

Governing an Air Quality Data Commons

A public stack approach to governance in the
Hollandse Luchten citizen science initiative

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 SHARED CITIES
 SMART CITIZENS

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1. Introduction

Surveillance capitalist and smart city models of data ownership are increasingly ubiquitous in our shared spaces. This includes cities, neighbourhoods, public spaces, and in some cases, even the air that we breathe – places and resources that are considered as *common in theory*, but are treated as *privately owned in practice* all too often when it comes to gathering, documenting, sharing, leveraging, analysing, or even selling data and information.

Commoning – the active practice of collectively organising around a common good (and often with a democratic connotation) – holds promise as a way to uphold our common spaces and resources in practice. There are ongoing questions surrounding commoning as a governance model. These questions extend to the area of data commons, an area of study and practice in which data is considered as a tangible common good that lends itself to being managed in novel ways which are, ideally, more open, fair, and inclusive than the current practices which are most commonly found in closed, proprietary surveillance capitalist and smart city models.

The Noord Holland pilot of *Shared Cities, Smart Citizens* explores how the Hollandse Luchten citizen science initiative is and could be governed as a commons. Can the notion of a data commons be applied to the air in a community? What needs to be governed in order to govern a commons? How can we grasp a starting point, and who gets to lead this process? These were all central questions faced in the course of our research.

To address such questions, we conducted the participatory public research process which is described below and on our [project website](#). The research began by identifying Hollandse Luchten as a case study. Along with participants from local sensing communities, we identified issues that ought to be governed; prioritised data use cases; and mapped next steps in governance for each data use case.

Our research is one of many possible contributions to the questions surrounding how to govern a data commons in practice. Our main finding is that governing a data commons is primarily about governing the group and the (social) context itself, and secondarily about governing the data and the wider technological infrastructure. In order to do this, we adopted a public stack approach to consider the various layers of foundational values, process, technology, and people – all of

which comprise Hollandse Luchten (or any data commons) and all of which require governance.

The processes surrounding commoning are neither straightforward nor prescriptive; instead, democratic governance of a commons is highly dependent upon context and subjected to the capacities, motivations, contributions, collaborations, and initiative taken by those involved. We hope this documentation of our research process is a helpful and practical resource for those who wish to develop their own commons.

Colofon

This document reports the research conducted by Waag Futurelab in 2021-2022 into the governance of data commons in the province of Noord-Holland, specifically in the project Hollandse Luchten. This project is funded by NWO through the NWA small projects call 2020 named 'Citizen participation towards a SHARED smart city' (NWA. 1418.20.024). In this call Waag worked together with the Leiden-Delft-Erasmus Centre for BOLD Cities and Utrecht University.

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After identifying the data use cases, we wanted to know what was needed in order to make them a reality. We collaboratively considered what was needed in each layer of the public stack per use case, re-designing a 'new' public stack mapping for each of the four use cases.

Based on the gaps identified in the public stack mapping of each use case, we can make the following recommendations for Hollandse Luchten and its next steps towards participant-led autonomy and self-governance:

So, how do you govern a data commons?

How to govern a data commons? We explored this question using Hollandse Luchten as a case study.

Hollandse Luchten (*Dutch Skies* or HL) is a community of citizen scientists (referred to throughout as *participants*) measuring the quality of their living environment in the Province of North Holland through open source and affordable air quality sensors. The participant monitoring network collaborates with the Province, the RIVM (Dutch National Institute for Public Health and Environment), GGD (Department of Public Health), TNO (Dutch Organisation for Applied Scientific Research), and Smart City Haarlem to gain more insight into the air quality.

As a public research project Hollandse Luchten explores the relation between data commons, public research, and governance structures. The role of governance in citizen science projects, and how citizen science and community-led data sets can have a role in official governance are central questions for the group. The starting point is that open data and a growing knowledge of air quality, combined with the Hollandse Luchten platform for interaction with different stakeholders, will empower people to have more agency and influence on their environment.

Currently there are sensing communities active in Hollandse Luchten in the IJmond region, Amsterdam North and Zaanstad.

- **IJmond region** – This includes Wijk aan Zee, Beverwijk/Heemskerk and IJmuiden/Velsen, which are concentrated around the area of the Tata Steel factory. The factory emits PM, NO_x, CO₂ and other poisonous substances that have a negative impact on health and the environment in surrounding areas. Local communities have been concerned about air quality for decades. They have experienced difficulty in creating insight and building knowledge about the impact that current air quality has on their health and local environment.
- **Amsterdam North: Buiksloterham** – Buiksloterham has an active community of local residents, businesses and initiatives. The neighbourhood was historically one of the most polluted areas of Amsterdam, due to its history as a centre for heavy industry and shipping. In 2009 a redevelopment plan was launched to transform the neighbourhood from an industrial area into a circular and sustainable residential area with a combined living and working function. Concerns about air quality in the district centre around the growing population and how an increase in traffic emissions may influence the air quality. Another area of concern is the shipping that passes through the IJ river.

- **Zaanstad: Kogerveld** – Kogerveld is a neighbourhood in Zaandam, located between the A8 and A7 highways. It is in development and the number of residents is quickly rising. Due to traffic emissions, people here are concerned about the air quality and its consequences on health and the living environment.

We undertook a public research methodology that prioritised community perspectives through co-creative, participatory formats.

Our research into Hollandse Luchten and its governance was conducted through the Shared Cities, Smart Citizens pilot in Noord-Holland. Our pilot utilised a public research methodology. Rather than academic research (which tends to be concerned with advancing scholarly debates) or market research (which tends to be concerned with profit), at Waag we consider public research as primarily concerned with promoting positive public or societal change. Our public research methodology was both active and participatory – we interacted and collaborated with our ‘case study’ community, in this case towards the shared goal between participants and facilitators to clarify how Hollandse Luchten is governed, and to understand how the initiative can move towards becoming a self-sustained, participant-led data commons.

Our research methodology also drew heavily from and incorporated aspects of citizen sensing, citizen science, commoning and co-creation. Citizen sensing and citizen science are at the core of Hollandse Luchten, as citizens (and non-citizens) take the lead in measuring their own living environment. Co-creation – the participatory development of a process led by community concerns and implemented by the community itself – is familiar to participants in Hollandse Luchten. Co-creation was also central to the Shared Cities, Smart Citizens research, which utilised collaborative sessions, focus groups, interviews, and other co-creative strategies to identify issues and strategies related to the governance of Hollandse Luchten. We brought these various methodologies together to answer pressing questions about which areas of governance to focus on next in Hollandse Luchten, as well as to contribute to a wider field research into the governance of data commons and community-led groups.

Implementing a participatory public research methodology is never neutral – it is inherently performative, and subject to forces outside of our direct control. For example, restrictions on in-person gatherings due to the Covid pandemic resulted in fewer live co-creation sessions than we would have ideally implemented.

Moreover, terms like ‘citizen science’, ‘co-creation’ and others mentioned here face the danger of being imprecise or underestimating the heterogeneity of a community. Indeed, the idea of a ‘community’ is itself intangible and often difficult to define at the margins (who is part of Hollandse Luchten, and who is not?). Beyond such discursive aspects, any participation method shapes who can participate, how people can articulate the problems affecting them, as well as how they can contribute to their solutions. In short, different participation methods create different publics. It is thus fundamental to acknowledge the partiality of such methodologies, terms, and ways of engaging and grouping people. In practice, this may mean for example considering the different skills and interests of the people involved in a participatory process; being explicit about commonalities and differences within a group; and providing different formats for engagement (in this case, some people are interested in sensors, others in data visualisation, and others in getting together for a walk with neighbours and local policymakers).

We started our process by asking people: what issues need to be governed?

Initial Public Research (Summer 2021)

We held a focus group and series of interviews during summer 2021 with members of ‘Hollandse Helden’ (highly involved participants in Hollandse Luchten). These discussions identified certain commonly shared goals and concerns amongst the people we interviewed:

- **Fairness, inclusion, and democratic value** – HL is based upon shared concerns about air quality, but also around a shared drive to participate, make political deliberation more fair in their region, and make HL stakeholders and issues around air quality more represented within the political sphere. These values ought to be reflected internally as well, meaning that the governance of Hollandse Luchten itself ought to be fair, inclusive, and legitimised by democratic means.
- **Shifting power towards autonomy and sustainability** – There seemed to be a desire for bottom-up autonomy, but this assumption remains unconfirmed (e.g. through a co-creative process). Questions to address included: Does the HL community want Waag to lead as a facilitator through public funding? (Funding inherently begs the question *whose side are you on?*) Or do HL participants want to gradually ‘cut out the middle-man’ and move towards self-governance? What are the financial and formal requirements for long-term sustainability?

- **Reliability in technology and community towards growth and replication** – Members of Hollandse Helden noted they would like to grow, expand to other cities, and become a more prominent fixture in official governing processes. Before HL can do this, however, it needs a reliable technical network and a robust community structure which can function smoothly and be documented, replicated, and tailored to other contexts.

This process also revealed challenges within Hollandse Luchten, which now found itself at a critical juncture. The group had grown to be large, with around 200 sensors deployed by people across North Holland. Delays and uncertainties about responsibility and process threatened to inhibit the project as its members faced increasing questions regarding the governance of the sensor network, of the data, and of the group itself. These challenges were summarised as problems of (the):

- **Governance: transparency, accountability, decision making, and ownership** – It was unclear who makes decisions; how HL decided who makes decisions; and thus who was ultimately responsible when various problems and questions arise in the project.
- **Data use cases** – It was unclear what purpose the data serves in the project. While such goals had been formulated in early stages of the project (in [Beverwijk](#), [Wijk aan Zee](#), [IJmuiden](#), and [Buiksloterham](#)), they were no longer in focus. This, in turn, added opacity to other areas in the project (such as how data should be managed; or what the communications strategy ought to be).
- **Internal communications** – People did not always know where to look for updates, how best to communicate with one another, or whether they are being heard.
- **Technical network** – The process to fix technical issues was often unclear.

This revealed: There is more to govern in a data commons than just the data itself.

Governance everywhere you look

In Hollandse Luchten – as in other data commons, and in any human organisation – there are questions of governance everywhere you look. Data turned out to be just one of the aspects that needed to be addressed. As was to be expected, we encountered questions about how the data itself is governed (*‘Why is Hollandse Luchten data held by the Province, and how was this decided?’* [the data platform is hosted by the Province; the data is calibrated by RIVM; the data itself is open

data that is accessible on the [HL website](#)]). Furthermore, we also encountered questions about governance of every aspect of the project: about how to govern the physical hardware that gathers the data; the firmware; the visualisation; and how to govern the people and the processes that make all of this happen. We even encountered governance questions about the governance of the project itself (*'Who gets to decide decisions? Who gets to decide who decides decisions?'*).

We needed to add clarity to this confusing rabbit hole of governance – to grasp the various aspects of a data commons which need to be governed, and focus on the most important areas. To do so, we utilised and developed the public stack framework by organising the various components of Hollandse Luchten (all of which could potentially be governed) within layers: the people, technology, processes, and foundational goals, values, and assumptions which together comprise Hollandse Luchten as a whole.

We adopted a 'public stack' approach to add structure to the complexity.

What is the Public Stack?

The [public stack](#) is a framework for building public technology based on shared values. It sits in contrast to the private stack (where the foundation is profit, design processes and technology are closed and proprietary, and users are considered as consumers) and the state stack (where the foundation is state power, design processes and technology are closed, and users are considered as subjects). Instead, the public stack is based on a foundation which is defined by shared values. Its design process is open and participatory, and its technology is open source. In this model, 'users' are rather considered as citizens and human beings.

The public stack model reveals that there is much more to technology than meets the eye – think of design choices, physical infrastructure, patents, and hardware. All of this plays a role in determining the extent to which technology (or an initiative to develop technology) is in line with the shared values of a community or society. Each layer of a stack builds upon the steps beneath it. Ultimately, all layers are based on the foundation, and in turn, all layers influence the position of the people who use or are affected by technology.

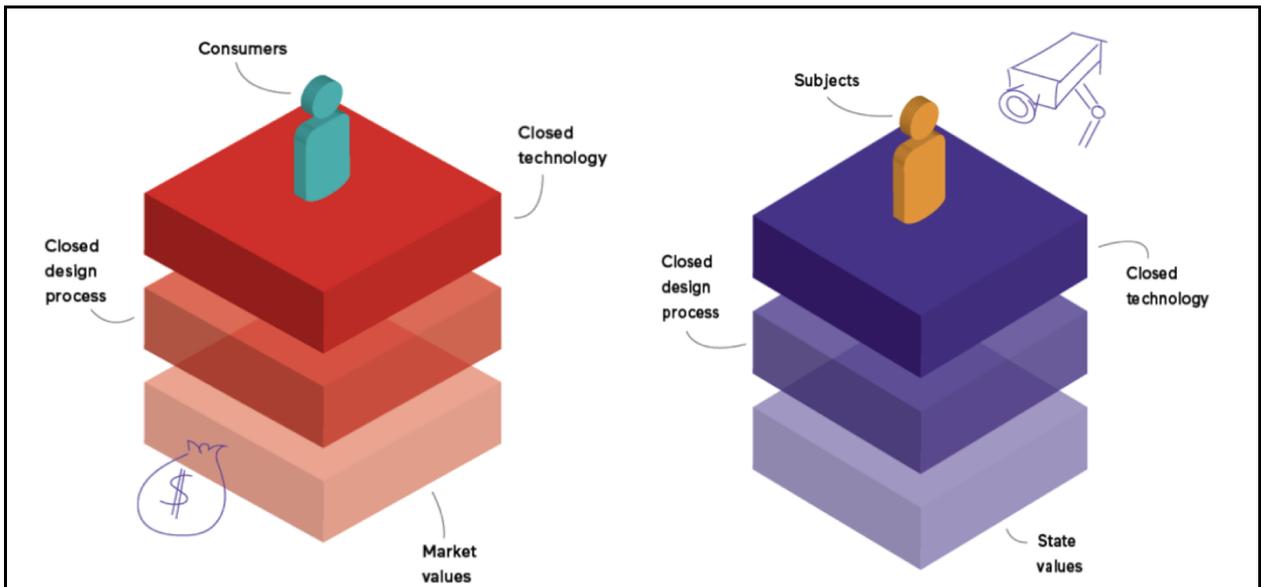


Figure 1 The private stack and state stack. The private stack (left) is based on market values and is profit-driven. The state stack (right) is based on state values and values centralised state values. Surveillance is a central feature of both models

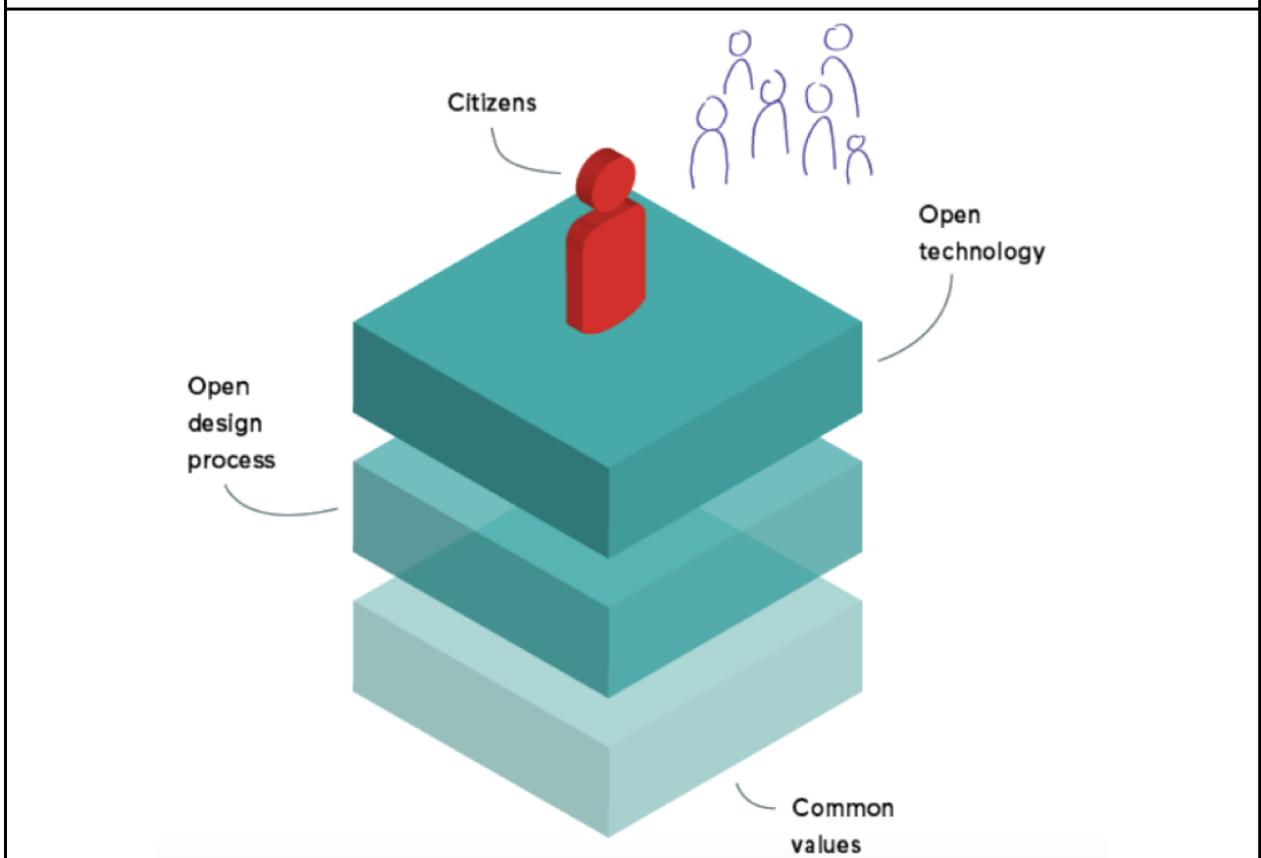


Figure 2 The public stack. The public stack is based on a foundation of common or shared values.

We analysed Hollandse Luchten by mapping it out along layers of the public stack: foundation, technology, process and people.

Mapping Hollandse Luchten along the public stack framework

We began our analysis by mapping Hollandse Luchten along the public stack framework. This started as a broad and simple exercise: for example, a shared concern about air quality in Noord Holland and the aim to put local communities in the driving seat of the data collection forms the project's foundation; the design process is open, co-creative, and participatory; the technology consists of sensors, a technical infrastructure to send and process data, and a visualisation; and the participant's perspective is proactive and participatory, supported by a range of other stakeholders in government, the nonprofit sector, and even the private sector.

We decided to dig deeper and approach each layer with attention to detail and through a critical lens. We based our detailed analysis on existing questions that can be found in the foundation layer at <https://publicstack.net/layers/> such as '*In what way is society represented?*' and '*Who does this initiative belong to and who are the other stakeholders?*'. (Some of these questions were removed because they did not apply to Hollandse Luchten, while a few new questions were added.) We considered similar additional questions in each layer of the stack.

The resulting analysis is a detailed overview of the many moving parts that comprise Hollandse Luchten. (Again, under this lens, Hollandse Luchten is not just the data or the sensors, but the culmination of people, processes, values, and everything else that contributes to these various stack layers). Importantly, this detailed analysis **revealed gaps** in each layer of the stack. For example, while most of the technology is open source, the HoLu sensor does make use of certain proprietary sensor parts; while the processes are open and participatory, there are indeed areas where participants' control and agency within the project could be increased.

Perhaps most importantly, our detailed analysis of Hollandse Luchten within the public stack framework revealed a major gap in the foundation of the project: While data goals had been defined early in the project, focus and clarity around them had diminished as the project shifted its focus towards developing a robust and reliable technical and social infrastructure. Just as is the case with a house or building, we found it important to address such foundational gaps first, because

what happens in the foundation affects each other layer of processes, technology, and people in the project.

View [the detailed public stack analysis](#) of Hollandse Luchten

[View our open-source method](#) to conduct your own public stack analysis.

Our mapping revealed a key gap in the foundation: how do participants want to use the data? To govern a data commons, the data use cases must be clear.

Gaps in the Foundation: The need for data use cases in Hollandse Luchten

Data is not valuable in and of itself; data is a means to an end and *should be* a means to improving people's lives. How, then, should Hollandse Luchten data be used to affect change which ultimately improves the air quality – and thus the health and wellbeing – of people in pilot areas?

We refer to the particular ways in which Hollandse Luchten data could be used as the *data use cases*. What do participants actually want to use data for in Hollandse Luchten? This is a *foundational* question for Hollandse Luchten, because the subsequent design decisions, tech, and people we will need change depending on what this data use case is. For example, if the goal is to allow people to check whether official measurements are correct, then the government should probably not house the data, and that data must be accurate (meaning that the sensor must be reliable). But if the data use case is rather to raise community awareness about air quality sensing and political decision making, it would presumably be no problem for the data to be held and calibrated by the RIVM (as is currently the case).

All of this is to say that the data use cases form a major part of Hollandse Luchten's foundation; as the data use cases change, the subsequent needs regarding tech, processes, and people also change. In order to move forward in governing Hollandse Luchten as a data commons, we needed to know what the data is for. Our next step was thus to identify Hollandse Luchten's data use cases.

We held interviews and created a survey which identified four key data use cases for Hollandse Luchten based on participants' responses.

Identifying data use cases in Hollandse Luchten

We needed to identify the purpose or purposes for which Hollandse Luchten data would be used. Moreover, we found it important that these purposes or 'data use cases' were rooted in the wants and needs of participants (thus, the local sensing

communities) involved in Hollandse Luchten (rather than the wants and needs of other stakeholders like the Province of North Holland, RIVM, or even those of us here at Waag). We thus began to ask participants: What do you want to do with the data that you and your fellow community members gather?

The process to identify use cases was documented by the interviewer in the blog '[How do Hollandse Luchten participants use their air quality data?](#)'. Most generally, the process included phone interviews and a written survey (a live co-creation session had been our first choice to gather input, but was not possible due to Covid-related restrictions). Following from these interviews and surveys, we were able to organise participants' answers into four general use cases for Hollandse Luchten data:

1. Community knowledge sharing – Hollandse Luchten data can be used to help inform people in pilot communities about air quality and how it is measured.
2. Policy change – Hollandse Luchten data can be used to apply pressure to policymakers and advocate for policy change.
3. Personal insight – Hollandse Luchten data can help an individual to be more informed about the air quality and make decisions accordingly in their own living environment.
4. Transparency and accountability – Hollandse Luchten data can be used to check and contribute to existing air quality measurements (for example from Tata Steel and RIVM) towards an accepted shared reality about air quality in the region and keep the polluters and/or the government accountable.

After identifying the data use cases, we wanted to know what was needed in order to make them a reality. We collaboratively considered what was needed in each layer of the public stack per use case, re-designing a 'new' public stack mapping for each of the four use cases.

In the previous step, we identified four data use cases for Hollandse Luchten data. We wanted to know what was needed in the other stack layers (process, technology, and people) in order to make those data use cases a reality; what already existed in those layers that could be leveraged to help achieve a certain data use case; and how the other layers of the stack might change depending on which data use case we chose. For example, our detailed public stack mapping had identified gaps including the lack of an onboarding process for new communities, a potential sensor update, and the lack of governance mechanisms around elevating issues of concern. Given the newly identified data use cases, were these gaps still relevant? What issues should be prioritised?

To answer these questions, we made four separate public stack maps – one for each of the four data use cases. *If our data use case is 'x', then what processes, technology, and people do we need to realise that goal?* We created four large, blank public stacks, with a different data use case forming the foundation or 'x' of each. We created these new 'stacks' per data use case during a co-creation session with participants from Hollandse Luchten, noting which gaps we encountered and which existing aspects of the project we could make use of. The outcomes of this process are described in the blog '[Hollandse Luchten: Mapping use cases with the Public Stack](#)'.

The resulting analysis pointed to concrete recommendations per data use case (which are also found in the aforementioned blog). Our next and final step was to consider the commonalities between recommendations of various use cases to understand which common issues were faced in multiple use cases. These common issues form the basis of our priorities and recommendations, which we present in the following section.

Based on the gaps identified in the public stack mapping of each use case, we can make the following recommendations for Hollandse Luchten and its next steps towards participant-led autonomy and self-governance:

In terms of general governance of Hollandse Luchten, two main goals presented themselves over and over throughout our study: The desire for Hollandse Luchten to function well and practically; and the aspiration for Hollandse Luchten to be increasingly led by its community participants towards autonomy and sustainability. The following recommendations are intended to take initial steps in this direction:

- **Strengthen the role and responsibility of working groups:** Working groups already exist in Hollandse Luchten for technology, data science, and communications & community management. Representatives of the local sensing communities are already taking part in these working groups, which is an important first step, but there is room for further involvement from community participants both within the working groups and for those who utilise the working groups but do not take part in them. The working groups can be utilised as a route through which participants can communicate and escalate their issues and concerns.
- **Increase the activities on data analysis:** In all four data use cases, the need to create insight and build knowledge was seen as an important

precondition to move forward. Several formats were discussed: data analysis sessions, pro-active and frequent communication on data insights, and storytelling through strong data visualisations.

- **Increase recurring opportunities for contact:** This includes hosting trial sessions in design and data analysis; hosting recurring Q&A sessions open to all participants; and issuing more regular communication (for example in the form of biweekly data reports). Hollandse Helden could benefit from establishing a more central point of communication, such as a [Signal](#) group. In general, communications intended for all participants should be low-threshold and meet people where they already are (for example, via email or the *wijkkrant* [community newspaper]). Meetings or notifications based on data (as addressed in the previous bullet point) could also help to increase points of contact, for example by sending an alert when average air quality is poor, or by hosting a community walk outside when the air quality is good.
- **Work towards a shared reality:** In terms of technology, this may mean developing an improved and more reliable sensor, or bringing together existing data and visualisations into a comprehensible platform. In terms of communication, the communication working group could take a lead in interpreting and telling the story of the data through recurring co-creation sessions with all parties. Ultimately, all stakeholders – from Tata Steel to the Province of Noord Holland to local residents – should be able to draw shared conclusions.
- **Pursue a structured approach to policy change:** Clarify how Hollandse Luchten can be involved in formal governance structures. A first step is to host meetings with relevant policymakers to develop a roadmap designating when, with whom, and at what level of government Hollandse Luchten participants can act within recurring policy cycles.

So, how *do* you govern a data commons?

We can make general recommendations for practitioners or other citizen science groups who are considering surrounding the governance of a commons or data commons. More generally, our findings apply to anyone who wants to practically approach anything through the lens of a data commons, as Hollandse Luchten does with air. There is no right answer, but one thing is certain: it requires governing much more than just the data. **Governing a data commons is primarily about governing the group and the (social) context itself, and secondarily about governing the data and the wider technological infrastructure.**

A first helpful step is to create an overview of the whole project, initiative, or piece of technology in order to note the various parts that need to be governed. We can recommend our public stack methodology as a way to get started when you are facing governance questions involving a complex ecosystem of values, processes, technologies, and people.

“Keep it simple, sunshine” (KISS) is another piece of advice arising from our work. This can be applied in many ways. Minimise rules, and do not over-govern or make rules before they are needed or for issues that do not yet exist. Similarly, avoid integrating complicated processes or digital tools to help organise decision making when lower-threshold means are possible – instead, try to meet people where they already are. Make expert knowledge accessible in early stages of a project, so that participants can easily discuss or analyse data together with those who have institutional expertise.

Keep the local community participants and communities central throughout the project. Make sure their needs and goals are the guiding principles and do not get sidetracked. If a project combines bottom-up empowerment with top-down facilitation, as is currently the case with Hollandse Luchten, then it is important to explicitly make space for local communities to be represented in the group’s governing structures and to dedicate explicit moments to check whether development is in line with their foundational goals.

All development – whether of a data commons, citizen sensing strategy, or ‘smart city’ initiative – is built upon foundational values. To develop technology is to take a stand and implement it. Hollandse Luchten’s core strength is that the community and facilitators consistently return to their foundational values; values like openness, inclusivity, and most explicitly, the shared desire for a better living environment. It is in this way that we hope a data commons, community project, or smart city initiative can learn from our research – to keep shared values at the core of decisions about design processes, technology, and to empathetically consider the cumulative impact that all of this has upon human beings.