

1 **Keep talking while everything gets sequenced: Digitization fragments the global**

2 **governance of genetic resources**

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11 12 **Abstract**

13 Genomics is the cornerstone of modern biology and large sequencing projects are expanding in the big
14 data era. Meanwhile, almost a decade after the debates started over the governance of digitalized omics
15 data in biodiversity-related treaties, no standardized governance solution emerged. In this paper, we take
16 a snapshot of the various evolutions of the Digital Sequence Information debates in all the international
17 environmental fora dealing with biodiversity, global health and genetic resources. What was first
18 considered a minor technical-scientific detail, the digitalization of data originating from the analysis of
19 biological material, has become a key element of many if not all negotiations fora dealing with genetic
20 resources (i.e. terrestrial and marine biodiversity, agriculture, health and human genomics). We discuss
21 the extent to which the increasing institutional and legal fragmentation, essentially dealing with very
22 similar issues with often distinct governance, stakeholders or spatial scope, is shaping the future of the
23 Access and Benefit Sharing framework. While equity has become a central element of multilateral
24 environmental negotiations, we question the ability of an increasingly fragmented institutional regime
25 to effectively tackle global challenges like the biodiversity crisis or the next pandemic.

26
27 **Keywords** Access and Benefit Sharing, Regime Complex, Digitalization, DSI, Genetic Resources

Digital data accumulates independently of its governance

Generation of and access to data derived from genetic resources is central to contemporary research, and biodiversity research is no exception. For example, one of the biggest genetic data repositories, NCBI Genbank, is hosting 19,6 trillion nucleotides¹ by mid-2024 and its size roughly doubles yearly (Sayers et al., 2023). The potential values and interests of genetic digital information for the bioeconomy have been discussed since the nineties (Pistorius and Wijk, 1999). However, the first formal consideration of digital data as a discrete agenda item in the framework of the Convention for Biodiversity only emerged some twenty years later, at the 14th Conference of Parties of the Convention for Biological Diversity (COP/CBD). It “recogniz[es] the importance of digital sequence information on genetic resources for the three objectives of the Convention” (CBD, 2018). As a reminder, the CBD was created in 1992 as a framework to govern the conservation, use, fair and equitable access and benefit sharing mechanism (ABS) of genetic resources. For a long time considered a technical detail, the idea gradually pervaded that biodiversity and genetic resources governance might be missing the point by only focusing on physical samples without considering the digital information extracted from their material shell (Aubry et al., 2022; Laird et al., 2020). Since 2016, all international treaties dealing with genetic resources have integrated digital sequence information (DSI) into their agendas, without effectively proposing a clear or coordinated governance mechanism to this day, and without influencing the development of major sequencing capacity in any way (Fig. 1). Nonetheless major landmarks and decisions have been taken in the process, like for example decision 15/9 of the COP/CBD in 2022, which aims to build a multilateral mechanism dealing with digital information, and which negotiations are still ongoing (CBD, 2022a). The cross-cutting issue over digital governance of genetic resources has crystalized many frustrations concerning a partially malfunctioning ABS framework, and we argue here that without a significant and quick transdisciplinary leap within this framework, scientists will still be gathering omics data derived from genetic resources for many years to come without any chance to consider equity or fairness further.

Towards building an Access and Benefit Sharing framework that considers digitization?

Convergent signals from various fora negotiating genetic resources data governance mechanisms (often referred to as Digital Sequence Information, DSI) and in particular ways to share the benefits arising from their use show very striking similarities and ask for more coherence across reglementary silos. Straight after the COVID-19 pandemic, major discussions started, on one side over the governance of omics data from pathogens under the auspices of the World Health Organization (WHO), and on the other side framing a new multilateral mechanism dealing with DSI from terrestrial biodiversity under the Convention for Biological Diversity (CBD; CBD, 2022a; World Health Organization, 2023). At its 15th Conference of the Parties, the CBD integrated DSI into Goal C of its Global Biodiversity

¹ Nucleotides are units of DNA, also expressed in base pairs.

1 Framework and agreed on a dedicated process to consider a multilateral mechanism to deal with DSI.
2 The modalities and technicalities associated with global data governance appear as an unavoidable
3 element of any negotiations relating to genetic resources, from pathogens, marine, agricultural or
4 terrestrial biodiversity. Even the decades-old discussions at the Intergovernmental Committee on
5 Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore of the World
6 Intellectual Property Organization that recently agreed on disclosure obligations for patents needed to
7 navigate the DSI conundrum to some extent in its negotiation (WIPO, 2024). Most of these instruments
8 deal with various elements of biodiversity, sometimes with some overlap, but generally share a
9 commitment to bring equity within the global governance of digital sequence information (Halewood et
10 al., 2023).

11 Digitization has been one of the major bottlenecks of the Access and Benefit Sharing (ABS) recent
12 negotiations. Currently, the terminology related to the omics data is not stabilised and at least two
13 acronyms commonly used refer to slightly overlapping concepts: Genetic Sequence Data (GSD) and
14 Digital Sequence Information (DSI). GSD is defined in the Pandemic Influenza Preparedness
15 Framework (hereafter PIP framework) as the “order of nucleotides found in a molecule of DNA or
16 RNA” (PIP, Art. 4.2). So far, GSD is almost exclusively used in the context of the PIP framework, while
17 transiently taken over in the Pandemic Treaty negotiation to be later replaced by “sequencing
18 information” (Walckiers et al., 2024). Noteworthy, it is unclear whether focusing solely on GSD
19 adequately addresses current practices of modern omics, like the growing importance of non-DNA based
20 approach like metabolomics for biomedical applications or nutrition (Gonzalez-Covarrubias et al., 2022;
21 Jarvis et al., 2024).

22 By contrast, the term DSI is used mostly under the remits of the CBD and other ABS instruments, with
23 a scope still to be determined. While many studies, publications, debates, workshops and informal
24 discussions have been produced for almost a decade, there is no formally agreed definition of DSI. The
25 absence of a definition, while leading to some legal uncertainty, also provided some constructive
26 ambiguity in the latest CBD negotiation rounds that led to the onset of a possible multilateral solution
27 (CBD, 2022a). A range of possible definitions have been proposed for DSI: *sensu stricto*, includes DNA
28 and RNA (being then equivalent to GSD) but *sensu largo* can range to proteins, metabolites or even
29 other phenotypic, structural, meta-data and traditional knowledge (CBD/DSI/AHTEG/2020/1/3, 2020).
30 Using a particular terminology may have very concrete impacts on the scope, obligations and
31 mechanically on the efficiency of these instruments (Walckiers et al., 2024).

32 Taking a step back, beyond the terminology itself, the decisions related to GSD/DSI taken in any of the
33 ABS-related instruments could have dramatic consequences on the others. Meanwhile, systemic
34 thinking seems largely absent from the discussions. Major institutional and political limitations impair
35 cross-sectorial dialogue: despite repeated calls, there is a lack of interest in learning from other
36 negotiations (Aubry et al., 2022). Even worse, there are obvious political interests not to engage outside
37 their own ABS backyard: an overarching solution encompassing several instruments might potentially

1 reduce the discretionary “power” of each specific secretariat or governing body at the UN level or
2 ministries at the national level. This institutional powerplay has been very well described in the
3 evaluation of regime complexes (Eilstrup-Sangiovanni and Westerwinter, 2022) but has nonetheless
4 dramatic consequences on the overall efficiency and accountability of the global governance of
5 biodiversity.

6 This siloed approach can also be explained by the context of public international law: its general
7 principles, practices, or rules of interpretation. For example, the Vienna Convention clearly states that
8 “any relevant rules of international law applicable in the relations between the parties” shall be taken
9 into consideration when interpreting a treaty (Art. 31.3(c), Vienna Convention, 1969). In accordance
10 with the principle *pacta tertiis nec nocent nec prosunt*, an obligation in international law applies only
11 between the parties who have consented to it. Therefore, the interpretation of a treaty can mobilize the
12 content of other treaties only if it is accepted by all parties (Gardiner, 2015, p. 311; McLachlan, 2005,
13 p. 314). Yet, despite the frequent overlaps in the ABS regime complex, there are significant differences
14 between the contracting parties to the various instruments (Supplementary Figure 1). This discrepancy
15 between contracting parties, signatories and third parties to various instruments dealing with similar
16 goals demonstrates a lack of systematicity and fragmenting international law, which tends to complexify
17 the negotiations and the implementation of the treaty’s provisions. In particular, globalized objects like
18 omics data repositories that mostly navigate independently of formal legal constraints increase this
19 complexity.

20 Trying to integrate the digitization of modern scientific practice as a parallel track that largely evolved
21 outside any legal construction has eventually revealed the permanence of the inequalities the ABS
22 framework is supposed to address.

24 **Sharing data for global health**

25 One of the most rapidly evolving discussions concerning data governance may be taking place within
26 the formal negotiations on the creation of a new international legally binding instrument dedicated to
27 pandemic prevention and response (World Health Organization, 2023). Since 2021, an
28 intergovernmental negotiating body was established by the WHO’s Member States to draft a convention,
29 agreement, or any other international instruments on pandemic prevention and response, formally
30 referred to as the WHO CA+ or the Pandemic Treaty. Major driving principles are leading the
31 negotiations: the new treaty should fit in the “One Health” approach, aiming for a cross-sectorial
32 approach to health, agri-food, environmental, human, and animal issues. The discussions have
33 concentrated on the modalities of inception of a new pathogen Access and Benefit Sharing System
34 possibly fitting into a pandemic context, in terms of speed, efficiency of access and equity (Walckiers
35 et al., 2024). The degree of multilateralism to be integrated into a new Access and Benefit-Sharing
36 mechanism remains to be determined. Interestingly, debates and positions are comparable to the DSI
37 debates under the CBD bodies (CBD, 2022a). In both cases, most parties advocate for norms of

1 solidarity, fairness, transparency, inclusiveness, and equity as a means to address the shortcomings of
2 their governance. For example, COVID-19 international response, both in terms of strain, data sharing
3 or vaccine distribution mostly happened outside any legal oversight. Even before considering their
4 digitization, the governance of pathogenic genetic resources is fragmented between the Nagoya Protocol
5 (Art. 8), the PIP framework and the forthcoming Pandemic Treaty. So far and in most cases, the pathogen
6 genetic resources belong to the pool of genetic resources under the national sovereignty of their country
7 of origin and their access is regulated on a bilateral basis (Huvos et al., 2020). Noteworthy, there is a
8 thin line between human pathogen genetic resources and human-derived genomic data that sometimes
9 leads to certain confusion, while it is commonly admitted that human-derived data are excluded from
10 the scope of the CBD (Lawson et al., 2018). Human genomic research standards have improved
11 dramatically in the last decades, but the question of whether and how data governance might include
12 more equity, particularly some modalities of benefit sharing is increasingly discussed (Mc Cartney et
13 al., 2024). It might be surprising that almost twenty-five years since the publication of the human
14 genome have been necessary to call for a coordinated framework over human data governance. We can
15 only interpret that as yet another reverberation of the DSI debate that started first in the biodiversity
16 circles.

17 Overall, the credibility of the global ABS framework is still being tested. The Pandemic Treaty
18 negotiations that almost stubbled down in May 2024 are not occurring in an institutional vacuum: it
19 evolves in busy regulatory environments at the crossroad between the biodiversity, the scientific data
20 and the global health governance regimes. The way a new Pandemic Treaty might interact with the
21 current ABS framework, particularly the way it deals with data, will have consequences on other sectors,
22 particularly for the conservation of biodiversity, and maybe even on human genomics.

23 24 **Sharing data for conservation**

25 The Convention on Biological Diversity established the basis for the ABS framework and was
26 operationalized with its Nagoya Protocol. They both promote sustainable use and ensure the fair and
27 equitable sharing of monetary or non-monetary benefits derived from the use of genetic resources and
28 associated traditional knowledge (Laird et al., 2020). While designed at a time preceding big data science
29 and therefore only concentrating on physical material, the attempts to retrofit the ABS policies struggle
30 to deliver credible options to deal with the non-exclusionary properties of data associated with genetic
31 resources like DSI and to provide fair and open access to science (Laird and Wynberg, 2018; Prathapan
32 et al., 2018).

33 The CBD is the umbrella treaty for the ABS regime complex (Raustiala and Victor, 2004) that also
34 includes sector-specific agreements: the PIP Framework under the WHO mentioned above, the
35 International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) under the
36 auspices of the Food and Agriculture Organization (FAO, 2004), and the agreement for biodiversity
37 beyond national jurisdiction under the United Nations Convention on the Law of the Sea

(BBNJ/UNCLOS, 2023). The ITPGRFA is considered the very first operationalization of the CBD objectives specific to one sector, where member states agreed to share access to their plant genetic resources for food and agriculture through a virtual common basket for seed exchange: the multilateral system. Today, it gathers crops representing about 80% of human consumption. While the multilateral system facilitates access to pooled resources, it failed to ensure a significant monetary flow as benefit sharing (Aubry, 2019; Frison, 2018). However, ongoing work to improve financial flows also recently considered potential ways to tackle DSI. The existing multilateral legal architecture of the ITPGRFA may relatively easily accommodate the non-exclusive nature of DSI (FAO, 2023). Whether and how the solution found in the agricultural sector will be compatible or timely with the CBD mechanisms remains unclear, but synergies are possible.

The BBNJ agreement provides the first explicit mention of DSI in a legally binding instrument (UNCLOS, 2023). While this is surely a step forward in considering the importance of digitization for genetic resources, the modalities of the treaty and its ability to eventually provide a financial contribution from the use of DSI remains to be shown. So far, most of the practicalities have been left in the hands of the conference of parties to be determined at a later stage. Again, the compatibility between scientific practice and efficient funding remains to be explored. Surely, the BBNJ example is paving the way for other ABS instruments to consider DSI as a central element of genetic resources governance.

All the ABS treaties considered here are meant to hold very similar views over equity and fairness and should generally be considered “mutually supportive”, despite partially overlapping scopes and distinct governance norms.

Incantatory mutual supportiveness

Despite repeated calls for consistency and supportiveness between ABS treaties, agreements and conventions, there is an increasing fragmentation of the genetic resource’s governance: the overarching regime complex gets increasingly complex (Fig. 2, Oberthür and Pożarowska, 2013). For example, independently of the final scope of the forthcoming Pandemic Treaty, the genetic resources from pandemic pathogens regulated through this new instrument will mostly originate from the genepool of the CBD and its Nagoya protocol (Fig. 2). This significant subtraction (terrestrial biodiversity *minus* pandemic pathogens), or more precisely this additional layer of regulatory complexity on a subset of genetic resources is a symptom of the increasing trimming forces applied to the ABS framework. We attempt to represent these forces as two dimensions (Fig. 2).

The first formal stream tends to multiply instruments with sector-specific scopes that aim to answer to a specific subset of stakeholders’ concerns. This is not a new process, *ad hoc* solutions are formally acknowledged in Article 4 of the Nagoya Protocol, but it may weaken the visibility and efficiency of the ABS framework generally. In this context, we can even question the relevance of creating new sector-specific instruments if they are to share the same underlying principles as the pre-existing instrument. (Oberthür and Pożarowska, 2013).

1 The second stream has been triggered by the digitization of genetic resources (Fig. 2). The many issues
2 underlying the digitization of genetic resources, like the speed and scale of sequencing and the
3 impossibility of holding a bilateral approach to benefit sharing, have not been anticipated (Aubry et al.,
4 2022; Laird et al., 2020). The omics data ecosystem has largely been evolving isolated from major
5 genetic resources governance discussions for many years. Despite several “mutually supportive”
6 provisions, the further the regime complex develops, the more unlikely a unique, inter-sectorial and
7 multilateral solution would emerge. Yet, ignoring other ABS “silos” and powerplay is counter-
8 productive in the long term for the credibility and efficiency of each of these treaties. While all ABS
9 instruments dealing with genetic resources share the same principles, the mutual supportiveness across
10 instruments remains largely incantatory (Aykut et al., 2021). Despite a context of fragmentation,
11 complexity, and institutional concurrencies in international law, particularly within genetic resource
12 governance, we suggest a more holistic approach to the different instruments, where care must be taken
13 across various negotiation fora to mitigate these tensions.

14 15 **ABS in a make-or-break moment**

16 We argue here that any further development of pandemic pathogens, animal, plant or virtually any
17 instrument dealing with digitized genetic resources would require some degree of mutual support and
18 coordination across silos (Aubry et al., 2022). A stable, ethically sound and politically viable legal
19 environment that considers newly adapted ABS modalities is necessary for the sake of the ABS
20 framework’s stability and to guarantee that environmental and public health challenges can be
21 addressed. Interestingly, what has been long considered a techno-scientific detail, the digitization of data
22 extracted from genetic resources pointed out a core weakness of the ABS framework architecture.
23 Meanwhile, care should be taken not to “tokenise” the DSI issue too far. While the issues over equity
24 remain central, slowing down negotiation streamlines for years might eventually be counterproductive
25 to the primary objectives of the conventions, particularly the imperatives of conservation. Indeed,
26 twenty-five years of open access science has produced enormous amounts of data: there might be enough
27 data available already that is openly accessible not to prime for a quick solution to share any benefits
28 that could be extracted from their use. Even if no viable running policy has yet emerged from this first
29 decade of discussion (with the notable exception of BBNJ), the DSI debate has undoubtedly reconciled
30 a lot of the science performed in isolation with many other previously unconcerned societal actors. The
31 tremendous work from parties, scientists and civil society that tirelessly tried to bring science and policy
32 to communicate effectively must be acknowledged. Meanwhile, multiple calls for reflexivity, new
33 normative frameworks and transdisciplinarity across the various ABS instruments appear to
34 systematically collide with some inertia, institutional competing interests and ever-growing legal
35 complexity. This may ultimately question the capacity of these institutional arrangements, the regime
36 they constitute and their underlying norms to tackle global challenges.

Contributors

SA, PW and CF conceptualized and wrote the paper.

Declaration of interests

We declare no competing interests.

Ethical approval

Not applicable

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References

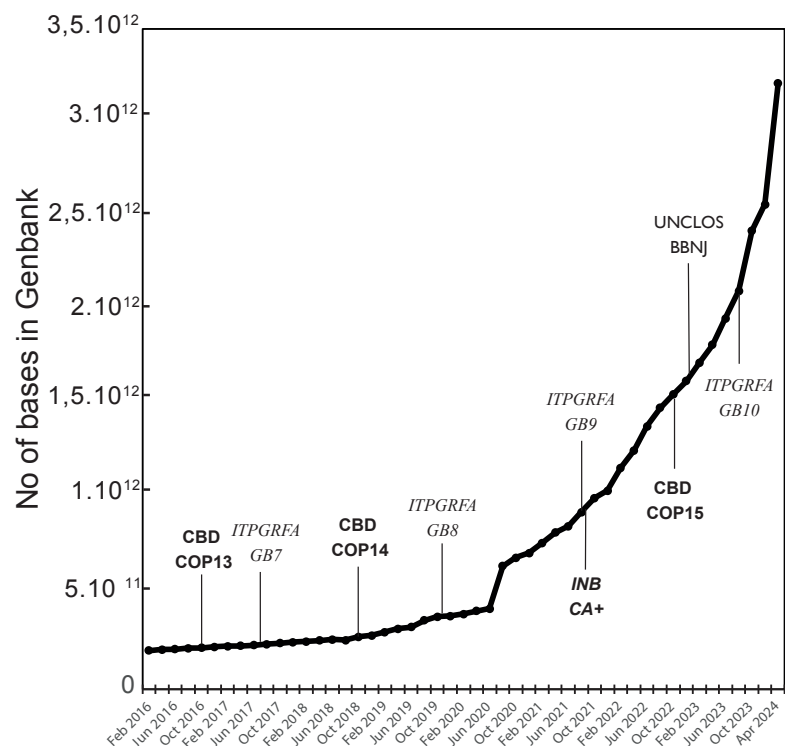
References

- Aubry, S., 2019. The Future of Digital Sequence Information for Plant Genetic Resources for Food and Agriculture. *Frontiers in Plant Science* 10, 1–10. <https://doi.org/10.3389/fpls.2019.01046>
- Aubry, S., Frison, C., Medaglia, J.C., Frison, E., Jaspars, M., Rabone, M., Sirakaya, A., Saxena, D., Zimmeren, E., 2022. Bringing access and benefit sharing into the digital age. *Plants, People, Planet* 4, 5–12. <https://doi.org/10.1002/ppp3.10186>
- Aykut, S.C., Morena, E., Foyer, J., 2021. ‘Incantatory’ governance: global climate politics’ performative turn and its wider significance for global politics. *Int Polit* 58, 519–540. <https://doi.org/10.1057/s41311-020-00250-8>
- CBD, 2022a. CBD/COP/DEC/15/9.
- CBD, 2022b. CBD/COP/DEC/15/4.
- CBD, 2018. CBD/COP/DES/14/20.
- CBD/DSI/AHTEG/2020/1/3, 2020. Digital Sequence Information on Genetic Resources: concept, scope and current use.
- Eilstrup-Sangiovanni, M., Westerwinter, O., 2022. The global governance complexity cube: Varieties of institutional complexity in global governance. *Rev Int Organ* 17, 233–262. <https://doi.org/10.1007/s11558-021-09449-7>
- FAO, 2023. ITPGRFA 10th Governing Body Report.
- FAO, 2004. International Treaty for Plant Genetic Resources for Food and Agriculture.

- Frison, C., 2018. Redesigning the Global Seed Commons Law and Policy for Agrobiodiversity and Food Security. Routledge, London.
- Gardiner, R.K., 2015. Treaty interpretation, 2nd ed. OUP, Oxford.
- Gonzalez-Covarrubias, V., Martínez-Martínez, E., Del Bosque-Plata, L., 2022. The Potential of Metabolomics in Biomedical Applications. *Metabolites* 12, 194.
<https://doi.org/10.3390/metabo12020194>
- Halewood, M., Bagley, M.A., Wyss, M., Scholz, A.H., 2023. New benefit-sharing principles for digital sequence information. *Science* 382, 520–522. <https://doi.org/10.1126/science.adj1331>
- Huvos, A., Solomon, S.A., Nannini, C., 2020. The Pandemic Influenza Preparedness Framework as an Access and Benefit Sharing Mechanism, in: Katz, R., Halabi, S.F. (Eds.), *Viral Sovereignty and Technology Transfer: The Changing Global System for Sharing Pathogens for Public Health Research*. Cambridge University Press, Cambridge, pp. 193–204.
<https://doi.org/10.1017/9781108676076.013>
- Jarvis, A., Gallo-Franco, J., Portilla, J., German, B., Debouck, D., Rajasekharan, M., Khoury, C., Herforth, A., Ahmed, S., Tohme, J., Arnaud, E., Golden, C.D., Dawid, C., De Haan, S., DeClerck, F., Feskens, E.J.M., Fogliano, V., Fritz, G., Hald, C., Hall, R., Hart, R., Henry, A., Huang, S., Hunter, D., Imanbaeva, B., Lowe, A., Turner, N.J., Jia, G., Johnson, E., Kalaiah, G., Karboune, S., Klade, S., La Cerva, G.R., Lal, V., Levy, A.A., Longvah, T., Maeda-Yamamoto, M., Minnis, P., Nuti, M., Octavio, M., Osorio, C., Pawera, L., Peter, S., Prasad, R., Quave, C., Shapiro, H.-Y., Sreeman, S., Srichamnong, W., Steiner, R., Turdieva, M., Ulian, T., Van Andel, T., Wang, R., Weissgold, L., Yan, J., De La Parra, J., 2024. Periodic Table of Food Initiative for generating biomolecular knowledge of edible biodiversity. *Nat Food* 5, 189–193.
<https://doi.org/10.1038/s43016-024-00941-y>
- Laird, S., Wynberg, R., 2018. A Fact Finding and Scoping Study on Digital Sequence Information on Genetic Resources in the Context of the Convention on Biological Diversity and Nagoya Protocol. CBD/DSI/AHTEG/2018/1/3.
- Laird, S., Wynberg, R., Rourke, M., Humphries, F., Muller, M.R., Lawson, C., 2020. Rethink the expansion of access and benefit sharing. *Science* 367, 1200–1202.
<https://doi.org/10.1126/science.aba9609>
- Lawson, C., Burton, H.B., Humphries, F., 2018. The Important Place of Information in the Evolving Legal and Policy Framework for the Conservation and Sustainable Use of the World's Plant Genetic Resources for Food and Agriculture. *European Intellectual Property Review* 40.
- Mc Cartney, A.M., Scholz, A.H., Groussin, M., Staunton, C., 2024. Benefit-Sharing by Design: A Call to Action for Human Genomics Research. *Annual Review of Genomics and Human Genetics*.
<https://doi.org/10.1146/annurev-genom-021623-104241>
- McLachlan, C., 2005. The Principle of Systemic Integration and Article 31(3)(C) of the Vienna Convention. *The International and Comparative Law Quarterly* 54, 279–319.

1 Oberthür, S., Pożarowska, J., 2013. Managing Institutional Complexity and Fragmentation: The
2 Nagoya Protocol and the Global Governance of Genetic Resources. *Global Environmental Politics*
3 13, 100–118. https://doi.org/10.1162/GLEP_a_00185
4 Pistorius, R.J., Wijk, J. van, 1999. The exploitation of plant genetic information: Political strategies in
5 crop development. University of Amsterdam.
6 Prathapan, K.D., Pethiyagoda, R., Bawa, K.S., Raven, P.H., Rajan, P.D., countries, 172 co-signatories
7 from 35, 2018. When the cure kills-CBD limits biodiversity research. *Science* (New York, N.Y.)
8 360, 1405–1406. <https://doi.org/10.1126/science.aat9844>
9 Raustiala, K., Victor, D.G., 2004. The Regime Complex for Plant Genetic Resources. *International*
10 *Organization* 58. <https://doi.org/10.1017/S0020818304582036>
11 Sayers, E.W., Cavanaugh, M., Clark, K., Pruitt, K.D., Sherry, S.T., Yankie, L., Karsch-Mizrachi, I.,
12 2023. GenBank 2023 update. *Nucleic Acids Research* 51, D141–D144.
13 <https://doi.org/10.1093/nar/gkac1012>
14 UNCLOS, 2023. Agreement under the United Nations Convention on the Law of the Sea on the
15 Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National
16 JurisdictionHigh Seas Treaty for Biodiversity Beyond National Jurisdiction.
17 Vienna Convention, 1969. Vienna Convention on the Law of Treaties.
18 Walckiers, P., Frison, C., Aubry, S., 2024. A roadmap to equity in pandemic preparedness, prevention
19 and response. *Journal of Global Health*. in press
20 WIPO, 2024. Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and
21 Folklore.
22 World Health Organization, 2023. INB.

1 **Figures**



2
3 **Figure 1. Accumulation of nucleotides (in bases) in NCBI Genbank since the beginning of the DSI**
4 **discussions in four ABS fora:** the Conference Of Parties of the Convention for Biological Diversity
5 (CBD COP, the Governing Body Meeting of the International Treaty for Plant Genetic Resources and
6 Agriculture (ITPGRFA GB), the Intergovernmental Negotiation Body mandated by the World Health
7 Organization for negotiating a Convention, Agreement, or any other international instrument on
8 pandemic prevention, preparedness and response (INB CA+) and the High Seas Treaty under the United
9 Nations Convention on the Law of the Sea ruling the Biodiversity Beyond National Jurisdiction
10 (UNCLOS BBNJ). Noteworthy, while UNCLOS BBNJ is adopted, all other processes are ongoing.
11 Since 2016, approximately 2.9×10^{12} nucleotides have been sequenced and stored in NBCI Genbank.
12 Data: <https://www.ncbi.nlm.nih.gov/genbank/statistics/>

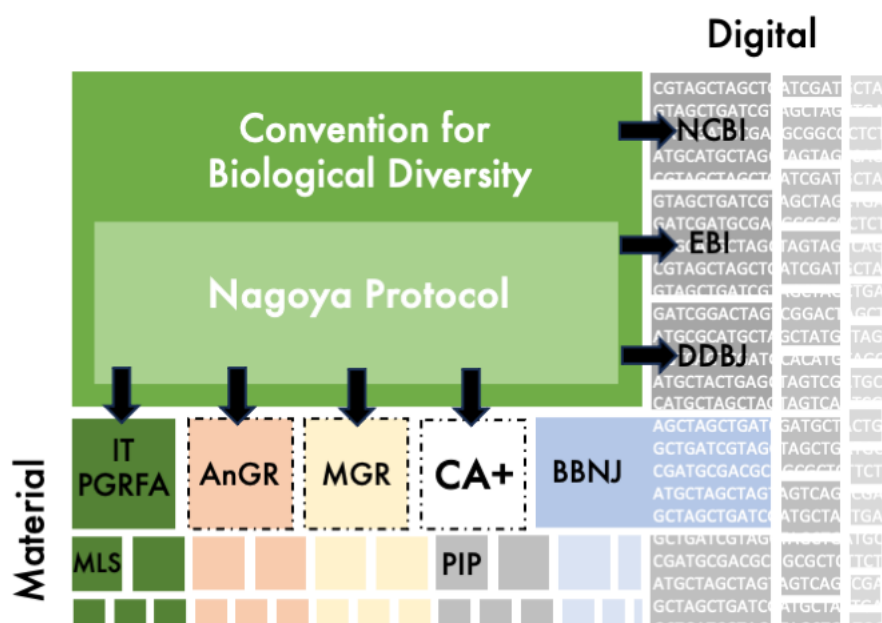
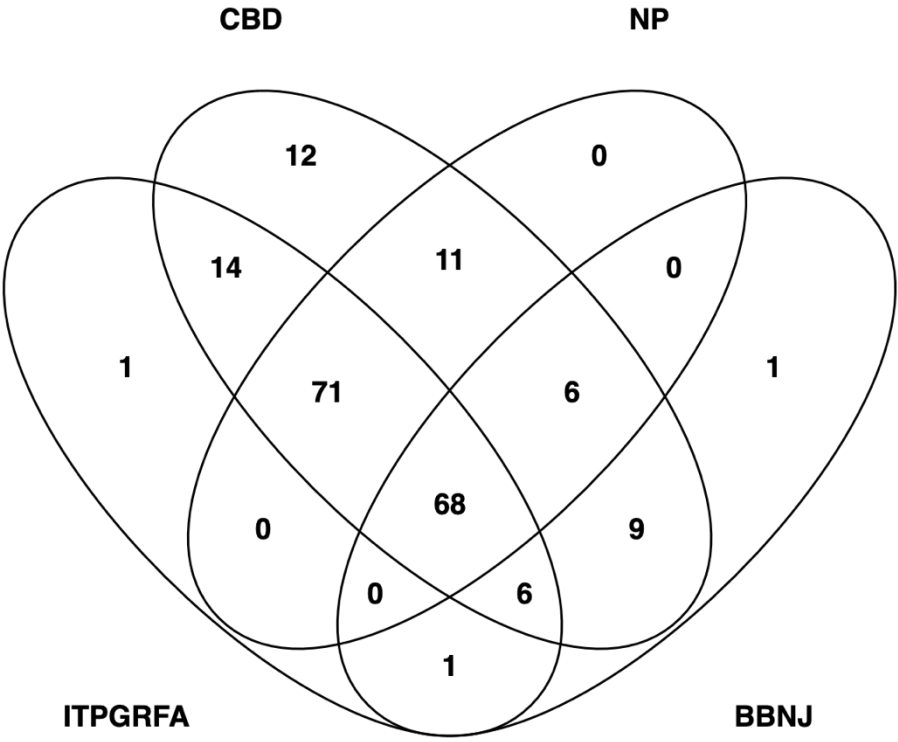


Figure 2. Trimming forces applied to the Convention for Biological Diversity and its Nagoya Protocol genepool. The multiplication of sub-sectorial instruments that extract specific subsets and try regulating them ad hoc (vertical arrows) and the split between material and digital resources. Some of the major databases are provided as an example: NCBI, National Center for Biotechnology Information, EBI, European Bioinformatics Institute and DDBJ, and DNA Data Bank of Japan. ITPGRFA, International Treaty for Plant Genetic Resources and Agriculture; MLS, Multilateral System; AnGR, Animal Genetic Resources; MGR, Microbial Genetic Resources; CA+, refers to the WHO CA+; PIP, Pandemic Influenza Preparedness Framework; BBNJ, Biodiversity Beyond National Jurisdiction.

1 **Supplementary Data**



2
3 **Supplementary Figure 1. The overlap between signatories of treaties dealing with genetic**
4 **resources.** CBD, Convention for Biological Diversity; NP, Nagoya Protocol; ITPGRFA,
5 International Treaty for Plant Genetic Resources for Food and Agriculture; BBNJ, Biodiversity
6 Beyond National Jurisdiction. All details about contracting parties are summarized in
7 Supplementary Table 1.

8
9 **Supplementary Table 1. Summary table of the data used for Supplementary Figure 1.**
10 Details over contracting parties and their respective status towards the various treaties.