project proponents to obtain consent & other authorisations	Improved consent management under Air & Water Act
	Central inspection system (CIS) integrated online with labour commissioner, factory directorate, boiler inspector, & legal metrology for red-category establishments – inspections scheduled randomly	Improved inspections under Air & Water Act
Tripura	The option of self-certification may be introduced in cases of CTO renewal for green-category establishments	Improved consent management under Air & Water Act
	Established a panel of third-party evaluators/inspectors in online consent management & monitoring system (OCMMS) portal	
	Validity period of CTE certificate (up to 3 years) for different industry categories to be based on capital investment	

State	Process innovation	Anticipated outcome
Tamil Nadu	Consent for red (small)-, orange-, and green-category industries can be auto-renewed on OCMMS portal within 7 days of self-certification without prior inspection	Improved consent management under Air & Water Act
	Green-category industries in industrial use zone/industrial estate need not get CTE – they can apply directly for CTO upon establishment	
	CTE issued with 7-year validity for projects that require EIA & 5 years for those that do not	
	For eligible cases, CTO issued with validity of 5, 10, & 14 years for red-, orange-, & green-category industries	
Madhya Pradesh	Provision of deemed consents	Improved consent management under Air & Water Act
	STP module prepared to assess the capacity of functional STPs in the state	Improved compliance under EP Rules & EIA Notification
	Integration of the Central Inspection System (CIS) with extended green node (XGN) portal	Improved inspections under Air & Water Act
	Automated warning messages sent to non-compliant industries by the Environment Surveillance Centre	Improved compliance under Air & Water Act
	Remote calibration check technique introduced to ensure air quality data accuracy & instrument reliability without access to physical equipment	Improved monitoring under Air Act
Karnataka	Online consent fee collection through XGN portal made mandatory	Improved consent management under Air & Water Act
	Drones procured for conducting aerial surveys of polluted areas	Improved monitoring under various Acts
	Installing sensors to STPs made mandatory for BWSSB ⁴ & other ULBs	Improved compliance under EP Rules & EIA Notification
	Big industries urged to install continuous ambient air quality monitoring stations (CAAQMS) & disclose air quality data on their websites	Improved monitoring under Air Act

Source: Authors' compilation using data from annual reports of selected SPCBs⁵

4. Bangalore Water Supply and Sewerage Board

5. The annual reports referred to in this chapter are MPCB (2019, 2020, 2021); GPCB (2020, 2021); GSPCB (2020, 2021, 2022); HPSPCB (2019, 2020, 2021); WBPCB (2019, 2020, 2021); TSPCB (2020, 2021, 2022); APPCB (2019); TNPCB (2020, 2021); MPPCB (2020, 2021, 2022).

4.2 SPCBs are recalibrating financial levers to improve environmental outcomes

The existing literature on SPCBs shows that financial constraints can hinder their functionality. The Organisation for Economic Co-operation and Development (OECD 2006) found vast financial disparities across SPCBs – even boards with surplus finances faced constraints in expenditure. Another recent study on the finances of SPCBs by the CPR indicated that most boards were unable to utilise the funds they generated due to limited fiscal expertise, conservative expenditure patterns, low absorptive

capacity, and a revenue-focused structure prioritising consent management over other considerations. (CPCB 2020). This prompted us to include financial innovations as a distinct category. These include practices and strategies that alleviate budgetary constraints faced by SPCBs, invite private-sector investment, and enhance financial management and reporting. It is crucial to note that the financial innovations identified by us are mainly of two kinds:

- Practices that augment the finances of SPCBs or improve their finance management
- Practices that utilise financial levers (e.g., reducing the consent fee) to incentivise behaviour that aids pollution control efforts

“Earlier SPCBs charged water cess and used this money. The GST regime has subsumed the water cess, which has stopped an important stream of revenue. At present, the consent fee is the only source of income for SPCBs, and it has increased manifold to make up for the lost funding of the water cess.”

— *ex-official, Uttar Pradesh SPCB*

Table 6. Financial innovations by SPCBs

State	Financial innovation	Anticipated outcome
Gujarat	CAAQMS monitoring via public–private partnerships (PPPs) with help from CPCB	Improved monitoring under Air Act
	To cover administrative costs & generate revenue, the board charges INR 100/2 per cent of consent fee as processing fee for any alterations made to CTE/CTO that require re-issuance with acceptable changes	Improved consent management under Air Act
	INR 1 lakh incentive for brick kiln owners who convert from conventional to zig-zag kiln technology	Improved compliance under Air Act
Tripura	Additional consent fee waiving for brick kilns proposed	
	Consent fee halved for red-, orange-, and green-category industries to encourage waste recycling & reduce establishment costs for recyclers	Improved consent management under Air Act
	Registration fee reduced & renewal fee waived for recyclers/recycling units/re-processors to promote plastic waste recycling	Improved compliance under PWM Rules

State	Financial innovation	Anticipated outcome
Goa	Enforcement & training cell established to generate additional revenue	Improved compliance under various acts and rules
	CPCB's methodology for assessing environmental compensation and action plan adopted to utilise PPP funds	Improved compliance under various acts and rules
	Consent fee relaxed on an annual basis due to COVID-19	Improved consent management under Air & Water Act
Madhya Pradesh	Registration charge reduced under HWM, PW, & BMW Rules	Improved compliance under HWM, PW, & BMW Rules
	Fee towards 5-yearly CTOs & CTEs reduced to promote long-term consents	
	Reduction in consent fee under Water & Air Act	Improved consent management under Air & Water Act
	Extension of <i>Vivaad Se Vishwaas Yojna</i> for issuing consents to industries which did not have/renew their CTE/CTO	
	Collecting bank guarantees from proponents towards pollution control arrangements discontinued	Improved consent management under Air & Water Act

Source: Authors' compilation using data from annual reports of selected SPCBs

4.3 Information technology tools are revolutionising SPCBs

The operational efficiency of several public-sector organisations have become more efficient by widely adopting through the wider adoption of information and technology (IT) tools, which IT tools are razing down obstacles to information exchange and promote faster, more inclusive, and sustainable growth. They also improve governance and accountability, leading to better management of resources and more sustainable development (Bajpai et al. 2021). However, this can be a complex and time-consuming process, often requiring significant

changes to organisational infrastructure (Ebrahim and Irani 2005).

Our analysis of annual reports reveals that SPCBs have enormously supplemented their capacity using IT tools, enhancing the functionality of SPCBs in the following ways:

- improved consent processing by making related procedures a predominantly online activity;
- improved monitoring through IT tools like GPS and cameras;
- improved transparency through management

information system (MIS) portals and single-window clearance facilities;

- improved stakeholder engagement through the development of apps, online portals, and grievance redressal windows; and
- reduced paperwork through office automation and

acceptance of e-signatures.

Wider IT adoption boosts public-sector efficiency, governance, and accountability, enabling faster, inclusive, sustainable growth.

“How many people are attached to a particular function at SPCBs varies from state to state and even district to district. Most of an SPCB’s day-to-day goes into processing consent applications. There is no rocket science in it, and it can be automated. If an SPCB accepts the form, consent to operate is automatically generated as soon as the fee is submitted. The problem is that all officials are disposing more clerical duties than technical, and automation can help the situation. Lack of funds is not the issue; the lack of understanding and initiative creates problems.”

— *ex-official, West Bengal SPCB*

“We are trying to put all our documents online to reduce the burden of RTI. Elaborate RTIs seeking data can take a lot of time because old data has not been digitised. It is the same for parliamentary and assembly questions.”

— *ex-official, Odisha SPCB*

Table 7. IT innovations at SPCBs

State	IT innovation	Anticipated outcome
	Implemented document storage in blockchain and e-signature in PFX ⁶ format	Improved consent management under Air and Water Act.
Maharashtra	Laboratory inventory management module developed & integrated with existing IMIS ⁷ for seamless sample registration & processing	Improved monitoring under Air & Water Act
	Joint visit sample payments module developed to collect sampling & analysis charges & generate bills – it is integrated with IMIS & LIMS ⁸	
	E-catalyst app developed for spreading environmental awareness	Improved IEC under various acts and rules
Himachal Pradesh	Biomedical waste transporters linked with GPS for improved coordination & tracking	Improved monitoring under BMW Rules
	Online real-time surveillance & monitoring of cement plants	Improved monitoring under Air and Water Act

6. PFX refers to personal exchange format. It is used to exchange public and private objects in a single file.

7. IMIS refers to Integrated Management Information System.

8. LIMS refers to Laboratory Information Management System.

State	IT innovation	Anticipated outcome
Gujarat	Re-engineered & strengthened online manifest system for waste transportation as per Hazardous Waste Rules, 2016, ensuring a closed-loop system that follows the cradle-to-grave principle	Improved monitoring under HWM Rules
West Bengal	Launched an integrated grievance management system to monitor grievances	Improved compliance under various acts and rules
	West Bengal's OCMMS integrated with Silpa Sathi ⁹ for all services	Ease of doing business
	Developed a geographic information system (GIS) for air quality management, identification of water body encroachments, legacy dumpsites, & polluted river stretches in the state	Improved monitoring under Air and Water Act
	Launched a court case monitoring system	Improved internal management of the board
West Bengal	Created an online portal for biomedical waste authorisation applications	Improved consent management under BMW Rules
	All state environment impact assessment authority & state-level expert appraisal committee meeting proceedings & clearances uploaded on PARIVESH portal	Improved IEC under various acts and rules
	PARIVESH portal to enable online interaction between public & board, including filing complaints & viewing upcoming events	Improved IEC under various acts and rules
	Registration, authorisation certificates, & grants of units dealing in hazardous wastes shifted online	Improved consent management under HWM Rules
Tripura	OCMMS portal linked to state government's SWAGAT portal	Ease of doing business
	Plans to introduce online inspections for small-scale industries with capital investments of INR 10 lakh or less	Improved inspections under Air and Water Act, ease of doing business
	OCMMS issues authorisations & registrations for all 7 Waste Management (WM) Rules	Improved consenting under all WM Rules
Tamil Nadu	Developed a hazardous waste manifest app for transporting hazardous waste	Improved compliance under HWM Rules
	Online grievance redressal system for public complaints	Improved compliance under various acts and rules
Goa	Office automation system implemented by SAP enterprise resource planning for paperless office	Improved internal management of the board

9. Silpa Sathi is a single-window portal to facilitate investors in accessing services required to set up businesses easily.

State	IT innovation	Anticipated outcome
Madhya Pradesh	Dealer registration under Battery Rules shifted online	Improved consenting under Battery Rules
	Online continuous emission monitoring systems (OCEMS) data integrated with MIS	Improved monitoring under Air and Water Act
	Grievance redressal system embedded into the EnvAlert app	Improved compliance under various acts and rules
	Centralised faceless scrutiny system embedded into the XGN portal for swift consent processing – this reduces travel & workload of field officers	Improved consent management under Air and Water Act
	E-office software for internal managerial updates & board officials' leaves	Improved internal management of the board
	E-signature system for online consent/registration processes to facilitate ease of doing business	Ease of doing business
	Complaints addressed to departments other than the MPPCB automatically redirected to the concerned department	Improved internal management of the board
	GPS used to track movement of hazardous waste	Improved monitoring under HWM Rules
	EnvAlert App to improve citizens' access to CAAQMS data	Improved IEC under various acts and rules
Online portal for registration under PWM Rules	Improved consenting under PWM Rules	
Karnataka	In-house software to monitor status of court cases pertaining to the board	Improved internal management of the board
	E-office software used at Head Office to encourage paperless transactions	
	In-house software to monitor COVID-19 waste disposal	Improved monitoring under BMW Rules
	App to connect governance with stakeholders & public to boost ease of doing business	Ease of doing business
	Applications for various authorisations including green, orange, and red categories of establishment, operation, expansion, HWM, e-waste, and plastic waste shifted online	Improved consenting under various acts
	In-house software for monitoring public complaints received by the board on pollution & waste management	Improved compliance under various acts

Source: Authors' compilation using data from annual reports of selected SPCBs

4.4 SPCBs are undertaking administrative innovations

The existing literature on innovations in public-sector organisations defines administrative innovations as a subset of management innovations. Birkinshaw, Hamel, and Mol (2008) define management innovations as management practices and tools that advance organisational objectives.

We found conceptual overlaps between the definitions of management innovation and process innovation. Hence, to more precisely identify innovative practices by SPCBs, administrative innovations were considered as a separate category. This category includes practices that attempt to alter the organisational structures and internal management in organisations to make the work of managing more effective (Chen, Walker, and Sawhney 2019). All such practices adopted by SPCBs are listed in Table 8.

Table 8. Administrative innovations at SPCBs

State	Administrative innovation	Anticipated outcome
Maharashtra	Extended producer responsibility scrutiny committee constituted to list criteria/parameters & scrutinise submitted plans	Improved compliance under E-Waste Rules
	District-level committees headed by the District Magistrates established to instruct stakeholders against releasing untreated effluent into neighbouring areas	Improved compliance under Water Act
	Procurement of SODAR ¹⁰ systems	Improved monitoring under Air Act
Gujarat	Two vigilance teams at Gandhinagar functioning directly under MS & chairperson to monitor independent inspections	Improved inspections under the Air and Water Act
	Regulatory forum constituted under GPCB MS & other boards, including MoEFCC, CPCB, Indian Institute of Packaging representatives, to boost waste co-processing in cement plants	Improved compliance under WM Rules
	Scientific committee constituted in 2020 for streamlining purchase of scientific instruments/equipment/glassware/chemicals for the board and its ROs	Improved internal management of the board
	Gujarat Environment Management Institute appointed to maintain inventory of state's e-waste generation	Improved compliance under E-Waste Rules
West Bengal	Pollution Awareness & Assistant Centre raises awareness & handles complaints received at Head Office	Improved IEC under various acts and rules
	Public grievance cell registers complaints through 24/7 telephone helpline, social media, physical letters, WBPCB app, email without disclosing complainant's identity	Improved compliance & monitoring under various acts and rules
	Committee constituted to help State Public Information Officer implement RTI Act, 2005	Improved compliance under RTI Act

10. Sonic detection and ranging.

	Separate section in the head office to take immediate action on petitions received via CM Cell & Amma Call Centre	Improved compliance under various acts
Tamil Nadu	Separate grievance redressal centre constituted to guide entrepreneurs & project proponents in obtaining consents, pollution prevention & control, cleaner technologies	Improved consent management under Air & Water Act
Goa	Committee constituted to empanel vendors to install, operate, & maintain STPs & ETPs	Improved compliance under the Water Act
Madhya Pradesh	Environment surveillance centre set up to analyse data on different environmental parameters received from CAAQMS, continuous emissions monitoring system (CEMS), CEQMS, & IP cameras	Improved monitoring under various acts
	Care centres established in all district offices to encourage industries to use OCMMS	Improved consent & authorisations management under Air & Water Act
	Establishing Environmental Response Centre	Improved compliance under various acts
Karnataka	GPS-enabled command control centre established to address & track public complaints	Improved compliance under various acts
	Consent <i>mela</i> organised for hassle-free MSME registration operating without consent	Improved consenting under Air & Water Act
	Limited phosphate content in soaps & detergents by collaborating with Bureau of Indian Standards to reduce lake eutrophication (first time in India)	Improved compliance under Water Act

Source: Authors' compilation using data from annual reports of selected SPCBs

4.5 SPCBs are adopting innovative ways to perform IEC functions

SPCBs have a legal obligation to conduct IEC activities (MoLJ 1974, 1981). The annual reports indicate that each SPCB has been undertaking significant IEC work through awareness campaigns, webinars, and competitions. Innovations which have enhanced their capacity to perform IEC functions are listed in Table 9.

4.6 Research and development innovations at SPCBs

One of the functions of SPCBs under Section 17 (1) (d) of the Water Act is "to encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution" (MoLJ 1974). While this is explicitly mentioned in the act, annual reports indicate that research conducted by the boards extends beyond the legal mandate and such endeavours of SPCBs have been provided in Table 10.

Table 9. IEC Innovations at SPCBs

State	IEC innovation	Anticipated outcome
Maharashtra	Launched <i>E-Bulletin</i> – a knowledge-sharing platform which publishes the latest developments related to the board	
Gujarat	Organised environmental clinics & open houses for efficient & better environmental management	Improved compliance under various acts
	Contacted FICCI ¹¹ & other industry associations to raise awareness on E-Waste Rules through articles, seminars, & training programmes – board is working with GIL as well	
	Advised manufacturers to publish biannual local newspaper ads to raise public awareness on lead–acid batteries & statutory requirements under Battery Rules, 2001	
Madhya Pradesh	Prepared citizen reporter module to ensure that their complaints/ suggestions reach the administration quickly	
	Introduced ENVAlert App to improve citizens' access to CAAQMS data	

Source: Authors' compilation using data from annual reports of selected SPCBs

Table 10. Research and development innovations at SPCBs

State	R&D innovation	Anticipated outcome
Maharashtra	Granted post facto approval to long-term field validation of low-cost air quality sensor–based monitoring network in Mumbai	Improved monitoring under Air Act
	MPCB & NEERI conducting a noise mapping research study as directed by Bombay High Court – proposals in Mumbai & Nagpur include a GIS-based noise information system, Noise ATM, and assessing heterogeneous traffic noise	Improved monitoring under Noise Rules
Gujarat	Entrusted R&D professionals & PhD candidates with developing solutions for environmental issues & pollution control	Augmenting human resources
	Institutionalised internship scheme for engineering & science students	Augmenting human resources
	Launched India's first <i>Emission Trading Scheme</i> pilot in Surat with Yale University & J–PAL to improve air quality – GPCB monitors PM emissions from industrial units in the scheme with CEMS	Improved compliance under Air Act
	Employed Paradigm Environmental Strategies Pvt. Ltd. to study hazardous waste inventorisation	Improved consenting under HWM Rules
	Accepted industrial use of multiple effect evaporators for treating concentrated effluent streams – this has reduced the load on common effluent treatment plants	Improved compliance under EPA and Water Act

11. Federation of Indian Chambers of Commerce and Industry.

State	R&D innovation	Anticipated outcome
West Bengal	Engaged IIT Kharagpur to study mitigation of solid waste open burning in active dump sites	Improved compliance under Air Act
	Engaged Jadavpur University to survey plastic product manufacturing inventorisation	Improved compliance under PWM Rules
	Audited e-waste material flow & value chain with assistance from National Institute of Electronics & Information Technology	Improved compliance under E-Waste Rules
	Engaged Indian Institute of Social Welfare and Business Management for a study on the development of environmental benchmarks, formulating action for HWM and evolution of software programs for inventorisation of wastes	Improved compliance under HWM Rules
Tamil Nadu	Engaged CSIR – Central Leather Research Institute – to fix inlet quality standards for 13 CETPs in the tannery sector	Improved compliance under EPA and Water Act
	Engaged South India Textile Research Association to fix inlet quality standards for all 20 CETPs in the textile sector	Improved compliance under Water Act
	Awarded e-waste inventorisation project to National Productivity Council	Improved compliance under E-Waste Rules
Goa	Approved IIT Goa's proposal on developing a machine learning & sensor-based network for continuous air quality monitoring & prediction	Improved monitoring under Air Act

Source: Authors' compilation using data from annual reports of selected SPCBs

Our analysis reveals that SPCBs adopt myriad innovative practices which could result in improved workload management. These innovations were tied with the different workload components of SPCBs to understand the types of innovations being undertaken to execute their expanding mandate.

We found that of the 127 innovations identified through this exercise (including those under the "Other Innovations" category provided in Annexure 5),

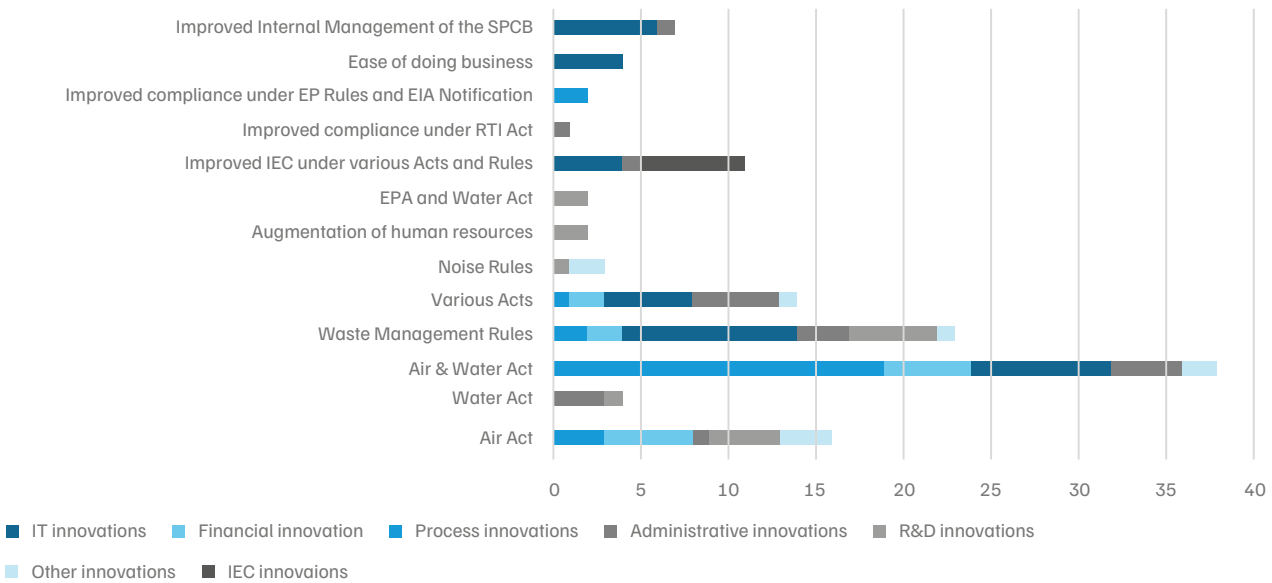
- 60 were adopted to reduce the workload associated with either the Water Act or the Air Act, or both of those laws.
- 38 were adopted to improve SPCBs' capacity to carry out their mandate under the Air Act and Water Act, both. Incidentally, these two laws outline the core functions of SPCBs: namely, consent processing and pollution monitoring.
- 23 innovations were aimed at managing workload associated with the functions outlined under the various waste management rules.

- 34 innovations were aimed at improving consent management by the SPCBs—processing consent applications constitutes a major segment of SPCBs' functions.
- 25 innovations were agnostic of any particular law; thus, were aimed at improving SPCBs' workload management under multiple laws.

In terms of innovation categories, SPCBs have adopted IT and process innovations with the highest frequency – 37 and 27 innovations, respectively. IT and process innovations were identified to be 64 cumulatively, which makes up more than half of all innovative practices that we identified under this study. Of the 37 IT innovations, those associated with managing the workload arising from the Waste Management Rules constitute the highest number (10). In the case of process innovations, the highest number (15) is associated with managing the workload arising from the Water Act and/or the Air Act.

While these innovations are compiled from the annual reports of SPCBs, they may not all have been perfectly executed. However, they provide a glimpse of the intended targets as well as the types of innovations being undertaken by SPCBs to execute their mandates (Figure 4).

Figure 4. Categories of innovations and their anticipated outcomes



Source: Authors' compilation using data from annual reports of SPCBs

5. What drives innovation in SPCBs? A Maharashtra case study

An analysis of the existing legislation and subordinate legislations reveals that over 45 years, the workload of SPCBs has grown drastically from just regulating water quality to environmental protection and waste management. To manage their increased workload and improve operational efficiency, SPCBs have adopted several innovative measures. Examples of such innovations include outsourcing specialised work to external agencies and creating enforcement cells to increase financial resource availability.

However, to truly understand the workload–innovation relationship, an analysis of the actual workload, that is, activities undertaken by SPCBs, and the resources available to perform these activities is needed. Here, we cover a case study of the MPCB to understand how the increased workload for SPCBs has expanded the scope of services provided by them and whether this

expansion has been met with graded increments in resource availability.

We analysed MPCB's Online Consent Management & Monitoring System (OCMMS) portal. We selected MPCB due to the availability of legislation and application-wise data on the services provided by the board. While all SPCBs maintain this data on their own portals or on the MoEFCC's OCMMS portal, the granularity provided by the MPCB allowed greater scrutiny (MPCB 2023; MoEFCC 2023a).

The MPCB's OCMMS portal currently provides 20 services across nine different legislations and subordinate legislations. These are listed in Table 11. However, it is important to note that this is just a subset of the entire spectrum of the SPCB workload.

Table 11. Services provided by the Maharashtra State Pollution Control Board (MPCB)

S. No.	Legislation	Associated service/workload			
1.	Water Act	CTE	CTO	CTO renewals	CTO auto-renewals
2.	Air Act	CTE	CTO	CTO renewals	CTO auto-renewals
3.	Battery Rules	Dealer registrations			
4.	Hazardous WM Rules	Authorisations	Trader registrations		
5.	Biomedical WM Rules	Authorisations			
6.	Plastic Waste Rules	Producer registrations	Brand owner registrations	Recycler registration	Registration for raw material manufacturer
7.	SWM Rules	Authorisations for municipal solid waste			
8.	E-Waste Rules	Authorisations			
9.	C&D Rules	Authorisations	Authorisations for dismantlers and recyclers		

Source: MPCB. 2023. "Maharashtra Pollution Control Board Dashboard." <https://mpcb.gov.in>

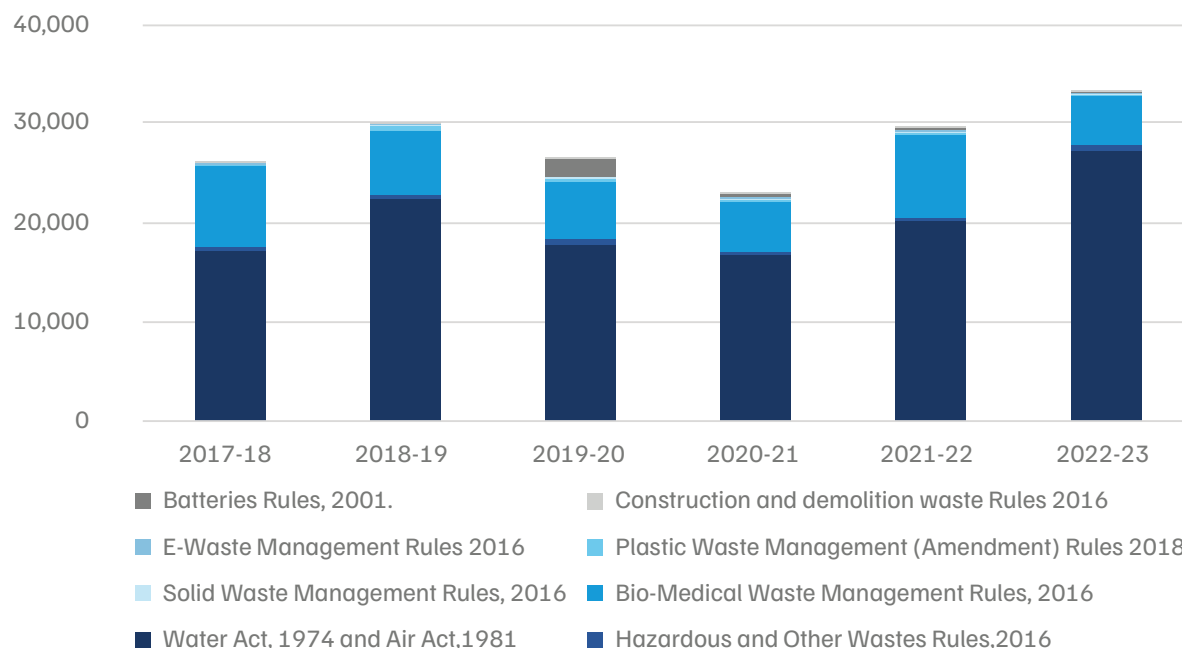
Between 2017 and 2022, the MPCB saw a nearly 28 per cent increase in total consents, authorisations, and applications, from 26,151 to 33,426 (MPCB 2023). During the same period, applications under the Water Act and the Air Act increased from 17,272 to 27,394 and those under the Hazardous Waste Rules increased from 416 to 566. Applications under the Biomedical Waste Rules decreased from 8,205 to 4,983 after peaking at

8,320 during 2021–22, and those under the Plastic Waste Rules also declined from 89 to 55. In contrast, applications under the Solid Waste Rules, E-Waste Rules, Batteries Rules, and C&D Rules increased from 62 to 112, 89 to 155, 12 to 133, and 6 to 28, respectively (MPCB 2023). Although there is a general increasing trend, it can be seen from Figure 5 that there is a decrease between 2019 and 2021, which may be attributable to the COVID-19 pandemic.

“Additional responsibilities, such as responding to queries from the CPCB and preparing official correspondence, add to daily workloads. Routine activities also include drafting project reports and attending to administrative tasks involving interactions with other departments and ministries.”

– ex-official, West Bengal Pollution Control Board

Figure 5. Maharashtra State Pollution Control Board registered a 28% increase in applications made between 2017 and 2022¹²



Source: MPCB. 2023. "Maharashtra Pollution Control Board Dashboard." <https://mpcb.gov.in>.

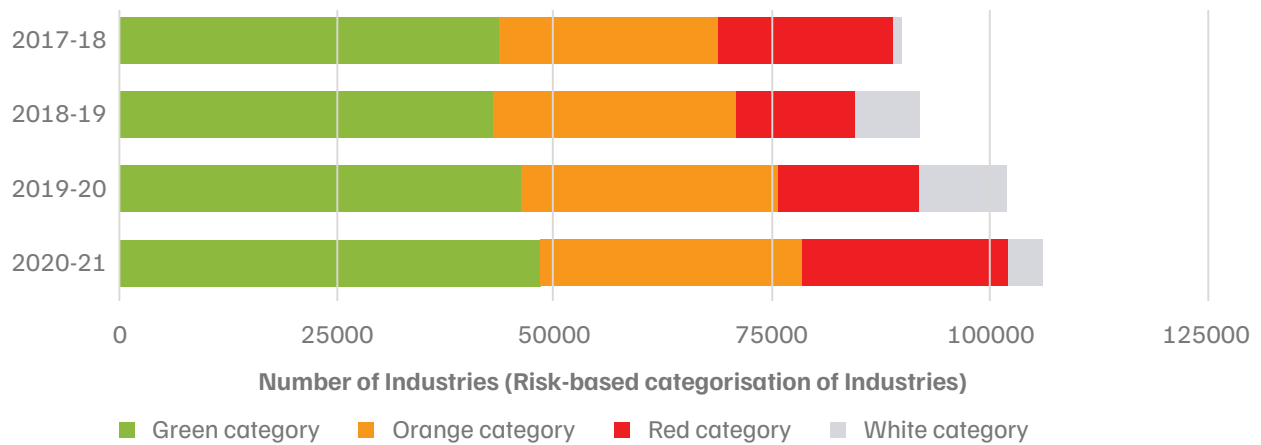
Processing applications for consenting, authorising, and registering is a crucial aspect of SPCBs' workload, but only a part of it. Interviews with experts revealed that inspection is an equally vital task. As one interviewee mentioned, "Processing consent applications and doing inspections are the top priorities of SPCB leadership."

SPCBs carry out inspections under the Water Act and the Air Act. As per the MPCB's inspection policy, industries are inspected monthly, once in six months, quarterly, or annually, depending on their risk-based categorisation (GoM 2017).¹³ The MPCB's annual reports indicate that a steady increase in the number of industries also implies an increase in the number of inspections the board is required to carry out. (Figure 6)

12. In 2020, several PCBs provided relaxations on consent applications due to the pandemic-induced slowdowns.

13. A description of the inspection policy is available in Annexure 2.

Figure 6. Number of industries under Maharashtra State Pollution Control Board's purview increased by 18% between 2017-18 to 2020-21¹⁴



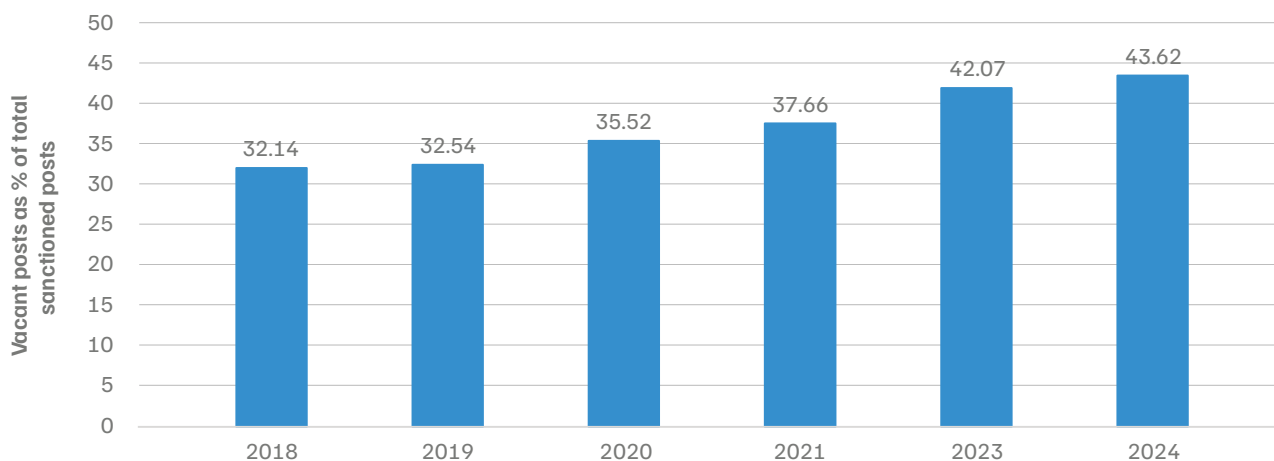
Source: Authors' compilation using data from the MPCB's annual reports

Note: Industries are classified into Red, Orange, Green, and White categories by the Pollution Control Boards based on their pollution potential, with Red being the most polluting and White the least.

Although innovations in workload management are necessary to handle the increasing workload of SPCBs, it is the persistent understaffing that makes such innovations critical. Recent data presented by CPCB indicates that of the 839 posts sanctioned at the MPCB,

366—that is, 43.62 per cent of them—were vacant, highlighting a long-standing problem across SPCBs (CPCB 2024). The vacancy rates have also witnessed an increasing trend over the years (Figure 7).

Figure 7. Vacancy percentage in MPCB has increased by over 11% between 2018 and 2024



Source: MPCB. 2021. "Annual Report of Maharashtra Pollution Control Board 2020-21." Mumbai: Maharashtra Pollution Control Board. and CPCB. 2024. Report of Central Pollution Control Board (CPCB) in OA No. 693 of 2023. National Green Tribunal.

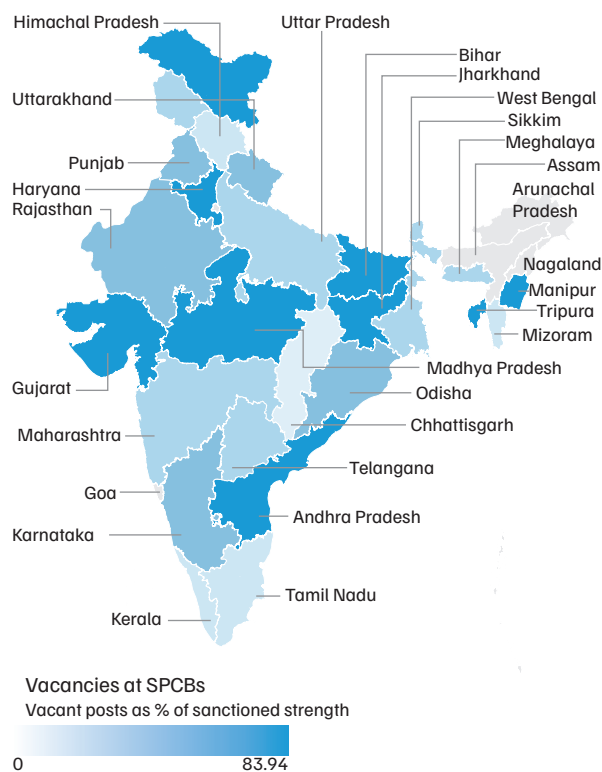
Note: Data for the year 2022 could not be retrieved.

14. The numbers are for financial years.

It is worth noting that high levels of vacancies are not exclusive to the MPCB. The CPCB's report tabled before the National Green Tribunal indicates that 26 of 28 SPCBs have vacancies. Bihar SPCB has the highest rate of vacancy at 83.94 per cent of its total sanctioned strength, whereas Arunachal Pradesh and Nagaland have no vacancies (CPCB 2024). The response also shows that the CPCB's vacancies stand at 33.44 per cent. This reinforces the literature findings, which highlight understaffing as a persistent issue in pollution control boards. Figure 8 illustrates the vacancy rates across India's SPCBs as well as Pollution Control Committees (PCCs).

Between 2018 and 2021, the MPCB's consent and industrial data showed an increase in workload. Simultaneously, there was also an increase in the percentage of vacant positions in the board. During one of the interviews, an ex-official from Odisha SPCB explained, *"The number of people we require depends on the number of industries under consent administration. Initially, hotels did not need consenting provisions. The NGT added them to the consenting framework. We had to monitor a few hundred industries and suddenly had thousands of hotels. By the time we recruit one batch, the need for the next lot is already there as the workload increases. There is a constant catch-up game in terms of workload and human resources."*

Figure 8. Vacancies at SPCBs



Source: CPCB. 2024. Report of Central Pollution Control Board (CPCB) in OA No. 693 of 2023. National Green Tribunal.

“While the manpower of the SPCBs is as per the functions under the Air and Water Act, the scope of their functions has expanded significantly over time. However, staffing levels have not kept pace with these growing mandates. This is a glaring gap in India’s pollution governance and warrants urgent attention.”

— ex-official, CPCB

6. Limitations

This study identifies the legally ascribed workload of SPCBs, the conditions that necessitate innovations, and the innovations that enable SPCBs to improve their workload management. However, it has a few limitations due to its methodological approach and data availability. We have identified the following limitations to our approach -

- Only workloads assigned by legislation and subordinate legislation were mapped, whereas work is also assigned through court judgements, internal protocols, and ad hoc instructions from the CPCB, which we have not considered in this study. Several interviewees highlighted judicial documentation, RTI responses, and legislative inquiries as critical components of their workload. We did not capture such workload due to the paucity of data. However, a comprehensive analysis of the workload of PCBs should encompass these sources.
- The annual reports of SPCBs were used as secondary literature to identify innovations. SPCBs are required by law to report their activities to the state legislature, and we found many innovative practices listed throughout these reports. However, because the legislation does not mandate including such innovations in the annual report, we could have missed out on those that were not mentioned. Additionally, we also assumed that the data provided in the annual report is accurate and provides a

complete picture of the status and progress of the SPCBs. We believe that to truly understand the workload-innovation relationship, an analysis of the actual workload, that is, activities undertaken by SPCBs and the resources available with them to carry out these activities is needed.

- We limited our study to states which published annual reports over three consecutive financial years and selected those with similar content and presentation. Consequently, innovations carried out by SPCBs that do not meet these criteria were missed out.
- There are issues with the different criteria for classifying innovations in public-sector organisations that have been proposed earlier. They have been criticised for being designed from the perspective of the private sector, being inward in outlook and not covering collaborative innovations, having conceptual overlaps across categories, and being created without a coherent set of parameters (Hartley 2005; Damanpour and Aravind 2012; Ansell and Torfing 2014; Chen, Walker, and Sawhney 2019).

These limitations are stated here to underscore that we have created innovation categories specific to SPCBs, based on their functions and the obstacles faced by them. These categories are not universally applicable to public-sector organisations and are unique to the Indian pollution regulation ecosystem.

7. Recommendations

Our review of the annual reports of the selected SPCBs led to the discovery of several innovative practices that can be adopted by SPCBs across the country. These innovations can be categorised as **short-term innovations**, which can be adopted immediately due to the availability of required technologies, **medium-term innovations**, which require input from external organisations or further desk research, and **long-term innovations**, which will require the creation of new platforms and processes. In this chapter, we highlight key recommendations that SPCBs can incorporate within the course of their functioning to ensure efficacious workload management.

7.1 Short-term recommendations

Creating a knowledge-sharing platform: Cross-learning and knowledge sharing among SPCBs can catalyse the adoption of innovations. A platform to facilitate the exchange of innovations and best practices across states could be anchored by the CPCB and/or a group of officers from a few SPCBs. Such exchanges should be organised periodically to ensure that information is constantly shared and up to date.

- **Automation:** We understand automation as innovations that reduce human intervention in a particular task. This is particularly relevant due to the scarcity of human resources in SPCBs. Many examples of automation-based innovations were found among the six types of innovations discussed in the annual reports. Those that can be adopted in the short term include the following:
 - Office automation systems for a paperless office
 - Auto-renewing consents based on risk profile and compliance records/accreditations of industries
 - Visit schedulers to assign inspection responsibilities to officers

- Automated messaging services to send warnings and instructions to non-compliant industries

- **Harnessing modern monitoring technologies:** SPCBs are entrusted with the responsibility of monitoring polluters, pollution levels, and areas with pollution. These are human resource-intensive activities. However, several technologies to facilitate monitoring have emerged, and some, such as OCEMS and video surveillance cameras, have already been adopted by most states. Our review of annual reports found several instances of modern technologies being used to reduce the physical workload associated with monitoring. Monitoring technologies that can be implemented in the short term are as follows:

- Machine learning-based network for continuous air quality monitoring and prediction (as adopted by Goa)
- UAVs to monitor industrial pollution and GIS for surveillance (as adopted by Karnataka, Maharashtra, and West Bengal)
- GPS to track waste movement (as adopted by Himachal Pradesh and Madhya Pradesh)

7.2 Medium-term recommendations

- **Rationalising processes:** SPCBs can use these processes to identify areas of inefficiency, reduce duplication of efforts, and optimise resource allocation, thus resulting in better workload management. Seven out of the nine selected SPCBs have made significant alterations to their processes using technology, communication, and

new protocols. Examples of such rationalisation measures include

- using the remote calibration check technique to ensure data accuracy and instrument reliability without physically accessing equipment;
 - creating industry- and application-specific templates to facilitate online consent administration;
 - stipulating minimum documents for processing consent and authorisation applications; and
 - creating online redressal systems for registering public complaints.
- **Delegating functions:** Annual reports show that SPCBs often leverage the expertise of third parties, which include not just the private sector, but also other government departments and research institutions. Such engagements have been proven to cut costs and enhance output. Furthermore, the human resource deficits that several SPCBs experience can be met via such engagements. Delegation efforts that are replicable across SPCBs in the medium term include
 - advising manufacturers/enterprises to publish biannual newspaper ads to raise public awareness of environmental issues;
 - operating CAAQMS systems via PPPs;
 - conducting research on pollution and associated areas by collaborating with universities and relevant organisations;
 - introducing an environment audit scheme with engineering colleges as auditors, thus decreasing the workload while ensuring that it is in responsible hands.

One of the interviewees highlighted that the delegation of functions had been a major success during his tenure. He observed, *“During my time we hired 150 new people. But it will never increase proportionately to workload. We outsourced lots of our work to consulting labs. So, the burden of monitoring was reduced. Because consenting is the only thing we could not outsource, so*

we tried outsourcing everything else. This ensured that no technical staff is engaged in non-technical work. We essentially re-arranged the human resources available to us. We increased the revenue and used it to outsource. We put a lot of effort to make sure those we outsourced our work to were responsible.”

- **Preparing repositories of innovative practices:** Creating a dedicated space to highlight successful innovations on SPCB websites is recommended. This space will serve as a repository of innovative ideas, best practices, and success stories. It will inform and inspire other states and actors involved in environmental management. An example is the *Best Environmental Management Practices* bulletin available on the CPCB's website (CPCB 2021a). While this is maintained sparingly at present, such initiatives can help nurture a culture of innovation within SPCBs and encourage the adoption of best practices.
- **Regular annual reporting:** SPCBs are legally mandated to prepare annual reports under Section 39 (2) of the *Water Act* and Section 35 (2) of the *Air Act* (MoLJ 1974, 1981). Such reporting exercises will enhance SPCBs' compliance with the acts, allow them to reflect on what could have been done differently, and enable better planning, resource allocation, and decision-making. The CPCB has urged SPCBs to release their annual reports regularly to ensure that the CPCB's national status reports can be published on time (CPCB 2020). The Comptroller and Auditor General of India emphasises that enhanced governmental accounting and financial reporting can lead to improved accountability and decision-making (CAG 2022). Regular reporting not only recapitulates past performance but also provides insights for optimising value creation (OECD 2022). However, annual reporting must include all information relevant to assess the performance of an organisation on its mandated workload (Lee 2008). Hence, consistency in reporting across SPCBs is crucial for self-assessment and will also enable cross-learning between states. Schedule III of the *Air (Prevention and Control of Pollution) Rules, 1982*, provides a template that the SPCBs' annual reports can adhere to (MoLJ 1982).¹⁵ This template is already in use by Karnataka and Goa. Other SPCBs can create and use similar templates to enhance the comprehensiveness and coherence of their reports.

15. Available as Annexure 3.

7.3 Long-term recommendations

- **Promoting innovation through frameworks and data:** To enhance the effectiveness of SPCBs in mitigating pollution, we recommend creating an innovation risk framework that incorporates transparent risk governance and involves board officials, citizens, and other relevant stakeholders. This framework should balance the risks and potential benefits of innovations and promote a culture of risk awareness and learning. Collecting

comparable data on innovation for SPCBs and industry sectors can provide valuable insights into their interconnection and add to organisational innovations in SPCBs. Such data can enable board officials to identify innovations that require inputs from multiple actors, thereby promoting collaborative approaches to address challenges (Osborne et al. 2020; Kapuscinska and Matejun 2014; Arundel, Bloch, and Ferguson 2019).

8. Conclusion

SPCBs have been the subject of frequent and systematic research, given their important role in the pollution regulation ecosystem. The existing research on the performance of SPCBs focuses on the scarcity of human resources as well as their limited financial resources.

Our review of the literature suggests that while these limitations are prevalent across states, they must be contextualised with respect to the expanding workload that SPCBs are entrusted with. We identify a significant increase in workload due to the increasing number of legislations and subordinate legislations aimed at regulating pollutants, preserving the environment, and handling waste. In addition, it has been found that SPCBs are constantly juggling their increasing workload with persistent and often increasing resource constraints.

Given these constraints, we focused on what boards can do to better manage their workload. We analysed 27 annual reports of nine SPCBs and identified several innovative practices to improve workload management. Of the 127 innovations identified, 27 were related to the alteration of processes, 14 instances were of financial levers being utilised to enhance capacity, 37 were associated with the use of IT tools, 19 were related to administrative changes, 6 were related to innovations in IEC, 15 were associated with research and development, while there being 9 that could not be fitted in any of the chosen categories.

Our analysis and consultations indicate that several of these innovations have the potential to be replicated across states. In the short term, SPCBs can create a platform to facilitate cross-learning of innovative practices, use automation to reduce human intervention in processes, and use new and emerging technologies to reduce monitoring. This issue brief is an initial step towards identifying and cataloguing the innovative practices of SPCBs. However, we recommend that, in the medium term, SPCBs and the CPCB collaborate on creating a repository of innovations and institutionalise annual reporting in a consistent format. Delegating responsibilities and rationalising internal processes will also improve workload management in the medium term. In the long term, SPCBs should focus on developing a system that promotes continuous innovations in workload management. This will require the development of an innovation framework that balances the risks and potential benefits of innovations and promotes a culture of risk awareness and learning.

Well-functioning SPCBs are indispensable for pollution control in India. Adopting innovative approaches and engaging in cross-learning can enhance the operational efficiency and promote a culture of collaboration amongst SPCBs. It will also help them address the increasingly complex nature of emergent environmental challenges. A continued commitment towards transparency, cross-learning, and innovation will enable SPCBs to engineer the transition towards a cleaner, healthier, and more sustainable India.

Acronyms

BWSSB	Bangalore Water Supply and Sewerage Board	GIS	geographic information system
C&D Rules	<i>Construction & Demolition Waste Management Rules, 2016</i>	GoM	Government of Maharashtra
CAAQMS	continuous ambient air quality monitoring stations	GPCB	Gujarat Pollution Control Board
CEMS	continuous emissions monitoring system	GPS	global positioning system
CETP	common effluent treatment plants	GSPCB	Goa State Pollution Control Board
CIS	central inspection system	GST	goods and services tax
CPCB	Central Pollution Control Board	HWM Rules	<i>Hazardous Waste Management Rules, 2016</i>
CPR	Centre for Policy Research	IEC	information, education, and communication
CRZ	coastal regulation zone	IIT	Indian Institute of Technology
CSIR	Council of Scientific & Industrial Research	IMIS	integrated management information system
CTE	consent to establish	IT	information technology
CTO	consent to operate	J–PAL	Abdul Latif Jameel Poverty Action Lab
EIA	environmental impact assessment	JVS	Joint Visit Sample
EPA	<i>Environmental (Protection) Act, 1986</i>	LIMS	laboratory information management system
EPR	<i>Environment Protection Rules</i>	MIS	management information system
ETP	effluent treatment plant	MPCB	Maharashtra Pollution Control Board
ETS	Emissions Trading Scheme	MS	member secretary
GEMI	Gujarat Environment Management Institute	MoEFCC	Ministry of Environment, Forest, and Climate Change

MoJ	Ministry of Law and Justice	PLI Act	<i>Public Liability Insurance Act, 1991</i>
NGT	National Green Tribunal	PPP	public–private partnership
NIELIT	National Institute of Electronics and Information Technology	R&D	research and development
OCEMS	online continuous emission monitoring systems	RO	regional office
		RTI	right to information
OCMMS	online consent management & monitoring system	SODAR	sound detection and ranging
OHWMS	Online Hazardous Waste Manifest Application System	SPCB	state pollution control board
		STP	sewage treatment plant
OLGPRS	Online Grievance Waste Manifest Application System	SWAGAT	state-wide attention on grievances by application of technology
PAAC	Pollution Awareness & Assistant Centre (PAAC)	SWM Rules	<i>Solid Waste Management Rules, 2016</i>
PARIVESH	proactive responsive facilitation by interactive and virtuous environmental single- window hub	UAV	unmanned aerial vehicles
		WBPCB	West Bengal Pollution Control Board
PFX	personal information exchange	WM	waste management
PIL	public interest litigation	XGN	extended green node

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