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Is sharing truly caring? Environmental data value chains and policymaking in Europe and Central Asia

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ABSTRACT

Access to high-quality, timely and comparable data is a prerequisite for any effective decision-making process and having such data available for the environment is absolutely fundamental to efficient and evidence-based policymaking. This article reviews the establishment of a Shared Environmental Information System (SEIS) in Europe and Central Asia to improve our understanding of how environmental data value chains are being employed to produce, share and use reliable data on the environment and whether this data is used in policymaking. Three sources of data are utilised to analyse whether relevant environmental data and information are being drawn upon by policymakers, namely, the 2019 SEIS mid-term review, SEIS Factsheets and SEIS Gap Analysis Reports. The results reveal that the pan-European region still faces significant data harmonisation problems, owing in part to differences in types and methods of data collection, data definitions and legislation. Whilst problems in some individual country's participation have persisted since the launch of the SEIS initiative in the pan-European region, the development and successful piloting of the SEIS self-assessment framework is considered as evidence of positive progress. However, it remains difficult to adequately assess to what extent the data flows covered by this study impact on policymaking, nevertheless, the analysis serves to highlight the interlinkages between environmental data flows, policymakers and environmental governance. In practical terms, the paper demonstrate a disconnect between data production and data use in policymaking and emphasises the need to both improve our understanding of the political determinants of data use and to further investigate how the uptake of environmental data and information can be facilitated in policymaking.

1. Introduction

Meaningful environmental data and information is essential for effective environmental policymaking at all levels of environmental governance. Without access to high-quality, timely, comparable and accessible data, it is impossible to make informed decisions about the environment (Beniston et al., 2012; Bilotta et al., 2014; Capalbo et al., 2017; Soomai, 2017; Mollenhauer et al., 2018). The importance of environmental data and reporting is enshrined in many policy initiatives and instruments at the international, regional and (sub)national levels. Examples include reporting obligations for Multilateral Environment Agreements (MEAs), such as the Convention on Biological Diversity (CBD) and the assessment reports of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC), European Union (EU) reporting and monitoring of environment legislation, such as the Infrastructure for Spatial Information in the European Community (INSPIRE) Directive, Habitats and Birds Directives, as well as regional (or country-specific) reporting obligations, such as the Alpine and Carpathian Conventions. These policy instruments create data flows that provide the basis for a plethora of governments, organisations and institutes to monitor and report on progress towards environmental targets and objectives. As such, these data flows are an essential part of national and international policymaking, or at least they should be, in theory.

One interesting example that showcases the complexity underlying the production of environmental data is a Fitness Check that was conducted by the EU in which it addressed as many as 181 reporting obligations for 58 pieces of legislation (EC, 2017). The Fitness Check proved to be something of a double-edged sword as it demonstrated that data value chains in the EU are yielding the necessary complex and

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in-depth information but the sheer quantity being produced places a significant administrative burden on the reporting countries. This report gives rise to several interesting questions, such as whether current data flows are being adequately used in environmental reporting and, perhaps more importantly, whether all this environmental data and information is being used to improve the state-of-the-environment by policymakers? Even setting aside the inherent difficulties of establishing an (internationally) comparable data flow, which essentially concerns data production, harmonisation and reporting, questions remain over the actual uptake and use of relevant information (de Haan, 1999; Köhl et al., 2000; Pearce and Smith, 2011; Aggestam, 2019). The Fitness Check's results also raise questions as to why all this data is being produced and whether these efforts contribute towards improving human wellbeing and that of the wider environment. The focal point in this regard is the relevance of data governance and that data production is not only limited by the data content and infrastructure involved in its production. In other words, all the elements in an environmental data value chain are intrinsically interconnected and should be of equal import. However, adding to the complexity of the situation is the fact we find ourselves in an era of alternative facts and the increasingly subjective (and selective) use of data in public discourse, which means that environmental data and information is given varying degrees of relevance across governance systems.

Despite what may seem a gloomy outlook for data producers, quality, access and sharing remain high on the political agenda both in Europe and around much of the world. The truth of this as far as Europe goes is demonstrated not only by the Fitness Check on EU monitoring and reporting obligations (EC, 2017) but also by work on the European cloud initiative (EC, 2016), open access in science (EC, 2012), digital science (EC, 2013a, 2013b) and big data (EC, 2018; Zotti and La Mantia, 2014). Another prominent example is the INSPIRE Directive, which constitutes the backbone of a European wide spatial data reporting system, and presently one the largest data harmonisation efforts of environmental information infrastructures in the world (Kotsev et al., 2015). These initiatives demonstrate that data is seen as fundamental to efficient and evidence-based policymaking, irrespective of the policy domain and level of governance. However, while environmental agencies – both public and private – collect and process massive amounts of data, relatively little is still known about how this data is being utilised to improve policy (Head, 2015; Rose et al., 2017; Aggestam, 2019).

Given the enormous scope of data-focused policy initiatives, this article is restricted to a review of the Shared Environmental Information System (SEIS) in Europe and Central Asia. The purpose of the paper is to contribute to a better understanding of how environmental data value chains and associated policy instruments are being employed to produce, share and use reliable data on the environment. The paper applies a definition proposed by BDVA (2017) whereby the data value chain covers data: (1) generation and acquisition, (2) analysis and processing, (3) storage and curation, as well as, (4) services and visualisation. We inquire whether ECE[1] countries are producing and sharing increasing amounts of environmental data under SEIS and if the resultant environmental data flows contribute towards better policymaking and, more fundamentally, whether data sharing genuinely provides for better environmental policymaking.

2. The Shared Environmental Information System (SEIS)

2.1. SEIS pillars

SEIS can be described as a set of seven principles,[2] operationalised as a distributed environmental information system that is connected and integrated with the help of modern technologies (ECE, 2016b, 2019c, 2019a). Three SEIS pillars (content, infrastructure and institutional cooperation) have been defined to reinforce the importance of linking environmental data flows, networks, policymakers and governance:

- Content comprises all the data and information necessary to understand the changes in the state of the environment per specific thematic areas (e.g., air, water, waste) and the links between them. Such data needs to follow agreed-upon common format requirements, at least for the data and information included in an international data flow.
- Infrastructure includes all the e-tools and e-instruments that facilitate providers sharing data and information so that it can be accessed by users, including experts, who analyse the information and then re-share it for further use. Such infrastructure comprises IT platforms, software, standards, methodologies, policy agreements and protocols for data sharing and exchange.
- Institutional cooperation (networks) refers to all the holders of relevant data at the various levels that need to be enabled to simultaneously become data, information and even assessments providers as well as users under SEIS. This pillar includes issues such as the development of and amendments to the legal framework, data policy agreements and protocols to enable data exchange, cooperation and coordination all while ensuring the trust-building process continues.

Notably, efforts to improve data content, cooperation, and infrastructure, across the ECE region to date have fundamentally focused on the comparability and interoperability of environmental data sets at the appropriate geographical scale. This is why the seven SEIS principles and the international standards applied through the ECE environmental indicators are the backbone of the SEIS framework in the ECE region. The INSPIRE legal framework also uses international standards as building blocks of the European interoperability infrastructure. For more information on SEIS, the reader is referred to EC (2008, 2013b), ECE (2016b) and (2019c), Aggestam (2019) and Mangalagiu et al. (2019).

2.2. SEIS progress reporting

SEIS implementation in the ECE region is assessed by the United Nations Economic Commission for Europe (ECE) Committee on Environmental Policy (CEP) and its Working Group on Environmental Monitoring and Assessment (WGEMA). The first SEIS progress report was published in 2016 and is based on the review of 67 data flows that should be accessible in common formats and standards (Aggestam, 2019; ECE, 2016b). The report found that there had been progress across the region in terms of countries' capacities to provide environmental information, meet reporting obligations and increase public accessibility. For example, it was noted that 32 out of 50 ECE countries covered by the report had increased the online accessibility of environmental data flows during the assessment period in 2015 (ECE, 2016b).

From a data perspective, the report highlights the potential of SEIS as a policy instrument in implementing greater cooperation in the ECE

[1] All United Nations Economic Commission for Europe (ECE) Members States are listed here: http://www.unece.org/oes/nutshell/member_States_representatives.html.

[2] Data should be: (1) managed as close as possible to its source, (2) collected once and shared with others for many purposes, (3) readily available to easily fulfil reporting obligations, (4) easily accessible to all users, (5) accessible to enable comparisons at the appropriate geographical scale and the participation of citizens, (6) fully available to the general public and at the national level in the relevant national language(s), and (7) supported through common, free, open software standards (see EC (2008, 2013b)).

region in setting up a shared framework for environmental data collection. However, it also outlines the challenges facing SEIS's implementation, such as the lack of interest from some countries in the ECE region and their inability to take into account internationally accepted standards for data production and quality. The report also underlines gaps among ECE Member States, such as the necessity to achieve and then maintain high levels of SEIS performance through continuous and regular data production, the publishing of environmental information online and the need for greater cooperation between environmental authorities and national statistical agencies.

The most crucial aspect of the report is however that it reveals significant and persistent challenges in developing comparable environmental indicators across the ECE region, even though the SEIS indicators are based on long-standing international reporting obligations. This is directly related to the sub-optimal use of information, particularly where comprehensive data flows are not being used adequately in support of policymaking or where there is selective use of statistical information. In a nutshell, the findings show the subjective and biased use of environmental information, often for political purposes, rather than an objective embrace of widespread evidence-based policymaking.

2.3. SEIS assessment framework

In response to the SEIS progress report, the SEIS assessment framework was reviewed, revised and piloted with the aim of developing a mechanism better capable of monitoring countries' performances, such as including the three SEIS pillars (content, infrastructure and cooperation) and the expansion of the review criteria (ECE, 2018a). The updated assessment framework includes a self-assessment questionnaire with 25 questions (15 mandatory and 10 non-mandatory) that were answered by the countries in the ECE region when carrying out a mid-term review on SEIS's establishment in 2018. Moreover, the expansion of the assessment framework means it now includes seven categories, namely, relevance, accuracy, timeliness and punctuality, accessibility, clarity, comparability and institutional as well as organisational arrangements. It also describes how a performance score for the regional assessment of progress in establishing SEIS in the ECE region is calculated. Several review criteria for quality assurance were introduced and these now provide for a more comprehensive assessment process through which national SEIS performance scores can be calculated. For more information on the SEIS assessment framework, the reader is referred to ECE (2018a).

3. Approach

This paper used two data sources to assess whether the quality of the environmental data and information produced by countries has improved and if it is being used by policymakers. First, we carried out additional analysis of the data collected for the mid-term review on establishing SEIS (ECE, 2019c) as well as the data from the first progress report on SEIS that was outlined above (ECE, 2016b). The data analysis, as based on the SEIS self-assessment by countries (ECE, 2018a), provides the backbone for reviewing the added value in having shared data value chains. Subsequent to this, results from a sub-regional case study based on a number of SEIS factsheets and SEIS gap reports – as outlined below – were reviewed and integrated to complement the overall analysis.

3.1. Data collection for the mid-term review

The SEIS mid-term review was carried out against seven data flows underlying ECE environmental indicators, covering three indicators and three environmental themes (see Table 1).[3] Notably, this contrasts to the first SEIS progress report which covered 49 environmental indicators (based on 67 related data flows) categorised into seven environmental themes (ECE, 2016b). The scope for comparison is thus somewhat limited.

Data collection was based on the SEIS self-assessment questionnaire and data analysis for the mid-term review report, which was conducted in the second half of 2018. It should be noted that more details on the analysis can be found in the Annex to the mid-term review report (ECE, 2019c). Self-assessments were submitted by 34 European and Central Asian countries out of the 50 ECE countries covered by the first SEIS progress report.[4] Of these 34 countries, 30 submitted results for all 7 data flows and answered all 15 mandatory questions, while 19 also answered all 10 non-mandatory questions for at least one data set. Four countries did not answer some of the mandatory questions for one or two data flows. All questions are available in ECE (2018a).

3.2. SEIS factsheets and gap analysis reports

The analysis is complemented with a sub-regional case study on the Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine), the Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and the Russian Federation. The case study is based on not only factsheets produced by the ECE[5] but also on data collected for the ENI SEIS II East project[6] in 2018 (ECE, 2019b) which aimed to continue the implementation of the SEIS principles and practices in the Eastern Partnership countries and was funded by the EU via its European neighbourhood instrument. Finally, additional data on 7 of the 12 countries are provided by the Central Asia regional synthesis report (ZOI, forthcoming) and SEIS gap analysis reports produced for Armenia, Georgia, Kazakhstan, Kyrgyzstan and Tajikistan in 2019.[5]

Each factsheet synthesises the state of SEIS implementation in the relevant country in 2018. Concretely, it assesses the state of application of the 7 SEIS principles, identifies the organisations responsible for collecting, producing, managing and sharing environmental data and information, the state of production and sharing of environmental indicators, the quality of the seven data flows based on self-assessed in the mid-term review and the use of environmental indicators. Finally, each factsheet assesses the country's potential to achieve the 2021 target on ECE indicators' availability and SEIS implementation - as set out in the Batumi Declaration. The SEIS gap analysis reports[5] were produced for an ECE project designed to improve environmental monitoring and assessment in support of the 2030 Agenda in South-Eastern Europe, Central Asia and the Caucasus (ECE, 2018b).

We focus here on the use of environmental indicators and SEIS for policymaking by the 12 countries analysed, namely, their use in environmental assessments and state of the environment reports as well as the implementation of the Sustainable Development Goals (SDGs) at the country level and in the potential to achieve having SEIS meaningfully established in Europe and Central Asia by 2021.

4. Results and analysis

The data from the SEIS mid-term review was grouped under the SEIS pillars (content, infrastructure and institutional cooperation) and addressing each data flow (see Table 1). Some of the main findings are

[3] The ECE environmental indicators: https://www.unece.org/env/indicators.html.

[4] Albania, Armenia, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Estonia, Finland, France, Germany, Georgia, Hungary, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Montenegro, Poland, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Sweden, Switzerland, Tajikistan, North Macedonia, Turkey, Turkmenistan, Ukraine and Uzbekistan.

[5] See https://www.unece.org/environmental-policy/environmental-monitoring-and-assessment/areas-of-work/shared-environmental-information-system.html.

[6] See https://eni-seis.eionet.europa.eu/.

Table 1
Data flows used for the SEIS mid-term review.

Theme	Indicator	Data flow
A. Air pollution and ozone depletion	*A2. Ambient air quality in urban areas*	Annual average concentration of PM10 – validated Annual average concentration of sulphur dioxide – validated Annual average concentration of nitrogen dioxide – validated Annual average concentration of ground-level ozone – validated
C. Water	*C10. BOD and concentration of ammonium in rivers*	Mean concentration of BOD5 in major rivers Mean concentration of ammonium in major rivers
D. Biodiversity	*D1. Protected areas*	Total protected areas (by International Union for Conservation of Nature categories)

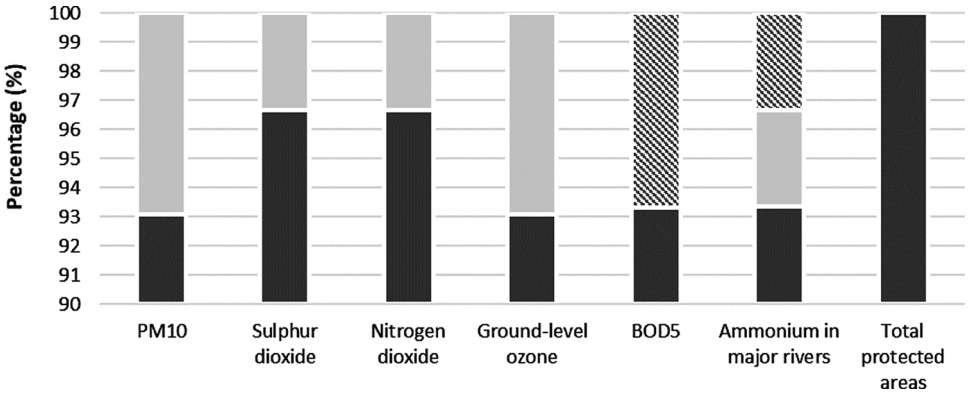

Fig. 1. Using data for more than one purpose.

set out below.

4.1. SEIS content

The questions associated with SEIS content cover factors ranging from the relevance of the data to whether it is published regularly and clearly (see ECE (2018a)). Overall, countries throughout the ECE region reported that virtually all of the seven data flows are being produced at the national level (90 per cent). From the available data flows, it can further be noted that almost all the countries (95 per cent) specified that the data was being used for multiple purposes (see Fig. 1), including but not limited to, reporting obligations under EU directives, MEAs and for national state-of-the-environment reports as well as for policymaking and dissemination to the public. Despite some variation across the data flows, this suggests that most countries adhere to the SEIS principle of collecting data once and then using it for many purposes.

It can also be noted that while most countries have regularly improved the available data flows over time, the use of data pertaining to nitrogen-dioxide, PM10, sulphur dioxide, BOD5 and ammonium in major rivers remains somewhat problematic. On a more positive note, data validation procedures are generally in place and the data is (often) systematically compared with data from other sources and regularly revised. For example, BOD5 and ammonium in rivers are systematically compared in about 80 per cent of the cases, however, the performance for ground level-ozone, nitrogen dioxide, PM10 and sulphur dioxide and total protected areas is lower. Regular revisions of the data occur in only 65 per cent of the cases, while for the total protected areas it drops to around 40 per cent of the cases. These variations and shortcomings suggest that further improvements are needed for all 7 data flows if the reporting countries are to succeed in effectively implementing SEIS by 2021.

Concerning how and whether the data flows are being published, primary data from public authorities are accessible in most cases (71 per cent) and a majority of countries specified that dissemination of data flows occurs on an annual basis in 70 per cent of cases regarding BOD5, ammonium in major rivers and total protected areas, while the figure for ground-level ozone, nitrogen dioxide, PM10 and sulphur dioxide drops to 55 per cent of cases. The degree to which information is presented in a clear and understandable form, released in a suitable format with supporting metadata and guidance, as well as whether procedures and guidelines for data quality management exist were also assessed. The results of this assessment demonstrate some variation with, for example, all countries reporting that procedures and guidelines for data quality management exist for sulphur-dioxide while data regarding total protected areas had the least available information pertaining to procedures and guidelines for data quality management. The same trend persists even if internationally agreed procedures are applied to the production of the data flows (e.g., the results show that internationally agreed procedures were applied in 72 per cent of cases, falling to 67 per cent for total protected areas). However, almost all countries reported that procedures and guidelines for data quality management exist (89 per cent) and that metadata is available for all seven data flows (92 per cent).

4.2. SEIS infrastructure

Concerning accessibility, it is interesting that 90 per cent of the data flows are readily available and accessible online, however, that proportion drops to 77 per cent for water-related data flows (see Fig. 2). There is consequently some variation across the data flows. It should further be noted that the countries, as members of the WGEMA, chose to focus on only seven out of 67 data flows (ECE, 2016a). These results are, as such, not fully indicative of the general accessibility of environmental data. In terms of publishing, the most popular formats were a variety of reports, such as state-of-the-environment reports and visual presentations (see Fig. 3).

Nearly all the seven data flows are readily available and accessible via online national platforms for users and most countries also reported that these data flows can also be accessed on integrated platforms (90 per cent). This suggests a positive development regarding the accessibility and availability of the data flows which, at least in part, is due to the efforts to

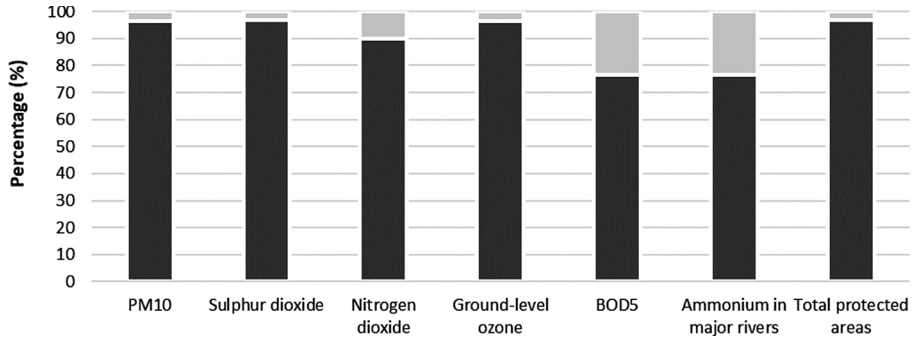

Fig. 2. Data flows online availability and accessibility.

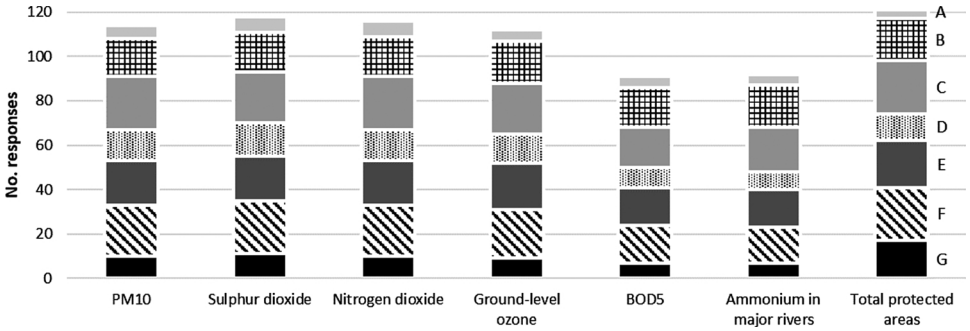

Fig. 3. Formats in which the data flows are presented.

establish SEIS. The varied formats (see Fig. 3) in which the indicators are available – ranging from SEIS production templates to visual presentations – would imply that the data can be easily re-used, integrated and re-distributed to a wide network of diverse users. This supports the argument that we see increasing interoperability of environmental data across the ECE region and, as noted in the SEIS content section, many countries have also established internal procedures, such as regular data validation (79 per cent) and revision processes (61 per cent) for all seven data flows. The prevalence of internal procedures for how to use and manage these flows implies that the trustworthiness of the data infrastructure has similarly increased. Nevertheless, some limitations have been reported, notably for BOD5 and ammonium in major rivers and total protected areas, where the results show that in 20 per cent of such cases primary data has not yet been made available and accessible for users. Inconsistencies have also been found in the self-assessments regarding the links provided for the respective data flows as many are not operational or do not indicate a relevant source or platform.

4.3. SEIS cooperation

Countries reported having national legislation, plans, programmes or strategies related to the production of the indicators as well as legal or institutional arrangements for regular sharing of data between various institutions at the national level (97 per cent). For the data flows involving ground-level ozone, sulphur dioxide and total protected areas, only one country reported that no national legislation, plans, programmes or strategies were in place for the production of the required data flow (see Fig. 4).

Notably, countries highlighted that the self-assessment questionnaire facilitated communication between data producers that normally do not share or exchange information and thus demonstrates the added value of the assessment framework as an instrument that can improve communication between data producers. However, it also highlights the need to improve the amount of inherent institutional cooperation between fragmented data producers and users as effective institutional and administrative capacities at the local, regional and national levels are crucial for the establishment of SEIS.

4.4. SEIS performance across indicators and countries

The results – as structured around the three SEIS pillars – demonstrate that there are different challenges associated with the respective data value chains. This supports the argument that solutions are contextually specific depending on the data flow and can range from issues such as missing equipment through to a lack of data validation procedures or even an absence of institutional cooperation. The SEIS performance scores (see Figs. 5 and 6), which are aggregated and weighted values based on how the various countries responded to the questionnaire (ECE, 2018a), further supports this assertion as the respondents varied significantly with regards to their overall SEIS performance (see Table A1 in the Appendix).

Since the results from 2019 only cover 7 data flows (see Fig. 5), this limits the generalisations that can be made concerning data sharing. Regardless, Fig. 6 integrates the 2016 and 2019 SEIS performance scores for 34 countries to emphasise some of the significant variations in performance when considering all the ECE data flows. The significant variation in performance cannot be attributed purely to a revised assessment framework as it is also impacted by the limited number of data flows accounted for in 2019. Fig. 6 additionally makes a distinction between EU Member States (hollow circles/triangles) and other European and Central Asian countries as some of the sub-regional variations highlighted in the 2016 progress report remain (Aggestam, 2019; Mangalagiu et al., 2019). More detailed information on how the 34 countries have performed across the environmental data value chains is available in Table A1 (see the Appendix).

Despite limitations inherent to the SEIS mid-term review, the updated assessment framework for measuring SEIS establishment indicates that significant progress has been made in terms of regional cooperation (ECE, 2018a, 2019a). The problems with the original review approach, such as no consideration being given to all three SEIS pillars, have now been addressed. The SEIS performance scores also demonstrate that concrete progress has been made in making harmonised environmental data available across Europe and Central Asia (see Fig. 6). These are encouraging results considering the significant challenges in developing uniform data flows across multiple countries with

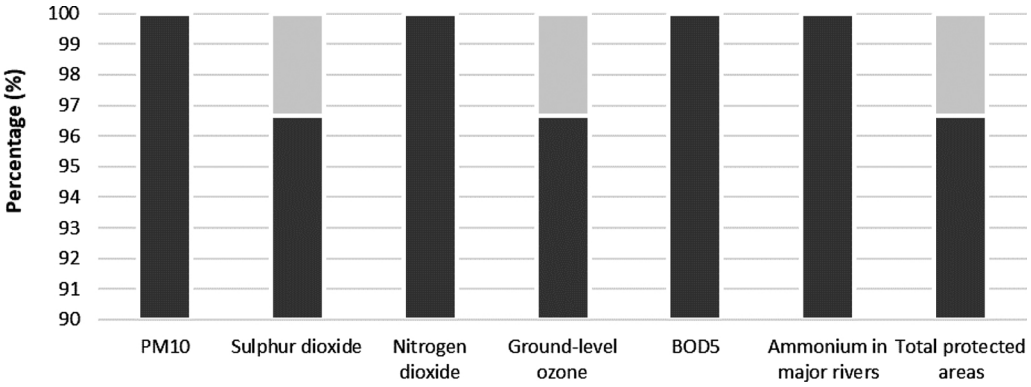

Fig. 4. Availability of national legislation, programmes or strategies for the production of data flows.

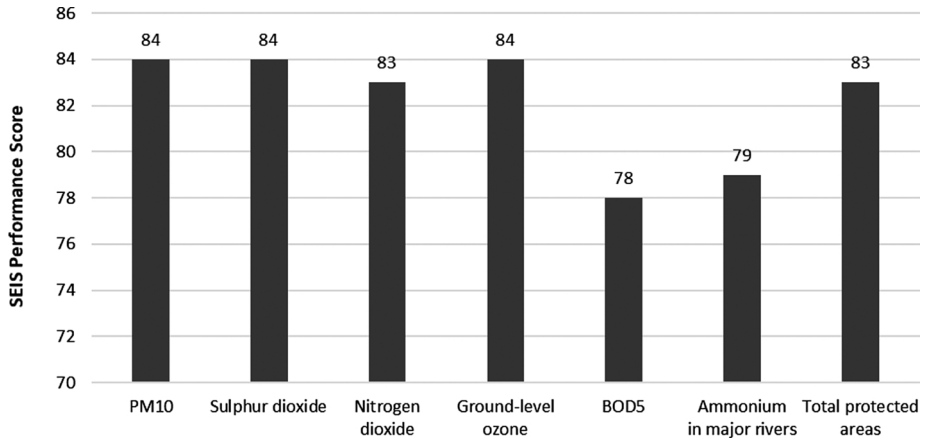

Fig. 5. SEIS performance scores by indicator.

significantly varied institutional settings, legislative frameworks and financing capabilities (Aggestam, 2019). Many challenges nevertheless remain and it can be noted, for example, that water-related data value chains (in this case BOD5 and ammonium in major rivers) are comparatively areas of underperformance (see Fig. 5). This is a result that was already apparent in the 2016 progress report (ECE, 2016b) and suggests limited progress has been made in these particular data value chains. Moreover, sub-regional variations also remain as countries in Central Asia, in particular, are still performing comparatively worse than the rest of the ECE region (see Table A1 in the Appendix). These variations provide a heterogeneous perspective on SEIS establishment.

4.5. The use of environmental indicators in Eastern Partnership Countries, Central Asia and the Russian Federation

The SEIS factsheets and gap analysis reports demonstrate that this cluster of 12 countries (see section 3.2) vary considerably in their use of environmental indicators in their assessments and state-of-the-environment reporting. For example, only Kazakhstan, Kyrgyzstan, the Russian Federation and Ukraine prepare national state-of-the-environment reports that cover ECE indicators. There are also large disparities between the 12 countries in their use of environmental indicators in other thematic environmental reports and statistical bulletins. Furthermore, several of the countries have such limited local and national capacity that they rely on international support for most environmental reporting, such as the ECE Environmental Performance Reviews. Another example are publications issued by the secretariat of the Aarhus Convention or by local Aarhus centres providing the basis for data series that underpin the ECE environmental indicators.

Environmental indicators are increasingly used by national governments, local communities and municipalities, natural resource users, scientific and higher education institutions, non-governmental local and international environmental organisations. However, this use is not necessarily uniform, for example, in Uzbekistan, Tajikistan and Kazakhstan, parliamentarians are among key users of environmental indicators, while in Turkmenistan and Uzbekistan public use tends to be restricted while disaggregated and province-level data is rarely disclosed in any of the 12 countries. Additionally, the factsheets and gap analysis reports demonstrate that the indicators are often linked to policy targets. For example, environmental indicators are linked to environmental policy targets in Belarus (defined as forecasts in the Environment Protection Strategy until 2025), Kazakhstan (National Strategy Kazakhstan 2050), Kyrgyzstan (National Development Strategy for 2018–2040), Republic of Moldova (Environmental Strategy for 2014–2023), Russian Federation (Environmental Protection Strategy to 2025) and Ukraine (State Environmental Policy until 2030). There are also data gaps which limit the use of relevant environmental data to monitor policy targets or contribute to policymaking, with one example being the limited availability of waste-related indicators in all 12 countries. All-in-all, while the analysis suggests that the implementation of SEIS principles and practices have strengthened regular environmental reporting, a detailed examination of how environmental indicators contribute to more effective and evidence-based policymaking is unconvincing.

It is further interesting to note how this group of countries use environmental indicators for reporting purposes in their Sustainable Development Goals (SDG). All 12 countries have developed SDG Voluntary National Reviews (VNR),[7] the first being conducted by Georgia in 2016, followed by Azerbaijan, Belarus and Tajikistan in

[7] See https://sustainabledevelopment.un.org/vnrs/.

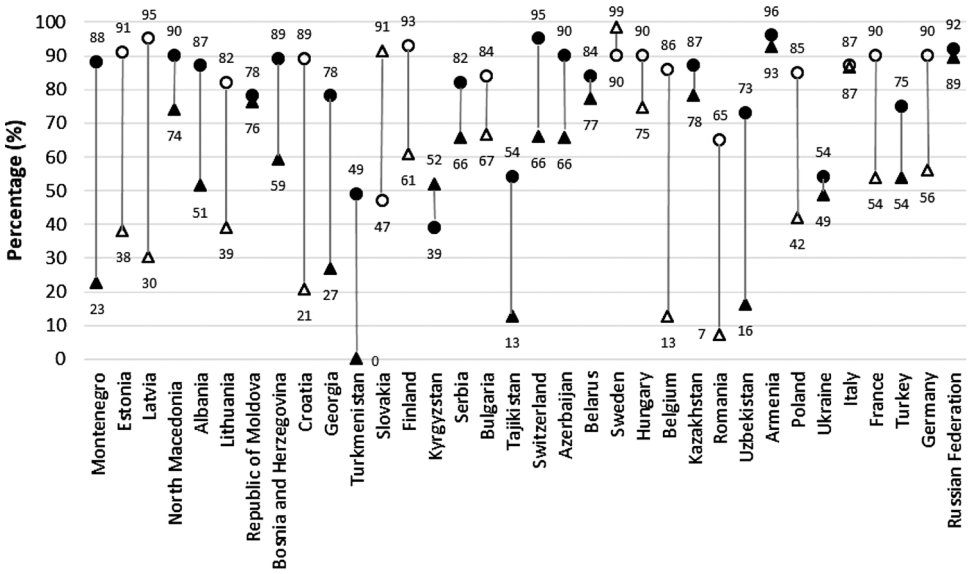

Fig. 6. SEIS performance scores in 2016 and 2019, by country.

2017, Armenia in 2018, Kazakhstan and Azerbaijan in 2019 and the remaining five committed to undertake them in 2020. According to the factsheets, all Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine) could potentially use 30–32 of the 36 ECE indicators to monitor SDG implementation at the national level. For example, in Armenia, 31 ECE environmental indicators were used to develop most of the national SDG indicators either directly or via proxy data that may not fully match the definitions of the respective global SDG indicators.

The most prolific user of ECE environmental indicators for SDG reporting among the 12 considered is Kazakhstan, which elaborated the environmental dimension of its new SDG indicator framework based on SEIS and 33 ECE environmental indicators to monitor its SDG advancement. This includes monitoring data for the period 2010–2017 and is supplemented with metadata and references to the data sources and to the government agencies responsible for generating the indicators. Georgia was one of the first countries to develop a VNR and its Ministry of Environment Protection and Agriculture took responsibility for the implementation of 11 global environmental protection indicators. However, in the 2019 gap analysis report for Georgia, no evidence emerged of the ECE environmental indicators being used for monitoring and reporting on its SDG nor of any adaptation of global SDG indicators to suit national conditions. The Russian Federation adopted 90 national SDGs indicators in 2017, including 15 environmental indicators. However, no evidence was found regarding the use of SEIS and ECE indicators and most of the national-level indicators are still being developed and will only be reported on in the forthcoming 2020 VNR. In Tajikistan, 31 ECE environmental indicators were chosen for its SDG reporting, but the gap analysis report could not determine whether the indicators were used in the development of national indicators for monitoring and reporting progress in achieving the SDG. Azerbaijan, in its SDG reporting in the second VNR published in 2019, no environmental dimension or indicator is considered a priority.

5. Discussion: towards a shared environmental knowledge base

One overarching purpose for having SEIS would be to bridge the data gaps between countries and to use this information to manage shared natural resources, such as water, air and biodiversity. Ultimately, this would apply to different regions or countries that share natural resources and that need harmonised data for effective shared management. Even though the results demonstrate continued progress is being made by countries in harmonising data, increasing accessibility and aligning national environmental indicators to the ECE indicators, the analysis also indicates that the development of a fully-functional shared knowledge base is still far from realisation. The mid-term review, the factsheets and the gap analysis reports reveal that the ECE region still faces significant data harmonisation problems, including varied classifications, different aggregation levels, as well as different identifiers and source data. For example, some countries provide data at their own specific and hence different levels of aggregation, which limits the capacity to compare and integrate the data for the entire region. These variations obviously have an impact on the usability, applicability and interoperability of a shared system of environmental indicators. Moreover, the problem of country participation in the mid-term review remains, as was the case for the 2016 progress report (Aggestam, 2019). What this tells us – in conjunction with the results from the review, the factsheets and the gap analysis reports – is that the establishment of SEIS in Europe and Central Asia has been assigned significantly varied levels of priority by the involved countries and has, as such, met with varying degrees of success.

The sub-regional case study demonstrates that all Eastern Partnership countries as well as the Russian Federation have been making significant progress in producing and enhancing the accessibility of the ECE environmental indicators and have the potential to achieve the 2021 target on ECE indicators' availability as well as on SEIS implementation. In Central Asia, while Kazakhstan is the leader in environmental information in the region and is well placed to achieve the 2021 target, Kyrgyzstan, Tajikistan and Uzbekistan will need to manifest considerable improvement to achieve the 2021 target while Turkmenistan has no potential to do so. Regarding the use of SEIS and ECE indicators to adapt global SDG indicators to the national level and report on each country's SDG, while several countries among the 12 under review mention such use, we found evidence only for Kazakhstan which has elaborated the environmental dimension of its new SDG indicator framework based on SEIS.

The results do reveal progress since the 2016 progress report (ECE, 2016b; Aggestam, 2019), nevertheless, significant barriers still exist with regards to comparing data flows across the ECE region owing to differences in data collection, data definitions and legislation. These barriers also relate to the configuration and peculiarities of the monitoring networks that make up the respective monitoring systems for resources such as air, water, land and biodiversity. Moreover, given the abundant examples of good practices that are available, there are clearly still ways to improve the communication of indicators in terms of content, completeness of meta-information, the visual representation

of trends and patterns and, especially, the assessment of indicators in the context of environmental policy. This is apparent in that the data flows are most often used to produce different types of content (69 per cent) such as reports and visual representations. While this is a positive development, aside from the relatively low use of indicators in state-of-the-environment reporting, it suggests a disconnect between the availability of information on the environment and policymaking. This raises concerns about whether the knowledge generated by various bodies (e.g., public and scientific institutions), through the collection and processing of environmental data, is being used for evidence-based decision-making (Nativi et al., 2020). In fact, the analysis would suggest that improved knowledge sharing (e.g., through institutional cooperation and international reporting) is positively trending but this is not translating to an increase in the use of that knowledge.

More positively, countries have improved their infrastructure associated with data sharing which ranges from having integrated national platforms to the establishment of internal procedures for data validation and revision. The core issues reported by the 12 countries under consideration here are principally related to the absence of primary data, inactive or outdated links to the data flows and the lack of sources. These issues could be perceived as procedural challenges underlying the provision of data as they relate more to how data is being published online rather than the (physical) infrastructure or the lack of data. These variations reflect the different levels of data quality associated with the seven data flows and suggests that even though a country provides access to the data, as agreed, it does not mean that the data is of high quality or that it is timely.

Institutional cooperation at the international level remains active, such as between the ECE, the European Environment Agency, the United Nations Environment Programme and the Group on Earth Observations, however, the analysis underscores the need to improve cooperation between fragmented national data producers and users. This is emphasised by the fact that many national data producers are not communicating with each other, which may limit data relevance and applicability. The interaction between data producers, data managers and data users is another aspect of the same problem. Communication and cooperation is ultimately a key determinant in whether environmental data and information become a real tool to understand and manage environmental problems. The current state of interaction between data producers would suggest that countries would benefit substantially from improved inter-process communication on national environmental data value chains. For example, several countries highlighted that the self-assessment questionnaire facilitated communication between data producers that normally do not share or exchange information. Methodologically speaking, the development and piloting of the SEIS assessment framework is also an example of key institutional actors and countries cooperating successfully.

In summary, the results show that the next steps for SEIS implementation – both nationally and internationally – require improvements in concretely addressing the requirements of the three SEIS pillars of content, infrastructure and cooperation. In terms of content, the varied SEIS performance scores reveal that countries still need assistance in producing and sharing environmental indicators and data flows in supports of regular assessments and reporting. SEIS implementation can help to further streamline environmental reporting and to harmonise it with reporting formats used by other indicator-based initiatives (e.g., green growth). In addressing the infrastructure requirements, the assessment of information platforms (as part of the SEIS assessment) can help countries to improve both the effectiveness and efficiency of discovering, accessing and reusing nationally and internationally significant environmental data and information. Finally, with regard to cooperation, the continued need to review progress in establishing SEIS can not only help identify current and future data gaps but also act as a tool to maintain international cooperation while simultaneously improving national institutional cooperation.

6. Conclusions

This paper set out to question whether data sharing really provides for better policymaking on the environment. This has ultimately been a difficult question to address as we cannot link the state of the environment with the respective data flows that have been reviewed. Adding to this difficulty is the fact that the criteria for “better” policymaking are not only connected with the environment but also to socio-economic and behavioural factors that may affect environmental conditions on the ground. For example, even if pertinent environmental data is not used by policymakers, the raised awareness generated by simply having access to information cannot be underestimated, unfortunately however, it also cannot be quantified. Our analysis consequently emphasises how important the inter-linkages between data flows and policymakers are for improving environmental governance. Moreover, if we look beyond just content and infrastructure where a lot of work is being carried out, we still do not fully comprehend how environmental data and information is being used to improve the environment, an issue caused largely by missing evidence. More specifically, it is very difficult to assess whether relevant data flows have an actual impact on policymaking, this stands in stark contrast to assessing the availability of data or the quality thereof, which is comparatively easy to do. Data value chains are also framed by the political institutions that are governing (or using) the data flows. Environmental data production and sharing can ultimately be seen as a “chicken or egg” problem. In other words, does data need to be produced before policymaking takes place or does policymaking need to precede the data to understand which data needs producing? This is a highly relevant question as it relates to data fitness (e.g., are we producing the correct data) and data relevance (e.g., are we producing relevant data). However, this is a question that it is beyond the scope of this paper.

Even though SEIS is a non-binding policy instrument, it should be recognised that it has nevertheless had a concrete impact on the production and harmonisation of environmental data and information throughout the ECE region. The present analysis has demonstrated these improvements and highlights some core challenges that remain. Positive examples of SEIS’s impact include the improved regional and institutional cooperation that was needed to develop the SEIS assessment framework as well as significant progress in both the production of and enhanced access to ECE environmental indicators in many ECE countries. Having said that, challenges still remain and include limited country participation, varied data quality, as well as the limited use of environmental data and knowledge in policymaking. It should also be noted at this point that the present analysis is limited to a small number of data flows and it will, therefore, be interesting to see how countries progress when measured against a much larger set of data flows leading into 2021 and the Ninth Environment for Europe Ministerial Conference. However, if the present results are anything to go by, it would suggest that the Batumi target to have SEIS established by 2021 in Europe and Central Asia will not be achieved.

The key take-away message from this paper is that we need to further improve our understanding of the political determinants of data use and to more expansively investigate how the uptake of environmental data and information can be facilitated in policymaking. This is fundamentally connected with a series of largely human factors such as attitudes, subjective norms, perceived behavioural controls (e.g., costs and benefits) that invariably determine the willingness of individual policymakers (or institutions) to use pertinent data flows as well as the receptiveness of recipients, be they various individuals or groups, all of which form a part of this equation. While it may be possible to argue for more hardcoded requirements regarding the use of environmental data as a form of evidence-based policymaking, the present regulatory framework also illustrates that the “stick” is not necessarily more effective than the “carrot” in ensuring that data flows are utilised properly. Furthermore, forcing policy-makers to hear what the data says does not necessarily mean they will listen to it and rely on the provided data to

engage in more evidence-based policymaking. This highlights the disconnect between data production and data use and the widespread existence of non-evidence-based policymaking. To put it more bluntly, producing and sharing environmental data does not necessarily prove that we care sufficiently for the environment.

CRediT authorship contribution statement

Filip Aggestam: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing. **Diana Mangalagiu:** Investigation, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Table A1
National Performance Scores (*Source*: ECE (2019c)).

	A. Air pollution and ozone depletion *A2. Ambient air quality in urban areas*				**C. Water** *C10. BOD5 and concentration of ammonium in rivers*		**D. Biodiversity** *D1. Protected areas*
	Annual average concentration of PM10 – validated	*Annual average concentration of sulphur dioxide – validated*	*Annual average concentration of nitrogen dioxide – validated*	*Annual average concentration of ground-level ozone – validated*	*Mean concentration of BOD_5 in major rivers*	*Mean concentration of ammonium in major rivers*	*Total protected areas (by IUCN categories)*
Albania	87	87	87	87	87	87	87
Armenia	97	97	85	97	100	100	100
Azerbaijan	90	90	90	90	90	90	93
Belarus	90	90	90	90	85	85	60
Belgium	87	87	87	87	85	85	83
Bosnia and Herzegovina	90	90	90	90	92	92	82
Bulgaria	87	87	87	87	70	70	98
Croatia	90	90	90	90	92	85	85
Estonia	90	90	90	90	93	93	88
Finland	93	93	93	93	98	98	82
France	88	88	88	88	92	92	93
Georgia	80	80	80	80	78	78	68
Germany	100	100	100	100	73	80	77
Hungary	87	87	87	87	93	93	93
Italy	88	88	88	88	87	87	82
Kazakhstan	87	87	87	87	87	87	87
Kyrgyzstan	N/A	53	48	N/A	50	53	65
Latvia	100	90	100	90	95	95	97
Lithuania	85	85	85	85	80	80	73
Montenegro	100	100	100	100	77	77	65
Poland	97	97	97	97	62	62	82
Republic of Moldova	70	72	70	70	95	95	73
Romania	63	63	63	63	50	50	100
Russian Federation	93	93	93	93	87	87	95
Serbia	97	97	97	97	47	47	93
Slovakia	52	52	52	52	38	38	45
Sweden	87	87	87	87	93	93	100
Switzerland	95	95	95	95	95	95	95
Tajikistan	43	N/A	42	55	62	77	100
North Macedonia	93	93	93	93	83	83	93
Turkey	85	92	90	85	65	65	42
Turkmenistan	47	47	47	40	47	47	67
Ukraine	62	62	62	N/A	62	62	70
Uzbekistan	73	68	75	75	67	72	80

Abbreviation: N/A= Data not available; performance score for the indicator is assumed to be zero.
Note: Calculation of the performance scores is explained in the SEIS Assessment Framework (ECE, 2018a).

Legend

0%-50%: Requires improvement
51%-75%: Moderate performance
76%-95%: Good performance
96%-100%: Very good performance

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