

Open Consultation on the NPOS2030 Ambition Document

The foundations of the Netherlands National Programme Open Science (NPOS) are rooted in 2017, when the National Plan Open Science was signed by a large group of stakeholders from the Netherlands. The years to follow brought us all kind of developments in the transition to Open Science. Progress has been made in many aspects, more stakeholders joined the NPOS, new aspects of Open Science emerged, and on the international level the European Open Science Cloud was launched and the UNESCO Recommendation on Open Science has been unanimously adopted by 193 Member States.

All these developments, and the new insights they brought, are taken into account in this NPOS2030 Ambition document, which will form the first chapters of the new NPOS2030 Programme Description. It includes the NPOS Vision for 2030, Guiding Principles that underlie this Vision, a NPOS Programme Framework and its Key Action Lines. The NPOS2030 Programme will facilitate all national stakeholders to collaborate in realising Open Science, and to implement the Open Science practices in alignment with international initiatives, moving from science 'as is' to science 'as will be'.

In the process of writing this NPOS2030 Ambition Document many stakeholders were already asked to reflect. The NPOS Steering Board and the NPOS Advisory Board share the opinion, that general support within the community is of the utmost importance. Therefore, we seek further feedback on the NPOS2030 Ambitions, before the actions that are going to be carried out through the NPOS Programme are defined.

Aim of this Consultation and next steps

This Open Consultation aims to give all stakeholders the opportunity to reflect on the NPOS2030 Ambition Document. The feedback received in this consultation will help the NPOS Steering Board and the Programme Line Leads to start filling in actions for each of the Key Lines of Action for the coming years, thus creating a Rolling Agenda for the next decade. These actions will be discussed with the relevant stakeholders that will contribute by taking on this action to ensure that the ambitions are met.

The Open Consultation is online from November 22nd to December 22nd 2021. It can be found here <https://survey.surf.nl/index.php/493148>. The results will be shared mid-February 2022. After that, the NPOS Programme Leads will start filling in the Rolling Agenda.

The questions in this consultation are the following:

Do you agree with the following elements that are described in the NPOS2030 Ambition Document:

- The NPOS Guiding Principles;
- The NPOS Vision for 2030;
- The Programme Lines and the Requirements;
- The Key Lines of Action for the Programme Lines.

We appreciate any comments and suggestions to improve the four elements above. This will help us to make an ambitious national implementation plan for the next decade.

Karel Luyben, National Coordinator Open Science

Jet de Ranitz, chair NPOS Advisory Board

Stan Gielen, chair NPOS Steering Board

Open Science 2030 in the Netherlands

NPOS2030 Ambition Document

Version 0.8 | 22 November 2021

NPOS (2021) Open Science 2030 in the Netherlands – NPOS2030 Ambition Document – v0.8



Nationaal Programma Open Science, 2021. This work is licensed under a [CC BY 4.0 license](https://creativecommons.org/licenses/by/4.0/)

Preface	6
Summary	7
1 Vision on Open Science and Open Science practices	9
1.1 Introduction to Open Science.....	9
1.1.1 Defining Open Science	9
1.1.2 Guiding Principles.....	9
1.2 An integrated systemic approach to facilitate Open Science.....	10
1.2.1 Ambitions European Commission.....	10
1.2.2 Programme Lines in the NPOS2030 programme	10
1.2.3 Requirements to realise Open Science	12
1.3 Open Science in the Netherlands	14
1.3.1 Open Access	15
1.3.2 FAIR Data	16
1.3.3 Citizen Science	17
1.4 Vision: What Open Science will bring in 2030	18
2 Open Access	19
2.1 Mission	19
2.2 Key lines of action	20
3 FAIR Data	22
3.1 Mission	22
3.2 Key lines of action	23
4 Citizen Science	24
4.1 Mission	24
4.2 Key lines of action	26
Appendix: List of Abbreviations and Acronyms	30

Preface

The National Programme on Open Science 2030 (NPOS2030) aims to mark the next chapter in the Dutch ambitions to further Open Science. From the multiple, exciting demonstrators of Open Science we briefly highlight three. At first, in 2020 more than 70% of Dutch scholarly articles are openly accessible on the internet, contributing to more visibility and impact of Dutch research output. The rise of Open Access in the Netherlands comes with an increase of societal participation in scientific research (citizen science). Secondly, several large scale initiatives like ODISSEI and Health-RI have been successfully launched to facilitate single entry point access and to reduce fragmented data sources in a multi-disciplinary environment, illustrating that Open Science gives better science. Thirdly, in recent years we have seen eye-catching research initiatives of citizens. The widely known Ocean Clean-up has grown from a child's dream, a school project, to an operational vessel at the Atlantic.

What have these three demonstrators in common? They indicate a trend that Open Science facilitates the (re)use of research output within and across disciplines and that Open Science connects science to society and vice versa. Internet and digitalisation significantly impact knowledge creation and dissemination. Science must respond to the new trend and new digital technology and does so. This process of change is known as Open Science. As such Open Science is not new science, but a next step in the evolution of science. The European Commission has concluded that "Open Science must ultimately be embedded as part of a larger more systemic effort to foster all practices and processes that enable the creation, contribution, discovery and reuse of research knowledge more reliably, effectively and equitably." In this NPOS Programme we choose to concisely frame Open Science as a path leading from science 'as is' to science 'as will be'.

"The recent response of the scientific community to the COVID-19 pandemic has clearly demonstrated how Open Science can accelerate the achievement of scientific solutions for a global challenge." This conclusion was drawn by UNESCO in 2021¹, while also emphasising that "By encouraging science to be more connected to societal needs and by promoting equal opportunities for all (researchers, policymakers, and citizens), Open Science can be a true game changer in bridging the science, technology and innovation gaps between and within countries and fulfilling the human right to science." We embrace the UNESCO Recommendation on Open Science as a guideline to improve the quality of science and by placing the link between science and society at the heart of our Open Science activities in the Netherlands.

We acknowledge that besides impressive progression, new challenges lie ahead to make Open Science a success. We believe now is the time to give a follow up on the first National Plan for Open Science from 2017 with a new Programme inspired by a long-term horizon in 2030 to make the full transition to Open and better science and to connect science to society.

With this NPOS2030 Ambition Document we aim to identify the new Open Science challenges in the context of recent (inter)national developments and to use these challenges to articulate our ambitions. Furthermore, this Ambition Document serves to outline the Key Action Lines necessary for a successful implementation of Open Science in the Netherlands in the next decade. Feedback will be sought via an Open Consultation on the NPOS2030 Ambition Document, before defining the concrete actions that will be carried out through the NPOS Programme in a Rolling Agenda to be added at a later stage.

The Netherlands is among the leading countries regarding Open Science; a position we owe to efforts from stakeholders individually, and jointly under the NPOS flag. Building on this solid foundation, we will now accelerate this transition and achieve our Open Science ambitions in practice. While doing so, we will be open to learning experiences of the many stakeholders already involved across disciplines, institutions and society.

The NPOS Steering Board:
NWO, VSNU, NFW

¹ UNESCO <https://en.unesco.org/science-sustainable-future/open-science>

Summary

The foundations of the Netherlands National Programme Open Science (NPOS) are rooted in 2017, when the National Plan Open Science was signed by a large group of stakeholders from the Netherlands. The years to follow brought us all kind of developments in the transition to Open Science. All these developments, and the new insights they brought, are taken into account in a NPOS2030 Ambition document, which will form the first chapters of the new NPOS Programme Description. The NPOS Programme will facilitate all national stakeholders to collaborate in realising Open Science, and to implement the Open Science practices in alignment with international initiatives, moving from science 'as is' to science 'as will be'.

The key elements of this Ambition Document in short are:

The Guiding Principles

1. Scientific knowledge is a public good, and access to it is a universal right;
2. Open as early as possible, and closed when necessary;
3. Subsidiarity: each organisation implements Open Science within their local organisation and infrastructure in line with (inter)national guidelines on Open Science, in a federated fashion;
4. We stand for inclusiveness and invite all stakeholders to contribute;
5. Academic and digital sovereignty must be safeguarded via concerted action in the interest of transparent, inclusive and reliable knowledge creation.

Open Science 2030 in the Netherlands: the Vision

'By 2030, scientific knowledge will be freely available, accessible, and reusable for everyone. Open Science in the Netherlands will be embedded as a standard practice across all scientific disciplines from basic to applied sciences, in the natural, medical, social sciences and the humanities.

We will see diverse and transdisciplinary scientific collaborations and knowledge-sharing through deeper engagement with societal actors, improving the quality of science and scientific output.

The Netherlands has strengthened and expanded its leading role in Europe and beyond to change science for the better with recognition and rewards that do justice to scientific teamwork. We will see a stronger link with, and impact on, societal challenges and sustainable development goals.

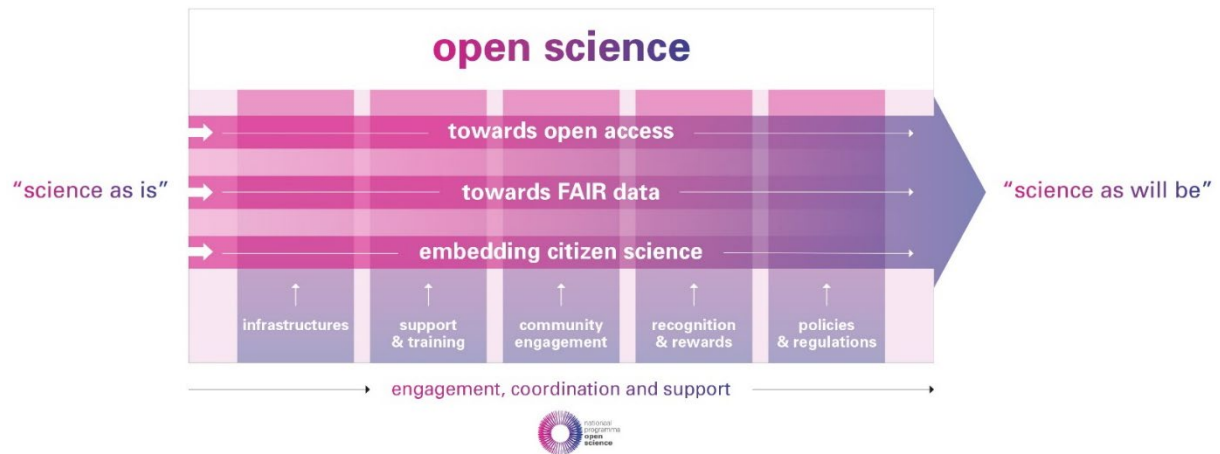
The scientific process will be transparent and inclusive, to the benefit of both science and society. A broader range of stakeholders beyond the traditional scientific community will be engaged with the research life cycle from agenda-setting, research performance to evaluation and communication of outcomes.

New ways to disseminate digital research results and protected sharing are at the heart of this transition process. The distinction between data and publications will become fluid as they will be published together or with links to each other. New scientific products will see the light, made possible through novel digital services. Journals will change form and format.

Digital research results will be the core of scientific output, supplemented by enriched meta data and publications according to the FAIR principles, public values, and academic sovereignty. This scientific output will be in a format that is accessible to and reusable by a wide audience.'

The NPOS Programma Framework

The NPOS Programme will focus on three Programme Lines and a set of requirements that together focus on realising availability of all scholarly output and open collaboration practices:



The three Programme Lines are not separate, distinct lines but are related, even increasingly overlapping in many aspects. Implementation of the three NPOS Programme Lines will be done in close alignment, to synchronise activities and build on each other's progress. The programmes will involve all NPOS stakeholders and will jointly address the set of essential requirements to implement an active Open Science ecosystem in the Netherlands.

Moreover, the decision to work with a Rolling Agenda in the coming decade will ensure the Programme is updated whenever new themes and challenges occur. Within NPOS, the Steering Board coordinates the Programme and its Programme Lines, and the actions outlined in its Rolling Agenda. It facilitates feedback from and interactions between key stakeholders across the Dutch scientific community and monitors the alignment of the Open Science activities in The Netherlands with similar initiatives elsewhere in Europe.

Key lines of action

In bundling and bridging national efforts, the following key lines of action are defined for the three Programme Lines, which will be increasingly overlapping over time:

Key lines of action: Open Access

1. Making all scholarly output Open Access;
2. Ensuring that society can reuse all scholarly output;
3. Cost control: full Open Access without additional costs;
4. Maintaining high quality and research integrity;
5. Novel ways of Recognition & Rewards, away from quantitative measures;
6. Control over ownership, public values, and academic and digital sovereignty;
7. Open services, growing towards less dependency on publishers.

Key lines of action: FAIR Data

1. Build a professional community of skilled data stewards that have a wide range of expertise;
2. Support, guide and incentivise the generation of sufficiently rich, standardized, open and machine-actionable FAIR digital research outputs and associated FAIR metadata to enable optimal (re)use;
3. Enable sustainable interoperable networks of FAIR Data services and research infrastructures at the institutional and domain level and national level;
4. Foster the development of a national trust framework for access to FAIR Data including sensitive and confidential data, in synergy among societal stakeholders.

Key lines of action: Citizen Science

1. Raise awareness;
2. Consolidate and further develop best practice;
3. Build capacity;
4. Enhance cooperation, synergies, and transdisciplinary collaboration;
5. Develop and invest in supporting infrastructures.

1 Vision on Open Science and Open Science practices

1.1 Introduction to Open Science

1.1.1 Defining Open Science

Open Science is defined by UNESCO (2021) as an inclusive construct that combines various movements and practices aiming:

- to make multilingual scientific knowledge openly available, accessible and reusable for everyone;
- to increase scientific collaborations and sharing of information for the benefits of science and society;
- and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community.

The shared objective of Open Science is to advance science, innovation and knowledge through a practice of openness, sharing, collaboration and co-creation.

1.1.2 Guiding Principles

To ensure that Open Science practices increase the quality of research and societal relevance and protect the interests of all stakeholders involved, we accept the following principles:

- 1. Scientific knowledge is a public good and access to it is a universal right**
This is worldwide agreed on and set in Article 27 of the Universal Declaration of Human Rights (United Nations (1948²)).
- 2. Open as early as possible and protected when necessary**
Open Science aspires for openness and reuse of knowledge and information. Aim is to include others outside the traditional scientific community as early as possible in the research process and provide access to scientific output as soon as possible (without embargo periods). In all cases, we adhere to the principle “comply or explain”.
- 3. Subsidiarity**
The starting point is that each organisation implements Open Science practices, support structures and internationally agreed standards within their local organisation and infrastructure in line with (inter)-national guidelines on Open Science. Unless stakeholders would choose to centralise resources in specific situations, the Open Science ecosystem and necessary support infrastructure will be set up in a federated fashion.
- 4. We stand for inclusiveness and invite all stakeholders to contribute**
Open Science aims to connect science and society. This can only be successful if all stakeholders are involved in the process to make Open Science work. This includes researchers, professionals and research institutions (universities, academic medical centres, universities of applied sciences, research and technology organisations, enterprises), funding organisations, publishers, service organisations, companies, NGO's, governmental organisations and citizens.
- 5. Academic and digital sovereignty³ must be safeguarded via concerted action in the interest of transparent, inclusive and reliable knowledge creation⁴.**
Digital sovereignty is the ability to autonomously take decisions and act accordingly to crucial digital aspects of a long-term future in economy, society, and democracy. Academic sovereignty is about the protection of an independent academic community in the interest of transparent and reliable knowledge

² https://www.ohchr.org/EN/UDHR/Documents/UDHR_Translations/eng.pdf

³ Digital sovereignty is the ability to autonomously take decisions and act according to crucial digital aspects of a long-term future in economy, society, and democracy. It is not restricted to having control over the use and design of crucial digital systems and their generated and stored data. Digital sovereignty must also be seen in the context of economic interest (control over crucial economic ecosystems) and society and democracy (trust in legal system and quality of democratic decision making). For academic sovereignty, see also https://vsnu.nl/en_GB/publieke-waarden-en-academische-soevereiniteit.html

⁴ <https://eua.eu/resources/expert-voices/250:safeguarding-academic-and-digital-sovereignty-a-model-for-action.html>.

creation, and the safeguarding of academic contributions to economy, society and democracy including public values.

1.2 An integrated systemic approach to facilitate Open Science

1.2.1 Ambitions European Commission

The road towards Open Science is characterised by reforms in many practices and activities throughout the workflow of researchers and educators. Hence, enabling the transition to Open Science requires an integrated and systemic approach at institutional, national and international level, working on a range of coherent topics and with all stakeholders. To structure our efforts, we follow the eight ambitions⁵⁶ on Open Science as described by the European Commission:

1. Open Data;
2. European Open Science Cloud (EOSC);
3. New generation metrics;
4. Future of scholarly communication;
5. Rewards;
6. Research integrity & reproducibility of scientific results;
7. Education and skills;
8. Citizen Science.

These eight ambitions are our starting point. We distinguish three Programme Lines (see next section) and for each Programme Line we address requirements and key action lines (see subsection 1.2.3).

1.2.2 Programme Lines in the NPOS2030 programme

Key to the Dutch Open Science strategy will be to facilitate access to and to optimise (re-)use of all forms of scholarly output and knowledge free of charge and without embargo periods, and to involve societal stakeholders and the public in the science and innovation process.

To facilitate access and optimise (re-)use, all digital forms of scholarly output⁷ must be made Findable, Accessible, Interoperable and Reusable according to the globally accepted FAIR Guiding Principles that have been conceived in the Netherlands early 2014⁸. This includes accompanying software and metadata as well as sources of 'meta-information' used in science policy development and research-assessment. Moreover, as much as possible, scholarly output should be made available under an Open Access license and free of charge. Arranging this clearly comes at a cost, as it requires infrastructure and services to support sustainable access to publications, data and software. But it also comes with returns: better and faster access for all and switching to sustainable and transparent budget models for publishing.

The large-scale and sustainable availability of scholarly output is essential for open collaboration with communities within the academic world and with society. The participation of societal stakeholders and the public

⁵ Similarly, the Open Science Policy Platform (OSPP) defines eight pillars of Open Science: (1] FAIR Data, 2] Research Integrity, 3] Next Generation Metrics, 4] Scholarly Communication, 5] Citizen Science, 6] Education and Skills, 7] Rewards and Incentives, and 8] EOSC.

⁶ https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en#8-ambitions-of-the-eus-open-science-policy

⁷ We define scholarly output as any element of research that can be represented as a digital object and can be made FAIR and accessible via an Open Access licence. This includes, traditional research articles, conference proceedings, monographs, academic books, open textbooks, open educational resources, raw data, analysed data-sets, data notes (with persistent links to accompanying datasets), software codes, software tools, software tool articles, study protocols, registered reports, and living systematic reviews (reviews that are periodically updated).

⁸ The FAIR Guiding Principles, published in 2016, were conceived as the result of a workshop at the Lorentz Centre in Leiden, the Netherlands in January 2014: <https://www.lorentzcenter.nl/jointly-designing-a-data-fairport.html>

should be fostered through Public Engagement and Citizen Science activities throughout the various stages of research and innovation processes.

The NPOS Programme will focus on the following three Programme Lines (see also Figure 1):

1. Open Access

The Programme Line Open Access focuses on the arrangements necessary to guarantee sustainable access to the Dutch scholarly output (and related software/metadata/meta-information) as soon as possible, free of charge without embargo periods under an Open Access licence.

2. FAIR Data

The Programme Line FAIR Data is geared to make all digital forms of scholarly output and associated (meta) data technically FAIR, so that as much as possible resources will be Findable, Accessible, Interoperable and Reusable for both people and IT systems. The FAIR Data Programme Line will unite all stakeholders in building up sufficient data stewardship expertise and capacity to realise and handle FAIR Data & services and to connect the Netherlands to the European Open Science Cloud (EOSC).

3. Citizen Science

The Programme Line Citizen Science (*societal participation*) focuses on furthering best practice and building capacity for the engagement of societal stakeholders and the general public in collaborative research and innovation processes, working in close alignment with the FAIR Data and Open Access Programme Lines to facilitate access to and contribute to the Dutch Open Science ecosystem. The Citizen Science Programme Line will support and grow the community of Citizen Science practitioners in the Netherlands by establishing and launching a National Network for Citizen Science, building a platform for knowledge sharing, and organising events that bring practitioners, academics, societal actors and policy makers together to develop new resources and collaborate on new initiatives.

Implementation of the three NPOS Programme Lines will be done in close alignment, to synchronise activities and to build on each other's progress. They are not three separate, distinct lines but related in many aspects. For example, scholarly output includes both *Open Access* publications and *FAIR Data objects*. And making sure that academic output is accessible according to FAIR principles to non-experts is critical for the success of *Citizen Science* and to the successful engagement of society in knowledge creation. Together, the Programme Lines are necessary to achieve our Open Science goals; the content and implementation of the activities in the Programme Lines should be tuned to ensure the success of each.

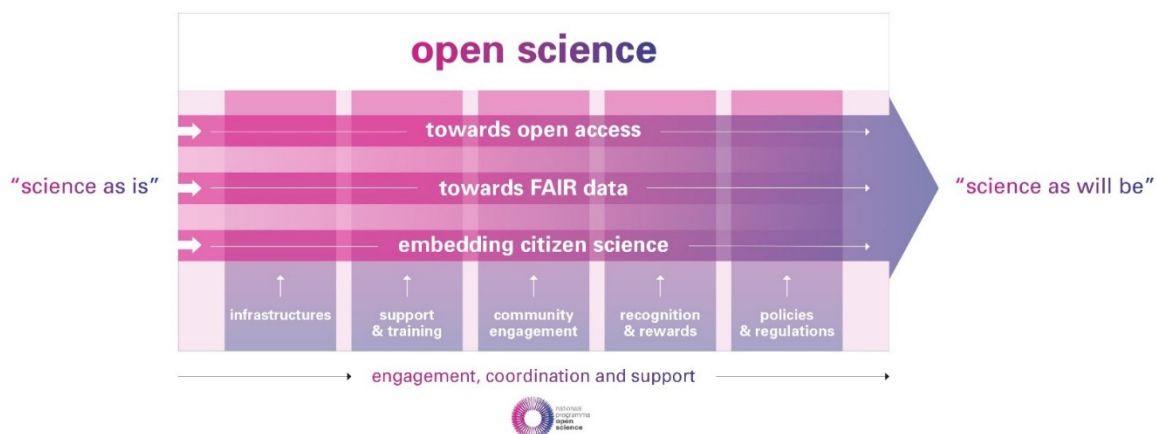


Figure 1: Graphical representation of the key elements of the NPOS2030 programme

Figure 1 might suggest that the full deployment of Open Science can be realised with three Programme Lines only. This is not the case: the topics Open Access, FAIR Data and Citizen Science have been taken up by the NPOS Steering Board as they require large investments and intensive coordination and alignment among partners in the Open Science community. There are many more important aspects on Open Science, such as

Open Education⁹, Research Integrity and Reproducibility of scientific results. Some of these topics have already been taken up by partners in the scientific community. Others are relatively new: we have to see how they develop and how they are related to other topics. In the upcoming period we will evaluate our progress, monitor new developments, and accordingly update our activities to achieve our goals. With this approach the NPOS Steering Board gives ample room for bottom-up initiatives, and takes the lead for new initiatives when necessary.

Implementing and embedding Open Science practices requires a change of culture in the scientific community and in society. Therefore, the Programme Lines will address a set of essential requirements needed for this culture change, and thus for implementing an active Open Science ecosystem in the Netherlands. These requirements have a value on their own but they each are necessary to achieve the goals of the three Programme Lines.

In short, these requirements are:

Make Open Science:

1. possible by implementing open **infrastructures** supporting Open Science practices;
2. easy by setting up **Support & Training**;
3. normative through active **Community Engagement**;
4. rewarding through incentives (**Recognition & Rewards**);
5. compulsory through **Policies and Regulations**.

1.2.3 Requirements to realise Open Science

To achieve the Open Science goals, the Programme Lines should meet the requirements¹⁰ mentioned in the previous section to ensure that institutions and researchers are able to practice the Open Science principles:

1. **Make Open Science possible by implementing open infrastructures supporting Open Science practices**

It should be possible for researchers and teachers to make scholarly output and research and educational materials FAIR (Findable, Accessible, Interoperable, and Reusable) and, as far as possible, open for all in an easy way without too much time investment. This requires (inter)national agreements regarding a technical and organisational infrastructure, which must be implemented in collaboration with all national stakeholders and (inter)national partners, in line with the European Open Science Cloud (EOSC) and innovative publication platforms. This infrastructure should facilitate the standardisation of workflows, open standards for the creation of metadata and the interoperability of research objects within and across disciplines, allowing geographically dispersed groups of people to collaborate across institutional and academic boundaries. In designing, implementing, and connecting research and education infrastructure, the principles of digital and academic sovereignty should always be upheld.

2. **Make Open Science easy by setting up Support & Training**

Researchers, teachers, and students should be familiar with the skills and knowledge to engage in Open Science and with the support provided by data stewards and research software engineers, data competence centres, and citizen science knowledge centres to fulfil the ambitions of Open Science. Open Science values and practices should be embedded in research groups and educational curricula and incorporated into policies, similar to the University Teaching Qualification (UTQ/BKO), to “facilitate and accelerate the transition that simultaneously realigns research and education and empowers

⁹ In addition many Open Science programs nowadays include and foster Open Education as part of Open Science. Research and academic education are strongly interwoven at universities and the re-use of open and FAIR scientific results in open textbooks and open educational resources are essential for students and those in lifelong learning programs. Moreover, open education is one of the strongest means to realise societal impact and should include Open Science practices next to Open Access output and FAIR Data and software. Open Education strengthens Open Science as a more open, transparent way of research such that scholarly output becomes useful/applicable (in addition to open availability). Currently, open educational resources form part of ‘The Acceleration Plan for Education Innovation with IT’ (www.versnellingsplan.nl/en).

¹⁰ Based on “Center for Open Science – Strategy for culture change”: <https://www.cos.io/blog/strategy-for-culture-change>

students for a transformative role after graduation.”¹¹. This requires professionalization of current scientific, support and teaching staff and the emergence of new roles like data stewards and research software engineers. Furthermore, the training capacity and training materials on relevant topics should be increased. Collaboration at a national level and a common training framework for skills and knowledge are key to ensure the effective use of teaching capacity and new resources.

3. Make Open Science normative through active Community Engagement

The transition towards an open academic culture requires a lively Open Science community of academics, support staff^{12, 13} and interested non-academics to create awareness of the Open Science principles and practices. Within local Open Science communities, members can learn from each other’s experiences and share their good practices for Open Science during events, workshops, and regular meetings. To explore and create a sustainable and equitable system of knowledge creation and sharing, societal stakeholders should be included in this transition. Next to this, engagement with society, for instance via Public Engagement and Citizen Science projects, should be encouraged to provide for open, inclusive and participatory processes for knowledge creation. This requires building capacity at knowledge institutions and creating and sharing best practices.

4. Make Open Science rewarding through incentives (Recognition & Rewards)

In the current academic environment, practices reflecting the Open Science values (ranging from sharing results, altruistic cooperation, and engaging with stakeholders outside academic institutions) are not the norm yet, as they generally are not rewarded. However, many societal challenges require transparency, inter- and transdisciplinary collaboration and close cooperation with actors in society, including citizens, entrepreneurs, policy makers and industry. To facilitate the transition to Open Science, reward structures should change in such a way that its values and practices are fit to improve the quality of science and its impact and are better recognized and rewarded^{14,15}; taking Open Science into account in the process of selecting new staff and evaluation for promotion of existing staff; and incorporating Open Science as point of evaluation in annual staff interviews and evaluations. To this end, concrete quantitative metrics for and qualitative evaluation of contributions (scientific output, as well as activities like leadership, mentoring, reflection, and teamwork) to Open Science values and practices need to be developed. This will be done in close collaboration with VSNU, NFU and other stakeholders, since Recognition & Rewards is an important topic in a broader context (also including aspects such as education, training and valorisation).

5. Make Open Science compulsory through Policies and Regulations

To safeguard scientific knowledge as a public good for collective benefit, it is important to consider its governance and retain (or retrieve) digital and academic sovereignty through the adherence to guiding principles¹⁶ and through supportive legislation and regulations at national and/or European level (e.g., on copyright retention and open licensing, European Knowledge Act). Universities and Universities of Applied Sciences can only make the transition towards Open Science if governments provide support at the international level (seek agreement on European policy) and at a national level by providing financial support for the transition towards Open Science that safeguard the position of universities and

¹¹ de Knecht et al. (2021) Reshaping the Academic Self: Connecting Education & Open Science: <https://zenodo.org/record/5345573>

¹² Open Science Communities: www.osc-nl.com, <https://www.openscience.nl/node/240>

¹³ Armeni, K., Brinkman, L., Carlsson, R., Eerland, A., Fijten, R., Fondberg, R., Heininga, V. E., Heunis, S., Koh, W. Q., Masselink, M., Moran, N., Baoill, A. Ó., Sarafoglou, A., Schettino, A., Schwamm, H., Sjoerds, Z., Teperek, M., Van Den Akker, O. R., Van’t Veer, A., & Zurita-milla, R. (2021). Towards wide-scale adoption of Open Science practices: The role of Open Science communities. *Science and public policy*, 1-7. <https://doi.org/10.1093/scipol/scab039>

¹⁴ VSNU (2019) Position paper Room for everyone’s talent: <http://vsnu.nl/recognitionandrewards/wp-content/uploads/2019/11/Position-paper-Room-for-everyone%E2%80%99s-talent.pdf>

¹⁵ Strategy Evaluation Protocol 2021-2027: https://www.vsnu.nl/files/documenten/Domeinen/Onderzoek/SEP_2021-2027.pdf

¹⁶ Guiding Principles on Management of Research Information and Data (2021): https://www.vsnu.nl/files/documenten/Nieuwsberichten/Guiding%20Principles%20on%20Management%20of%20Research%20Information%20and%20Data_11May.pdf

other stakeholders have joined. Within NPOS, the Steering Board coordinates the Programme Lines and the actions outlined in the action plan, it facilitates feedback from and interactions between key stakeholders across the Dutch scientific community and monitors the alignment of the Open Science activities in the Netherlands with similar initiatives elsewhere in Europe.

1.3.1 Open Access

Open Access and Open Science are both embedded in Dutch governmental policy. The ambition of 100% Open Access has been endorsed by all NPOS member organizations including all relevant research-performing organisations (RPOs) and research-funding organisations (RFOs). The Dutch Open Access policy has been very successful so far, with 71% of all peer-reviewed articles ²⁰published in 2020 under green, hybrid or gold Open Access, ranking among the highest worldwide. Worldwide, the VSNU/NFU library consortium (UKB²¹) has the widest coverage ratio in terms of transformative 'read and publish' deals²². The universities of applied sciences have developed a national platform to increase Open Access of their rich and diverse research outputs. Various studies have shown that Open Access publications receive more downloads, views, and citations, and reach a wider readership outside academia²³. This emphasizes the impact of Open Access and its relevance for the visibility and high impact of Dutch research.

Currently the implementation of Dutch Open Access measures is taking place at the organizational level with different approaches between umbrella organizations and knowledge institutions, each operating from its own perspective and with its own (often limited) means. For example, small institutions outside UKB (about 150) often have limited facilities and do not (fully) benefit from Open Access. Outside the UKB consortium, institutions pay full list Article Processing Charges (APCs) which are free for members from the UKB consortium. This situation can, and should be, improved by a stronger collaboration at a national level. Within the UKB consortium double dipping has been avoided through Read and Publish deals, which has led to considerable savings. In addition, the price per article in Read and Publish deals is considerably lower than the APCs for the same journals. Comparison with other international consortia deals shows that pricing in the Netherlands is lower than internationally. This situation illustrates the need for a national consortium including all RPOs and RFOs in national transformative deals to control the costs for read and publish and to increase visibility and impact of research in the Netherlands.

Monitoring expenses for all read and publish activities has become more urgent as the number of researchers and the number of publications worldwide is growing. The number of journals is increasing strongly, as is the number of articles that Dutch researchers publish each year (on average 4-5% per year). For the years 2020 and 2021, many publishers report an increase of 10-20%. As the Open Access transition shifts to paying for publication, the pressure on budgets for scholarly communication will increase with the increasing number of publications. The transition from a subscription-based business model for access to read scientific journals, to a

²⁰ According to Rathenau fact sheet 71% for all articles in the Netherlands are published as Open Access in 2020, 73% for articles published by universities and 85% for peer reviewed articles funded by NWO

²¹ Libraries of universities and academic hospitals together with The Royal Library of the Netherlands are closely working together in a strong consortium called UKB, already since 1976 (<https://www.ukb.nl/ambitions>)

²² In country overview of transformative agreements by ESAC, the Netherlands has the widest coverage, see <https://esac-initiative.org/market-watch/#TAs> (consulted September 2021)

²³ OA articles get 60% more views (Piwowar et al., 2019) and 18% more citations (Piwowar et al., 2018). See also recent Dutch analysis: <https://101innovations.wordpress.com/2021/03/09/open-access-citatievoordeel/>

- Open Access publications are read on average 2.7 times to 4 times more compared to publications that require payment to read. More than 43% of the readers are not from academia

(https://vsnu.nl/nl_NL/nieuws.html/nieuwsbericht/670)

- On average Open Access books have 10 times more downloads than non-OA digital books and get 2.4 times more citations according to a recent study of nearly 4,000 book titles. Other studies show that the range of printed versions (in terms of number of copies sold) lags far behind the digital OA versions (in terms of number of downloads).

model where society has free access to all scientific publications requires new business models. It also implies a re-distribution of available budgets at RPO's and RFO's.

The UKB consortium has centralised budgets for Publish and Read deals with major publishers and for supporting the green Open Access route through 'Taverne'²⁴. This proved to be important to reach transformative deals with the major publishers, but also explains why, for example, the Netherlands do not have national deals for full gold journals and publishers²⁵ and why there is room for improvement of our track record regarding Open Access publishing of other scholarly output (e.g. monographs, textbooks)²⁶. Moreover, sustainable and effective investments in non-commercial alternatives (diamond, subscription-to-open (S2O), contribution-to-open (C2O)) and alternative publication platforms are limited²⁷. With the support of NWO the KNAW has developed the platform Openjournals.nl to allow Dutch scholarly journals to transform to a (diamond) Open Access model and NWO has provided budgets to boost Open Access for books. However, structural funds for the latter two outlets are not available and as such the Dutch landscape tends to sustain the current publishing system in favour of the large publishers.

The supportive infrastructure for Open Access should be in line with public values related to academic sovereignty. Principles such as data sovereignty (control over data and intellectual property), interoperability and proper reference to origin (provenance) must be leading. This recognises the role of universities, university medical centres and universities of applied sciences as a vital knowledge infrastructure for society, open according to public and academic values²⁸. To date, digital sovereignty as a digital dimension of strategic autonomy has hardly been taken as a starting point for policy (e.g., Cyber Security Council, Dutch strategic autonomy, and cybersecurity, 2021). Establishing an 'open' infrastructure for all scholarly output involves many aspects, such as innovation of publishing platforms and renegotiations with publishers.

We remain fully committed to 100% Open Access to all scientific articles by Dutch authors. To achieve that goal, we broaden our Open Access ambitions to include all scholarly output (i.e. small international publishers, books, scholarly output in Dutch). We strengthen our efforts to innovate the publishing system by becoming less dependent on commercial publishers, jointly strive for diversification of business models and collectively support non-commercial publication platforms (including non-APC based Open Access models) in the context of different publication cultures (bibliodiversity!) for different disciplines.

1.3.2 FAIR Data

The globally accepted 15 FAIR Guiding Principles^{29,30} offer a beacon for the Netherlands Open Science Programme. The FAIR Principles offer guidance for scientists and for the new profession of data stewards in describing how to make digital scholarly output such as datasets, corresponding data-analysis software and

²⁴ The Dutch copyright law (Taverne Amendment) allows researchers to share short scientific works (e.g., articles & book chapters), regardless of any restrictive publishers' guidelines: <https://www.openaccess.nl/en/in-the-netherlands/you-share-we-take-care>

²⁵ <https://vsnu.nl/files/documenten/Domeinen/Onderzoek/Open%20access/Naar%20100%20procent%20Open%20Access%20%20tijdschriftartikelen.pdf>

²⁶ <https://vsnu.nl/files/documenten/Domeinen/Onderzoek/Open%20access/Naar%20100%20procent%20Open%20Access%20%20academische%20boeken.pdf>

²⁷

<https://vsnu.nl/files/documenten/Domeinen/Onderzoek/Open%20access/Alternatieve%20platformen%20als%20change%20agents%20van%20het%20publiceren%20versie%201.0.pdf>

²⁸ Open in this context not per se implies that services supporting such infrastructure are developed and maintained by public parties only. This includes both public and private services developed according to values and principles of public parties, as for example set in Guiding Principles for research information (see also https://vsnu.nl/en_GB/publieke-waarden-en-academische-soevereiniteit.html)

²⁹ Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018 (2016). <https://doi.org/10.1038/sdata.2016.18>

³⁰ <https://www.go-fair.org/fair-principles/>

associated metadata *Findable, Accessible, Interoperable and Reusable*. This optimally prepares data and corresponding data-analysis software for use across disciplinary domains with advanced solutions in data science, machine learning and Artificial Intelligence (AI), adding reference to the background and quality of the data used. In the framework of global Open Science programmes, a lively web of FAIR Data services arises based upon generic standards and systems to reward sharing, replacing the variety of data silos we are facing today due to a lack of incentives for sharing in the past. These days only a small fraction of scholarly output that could be made available through the internet, is actually accessible.

Creating a general practice of good data stewardship is key, and so will be building professional capacity in data stewardship. Under the auspices of the NPOS Programme 2017-2020, the groundwork has been done to define the competences, training, and education for the next generation of research data stewards³¹. Dutch universities, university medical centres, universities of applied sciences and other research performing organisations are now in the process of implementing the recommendations of the NPOS data stewardship competence and training framework in their policies. The research performing organizations play an important role to create ample room for capacity building of well-trained data stewards, connected with colleagues outside their direct team in a strong national data stewards learning community, where communities easily connect and understand each other's digital data. In addition, these organizations should provide a stimulating Open Science environment with proper incentives and rewards to value work and effort on curating and sharing data, moving away from the traditional career system where the classical impact factors for publications and citations were the main driver.

Data and other forms of digital output are the fuel of the shared research knowledge system for science envisioned in 2030. To realise a collaborative and transparent science ecosystem, well integrated in societal (public and private) sectors, it will be imperative to create a research culture and infrastructure in which data receive a royal treatment and are easily shared. Transition to such a FAIR-enabled research environment clearly requires positive incentives to be developed with the help of all stakeholders, with an important role for NWO and other research funders to design programmes that stimulate researchers to collaborate in multi-professional teams sharing their data. In 2019, NWO started a programme to help research performing organisations to implement a network of Digital Competence Centres (DCCs) supporting the local implementation of good data stewardship practices. This network of DCC's has developed fast and efficiently with great support from the universities. In 2021, NWO created an additional programme for domain-specific 'Thematic DCCs' to address domain-specific aspects of FAIR implementation.

To align efforts among all Dutch stakeholders, a FAIR Data Table has been set up under auspices of NPOS in 2021, to make an inventory and appropriate tuning of relevant FAIR-related initiatives in research performing and research supporting organisations.

1.3.3 Citizen Science

Thanks to the individual efforts and initiatives of many researchers and societal actors, the Netherlands has a prominent position regarding Citizen Science. It plays a pioneering role in some fields of research and sectors to promote and facilitate Citizen Science in universities, university medical centres as well as universities of applied science. Citizen science promotes societal participation in science, improves the awareness of the impact and relevance of scientific research, contributes to the quality of research, facilitates societal impact of research, and increases people's understanding of and involvement in the scientific process; it places social issues on the research agenda, offers action perspectives and provides inspiration for policy adjustments.

Opening access to data, publications, and other research products is necessary but not sufficient for the transition towards full Open Science. Citizen Science is an essential means for providing open, inclusive, and participatory processes for knowledge creation³².

³¹ Mijke Jetten, Marjan Grootveld, Annemie Mordant, Mascha Jansen, Margreet Bloemers, Margriet Miedema, & Celia W.G. van Gelder. (2021). Professionalising data stewardship in the Netherlands. Competences, training and education. Dutch roadmap towards national implementation of FAIR Data stewardship. Zenodo. <https://doi.org/10.5281/zenodo.4320504>

³²Wehn, Uta, et al. "Global citizen science perspectives on Open Science." (2020). https://en.unesco.org/sites/default/files/csgp_csos_cop_short_paper_on_open_science_may_2020.pdf

Citizen Science initiatives have – so far – lacked coordination at the national level, and support of Citizen Science within research-performing and research-funding organizations has been modest. In 2020, the National Programme Open Science Steering Board approved the report 'Knowledge and strengths combined - citizen science in the Netherlands (2020)³³' and its recommendations, which include the recommendation to form a sustainable national network for Citizen Science to make citizen science flourish. This has paved the way for various new initiatives, but financial constraints were the main stumble block for implementation of the recommendations in this report.

The vision of the Citizen Science Working Group is to further strengthen the already prominent position of the Netherlands in the field of citizen science through innovation and collaboration. The pioneering role of our country, thanks to individual projects in individual disciplines and initiatives from society, creates an excellent starting position. To anchor citizen science in the scientific domain and to promote cooperation between science and society, a next step is needed with a triple focus: on network development, promoting quality and supporting promising citizen-science initiatives across the whole domain of (applied) science. A major challenge is to structurally connect science³⁴ with citizen scientists and civil organizations to identify shared goals.

1.4 Vision: What Open Science will bring in 2030

'By 2030, scientific knowledge will be freely available, accessible, and reusable for everyone. Open Science in the Netherlands will be embedded as a standard practice across all scientific disciplines from basic to applied sciences, in the natural, medical, social sciences and the humanities.

We will see diverse and transdisciplinary scientific collaborations and knowledge-sharing through deeper engagement with societal actors, improving the quality of science and scientific output.

The Netherlands has strengthened and expanded its leading role in Europe and beyond to change science for the better with recognition and rewards that do justice to scientific teamwork. We will see a stronger link with, and impact on, societal challenges and sustainable development goals.

The scientific process will be transparent and inclusive, to the benefit of both science and society. A broader range of stakeholders beyond the traditional scientific community will be engaged with the research life cycle from agenda-setting, research performance to evaluation and communication of outcomes.

New ways to disseminate digital research results and protected sharing are at the heart of this transition process. The distinction between data and publications will become fluid as they will be published together or with links to each other. New scientific products will see the light, made possible through novel digital services. Journals will change form and format.

Digital research results will be the core of scientific output, supplemented by enriched meta data and publications according to the FAIR principles, public values, and academic sovereignty. This scientific output will be in a format that is accessible to and reusable by a wide audience.'

³³ <https://www.openscience.nl/projecten/project-i-citizen-science>

³⁴ In this document, science explicitly includes all fields of science, namely humanities, social sciences, science & technology and the medical sciences

2 Open Access

2.1 Mission

WHAT

In 2030, preferably sooner, barriers³⁵ to accessing, reading, and re-using all scholarly output³⁶ will have been removed in the Netherlands, such that any interested person (be they a member of a research community, a professional practitioner, an educator, or member of the public) can have access to and benefit from scientific output.

The supportive digital infrastructure includes both services provided by commercial and public (e.g., scholarly-led publishing initiatives, openjournals.nl, overlay journals, national repository for scholarly output) organisations. These services should be compliant with standards, principles and protocols protecting public values and digital and academic sovereignty in line with European-standards, guidelines and services (e.g. EOSC, cOAlition-S³⁷, COAR). Permanent findability for researchers and for the public in general is facilitated by an open knowledge base³⁸ which supports independent research-information as well as research-assessment (including high-quality analyses of societal impact).

To date, most scientists are evaluated mainly using criteria such as the number of publications, journal impact factors and number of citations. In the future, more emphasis will be put on quality of scientific and/or societal impact, compliant with Open Access regulations, in line with the new system for Recognition and Awards. This will reduce the publication pressure for scientists, and might even induce a reduction of the number of publications in favour of quality and impact.

HOW

We will establish a sustainable, innovative open publishing-infrastructure for all scholarly data. This infrastructure comprises a diversity of existing and new services that enable Open Access in support of academic independence, provide transparency in scholarship and maximize the impact of open access output to both science and society. We will establish Open Access deals with publishers for all stakeholders in the Netherlands and we will provide national support for scientists to comply with Open Access guidelines. This includes, for example, links to Gold journals for all scientific disciplines and links to the Directory of Open Access Journals (DOAJ) such that researchers can easily find appropriate journals to publish their results Open Access.

We will implement multi-track open-access policies supporting the various publishing routes (green, gold, hybrid and diamond, with the restriction that the hybrid model is a temporary, transitional model) and supporting long-term investments in open publishing services within a broad, national consortium. The transition from pay-to-read into pay-to-publish requires combining forces and resources between umbrella organizations, including reallocation of research budgets (especially those nowadays used to finance APCs, diamond and alternative platforms). This requires good coordination and monitoring and, if necessary, adjusting the Dutch Open Access strategy and priorities, accordingly.

³⁵ Traditional Open Access focuses on the financial and time barriers providing access as early as possible (preferably immediately) to publications at no costs for end-users. In addition, the legal barrier is addressed for users (CC-By licence on articles) and increasingly for those who publish (maintaining ownership, rights retention). For maximum re-use of all scholarly output other barriers exist such as easy findability for all, independent analyses and (societal) impact metrics, social and cultural barriers, and those that ensure an easy-to-understand access and pathways to quickly acquire knowledge (pedagogical barriers, to make output usable and applicable)

³⁶ Scholarly output includes next to traditional research articles, conference proceedings, monographs, academic books, open textbooks, data notes (with persistent links to accompanying datasets), software tool articles, study protocols, registered reports, and living systematic reviews (reviews that are periodically updated). Data and software are part of the FAIR Data program line, although some publishers (e.g. Free Journal Network) already require data to be published together with articles.

³⁷ <https://www.coalition-s.org/about/>

³⁸ https://vsnu.nl/en_GB/os_onderzoekinformatiesystemen-open-knowledge-base.html

Quotes from the NPOS Open Access Round Table session organised in the spring of 2021 to gather input for this document:

“More impact with fewer publications”
“Focus on quality instead of quantity of publications”

~

“I imagine a future where research outputs are shared on interoperable platforms and accompanied by tools and guides to aid those outside of academia access this ‘global pool of knowledge’”

~

“Open Access is important and national cooperation is needed for stretching goals”
“National consortium buys and organized OA publications for all researchers in the Netherlands, part of which (20%) will be published on alternative platforms”

~

“All outputs of science are accessible - not just no paywalls, but access to science knowledge without jargon”

~

“In 2030 Scholarly communications are open and understandable for scholars & others”

~

“Valuing all forms of research output and all forms of impact
No profits from either publishing or (facilitating) research assessment”

2.2 Key lines of action

1. Making all scholarly output Open Access;
2. Ensuring that society can reuse all scholarly output;
3. Cost control: full Open Access without additional costs;
4. Maintaining high quality and research integrity;
5. Novel ways of Recognition & Rewards, away from quantitative measures;
6. Control over ownership, public values, and academic and digital sovereignty;
7. Open up services, growing towards less dependency on publishers.

1. Making all scholarly output Open Access

Building on the first national Open Access plans published in 2017, the aim is to broaden the policy scope of scholarly output beyond peer reviewed articles. Broadening refers to the type of output (not only peer reviewed articles, but also proceedings, books, chapters, publications in Dutch journals, software) and also to the stakeholders; we aim at an expansion of the UKB library consortium to publish scholarly output Open Access using the transformative deals to all RPO's and RFO's and inclusion of new users such as in education. Moreover, we will continue and expand our efforts for Open Access publishing of books and infrastructure for papers in Dutch-journals. We will actively participate in international consortia to promote and support strategies and actions to achieve full Open Access worldwide.

2. Ensuring that society can reuse all scholarly output

Embedding Open Access within Open Science emphasizes access and findability of all scholarly output and the ability to use that output for societal impact, contributing to societal challenges and increasing public engagement. From an international perspective, this transformation should be beneficial for all research disciplines and target groups, including developing countries and less well funded scholarly communities. All barriers should be removed for access by researchers, professional practitioners, educators, or members of the public to the scientific literature.

3. Cost control: full Open Access without additional costs

In the next ten years publishers will have to change their business model in a transparent way to comply with the guidelines for Open Access without overall additional costs (flip without additional costs). In the new situation, where authors pay to publish, prices are related to the actual publishing costs. More transparency is needed from publishers on the costs for their services. During the transition period, monitoring will be important to prevent excessive financial spending and to assure high quality of scholarly output. And if we talk about costs for the academic community: this involves cash money, but also 'in-kind' investments (like, for example, reviewing and editorial activities).

4. Maintaining high quality and research integrity

The quality of scientific publications is primarily the responsibility of the scientific community. The mounting scientific output puts a high pressure on scientists, not only to publish, but also for review and editorial processes. This may be a potential threat in a market with increasing numbers of publications. Monitoring the quality of scholarly output is therefore a responsibility for the international community. Another aspect concerns improper and injudicious reuse, data theft and plagiarism, image damage, predatory publishing. This introduces actions related to innovating the scholarly publication landscape (e.g., open peer review) while protecting the quality process in producing output. It is related to the overall emerging Open Science theme of Research Integrity.

5. Novel ways of Recognition & Rewards, away from quantitative measures

Novel ways of recognition and rewards can also help to deal with cost control and quality issues, especially if the emphasis is on quality, rather than quantity. This will put the high publication pressure in a new perspective, and might lead to fewer, but (on average) higher quality papers.

6. Control over ownership, public values, and academic and digital sovereignty

Where providers of commercial services will increasingly have to act in accordance with the conditions/requirements of the academic world (and the public values of society), whether or not laid down in legislation and regulations. It also creates more scope and emphasis on investments in publicly steered open infrastructures (PPS and/or diamond-like constructions). Additionally, relevant legislation and regulations might be needed to safeguard public values and strengthen the position of RPOs.

7. Open services, growing towards less dependency on publishers

In order to become less dependent on commercial publishers, we seek diversification of business models and collectively support for non-commercial publication platforms (including non-APC based open-access models). Providers of commercial services will increasingly have to act in accordance with the conditions/requirements of the academic world (and the public values of society), whether or not laid down in legislation and regulations. It also creates more scope and emphasis on investments in publicly steered open services (PPS and/or diamond-like constructions).

Transformative deals with publishers have been made in several countries. In the Netherlands, the UKB consortium has been very successful. However, since different countries follow different strategies at a different pace, publishers hesitate to make the transition towards a pay-to-publish system at affordable and transparent prices. There is evidence that the hybrid model, with both subscription fees and APC's, has created a lucrative situation for publishers, using their massive profits not only to resist and delay research- and public-oriented reform, but also to develop a range of services aiming to develop vertical integration over the entire scientific process³⁹ to track academic users, funding, scientific papers and their underlying data without any involvement of the scientific community. Such a development brings the risk of vendor lock-in, since without open standards it will be technically and financially impossible to substitute a chosen service provider with another one. This would be in conflict with the goal of independency of publishers. In order to become less dependent on large international publishers, Dutch stakeholders will contact their European organizations (e.g. cOAlition-S, Science Europe, EUA, ALLEA, WHO) to send a clear message if follow-up on the transformative deals in Europe does not lead to new transparent business models for the publishers or when transparency and reduction of costs for read/publish do not seem feasible.

³⁹ Björn Brembs, Philippe Huneman, Felix Schönbrodt, Gustav Nilsson, Toma Susi, Renke Siems, Pandelis Perakakis, Varvara Trachana, Lai Ma, & Sara Rodriguez-Cuadrado. (2021). Replacing academic journals. <https://doi.org/10.5281/zenodo.5526635>

3 FAIR Data

3.1 Mission

The mission is to have a FAIR-compliant, federated data ecosystem in which data access across science domains and society is without-barriers.

WHAT

Optimal use and reuse of data is an important aspect of Open Science. Many players in the scientific field such as universities, university medical centres, universities of applied sciences, science domains, and science related initiatives collaborate in developing, strengthening, and professionalizing the Dutch data landscape. The NPOS FAIR Data Programme Line sets out to actively foster this process, and to enhance, consolidate, and sustain these collective efforts. In the end Dutch researchers and their science fields in general will greatly benefit from the steps towards optimal use and reuse of data outlined below.

Our goal is that in 2030, Dutch researchers will be adequately supported and knowledgeable about handling FAIR Data in their institutional, national, and international setting, incorporating the introduction of advanced data science and artificial intelligence technology where and when appropriate.

Hence, our ambition is that researchers and their digital systems can easily find, access, and combine interoperable datasets, software, and other research objects to process, archive, curate, share, analyse, and publish research data for verification and reuse. Existing data are FAIR and in a national catalogue; new data are FAIR by design; ownership and IP issues on data, metadata, and data services are clear, and researchers can use – and know how to use – data from other disciplines. Metadata will always be FAIR by design and open by default. All underlying data will be FAIR by design where possible, with restrictions for access when necessary. Rich and machine-readable FAIR metadata will allow judgement of usefulness, quality, and conditions for access via national, institutional, and domain-specific data infrastructures.

HOW

The national FAIR Data ecosystem will be built as a supported network of FAIR Data sources and services, including software, and will be set up according to a FAIR digital object architecture as part of the European Open Science Cloud. For many disciplines, data sources will be available for distributed analysis and learning; they will be centralised only when necessary.

Building data stewardship and FAIR implementation capacity will be one of the key success indicators of the Dutch FAIR Data approach. Education and training with a strong focus on professionalizing the data stewardship profession both in and outside the national scientific realm, are therefore essential. Local organizations and domain/discipline-specific initiatives will be facilitated to work with shared minimal standards to achieve machine actionability and interoperability. Research performing organizations have the in-house capacity and access to nationally organised expertise and services, to reuse data without barriers.

Stakeholders in the Dutch science community provide clear conditions for citizens and societal stakeholders to collaborate or otherwise get access to scientific data. A trusted framework of open standards and public governance guarantees prevention of vendor lock-in or potential monopolies by individual public or private entities.

Quotes from the NPOS FAIR Data Round Table session organised in the spring of 2021 to gather input for this document:

“Data stewards are the key experts to enable creation of FAIR Data and reuse of data. They are recognised as such by research institutes, funders, and policy makers. There is no discussion anymore about the need for sufficient DS capacity.”

~

“I would like that: 1) research questions that we have that require data become easily actionable, i.e. that the whole process of conducting data driven science and innovation becomes more seamless; this will lead 2) to improved (life science) research (disease aetiology, diagnosis, prognosis, therapy) with large societal impact 3) we can not only learn from data, but also give the knowledge “back” to citizens and patient, e.g. guide a healthy lifestyle and study the impact of interventions.”

~
“Well-trained is the keyword”
~

“We are definitely converging more than before, and this is important to really implement Open Science.”

3.2 Key lines of action

In bundling and bridging national efforts, we have defined four key lines of action to fulfil our mission of a FAIR-compliant, federated data ecosystem and realise the 2030 NPOS Vision. These four key action lines are connected in a national FAIR Data Strategy:

1. Build a professional community of skilled **data stewards** that have a wide range of expertise;
2. Support, guide and incentivise the generation of sufficiently rich, standardized, open and machine-actionable **FAIR digital research outputs** and associated FAIR metadata to enable optimal (re)use;
3. Enable sustainable interoperable networks of FAIR Data **services and research infrastructures** at the institutional and domain level and national level;
4. Foster the development of a national **trust** framework for access to FAIR Data, including sensitive and confidential data, in synergy among societal stakeholders.

The NPOS FAIR Data Programme Line has a strong basis to rapidly grow and to become a world-leading example in Open Science. Clearly, it will build on ongoing policies, funding instruments, programmes, infrastructures, and initiatives launched by the universities, university medical centres, universities of applied sciences, NWO and ZonMw and by the national research-supporting organizations (SURF, DANS, NLeSC). Examples are existing initiatives and infrastructures to facilitate FAIR-based data access and sharing in several science domains (e.g., ODISSEI, CLARIAH, Health-RI, DTL), emerging local DCCs at the universities and their supporting networks (RDNL, LCRDM), the expected new layer of thematic DCC's and national nodes of international data expertise organizations (e.g., RDA, GOFAIR, CODATA).

1. **Capacity building: create a professional community of skilled data stewards**

This key action line is about professionalisation and specialisation in research data management. To make full use of, and efficiently work with data, we will need data stewards and dedicated curricula for training and education of data stewards. We also need training capacity (content and critical mass) to initiate and maintain a community of data stewards. In a similar track we need to develop/train a community of Research Software Engineers: professionalise and train, set up the curriculum, and build capacity.

2. **FAIR Data: support, guide and incentivise the generation of standardized, and machine-actionable FAIR digital research outputs and associated FAIR metadata to enable optimal (re)use**

First, we need to raise awareness on the 'FAIRification' of data - FAIR (meta)data must become an integral part of the research process. Second, funders and employers must provide proper rewards & incentives for this change - and this also links to the appreciation and roles of data stewards and research software engineers in Key action line 1. Third, the conditions (facilities and tools & services, but also budgets) must be in place to make this FAIRification structural and sustainable.

3. **Services and infrastructures: enable sustainable interoperable networks of FAIR Data services and research infrastructures at the domain level, institutional level, and national level**

The third Key action line is to expand the ecosystem and build networks of services and infrastructures around the data. Infrastructures must be present at the RPOs and in the overarching scientific domains. These networks will be at domain, institutional and national levels and are a prerequisite for full participation and optimal use of networks on European and global levels.

It will also involve close alignment with societal stakeholders in the public and private sectors to facilitate shared data access and fuel science with data generated in society. While commercial parties

may offer parts of the professional FAIR Data services environment, the FAIR Data infrastructure will have to be publicly governed to safeguard sovereignty of the science field based upon fundamental values of transparency and equality.

4. Trust Framework for data access: foster the development of a national trust framework for access to FAIR Data, including sensitive and confidential data, in alignment with societal stakeholders

The fourth key line of action is about bringing trust into the system. Trust is key in networks and platforms and in reusing data. Researchers rely on the quality of data when they are reusing them. It refers to the data, but also to safe and secure reuse of the data.

4 Citizen Science

4.1 Mission

The goal of Citizen Science is connect science and society as a whole, so the focus is not only on citizens. The mission is to embed Citizen Science approaches within Open Science practices across the Netherlands, such that participatory processes for knowledge creation initiated by both non-academic citizens and professional researchers are recognised, valued and supported as part of 'mainstream' research.

In 2030, Citizen Science will be a natural and indispensable part of scientific research portfolios that are anchored in the curriculum of higher and scientific education, are included in the system of recognition and awards, and supported broadly within research funding programmes.

WHAT

Across the globe, Citizen Science is a significant movement fostering the participation of members of the public, including citizens, civil society organizations, and other societal actors, throughout various stages of research and innovation processes. In this way, Citizen Science builds bridges between the scientific world and the rest of society, and dynamically connects different fields of science together in transdisciplinary initiatives that can improve scientific research, help answer complex scientific questions, and increase people's understanding of and involvement in the scientific process.

Citizen Science also activates urgent societal issues (such as public health, climate change, migration) on the research agenda, engaging a wide range of actors and stakeholders in collaborative research processes that provide data for improved governance, policy action, decision making, and behavioural change.

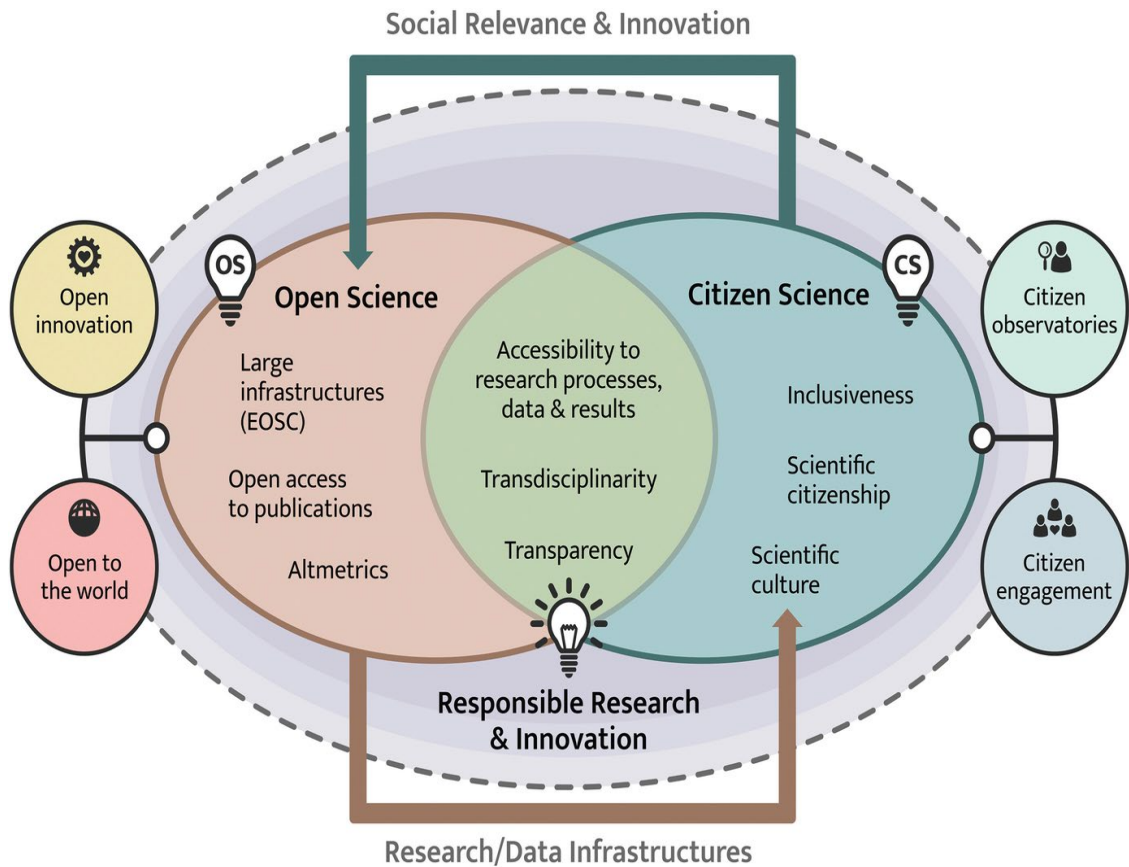


Figure 3: *The relationship between citizen science and Open Science.* (Based on Vohland and Göbel (2017), modified) - Schade et al. 2021⁴⁰

HOW

The main challenges to embed Citizen Science within the mainstream research environment are awareness of the unique value and benefits of Citizen Science approaches, recognition and rewards for researchers applying Citizen Science approaches in their research, the acceptability of Citizen Science data and methods for uptake in scientific research agendas and policy making, and the long-term sustainability of Citizen Science initiatives in terms of community and infrastructure support, execution skills and capacity, and the ability to scale initiatives for greater impact, at universities, university medical centres and universities of applied sciences. Citizen science is key for impact of science, as it adds citizens to the well-known triple helix (now “quadruple helix”) to complete the knowledge chain from basic research, applied research, practice-driven research to real-world applications.

The establishment of the first Citizen Science Practitioners Network in the Netherlands (‘the CS-NL Network’) will form the primary vehicle through which these challenges will be addressed, activating members of the Dutch practitioners network via communities of practice and working groups with defined objectives.

Quotes from the NPOS Citizen Science Round Table session organised in the spring of 2021 to gather input for this document:

⁴⁰ Schade S., Pelacho M., van Noordwijk T., Vohland K., Hecker S., Manzoni M. (2021) Citizen Science and Policy. In: Vohland K. et al. (eds) *The Science of Citizen Science*. Springer, Cham. https://doi.org/10.1007/978-3-030-58278-4_18

“Citizen Science facilitates the active participation of citizens in the scientific research process.”

~

“Citizen Science is thus both an aim and an enabler of Open Science. On the one hand, it presents the means for open, holistic, and participatory processes of knowledge generation; on the other, it favours openness that, as opposed to secrecy or exclusion, is key for the sustainability, accessibility and quality of scientific knowledge produced through citizen participation.” - Cigarini et al. 2021 ⁴¹

~

“Citizen Observatories can also shape environmental governance measures and complement Earth Observation monitoring efforts by increasing the availability of ground-based observations for all 17 Sustainable Development Goals [3]. For example, Open Litter Map [4] delivers data towards SDG 14.1.1 to measure floating plastic litter as a global indicator of marine pollution.” - WeObserve Consortium (2021)⁴²

4.2 Key lines of action

To accomplish our mission to establish a supportive ecosystem for open, inclusive, and participatory processes for knowledge creation we have identified five key action lines:

1. Raise **awareness**;
2. Consolidate and further develop **best practice**;
3. Build **capacity**;
4. Enhance **cooperation**, synergies, and transdisciplinary collaboration;
5. Develop and invest in supporting **infrastructures**.

1. Raise Awareness

Citizen Science initiatives connect science with society in research and innovations processes, often in multi-stakeholder collaborations that can include university researchers, environmental authorities, healthcare professionals, educators, policy makers, civil society organizations and other key societal actors and experts. To successfully achieve their stated objectives, it is important for Citizen Science initiatives to form collaborative partnerships, alliances, and networks to work towards shared goals and an outcome that has impact or scientific value. For this to be achieved, stakeholders and potential partners must be aware of the applicability and benefits of Citizen Science approaches to science, policy, and society.

To achieve this objective, we will establish communication channels with researchers, educators, research-performing and research-funding organizations to share best practices and lessons learned, and provide evidence of the impact of involving citizens, or being involved by citizens, in research and innovation processes.

With policy makers, local authorities, and other decision makers we will share examples and provide evidence of the benefits of collaborating with citizens and embedding citizen-generated data into the decision-making cycle (from local to national planning and management). Over time we will expand our efforts to raise awareness of the benefits of Citizen Science approaches amongst the fourth segment of the ‘Quadruple Helix’ - i.e., industry and business⁴³. All partners and key stakeholders in the aims of

⁴¹ Anna Cigarini, Isabelle Bonhoure, Julián Vicens, Josep Perelló, Public libraries embrace citizen science: Strengths and challenges, *Library & Information Science Research*, Volume 43, Issue 2, 2021, <https://doi.org/10.1016/j.lisr.2021.101090>. (<https://www.sciencedirect.com/science/article/pii/S0740818821000207>)

⁴² WeObserve consortium (2021). Roadmap for the uptake of the Citizen Observatories’ knowledge base. Report submitted to the European Commission. DOI: 10.5281/zenodo.4646774

⁴³ Florian Schütz, Marie Lena Heidingsfelder, Martina Schraudner, Co-shaping the Future in Quadruple Helix Innovation Systems: Uncovering Public Preferences toward Participatory Research and Innovation, *She Ji: The Journal of Design, Economics, and Innovation*, Volume 5, Issue 2, <https://doi.org/10.1016/j.sheji.2019.04.002>. (<https://www.sciencedirect.com/science/article/pii/S2405872618301394>)

NPOS will be encouraged to actively promote the many benefits of Citizen Science practices within their networks.

2. Consolidate and Further Develop Best Practices

Individual researchers, institutes and societal actors in the Netherlands have been pioneers in leading Citizen Science initiatives (such as for biodiversity and ecosystem monitoring) and innovating new areas of application (such as air quality, archaeology, cultural heritage, and public health). Researchers in the Netherlands have also led the development of best practice resources, such as the Quality and Success Factor Matrix contained in the 'Kennis & Krachten Gebundeld' report⁴⁴. The establishment of a Network of Citizen Science practitioners in the Netherlands (from both academia and society) will enable the centrally coordinated capture and dissemination of know-how, and the further development of best practice - particularly regarding the promotion of research quality and impact, and the inclusion of a diverse range of groups from society. The connection with society as a whole (including citizens, SME's) is important for impact of knowledge and for identifying needs from society, with a special role for the universities of applied sciences.

To achieve the objective of consolidating and furthering best practice, this Network will organise support for practitioners in the field; facilitate the exchange and development of knowledge via symposia, workshops, and training; and promote innovation by stimulating the development of new forms of transdisciplinary collaboration and new (co-creation) methods for Citizen Science. The new network organization will also set up pilot projects as case studies for new collaborations and new forms of citizen science.

3. Capacity Building

The UNDP defines capacity building as "the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time."⁴⁵ Capacity building is an iterative and adaptive process that requires the committed engagement of all involved actors from society, science, and policy.

In the field of Citizen Science, national capacity building involves five main steps: (1) identifying and engaging different actors, (2) assessing capacities and training needs, (3) developing a vision, missions, and action plans, (4) developing resources and guidelines to address identified needs, (5) developing and implementing a framework for the evaluation assessment of citizen science initiatives⁴⁶, (6) Recognition, rewards, and metrics, and (7) Dissemination and support.

With Citizen Science approaches becoming more widely exemplified in the Netherlands, it is time to pair capacity building with political commitment to fully realise the enormous potential that Citizen Science has locally for science, policy, and society. For example, publication of Green and White Papers in the policy area have been instrumental in helping enhance governance structures and developing organizational structures and frameworks, such as the SOCIENTIZE White Paper⁴⁷ recommendations that led to the establishment of the European Citizen Science Association (ECSA).

4. Establish a Citizen Science Network NL to enhance cooperation, synergies and transdisciplinary collaboration

Across the world, the field of Citizen Science is becoming increasingly professionalised, with Citizen Science practitioner associations in the United States⁴⁸, Australia⁴⁹, in various European nation-states

⁴⁴See: <https://www.openscience.nl/projecten/project-i-citizen-science>

⁴⁵ CAPACITY DEVELOPMENT: A UNDP PRIMER, 2009

⁴⁶ Richter, Anett, et al. "Capacity building in citizen science." UCL Press, 2018. 269-283.

⁴⁷ Serrano Sanz, Holoche-Ertl, Kieslinger, Sanz Garcia, and Silva (2014): White Paper on Citizen Science in Europe, http://www.zsi.at/object/project/2340/attach/White_Paper-Final-Print.pdf

⁴⁸ The Citizen Science Association (CSA), <https://citizenscience.org/>

⁴⁹ The Australian Citizen Science Association (ACSA), <https://citizenscience.org.au/>

(such as Austria⁵⁰, Switzerland⁵¹, Germany⁵², and Spain⁵³) in Europe⁵⁴, and at the global level⁵⁵. In their 2020 report 'Knowledge and strengths combined - citizen science in the Netherlands', the NPOS Citizen Science Working Group recommended the establishment of a national network in the Netherlands that facilitates the sharing of knowledge and experience; stimulates cooperation and innovation; links scientific initiatives with social initiatives (and vice versa) to bring widely shared questions in society to science; and both connects disciplines and develops new disciplines and Citizen Science methods.

5. Develop and Invest in Supporting Infrastructures

The Netherlands is challenged by the same set of highly complex and urgent issues that face the global community, such as the coronavirus pandemic, climate change, biodiversity loss, and political radicalisation. Facing and addressing these issues equitably and effectively requires new knowledge and action partnerships that engage citizens and a range of other critical stakeholders in urgently needed social innovation processes. Citizen Observatories (COs) are a particular form of citizen science that are well-positioned to address such socio-ecological challenges and can complement official data streams in innovative ways - by engaging citizens and communities in environmental and public health monitoring with a focus on collective action, governance, and policy change. To create a sustainable ecosystem of Citizen Observatories that can systematically address such challenges it is necessary to develop and invest in infrastructures that support the unique characteristics of Citizen Observatories - namely, their close links with policy; the fact that they can reshape public participation and governance of the commons; their use of mobile and web technologies, sensors, and other tools; and the significant time and effort required to build an engaged community of participants and to ensure it delivers value for participants.

Particularly within health research there are significant opportunities to better meet the needs of patients and healthcare professionals by involving citizens in research, from the co-determination of the research question together via co-creation, through collecting data, to producing and sharing the acquired knowledge with others. Many citizens are looking for ways to keep themselves healthy and employable within society, yet a recently published report concluded that the abilities and qualities of patients are not being harnessed, and that self-examination via a combination of self-monitoring and patient-driven big data research can produce significant insights for both research and patients. Examples of Citizen Science in healthcare where research is initiated by the patient in collaboration with researchers include MyCardio, where patients test their own cardiovascular interventions, and the iconic regional citizen science project TOPFIT Citizen Lab, where citizens, scientists and engineers work on prevention and solutions for a better life for healthy people and for patients with chronic diseases.

It is therefore important over the coming years to also develop Citizen Science and OS methods specifically for health research, and to expand best practices for responsibly bringing citizens, patients, and other public health stakeholders together in knowledge creation for health and wellbeing. In 2030, Dutch researchers are aware of the potential benefits of citizen science approaches and the wide range of participatory and collaborative research methodologies, have access to and contribute to the body of best practice for implementing such approaches effectively and equitably, and are supported in doing so both in terms of an enabling environment for citizen science and in terms of recognition and rewards for the unique impacts of participatory research. A national culture and supportive framework for citizen science are the key to embedding these approaches in Open Science research practices.

⁵⁰ Österreich Forscht, <https://www.citizen-science.at/en/>

⁵¹ Schweiz Forscht, <https://www.schweizforscht.ch/>

⁵² Bürger Schaffen Wissen, <https://www.buergerschaffewissen.de/>

⁵³ Ciencia Ciudadana, <https://ciencia-ciudadana.es/>

⁵⁴ the European Citizen Science Association (ECSA), <https://ecsa.citizen-science.net/>

⁵⁵ the Global Citizen Science Partnership (GCSP), <http://citizenscienceglobal.org/>

To maximise the Citizen Science contribution to Open Science, and to realise the enormous potential that Citizen Science has for science, policy and society, the Netherlands should now support the consolidation and further development of the vast practical experience within its research communities; foster greater and enhanced cooperation, synergies and capacity building among and between the Citizen Science and Open Science communities; and invest in a supportive ecosystem that includes both technical infrastructure and community networks.

Appendix: List of Abbreviations and Acronyms

APC	Article Processing Charges
COS	Chiefs Open Science
DANS	Data Archiving and Networked Services
DCC	Digital Competence Centre
DS	Data Science
EOSC	European Open Science Cloud
FAIR	Findable, Accessible, Interoperable, Reusable
GDPR	General Data Protection Regulation
KNAW	Koninklijke Nederlandse Akademie voor Wetenschappen
LCRDM	Landelijk Coördinatiepunt Research Data Management
NFU	Nederlandse Federatie van Universitair Medische Centra
NPOS	Nationaal Programma Open Science / National Programme Open Science
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
NREN	National Research and Education Network
PPS	Publiek-Private Samenwerking
RFO	Research Funding Organization
RPO	Research Performance Organization
SURF	coöperatieve vereniging van Nederlandse onderwijs- en onderzoeksinstituten
VH	Vereniging van Hogescholen
VSNU	Vereniging van Universiteiten
ZonMw	Zorg onderzoek Nederland/Medische Wetenschappen