



Documenting and protecting traditional knowledge in the era of open science: Insights from two Spanish initiatives

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ABSTRACT

Ethnopharmacological relevance: The documentation and protection of traditional knowledge face new challenges in the era of open science. Focusing on medicinal and food uses, we discuss two innovative initiatives in Spain to document, protect and return to the society traditional knowledge.

Materials and methods: The *Spanish Inventory of Traditional Knowledge related to Biodiversity* has compiled and published information on the traditional use and management of flora, fauna, fungi, geodiversity, and ecosystems. CONECT-e (www.conecte.es) is an online platform where citizens can document knowledge and uses of wild and domesticated species. We describe the extent of these initiatives in terms of participation and accomplishment, and discuss their complementarities and challenges.

Results: The initiatives described have fostered the establishment of a common standard for organizing traditional knowledge in databases that facilitate knowledge documentation: 131,066 uses and 152,246 local names have been documented so far. Using open data and copyleft licenses, these initiatives also contribute to the maintenance of traditional knowledge in the commons domain, guaranteeing the free exchange and reproduction of knowledge. However, the extensive focus of these initiatives on data sharing does not necessarily guarantee knowledge holders' data sovereignty.

Conclusion: To protect TEK in a context of open science more efforts should be done to operationalize traditional knowledge holders' rights to data sovereignty.

1. Introduction

Researchers and policy makers increasingly recognize that traditional ecological knowledge (TEK), i.e., the knowledge, practices, and beliefs about the relations between people and the environment (Berkes et al., 2000), not only can guide the sustainable use and management of species, habitats, and ecosystems, but is also essential for many aspects of human wellbeing (Pardo-de-Santayana and Macía, 2015). For example, in many places, traditional medicinal knowledge, a basic component of TEK systems, continues to be a first choice for primary

health care (Robinson and Zhang, 2011).

Given its relevance, there are numerous initiatives aiming at TEK documentation and preservation (Benyei et al., 2020b). For instance, Panama and Peru have national public TEK registers, and China, India and Venezuela have institutional databases for TEK documentation (Alexander et al., 2004). In several countries, TEK documentation efforts privilege medicinal over other uses, so patent examiners can use them as evidence of prior art (WIPO, 2012). Since 2014, access to genetic resources and associated knowledge is regulated by the Nagoya Protocol, an international agreement aiming at the fair and equitable sharing of

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benefits arising from the utilization of genetic resources and associated knowledge (CBD, 2021).

A major concern in relation to current efforts to document TEK is that they are not in line with new approaches to knowledge. Thus, current efforts to document TEK focus on storing, not on spreading knowledge by making it findable, accessible, interoperable and/or reusable (FAIR) using digital and collaborative technologies, or what is known as open science (Allen and Mehler, 2019). Similarly, current efforts to document TEK are not in line with concerns to secure data sovereignty by guaranteeing the protection of knowledge holder rights to data, tool ownership, and determining usage protocols around sensitive data, as proposed in the CARE (Collective benefit, Authority to control, Responsibility, and Ethics) principles (Carroll et al., 2020).

In this commentary, we present two ongoing initiatives in Spain aiming to document, protect and return TEK to society. We outline the main contributions of these initiatives to TEK documentation and then discuss their potential to ensure that TEK is as accessible as possible (FAIR principles) while preserving knowledge holders' data sovereignty (CARE principles).

2. Spanish inventory of traditional knowledge related to biodiversity

Since 1994, with the ratification of the Convention on Biological Diversity, Spain has committed to the conservation of biodiversity and associated traditional knowledge. Consequently, Spain has ratified the international protocols that regulate the documentation and protection of traditional knowledge, including the Cartagena Protocol (2003), the Nagoya Protocol on Access and Benefit-sharing (2014) and the Nagoya – Kuala Lumpur Supplementary Protocol on Liability and Redress (2018) (CBD, 2021).

Following the legislation derived from these protocols (i.e., 42/2007 Law of Natural Heritage and Biodiversity; 30/2006 Law of Seeds, Nursery Plants and Plant Genetic Resources), since 2011, an interdisciplinary team of more than 100 researchers from 29 institutions working in collaboration with civil society organizations are elaborating the *Spanish inventory of traditional knowledge related to biodiversity* (henceforth *Inventory*), which includes wild and cultivated biodiversity. Drawing on the systematic review of 286 published documents (i.e., 90 peer-reviewed articles, 96 books, 36 doctoral and master theses, and 64 other documents such as booklets, catalogues, or reports), the team has created a database compiling information on the traditional use and management of flora, fauna, fungi, geodiversity, and ecosystems in Spain. Plant uses, and specifically medicinal uses, are the most abundant entries in the database, with 40,390 use reports related to 1808 vascular plant species (Table 1). Other plant-use entries include human food - often related to medicinal uses - (16,351 use reports/1089 species), fodder (7113 use reports/1347 species), ritual uses (5423 use reports/1015 species), and ornament (3805 use reports/937 species).

To make the information accessible, the team has systematized the information by species and partially published it. At present, five published volumes, which are also freely available online, compile information on 801 species, mainly vascular plants (Pardo-de-Santayana et al., 2014, 2018; Tardío et al., 2018). The *Inventory* represents the collective effort of the Spanish scientific community to compile and analyze already published data creating a standard for future research (Pardo-de-Santayana et al., 2014). The *Inventory* also aims to return knowledge to society. Indeed, the publication of *Inventory* books has been an important milestone for sharing Spanish TEK, raising a wide public interest. For instance, the 1400 printed books of the first volume were sold out upon release and the different volumes online have been downloaded more than 1250 times.

Despite the extent and breath of the initiative, a complete inventory of the Spanish TEK would require additional funding for enlarging the database and the publication of about seven more volumes for wild and cultivated plants and several others for fauna, fungi, geodiversity, and

Table 1

Medicinal use reports and number of plant species in the database of the *Spanish inventory of traditional knowledge related to biodiversity*.

Medicinal uses related to the treatment of:	Use reports	Plant species
Digestive system	5232	684
Respiratory system	3986	512
Skin and subcutaneous tissues	3947	661
Circulatory system	2548	484
Symptoms of undefined origin	2498	445
Musculature and skeleton	1909	403
Genitourinary system	1811	426
Nervous system (includes mental illnesses)	1001	255
Other infectious and parasitic diseases	789	252
Endocrine-metabolic system	571	206
Sense organs	506	152
Conception, pregnancy, childbirth and the puerperium	285	104
Poisoning	275	126
Other medicinal uses	202	127
Cultural diseases	108	49
Tumor diseases	57	46
Immune system	45	36

ecosystems. Even with this effort, the *Inventory* would still fail to provide a complete picture of Spanish TEK, as it only includes published information, which is geographically and thematically biased. For example, the representation of the number of publications in the *Inventory* database suggests a geographical bias, some areas (e.g., Canary and Balearic Islands, Catalonia) having received more scholarly attention than others (e.g., the northwest and the southwest of Spain and northern plateau) (Fig. 1).

3. Conect-e online platform

Following international calls to increase traditional knowledge holders' participation in knowledge conservation efforts (Benyei et al., 2020b), in 2017 the same team launched CONECT-e (www.conecte.es). CONECT-e is a Wiki-like online platform that plays a double role in the documentation and sharing of TEK in Spain. CONECT-e includes the raw data contained in the *Inventory* database. A feature in CONECT-e is that it allows users to perform searches regarding specific areas, plant species and uses (Fig. 2). By sharing the disaggregated information collected in the *Inventory* database in a user-friendly interface, CONECT-e improves the accessibility to information already published but of difficult access, such as reports, master thesis, or local ethnographies. Moreover, given that many scientific publications are in English, by making information available in local languages (to date Spanish and Catalan), CONECT-e overcomes language barriers to the dissemination of documented TEK.

CONECT-e also contributes to TEK documentation by allowing citizens' to report their knowledge of wild and domesticated species (Benyei et al., 2020c; Calvet-Mir et al., 2018). Registered users can contribute text (e.g., local names, uses, and management techniques), photos, and other materials (e.g., references). Users can also comment on information already published in the platform. To maintain the place-based nature of TEK, all information is geo-referenced. A team of experts validates information entered in the platform. Given that, in Spain, traditional knowledge holders are typically aged people with limited skills in the use of information and communication technologies, CONECT-e developed a school program to train students in documenting information provided by their elders and recording it in the platform. This dissemination strategy helps bridge the gap between the platform's digital environment and traditional knowledge holders and promotes intergenerational transmission.

By March 2021, 902 people had registered in CONECT-e. CONECT-e users include 43.9% female, highly educated (65.5% had a university degree), young (avg. 35 years), and active ICT users (85.2% used ICT daily). About half of CONECT-e users live in rural or semi-rural areas and

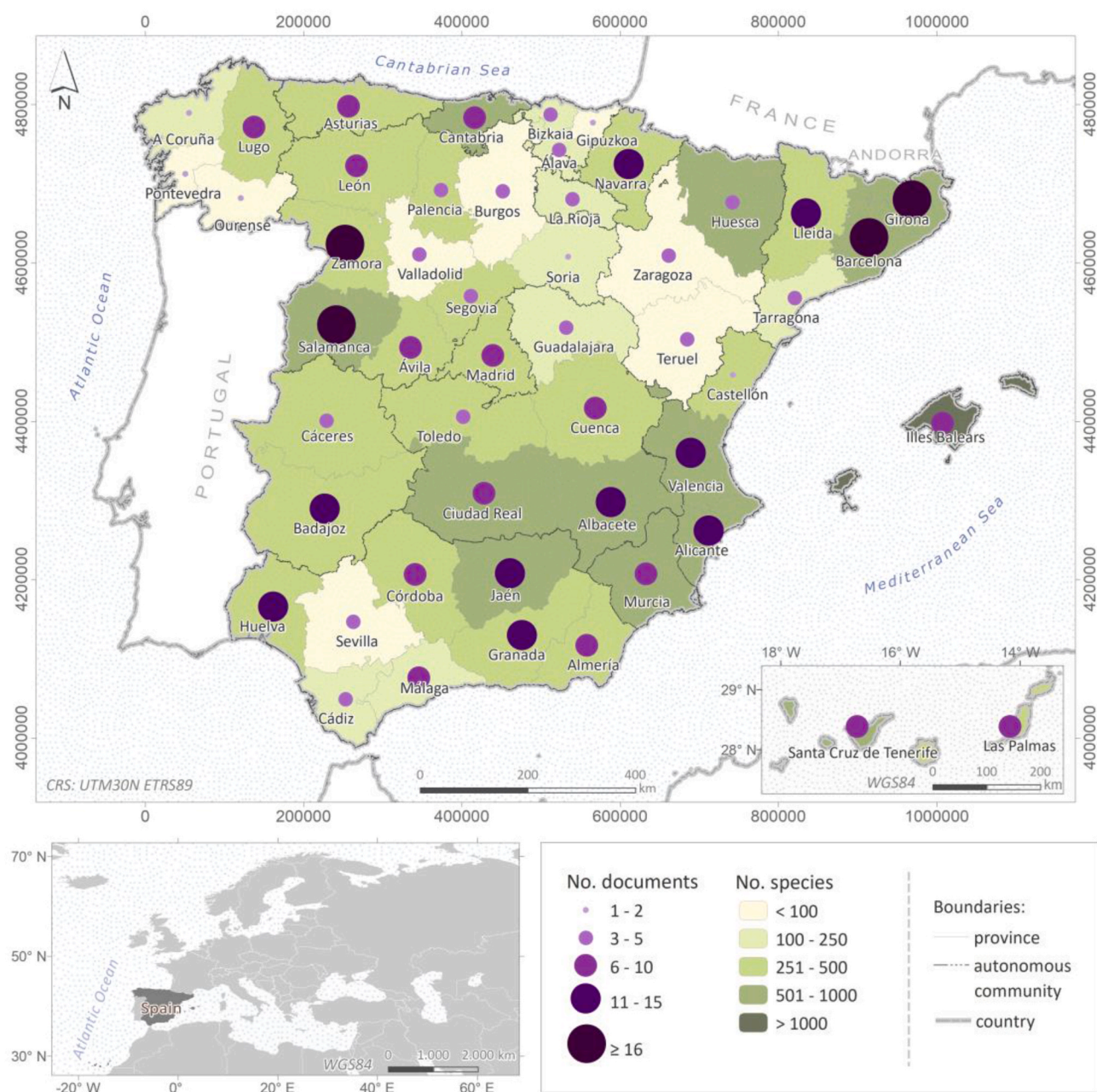


Fig. 1. Number of documents and plant species included in the *Inventory* database, by province. Note: Global administrative boundaries (country level). GDAM. <http://www.gdam.org/>. Administrative province boundaries (level 2) and autonomous communities' boundaries (level 1) of Spain. CC-BY 4.0. IGN (Instituto Geográfico Nacional). <http://www.ign.es>.

37.8% work on the primary sector (Benyei et al., 2020c). At the time of writing, CONECT-e included information on 2930 wild plant species and 634 crop landraces; it also contained 36,227 local names and 3323 images, facilitating species' identification. In relation to medicinal uses, CONECT-e contained 19,757 medicinal plant use reports registered in 730 municipalities. All together, CONECT-e included 178,719 entries, from which 97% came from the *Inventory*'s database.

CONECT-e has the potential to fill the geographical gap of information documented in the *Inventory*. CONECT-e also reinforces the value that citizens give to traditional knowledge (Benyei et al., 2020a) and promotes public participation in TEK documentation, a strategy that improves the amount and quality of information documented (Calvet-Mir et al., 2018). Finally, CONECT-e is in line with open science principles of spreading knowledge by making it FAIR using digital and collaborative technologies.

4. Protecting TEK in the era of open science

Together, the two initiatives described here promote access to TEK through the systematic compilation, publication, and improved accessibility to previously published, but scattered information. The approach to spreading knowledge potentially increases the availability, usability and dynamism of TEK. However, the focus on data sharing does not necessarily match traditional knowledge holders' rights and interests, and it does not guarantee knowledge holders' data sovereignty.

To protect the rights of knowledge holders, the *Inventory* and CONECT-e use licenses that maintain knowledge in the common domain. The *Inventory* books are published under an Open Data license, which allows reuse with citation of the source. Similarly, CONECT-e content is protected under a Creative Commons Attribution-ShareAlike 4.0 International License (CC BY-SA 4.0), which requires that any

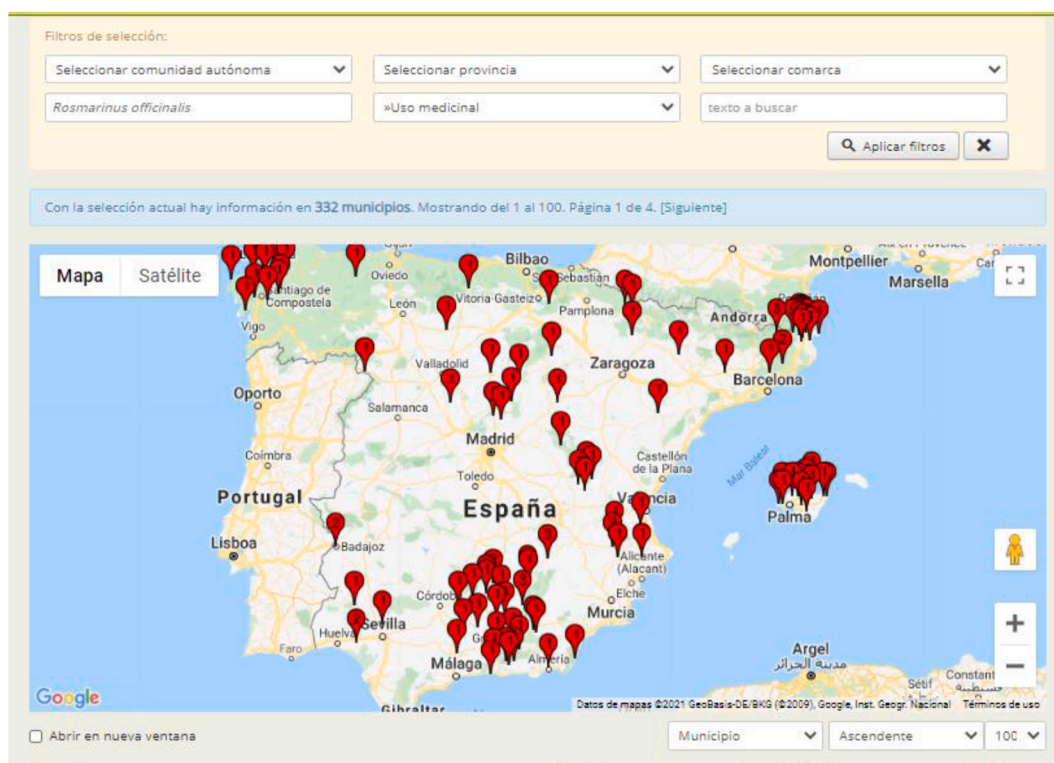


Fig. 2. Screenshot of CONECT-e output map displaying 100 locations (out of 332) where traditional medicinal uses of rosemary (*Rosmarinus officinalis* L.) had been reported.

product developed using its contents is protected under the same license (Reyes-García et al., 2018). In line with the Nagoya protocol, these measures aim to prevent misappropriation and to enforce benefit-sharing agreements. The measures are in line with measures adopted in other initiatives, such as the program of People's Biodiversity Registers (PBR) (Gadgil et al., 2000) and the India's Traditional Knowledge Digital Library (Poorna et al., 2014).

The measures adopted, however, do not suffice to protect the rights of the primary knowledge holder, as the open dissemination of TEK removes owner's control over the use of knowledge (Carroll et al., 2020). Following standard practices, the approach used in the *Inventory* and in CONECT-e focused on consultation, requesting knowledge holders' permission to share knowledge. This, however, does not guarantee knowledge holders' rights to data, tool ownership, and determining usage protocols around sensitive data, or data sovereignty (Kukutai and Taylor, 2016; Carroll et al., 2020).

While guaranteeing traditional knowledge holders' rights to data sovereignty in the era of open science is challenging, several initiatives exist aiming to operationalize traditional knowledge holders' data sovereignty. For example, the CARE (Collective Benefit, Authority to control, Responsibility and Ethics) principles for data management and stewardship aim for Indigenous data to be more within traditional knowledge holder's control and for collective benefit (Kukutai and Taylor, 2016). Similarly, the principles of the First Nations Information Governance Centre reflect on the importance of knowledge holders' Ownership, Control, Access, and Possession of data (OCAP Principles, <https://fnigc.ca/ocap-training/>). Finally, the Traditional Knowledge and Bio Cultural labels allow to embed local rules or conditions to certain knowledge through developing labels reflecting local world-views (e.g., only for woman; Kukutai and Taylor, 2016). Although these initiatives are context-specific and have been mostly developed in the context of Indigenous data, they share some common core principles that go beyond consultation: a) respecting traditional knowledge holders' knowledge ownership and b) authority to control and access

knowledge; c) prioritizing collective over individual benefits; d) recognition of context-specificity; and f) considering uses by future generations (Kukutai and Taylor, 2016). Overall, these principles should inform TEK protection in a context of open science.

5. Conclusion

The *Spanish Inventory of Traditional Knowledge related to Biodiversity* and CONECT-e are two innovative initiatives that create synergies to document TEK in Spain. In line with open science approaches, the two initiatives help to free TEK from its territorial boundaries and make it widely accessible, which in turn might contribute to TEK maintenance. However, the continuation and potential replicability of these projects face important challenges. Both initiatives depend on public funding and CONECT-e also requires maintaining citizens' interest and participation. Importantly, the focus on data sharing does not necessarily guarantee knowledge holders' data sovereignty. To protect TEK in a context of open science more efforts should be done to operationalize traditional knowledge holders' rights to data sovereignty.

Author's contributions

VRG, JT, and MPS designed the outline of this manuscript. VRG, PB, LAM, AG, MM, JT, MPS wrote the article and approved the submission.

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