Environmental Science & Policy 55 (2016) 1–10

Contents lists available at ScienceDirect

Environmental Science & Policy

journal homepage: www.elsevier.com/locate/envsci

Global scientific research commons under the Nagoya Protocol: Towards a collaborative economy model for the sharing of basic research assets

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ARTICLE INFO

Article history:
Received 2 February 2015
Received in revised form 17 July 2015
Accepted 11 August 2015

Keywords:
Collaborative economy
Open access policies
Access and benefit sharing
Biodiversity research
Culture collections

ABSTRACT

This paper aims to get a better understanding of the motivational and transaction cost features of building global scientific research commons, with a view to contributing to the debate on the design of appropriate policy measures under the recently adopted Nagoya Protocol. For this purpose, the paper analyses the results of a world-wide survey of managers and users of microbial culture collections, which focused on the role of social and internalized motivations, organizational networks and external incentives in promoting the public availability of upstream research assets. Overall, the study confirms the hypotheses of the social production model of information and shareable goods, but it also shows the need to complete this model. For the sharing of materials, the underlying collaborative economy in excess capacity plays a key role in addition to the social production, while for data, competitive pressures amongst scientists tend to play a bigger role.

1. Building global scientific research commons for biodiversity research

The importance of international cooperation for basic biodiversity research has been recognized since the very first debates on the design of global environmental governance regimes. Principle 20 of the 1972 Stockholm Declaration of the United Nations Conference on the Human Environment underlines that the "free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems" (UN Declaration on the Human Environment, 1972). However, in spite of important international initiatives, such as the Global Biodiversity Information Facility (GBIF) or the International Nucleotide Sequence Database Collaboration (INSDC), no clear legal and institutional framework has emerged to support such cooperation. Moreover, an increase in restrictions on global access to basic research assets has been documented in specific fields of life science research, with a potential detrimental impact on access to scientific publications, research samples and genomic databases (Jinnah and Jungcurt, 2009: 464; Reichman and Okediji, 2012). In addition, competitive pressures amongst scientists tend to counter-balance the social norms of scientific research communities, leading for example to delays in release of scientific results and research data (Dasgupta and David, 1994).

In this context, the Nagoya Protocol (Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity, 2010) offers an important opportunity for contributing to the emergence of an international institutional framework for biodiversity research. On the one hand, the implementation of the Protocol might add to the existing challenges for the functioning of the commons, but on the other, the Protocol also presents opportunities for a mutually supportive implementation between the existing practices of sharing of essential research assets and the access and benefit sharing regime. Indeed, as can be seen in particular in the annex to the Protocol, a broad variety of non-monetary benefit-sharing measures are envisioned as means to organize a fair and equitable sharing of research benefits between participating countries, which can be used to create a collaborative framework for the upstream dimensions of the research cycle. Moreover, different articles of the Protocol, such as articles 8, 10 and 11 explicitly address the issue of non-commercial and/or transboundary research cooperation.

Governments and research institutions throughout the world have already taken steps in the direction of such a mutually

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http://dx.doi.org/10.1016/j.envsci.2015.08.006

supportive implementation. Examples are the legislations on facilitated access to biological resources for non-commercial research in Australia or Brazil, amongst others, and the recommendations for accessing biological resources in basic research adopted by the German Research Foundation, DFG. However, these steps deal with the regulation of case by case bilateral transactions over single research assets and not with the building of global scientific infrastructures. In general, with the notable exception of the International Treaty on Plant Genetic Resources, little attention has been given to the likely consequences of the implementation of the Protocol for such global collaborations.

With a view to contributing to a better understanding of this issue, this paper analyses the functioning of global collaborations for biodiversity research in the specific field of microbiology. The field of microbiology has a long history of global collaboration, especially between the ex situ collections of microbial organisms that are member of the World Federation for Culture Collections (WFCC, cf. www.wfcc.info). The World Federation is a multidisciplinary commission of the International Union of Biological Sciences (IUBS) and has been actively promoting collaboration amongst the major collections in the world, in particular through the establishment of common standards for exchange and the building of an information network between the collections and their users (the so-called World Data Centre for Microorganisms). Therefore the case of the microbial culture collections is particularly interesting, as these collections have a well-established history of managing global scientific research commons. Within this specific context, this study aims to analyze what factors contribute to the public availability of the upstream research assets managed by the culture collections, including upstream research materials and associated genomic data.

The paper is organized as follows. First, some major challenges for organizing global collaboration with microbial resources are presented (Section 2). Second, some of the limits of the conventional public economy approach for understanding global commons are analyzed and the principles of an alternative, collaborative economy model, outlined (Section 3). Third, the paper analyses the functioning of this model through a survey of two existing practices of building global commons: sharing of basic research materials between public culture collections and public deposits of genomic information by the collection managers and/or scientists contributing materials to the collections (Section 4). The paper concludes with an overview of some options and best practices that result from the analysis. These research results show the need to consider a broad interpretation of the notion of non-commercial use in the implementation of the Protocol, in order to preserve these commons based exchange practices that are essential to global cooperation for basic biodiversity research (Section 5).

2. Global scientific research commons in microbial resources and associated genomic data

2.1. Use of microbial diversity for public health, food security and biodiversity conservation

Microorganisms are supporting the health of most ecosystems on earth and play a key role in many important issues, such as agriculture and food production and human health. For instance, microorganisms play a major role in soil fertility and are employed in disease diagnostics, efficacy testing of drugs, and vaccine production amongst others. Furthermore, microorganisms play a direct role in widely used biotechnology applications, which include the biological control of pests and diseases in agriculture and horticulture, production of natural products for pharmaceutical, food and other applications, bioremediation and detoxification of wastes.

Both private and public sector organizations collect, use and distribute microorganisms on a massive scale. The global market value for microbial products – used as biopesticides in agriculture as well as in chemical production – is an estimated $156 billion in 2011 with an expected increase to more than $259 billion in 2016 (BCC, 2011). Nevertheless, the overall market value is likely to be much higher, as the direct selling of microorganisms only represents a tiny part of the overall value of microorganisms as crucial intermediaries in basic and applied research. In addition, on average, over half a million cultured microbial organisms are distributed through various public service culture collections which conserve and distribute microbial organisms for basic and applied research purposes. Although the major part is distributed to public sector organizations (77% on average), a substantial part is also provided to for-profit private sector organizations (23% on average) (Dedeurwaerdere et al., 2012a).

Public service culture collections link academia, industry, government and international knowledge providers and users of microbial material. Although the utilization of the materials held in the collection is subject to the access and benefit sharing obligations of the country of origin of the isolates, the question of the full bundle of legal ownership rights over these is highly context specific. Nevertheless, most public collections do not claim any downstream ownership rights on the materials, which they keep in "custody" or "in trust" for the entire humankind. In practice, the materials are distributed against the payment of a fee in order to cover, in part, the additional administrative costs generated by the management of the distribution system.

The role and functions of the microbial collections as a basic life science research infrastructure bears a lot of similarities with other ex situ collections, especially in the field of animal and plant genetic resources, which have been studied elsewhere (Fowler et al., 2001; Gollin et al., 2000). However, two important features are specific to the microbial collections. First, microbial organisms have extremely high mutation rates upon reproduction (Dijkshoorn et al., 2010). As a result, there is no equivalent to the relatively well-defined species concept for plants and animals. Therefore, microbial science, and private sector research and development, depend to a large extent on the purified cultured organisms held in the microbial ex situ collections. Second, without globally accepted standards and quality control of microbial holdings, entire families of clones of collected microorganisms can be contaminated, as happened in the 1960s with the contamination of microbial cell lines for cancer research, which has led to over a decade of invalid scientific publications (Stern, 2004).

However, the vast majority of microbial diversity is yet to be discovered (estimated 90–95%). In addition, the combination of the high cost of conservation of purified microbes and the very high intra-species diversity makes it impossible for one collection to cover the entire breadth of microbial diversity, even for a specific set of microbial species. Intense collaboration and exchange amongst public culture collections is therefore a necessary consequence of this situation. In the more recent history, these global collaborations between the culture collections have been expanded to the public databases containing information on the country of origin, scientific publications related to the microbial holdings of the collections and automatic linkage to associated genomic information available through open access databases (Dawyndt et al., 2006; Reichman et al., 2015).

2.2. Challenges regarding the public availability of upstream research assets

The globally distributed infrastructure of culture collections has led to major scientific progress and technological innovations in the past, covering food security, environmental management,