Debiasing with foresight: A horizon scanning process on the digitalisation of research and policymaking

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Abstract: Research and policymaking organisations increasingly recognize the importance of digitalisation for both, their own operations and the transformations of their operating environment. The opaqueness and openness of digital developments ask for dealing with future uncertainty. However, biases distort the perception of changes and constrain the exploration of plausible and relevant alternative futures. This chapter explains and reflects how thinking about digital futures can be debiased with foresight. We present and discuss our conceptual design and empirical material building upon the three-year foresight project 'Environmental research and governance in the digital age' that we led as a contractor of the Federal Environment Agency. We co-designed a five-step horizon scanning process and integrated debiasing measures for each step thereby systematically mitigating six salient biases in futures thinking, among them the surveillance filter and the confirming trend bias. As a result, four success factors of debiasing with foresight stand out: eye-level foresight and digitalisation competences of both the contracting authority and contractor; co-creation of the scan field definition thereby reflecting different impact pathways of digitalisation; multiple flexibly adopted horizon scanning approaches encompassing semiautomated scanning, human main and fringe source analysis, interviews with radical thinkers and targeted meta-engine search; participatory sensemaking to leverage diverse and controversial external views in tailoring the future topics and anticipating different digital future trajectories and emerging issues. The suggested debiasing measures are systematically and explicitly integrated into the horizon scanning to ensure the novelty, relevance and validity of dealing with uncertain digital futures. The process yielded a disaggregated and multi-perspective view of digitalisation with its future topics, subtopics, and related emerging issues. Such a strategic compass for research and policymaking can stimulate organisational learning through a common reference. It should be kept modifiable and amendable to account for new insights into the dynamically changing panoply of digital phenomena.

Keywords: anticipation biases, integrated debiasing, hybrid human-automated search, participatory sensemaking, strategic compass

1. Introduction

Digitalisation is changing the way how organisations design, implement, and evaluate their activities. Pertinent definitions of **digitalisation** refer to improving, changing, and enabling processes through digital technology (e.g. Bitkom, 2016) or to the deep transformation that emerges from the interplay of social and technological digitalisation processes (e.g. WBGU, 2019). All kinds of organisations, policymaking government bodies in particular, recognise the importance of digitalisation for their own operations and are increasingly aware of its transformative effects on their environment and of the opportunities and risks entailed. The future impacts of digitalisation on government activities are uncertain, as the future is uncertain to a significant degree (e.g. Loveridge, 2008).

Foresight is the 'discipline of exploring, anticipating and shaping the future […] in a structured and systemic way' (EC, 2024). It is not about predicting the future but about dealing with future uncertainty and exploring different possible futures and strategic implications. A variety of foresight methods and approaches are available (Popper, 2008; Saritas, 2013), ranging from exploratory to normative methods, routing developments in the present (e.g. Horizon Scanning, Three Horizon Framework) or 'jumping' into the future (e.g. pictures of the future, shared vision). An understanding of foresight as a cycle of identifying current changes, imagining future changes, and promoting changes (action) is increasingly established (Cuhls, 2019).

Human perceptions of the future are biased. **Biases** can be defined as systematic distortions of perception that influence decision-making and judgement under uncertainty (Gigerenzer & Gaissmaier, 2011; Kahneman et al., 1982). The scholarship of psychology and behavioural economics has identified and examined a large range of unconscious biases in decision-making, some of which have been studied in relation to future change. For example, Ansoff (1975) identifies three perception filters that could lead to biases in the detection and assessment of weak signals of change: the surveillance filter structures an organisation's resource-constrained observation of its environment, the mentality filter shapes anyone's thoughts and judgements according to previous experiences, and the power filter distorts

the perception and judgement of the importance of weak signals through power relations and organisational and hierarchical routines.

Recognising perception filters that shape biases implies the need to widen those that structure our thinking about the future (Ansoff, 1975; Holopainen & Toivonen, 2012; Miller et al., 2012; Rossel, 2012; Warnke & Schirrmeister, 2016). In scenario building, biases analysed include 'group biases' leading to the conformity of participants and 'the end of history illusion' stating that people underestimate future change (Schirrmeister et al., 2020). The tendency to confirm one's own assumptions (confirming trends bias), the preference for positive trends (overconfidence bias), and the overestimation of predictability (overprediction bias) all contribute to biases in future-oriented thinking.

Dedicated foresight processes can be measures for debiasing a future-centred approach (Schirrmeister et al., 2020; Van Woensel, 2020). In our view, **debiasing** is a conceptual approach to make biases explicit and to provide measures to mitigate them and their impacts. For example, scenario workshop moderators can provide measures to stimulate thinking of alternatives and to create a communication climate to mitigate 'group biases' and 'the end of history illusion'.

Although there is a large body of research on the social, economic, and environmental future impacts of digitalisation (e.g. Muench et al., 2022; WBGU, 2019), there is little research on how digitalisation is changing the way knowledge is produced to inform policymaking (EC, 2023; Van Woensel, 2020). There is a substantial need for insights into how interactions between digital and other system transformations, the so-called 'wicked problem', could be addressed through strategic foresight approaches (Cork et al., 2023) and how typical biases in the perception and evaluation of signals of change in an organisation can be addressed (Schirrmeister et al., 2020).

In our chapter, we **aim** to contribute to making future thinking about digitalisation and related deep transformations less biased. By outlining the importance of debiasing with foresight when exploring digital futures, a conceptual contribution to the advancement of the field is made. We draw upon a **horizon scanning** study on environmental research and governance in the Digital Age developed for a public environmental agency that wished to analyse the consequences of digitalisation beyond its usual strategic considerations (see Acknowledgements). Horizon scanning comprises the systematic search for signals of change (e.g. events, trends, issues) and the assessment of their relevance, e.g. for policy implications (Cuhls, 2019;

Hines et al., 2019). Throughout the design, conduct, and evaluation of the results of this horizon scanning study, biases were identified, and debiasing measures were provided and applied. The scope of this endeavour is large, and there are valid studies on single issues of debiasing with and within foresight. However, such a comprehensive scope in the light of digitalisation, as presented here, is exactly what government bodies might increasingly ask from foresight practitioners. We conclude with an assessment of the novelty and added value of debiasing with horizon scanning and its transferability to other policy areas.

2. The approach to debiasing with horizon scanning

Two *research questions* guided the horizon scanning:

- What are the emerging digital developments in environmental research and governance?
- How is digitalisation transforming the policy organisation's context, and what impact could this have on future environmental research and governance?

To answer these questions, we developed and applied debiasing approaches for all steps of horizon scanning in order to minimise potential biases in exploring the two research questions.

a) Steps of the horizon scanning process on digital futures

In this subsection, we briefly introduce the principal steps of horizon scanning to the extent necessary to make the debiasing approach accessible to readers.

The horizon scanning process consisted of five major steps:

1. Scoping: The client's information requirements and the scan field were defined. The scan team was composed, and the scanning methods, channels, and sources were selected.
2. Scanning: The different scanning approaches were set up and conducted, and they delivered candidates for signals of change that were stored in a digital repository. The scan team routinely discussed the relevance of signals, the need for reframing signals, and the coverage of the scan field to redirect scanning activities.

3. Participatory sensemaking: This step involved moderated discussions with the contracting organisation and two co-creative, participatory workshops. The first was a workshop which clustered signals of change into future topics that have a certain weight in policymaking. The second was a workshop which involved experts and stakeholders in exploring emerging issue candidates.
4. Desk research: Future topics and emerging issues were analysed and validated through additional targeted desk research. Preliminary findings were sharpened and deepened, and the need for action was elaborated.
5. Foresight transfer: The results were condensed in the scan report (Erdmann et al., 2024). Workshops with the contracting authorities developed ideas for addressing the various signals of change and emerging issues in policymaking and everyday work. The findings of the horizon scanning are about to serve as a strategic compass for the digital future in the organisation's activities.

Throughout the process, possible biases were identified and addressed by specific measures.

b) Debiasing with horizon scanning

In preparation for an emerging digital society, biases could lead to the ignorance of relevant signals of change and their disregard for strategic decisions. Strategic foresight supports the handling of future uncertainty and, therefore, offers the potential for reducing biases in future thinking at the individual and organisational level (Van Woensel, 2020). Biases are also at play in foresight itself (Nestik, 2018), so it is not enough to apply foresight, but it is also important to select and combine appropriate methods for debiasing in foresight processes. In this particular horizon scanning, an innovative set of scanning methods was applied, and in this chapter, we assess its potential for debiasing.

Based on the literature analysis (see section 1), three perception filters shaping biases and three judgement biases relevant to foresight have been selected and addressed by debiasing measures:

- mentality filter
- power filter
- surveillance filter

- confirming trend bias
- overconfidence bias
- overprediction bias

Table 1 gives an overview of how different perception filters and biases in future-centred thinking were systematically addressed by debiasing measures in the horizon scanning process on digital futures. The implementation of the debiasing methods is then described following the five steps of the scanning process.

Table 1. Debiasing with horizon scanning – an overview

	Scoping	Scanning	Sensemaking	Desk research	Foresight transfer
Mentality filter	Co-design challenging the contracting authority's daily routines Diversity in the scanning team in view of disciplines and sociocultural disposition	Deployment of various complementary approaches, channels, and sources balancing specific weaknesses out Diversity in the scanning team regarding disciplines and sociocultural disposition	Diversity of workshop participants (experts and stakeholders) Co-creative workshop concept, moderated group discussions, stimulate dissent	Challenges mentalities through fringe source analysis and interviews with out-of-the-box thinkers	Clarify how to address clients in their daily work (keep them biased) or in separate formats (debiasing possible)
Power filter	Identify potential blind spots of power incumbents through intense questioning Diversity in the scanning team in view of hierarchies and eye-level communication with contracting authority	Detachment of the operational scanning from unwanted interference Value the contributions of juniors, newcomers, and other contributors with poor power	Diversity of workshop participants (strategic and technical level, non-academics and practitioners) Moderation to attract voices from all parties involved	Questioning the authority of usual suspects in the assessment of issues (consider lead users, revisiting blogs, and other fringe sources)	Involvement of different operational levels, strategic and specialist departments when discussing the potential for addressing emerging issues
Surveillance filter	360° scan of all possible domains Precise discursive delimitation of the scan field in cooperation with the contracting authority	Account for vast source semi-automated scanning 'scan the scanners' Targeted desk research to validate the initial findings of weak signals	Clustering of individual signals to identify emerging patterns and trends not visible from individual signals alone	Interdisciplinary experts desk research for validation of emerging issues identified in the workshops	Identify connections to ongoing work in the scan report and substantiate them with sources
Confirming trend bias	Consideration of all-encompassing and fringe	Combination of source types	Broad involvement of experts, foresight practi-	Challenge findings through external voices	Communication and transfer keep the future uncertain

	Scoping	Scanning	Sensemaking	Desk research	Foresight transfer
	sources detecting weak signals	Doubt is key within the scan team culture	tioners, involved and affected stakeholders	(e.g. interviews with visionaries)	Learn through reception by different audiences
Overconfidence bias	Variety of sources (different disciplines, media) Consideration of 'undesirable' and marginal sources	Search for signals of negative developments Doubt is key within the scan team culture	Application of the Three Horizon Model Workshop design leveraging pessimistic views	Reflection on underlying values	Propagate negative findings in the final results
Overprediction bias	Consideration of inconvenient and fringe sources challenging 'future certainty'	Search for signals of countertrends Doubt is key within the scan team culture	Application of the Three Horizon Model Workshop design leveraging alternative views	Search for signals of countertrends	Explicit link of emerging issues to current policy agenda and future mission of the organisation

Note: Compiled by the author

aa) Scoping

The aim of the horizon scanning was to identify signals of change driven by digitalisation that could have an impact on the field of action of the contracting organisation (Figure 1). First, digital technology itself is changing (e.g. maturity of quantum technology); second, digital technology is directly impacting the core issue under investigation (e.g. an organisation's processes are being digitalised); and third, the environment of the core issue under investigation – which is part of the wider society – is being digitalised (e.g. digital working practices), thus having an indirect impact on the core issue under investigation.

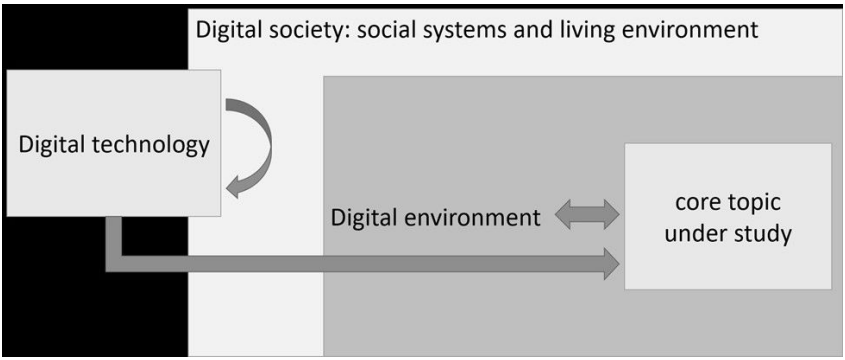

Figure 1. Generic scheme of digital change impact mechanisms (Erdmann et al., 2024)

The definition of the scan field included all three mechanisms of digital change. It covered 20 areas, ranging from the research cycle and the policy cycle (initiation, conduct, and evaluation/implementation) over digitalisation itself to social systems, such as education, and to the living environment, such as private life. The criteria for the search, selection, and assessment of signals of change were a) the relevance of the information for one of the three change mechanisms (Figure 1), b) the novelty of the information for current strategies and decision-making, and c) the coverage of the scan field.

The aim was to ensure the greatest possible diversity of expertise in the team and in the types of horizon scanning approaches, channels, and sources. To widen the filters of perception within the organisation, an interdisciplinary scan team was built, consisting of foresight experts with

additional expertise in media studies, sociology, economic policy, environmental science and technology, history, data science, semiotics, business studies, psychology, and policy research. Measures to mitigate biases in the set-up of the horizon scanning included the mutual challenging of mentality and power filters of both the contracting authority and the contractor.

bb) Scanning

The scanning process tapped five major source types: main sources, fringe sources (i.e. at the fringes of perception of the contracting authority), a vast digital news repository, interviews with unconventional thinkers, and a gap-closing targeted search with a meta-search engine. The objective of this source type set was to minimise the impacts of unconscious biases in main sources and to strengthen the validity of individual signals with multiple occurrences.

The semi-automated scanning exploited the vast digital news repository using an ontology of key terms, topic modelling, and the identification of highly relevant individual articles. It aimed at being as comprehensive as possible in detecting signals of change. The tapping of digital news was based on web scraping via the provider API-News.[1] Two separate corpora, one on general news (e.g. BBC, Hindustan Times) and one on science news (e.g. PNAS, *Nature*), were built. Search strings were defined by combing terms from the realms 'digital', 'research', 'governance' and 'environment' to scrape relevant content. The two scraped news repositories were analysed separately with and without accounting for the terms for 'environment'. For both, a natural language processing (NLP) approach was carried out to identify hidden topics from the two corpora of digital texts, which could not have been identified in the short time available using a qualitative evaluation. NLP has expanded the analytical capabilities of web scraping substantially (Goddard et al., 2021; Nemorin et al., 2023; Vignoli et al., 2022). The ontology, programming, interpretation of results, and iterative refinement are the human components in this hybrid human–automated search (Geurts et al., 2021; Krigsholm & Riekkinen, 2019). The findings from the automated search were evaluated by several experts regarding their novelty for the client and relevance to the action areas. Experts identified and conducted a detailed analysis of sources that contributed substantially to a topic.

1 https://newsapi.org/

In addition, digitally available primary and secondary sources that met the criteria of high quality, timeliness, and originality were evaluated (see Table 2). This expert-based activity covered main source exploitation (e.g. archives and specialist journal articles) as well as the search and analysis of so-called marginal or fringe sources. Fringe sources are sources usually not considered in the context of strategy development, e.g. podcasts, science blogs, special interest journals, or community platforms. However, they can be important sources for early signals of change as they look at developments from a less established perspective. Interviews with unconventional thinkers contributed to debiasing the confirming trend bias, too. Table 2 shows the source types selected, as well as their coverage and processing, to extract insights.

Table 2. Coverage of the dimensions of digital change and processing by main source types (own compilation)

Source type	Coverage (What?)	Processing (How?)
Digital science news repositories	Comprehensive coverage of digital technology and its applications	Web scraping, topic modelling, and analysis of most contributing sources
Digital general news repositories	Comprehensive coverage of digital society, more precisely, the digital environment of the core topic under study	Web scraping, topic modelling, and analysis of most contributing sources
Conferences	Deliberation of emerging digitalisation issues	Search and analysis of programmes and abstracts to identify premature emerging issues
Pre-print archives	Perception of emerging epistemic issues due to digital change	Search and analysis of principal articles at the fringes of scientific consolidation
Peer-reviewed journals	Perception of digital change in the core topic under study	Search and analysis of salient articles on the core topic under study
Foresight studies	Future assumptions on digital technology, digital society, and the core topic under study	Search and analysis of signals of change such as weak signals, wild cards, key factors, trend impacts analyses, and visions
Popular media	Insights into the living environment	Search and analysis of digital living practices
Social media	Deliberation of publicly resonating changes in the living environment	Search and analysis of speculative digital change

Source type	Coverage (What?)	Processing (How?)
Interviews with visionaries	Questioning future assumptions on digital technology, digital society, and the core topic under study	Exploratory interviews with a small set of open questions
Targeted Internet search	Coverage of subtopics on digital technology, digital society, and the core topic under study	Meta-search engine switching on and off certain dominant machines

The horizon scanning was carried out in iterations, identifying blind spots and new keywords that guided subsequent scanning activities, followed by desk research to validate initial findings. The scan team regularly reviewed results and modified the signal candidates. The diversity of sources and clarity of the scan field allowed for reflection and the recognition of the maturing of the search results. A long list of signals of digital change was produced, and each (e.g. cybernetic citizenship) was described in a short summary with various references providing evidence for the emergence of the development and noting why it should be considered novel and relevant for the future.

cc) Participatory sensemaking

The horizon scanning process identified roughly 70 pertinent weak signals of change. Sensemaking activities complement the scanning by participatory, multiple-actor, and stakeholder engagement in the assessment of signals of change and future assumptions (Rosa et al., 2021). The sensemaking aimed to formulate a smaller number of relevant future topics from the panoply of weak signals and to anticipate emerging issues. The aim of the debiasing was to minimise individual and group-related biases by leveraging and combining different perspectives and points of view.

Two co-creative and participative sensemaking workshops were designed, conducted, and evaluated:

- The cluster workshop aggregated and condensed signals of change to broader future topic candidates in an open process. These future topic candidates were later consolidated by additional desk research and internal discussion.
- The future workshop explored different developments of these future topics and identified related emerging issue candidates based on the Three Horizon Framework, which explores the strategic fit of current institutions (Horizon 1), emerging signals (Horizon 3), and innovating

institutions that account for emerging signals (Horizon 2) to the world as it is (Curry & Hodgson, 2008).

Both workshops ensured the relevance and directionality of the foresight in view of the organisation's activity field.

Debiasing efforts were supported through (a) the involvement of experts for the different topics addressed in the 70 signals both in interviews and/or participation in one or both workshops, (b) the engagement of topic experts and policymakers from the contracting organisation in both workshops, and (c) the choice of the workshop methods and setting (e.g. breakout groups, whiteboards to support visual thinking, moderated discussions). In total, 45 external experts were involved in the sensemaking workshops, alongside six experts from the policymaking organisation and five experts from the research team. The workshop participants' composition supported the reflection of the internal stakeholder perspective in light of the external perspectives from the policy field and from related research.

dd) Desk research for validation of the findings

The sensemaking results were transferred into a scan report. In addition, a cross-future topic analysis yielded a landscape of shared and specific emerging issues. The repercussions and implications of these emerging issues on the remit of the contracting organisation were represented in the Three Horizon Framework, which enables the visual integration of different futures routed in the present (Curry & Hodgson, 2008). Following an understanding of signals in horizon scanning as 'observations that trigger irritation and as an indication of possible changes' (Rossel, 2012, p. 236), the analysis of the future topics and emerging issues had to be related to other observations in public and other relevant discourses.

Debiasing was integrated into the research on the selected ten future topics and eight crosscutting emerging issues: First, by juxtaposing the assumptions from the sensemaking workshops with established discourses and positions on the topic; second, by rigorously applying the Three Horizons Framework (Curry & Hodgson, 2008) to promote consideration of emerging issues beyond business-as-usual future expectations; and third, by conducting targeted desk research including conforming and counterfactual search strategies.

ee) Foresight transfer

The integration of foresight into political decision-making (Da Costa et al., 2008) necessitates a comprehensive search for indications of change and the optimal involvement of actors and interest groups (De Vito & Radaelli, 2023). Possible obstacles to the development and adoption of future-oriented knowledge in any policymaking government body include a less open organisational culture as well as mental models and prejudices that lead to a reluctance to change or inhibit the development of new capacities (Mortensen et al., 2021).

The recognition of digitalisation for transformative change requires various systemic and dynamic capabilities (Borrás & Edler, 2020; Wu et al., 2015), including the ability to develop and test new policy approaches and anticipatory capacities. The establishment of such capabilities often faces a hierarchical and bureaucratic organisational culture. Such organisations' employees are typically preoccupied with well-defined and – to a certain extent – standardised operational tasks. Embedding foresight as a strategic activity naturally conflicts with these operational activities. Hierarchical organisations face challenges when collaboration in foresight is required across different departments. Foresight can either be set aside from the daily routines as an extra activity, or it reflexively feeds into and supports the daily work of employees as their roles evolve in the Digital Age.

The horizon scanning project material was reviewed, four open interviews for transfer ideation took place, and four virtual meetings were held with the contracting organisation to explore options for the transfer. These deliberations resulted in more than a dozen ideas on how to position the results of the horizon scanning within the organisation. Each concept elaborated on specific goals, target groups, and the estimated time and effort needed to adopt the horizon scanning results in daily work. Concepts developed ranged from low-hanging formats such as signal cards over the adoption of a strategic compass to outreach to other organisations.

The landscape of weak signals, future topics, and emerging issues was used to develop a strategic compass for an organisation that considered embedding its activities intentionally into the dynamic landscape of digital change. In addition to the two layers (future topics and emerging issues), the organisational remits, its departments, and operations represent a third layer of accessibility to digital change. In the digital pilot application of the strategic compass, there is a possibility to switch between the three different layers to identify the most suitable lens through which digital change is

viewed. The strategic compass is principally open to incorporating new future topics and emerging issues – and their relationships – into the established knowledge base. It allows for a systematic and transparent treatment of digital change, enabling organisational units to contribute to and benefit from accumulating experiences in dealing with digital change.

3. Reflection on debiasing in the horizon scanning process

The foresight process served as a pilot for the exploration of digital change and its implications in the policy area of the contracting organisation. It was **co-designed by the contracting organisation and the contractor**. Both sides disposed of substantial foresight literacy and were able to mobilise experts in certain newly identified realms (contractor) and actors of relevant organisational units such as the strategy department and the digitalisation department (contracting organisation). The process minimised future biases through measures consistently integrated into every step, from the set-up and conduct of the horizon scanning to the participatory sensemaking and validation of the findings in view of the foresight transfer. It addressed transformative policy goals, improved the quality of insights with transdisciplinary expertise (digitalisation and systems transitions) and collective intelligence building, supported by mutual learning between different actors and stakeholders, and thereby increased the legitimacy of the outcome for policymaking and research decisions.

A few insights from **this particular horizon scanning** on digital futures stand out: the added value of a concise scan field, the need for multiple flexibly adopted approaches to identify signals of change, and the participation in sensemaking. The concise scan field design was instrumental in relating the vast amount of information on digitalisation to concrete realms and provided orientation throughout the project. While the discovery of new signals was guided by cognitive dissonance, the assessment of signals onto the scan field was guided by resonance, thereby reducing the large number of signal candidates to a manageable set. The particularities of this scan field included a reflexive consideration of the changes of digitalisation, as well as the two impact pathways of digital change on the organisation's remit (Figure 1). These were either direct, in terms of research and governance, or indirect, in relation to the digital change of its environment (e.g. the development of digital work skills as a precondition for future recruitment).

A horizon scan produces a snapshot in time but could also be conducted repeatedly or continuously. The contribution of semi-automated scanning and of the other approaches to the outcomes differed. The semi-automated scanning of digital sources yielded results for digitalisation that made it difficult to distinguish the signal from the noise – in contrast to successful semi-automated scanning in other realms, such as biotechnology. The main reason is that terminology around the concept of digitalisation is contained in almost all digitally accessible documents.

Keyword combinations involving the concept of digitalisation and more specific topics such as artificial intelligence yielded useful single sources to be analysed in detail. However, there was still a great deal of noise in the entire repository of digital sources, so topic modelling rarely produced substantially meaningful topic landscapes. It was time- and resource-efficient to consider the other source types (Table 2) and to complement the search with a targeted search machine enquiry that made use of newly identified terms that emerged from sources identified in the topic modelling.

Meanwhile, web scraping bots have improved: Their harvest can be assessed to which extent single sources contribute to meaningful outcomes, which is key to machine learning algorithms that guide the web scraping bot to ever more useful sources.

The composition of the scan team and the involvement of expertise from the contracting organisation and other organisations proved to be key success factors for the interdisciplinary nature of the outcomes of the sensemaking and – finally – for the development of transfer formats. The evaluation of the signals using participatory sensemaking methods is a necessary but demanding task. The involvement of suitable experts contributed to a high degree of accuracy and differentiation of the future topic at hand. The dialogue formats delivered meaningful future topics and emerging issues; however, continuity of participant engagement was not always ensured. The multi-actor future workshop produced a first map of emerging issues, assuming that current trends continue. Upcoming future workshops may take workshop participants further, perhaps involving the assumption that current trends radicalise or become mainstream fast (instead of continuation). The engagement of the various actors contributed to the legitimacy of the process, which in turn could increase acceptance of the outcomes.

4. Conclusion

A horizon scanning of digital change was carried out to derive insights into how the activities of an environment agency are changing and how to seize the opportunities for transformation opening up through digital change. At its core, **debiasing measures were integrated throughout the process** to ensure the novelty, relevance, and validity of the process and of the results. The emphasis was put on how digitalisation affects the ways by which science, policymaking, and daily operations of the organisation are carried out. Signals of digital change were identified and condensed into overarching future topics, and emerging issues were uncovered. Participatory sensemaking enhanced the validity and legitimacy of the findings. The result is the first monograph on research and governance in the Digital Age for a policymaking government agency.

The approach yielded a **disaggregated and multi-perspective view** of digitalisation and its impacts and opportunities accounting for future uncertainty. The monolith 'digitalisation' was decomposed successfully into future topics, subtopics, and related emerging issues. Depending on the organisational units, different facets are of interest. Concepts on how to position the foresight results strategically within the organisation have been developed and handed over. The development of the strategic compass was a collaborative effort of the contracting organisation and the contractor. The actual use of the strategic compass with its accessibility via future topics, emerging issues, or organisational units requires further evaluation.

Promising next steps in the **research of debiasing with horizon scanning** include the development and sharing of smart keyword combinations, as well as leveraging the power of bots to reduce the noise in the web scraped content through machine learning. Debiasing in foresight requires an open and constructive working culture in exchanges between the contracting authority and contractor. The composition of the breakout groups in workshops, as well as more radical methods to drive participants towards the future journey and mitigate biases in future-oriented thinking, have been taken up in recent foresight exercises.[2]

Although the contracting organisation is active in environmental policy, the foresight approach with its debiasing measures is generic enough to **inform organisations in other policy fields** on how digital change can

2 e.g. Horizon scanning of developments relevant to climate protection (https://www.isi.fraunhofer.de/en/competence- center/foresight/projekte/klimascan.html)

be accounted for in their strategy development and daily activities. The digital trends, future topics, and emerging issues can serve other actors from research (e.g. research funding bodies, research-performing organisations, transformative research institutions) and governance (e.g. civil society organisations, government bodies at various governance levels, NGOs, business associations) to reflect their remits under the conditions of digitalisation and to adjust their activities.

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