

Co-creation of sustainable development knowledge in Biosphere Reserves

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Abstract

This study presents different situations of sustainability knowledge co-creation in Spanish Biosphere Reserves (BRs).

The analysis focuses on innovation processes addressed to improve sustainable development practices on a local scale by involving local actors. The study analyzes the roles performed by several actors (individuals or institutions) in establishing consensus on sustainable actions by means of cooperation. The main conclusions of the study are: a) models of governance for sustainability must take into account the participation of stakeholders at each level of action and facilitate the interactions between levels; b) scientists have roles to play in leading the process of knowledge acquisition and structuring; c) BR managers are fundamental drivers for transition toward sustainability on a local scale when they have sufficient institutional support, adequate skills, and positive attitudes.

Key words: collaboration among scientists/managers; collective learning; cross-level governance; institutional champions; knowledge co-creation; participatory research; personal leaders; social rules; stakeholder empowerment; sustainability facilitators

1. Introduction

In the current climate of environmental and social crisis, the United Nations (UN) has presented the 2030 Agenda as a plan of action in favor of people, the planet, and prosperity, as expressed in the UN Sustainable Development Goals (SDGs). In this context, one of the main missions of UNESCO's Man and the Biosphere (MAB) Programme is to contribute to the implementation of the 2030 Agenda through the worldwide dissemination of sustainability models, as set out in its strategy and the Lima Action Plan for 2016-2025 (UNESCO, 2017).

The path toward an alternative, sustainable future requires knowledge and social agreements, both of which are necessary for collective decision-making. Biosphere Reserves (BRs) integrate conservation and development, focusing on the sustainable management of resources as a way toward sustainability, and offer numerous examples of successful processes.

This chapter aims to explain how knowledge generated in five Spanish BRs, in support of sustainable development, was collected and structured. We focus on the knowledge acquired by the actors while taking action to support sustainability, as well as on the analysis of the most relevant factors leading to the success of these actions. Moreover, we reflect on the contribution of these experiences to the SDGs and on the relevance of the SDGs as guidelines for the sustainability of BRs.

Our thesis is that the knowledge generated in practice, if properly collected and structured, is a valuable source of information for the construction of sustainability science and for improving practices on the ground. In all of the cases studied, the actions were the result of the interactions between different points of view, varied and sometimes opposing interests, and different systems of knowledge – as well as, necessarily, consensus among stakeholders. Collective learning and the co-creation of knowledge are very useful for implementing new actions where the learning takes place and can also be applied to other locations, whether or not they are BRs.

A generally accepted meaning of the term *co-creation* is “making together” (von Hippel and Tyre, 1995); however, when the term is examined in more detail, there does not appear to be a common conceptual understanding (De Koning et al., 2016). Here, we understand *co-creation* to mean a situation where people learn together and collaborate in order to develop an action and reach a goal. Our experience is that there is no single truth established *a priori*, but rather, a socially-accepted meaningful truth constructed by each social group.

Undertaking research with local partners shifts the purpose of science from “seeking objective truth to seeking credible truth” about experience, with scientists acting as spokespersons of the environment and nature (Peterson et al., 2007 p 2500), being sensitive to social concerns and needs, and a “commitment to moving knowledge into societal action” (Kates, 2011 p 19450).

Scientists also play a crucial role in the process of turning knowledge derived from local experiences into sustainability science. Simply bringing different parties together will not produce change. Rather, multilateral facilitators are needed to ensure interventions and learning (Reed and Abernethy, 2018). In this study, we also try to outline the role of scientists as co-creators of knowledge beyond the geographical limits of local experiences.

2. Methodology

In this chapter, we analyze knowledge co-creation in five Spanish BRs with different environmental and socio-economic conditions. This analysis was undertaken through collaborations between scientists, managers, and other local actors, such as entrepreneurs

involved in sustainable development initiatives, following a collaborative science model (Herrero, 2016).

2.1. Experiences

Experiences associated with sustainable development were analyzed by the managers of the five BRs which took part in the project, four scientists, and the project coordinator. With respect to their specific objectives and circumstances, the five selected experiences are very different (see Table 1).

Table 1. Location and objectives of the five experiences analyzed in the project

BR, Region, and year of designation	Area km ²	Inhabitants	Studied experience	Objectives
Área de Allariz, Galicia (2005)	214.8	6,100 (30% in 92 rural nuclei)	The participation of local people in urban waste composting	Improve organic composting, focusing on encouraging domestic composting and promoting door-to-door organic material collection in food companies
Montseny, Barcelona-Girona (1978)	501.7	52,310	The evolution from natural park to BR	Adapt to MAB Programme Statutory Framework Establish a model of participatory governance
Alto Bernesga, Leon (2005)	334.4	5,261 (36 small rural centers and two main nuclei)	The role of rural women as promoters of economic activity and territorial sustainability	Find solutions to the problem of depopulation due to the crisis in the mining sector
Sierra de las Nieves, Andalucía (1995)	939.3	58,645	The transformation of agricultural land uses toward a more organic form of agriculture	Improve the sustainability of local agricultural practices Create new employment opportunities based on local resources
Lanzarote, Canary Islands (1993)	1,226.1 (846.10 terrestrial)	147,023	The role of the Reserve Participation Council during 20 years of the evolution of the BR	Search for the path of sustainability in a confrontational situation between two antagonistic development models

2.2. Information gathering

The experiences that were analyzed were proposed by the five BR managers as representative experiences for the Spanish Biosphere Reserve Network. Beginning with information about each experience provided by the respective manager, the project team identified possible common meaningful descriptors and gathered more information by interviewing the same managers (in sessions that lasted 4-10 hours) as well as several local practitioners. Thirty-three interviews were undertaken and recorded, with 10-16 hours of recording time per BR. For each experience, the information was structured according to the temporal sequence of the experience, highlighting the different aspects identified by the people who were interviewed. These compilations provide the base material for the project analysis.

2.3. Analyzing the compilations

Three procedures were used:

- Analysis of each descriptor in each of the five experiences. This allowed for cross-case comparison, as well as the identification of common traits and context-specific characteristics of each BR.
- Application of two conceptual frameworks – the theoretical approaches of the social-ecological system (SES) framework (McGinnis and Ostrom, 2014) and adaptive cycle theory (Holling, 2001) – in order to look for generalizable propositions derived from the cases studied. The process, developed in a participatory research format with the BR managers, aimed to systematize the knowledge gained from the transition to sustainability in practice.
- Reflection on the contribution of actions of sustainability to the SDGs.

3. Results. Descriptions and analysis of experiences

Once the compilations were complete, the most meaningful descriptors for the set of experiences were identified. Among the highlighted aspects, the descriptors that were found to be useful to all the experiences were: the trigger for the experience; the communication and participation system; and technical and human resources.

3.1. *The participation of the local people in urban waste composting in Area de Allariz BR*

History and trigger. The trigger for the experience was the implementation of a BR action plan that included the promotion of organic waste composting, which was not currently included in regional waste management plans. Social discourse was generated around composting organic matter, resulting in positive actions. This experience benefited from a participatory governance model introduced before the designation of the BR, almost 30 years ago, after a serious crisis in the municipal government.

Actors included the municipality, the manager of the BR, internal and external experts, citizens involved in the domestic sphere, food companies.

Results included the participation of more than 40% of the population in one year, progressive citizen acceptance and participation, improvements in the separation and management of local municipal solid waste (MSW), influence on MSW governance methods on a regional scale, and a demonstrative effect for other populations. In addition, the project had a favorable economic impact on the area as two jobs were generated.

Contribution to SDGs. The waste composting activities contributed to environmental and socio-economic sustainability and made it possible to develop a more resilient society, through actions corresponding to Goal 11 (Make cities resilient and sustainable) and Goal 12 (Sustainable consumption and production).

Lessons learned. The introduction of innovations in domestic practices and civic culture is possible. The principal incentive for the citizens was the satisfaction of being the protagonist of something done well. There was a need for methods of communication adapted to the subject matter, the recipients, and the population characteristics, and also to adapt the system to accommodate the big producers of organic waste.

Keys to success included a convincing technical project and the material resources for citizen participation. Community composters of one cubic meter were designed, each serving some 15 families and taking about two months to fill. The atmosphere of dialogue was a great advantage, as people saw that the municipal management team was open to listening to their opinions. The collaboration on a common project increased the self-esteem of the population by making them feel that they belonged to a group that did meaningful things.

3.2 Montseny BR: the evolution from Natural Park to BR

History and trigger. The initial BR, with an area of 31,064 ha, was a natural park whose objectives were fundamentally nature conservation. When it was designated in 1978, the BR mirrored the characteristics of the park and its conservation objectives. In this period, the MAB Programme focused on the conservation of natural areas (Reed, this volume). The Seville Strategy changed the focus to combining conservation and sustainable development (Bouamrane et al., this volume). After the first periodic review for the BR was submitted to UNESCO in 2000, the International Advisory Committee for BRs recommended that a management plan for the BR as a whole should be prepared, and that there should be a clear zonation in which conservation and sustainable development actions were developed. As a result of these recommendations and those following the second periodic review in 2011, and although the BR fulfilled the criteria in the Statutory Framework, the authorities responsible for the BR were aware of the need to expand in order to incorporate areas where sustainable development activities were being undertaken. The proposed expansion was approved in 2014 by the International Coordinating Council of the MAB Programme.

The BR is managed directly by the provincial administrations of Barcelona and Girona; on a local scale, municipalities also have responsibilities. In addition, most of the territory is privately-owned, which limits how the management authorities can establish agreements to develop actions.

Actors were the provincial administrations, the manager and the provincial administration staff based in Montseny BR, municipalities, and civil organizations.

Results. Montseny BR has expanded from 31,064 to 52,310 ha and from 1,200 inhabitants in its interior to 51,000, most of whom live in the transition area (18,194 ha). Local leaders and economic actors embraced the project and generated their own sustainability initiatives. In addition, the provincial administrations have created an administrative structure that is very favorable to the management of the new BR. Some sustainable development challenges are being addressed, for example through the development of renewable energy, registration of the Montseny brand, and support for the implementation of the European Charter for Sustainable Tourism.

Contribution to SDGs. The process of including various municipalities in a strategy directed toward sustainability contributed to a more sustainable society, corresponding to Goal 11, and to environmental protection, Goal 15 (Protect ecosystems).

Lessons learned. The model of participatory governance on a local scale, applied for more than 10 years, has led to a model of participatory governance in the provincial administrations. The resulting atmosphere of trust and collaboration is essential for the managers to communicate with stakeholders.

Keys to success. A specific information campaign was undertaken to demonstrate the commitments and opportunities involved in expanding the BR. The initial agreement of local actors was the most convincing argument for changing the initial positions of the higher-level regional institutional leaders, and mayors were the principal supporters of the proposed expansion.

3.3 The role of rural women as promoters of economic activity and territorial sustainability in Alto Bernesga BR

History and trigger. Alto Bernesga BR was designated in 2005 by a unilateral initiative of the Spanish MAB Committee. The situation at this time was of great socio-economic crisis caused by the closure of coal mining, which began in the 1990s. This phenomenon led to gradual depopulation, loss of employment, and collective frustration. Women in the area lacked training for any economic activity outside the home – and the initiative to do so. In this situation, the designation of the BR and the appointment of a manager (who was a city council staff member) played the driving role in exploring a new social and economic model for the area.

Actors. The manager of the BR; unemployed, frustrated men; women without training or a culture of productive initiatives; social organizations interested in restoring mining activity.

Results. In the last 10 years, about 150 women have been professionally accredited and dozens of business initiatives have been generated. An association of entrepreneurs of Alto Bernesga has been created, which functions as a support and stimulus centre for local entrepreneurship, and reinforces local products and the environmental quality of the territory. Local political leaders and regional and provincial institutions have changed their attitudes from skepticism to strong support.

Contribution to SDGs. The experience aimed to empower women through training courses as a strategy for addressing depopulation. The actions that were developed focused on employment creation, contributing to Goal 8 (Inclusive and sustainable economic growth). This project also contributed to Goal 4 (Inclusive and equitable quality education) and Goal 5 (Achieve gender equality and empowerment of women).

Lessons learned. Training actions are very effective as instruments of communication. Skills and values such as persistence, transparency, listening attitudes, and sincerity are key to generating a climate of confidence. A coherent and continued action, such as the events periodically organized by women, can change the relationship between superior governing bodies and the territory.

Keys to success. A continual information campaign about new alternatives for the territory and the population, directed at all the social actors. Training women, through courses, for employment in the following sectors: agri-food, health, production mushrooms and truffles, sustainable tourism, ecologically-sound livestock husbandry, and beekeeping. Locating resources and support for the territory, mainly in the state administration and support organizations for women.

3.4 The transformation of agricultural land uses toward an organic form of agriculture in Sierra de las Nieves BR

History and trigger. Sierra de las Nieves BR was designated in 1995 at the request of the local population. The main source of employment in the area was in tourist establishments on the Costa del Sol, one of the most touristic areas of the Spanish Mediterranean (10-70 km from the BR). A reduction in employment in the tourism sector due to the 2008 economic crisis caused some local people to return to agricultural activity. In this context, the managers of the BR raised the possibility of introducing ecologically-sound agricultural practices.

Actors. Municipalities; the manager and experts of the BR; external experts; local development agencies; local farmers.

Results. As a result of this initiative, 600 farms, belonging to 140 producers, were transformed to organic ones. They comprise 900 ha of olive groves and 100 ha of other organic crops. It may be noted that, at the beginning of the project, the forecast was that 150 farms would be involved. Other environmental results were decreases in soil erosion, the use of chemicals, and the impact of the withdrawal of external resources. **Importantly**, the knowledge of local actors increased.

Contribution to SDGs. The implementation of an economy based on organic production made new sustainable employment possible, as well as the conservation of the environment, contributing to Goals 8, 12, and 15.

Keys to success. The main success was in creating a territorial identity for the BR, which facilitated the introduction of initiatives proposed by the BR administration. The keys for this project were: a high number of conferences and courses offered in all the municipalities; visits to organic farms; complementary external resources.

Lessons learned. The experience of the town councils in working together to develop projects of interest for the whole territory; the need for resource and continuity of action when the initiative entails a profound cultural transformation.

3.5 The role of the Reserve Participation Council during 20 years of evolution in Lanzarote BR

History and trigger. Lanzarote BR was designated in 1993, at a moment of conflict over the future of the island in relation to the development of an economy based on tourism. This situation came about because of a promotion from the insular administration (Cabildo) of an artistic project to enhance development. Art, Culture, and Tourism Centers were promoted, and sculptures, paintings, and other land art projects designed by the artist César Manrique, a native of the island, were integrated into the landscape. The big tour operators identified this as a great opportunity for developing mass tourism. However, the population believed that the growth of the tourism industry was excessive, and most did not favor this. In this situation, in 1996, the insular administration, which is the management body of the BR, created the Reserve Participation Council (RPC) with an advisory function for managing the BR as a space for representing the different viewpoints of the island's society.

Actors. The island council; Lanzarote Council experts who were in charge of revitalizing and helping the RPC; external experts; local NGOs; representatives of all relevant social groups.

Results. The RPC provided information for a social debate and contributed to a proposal for a local development plan for each municipality and an environmental sustainability plan for the whole island, in order to establish a culture of limits to growth.

Contribution to SDGs. The measures taken through a participatory process in order to avoid environmental degradation, contribute to Goals 11, 15, and 16 (Promote peaceful and inclusive societies for sustainable development).

Lessons learned. The actions of the RPC over more than 20 years have yielded positive, measurable results in the form of increasing social awareness and concrete actions. Critically, they have also avoided disastrous situations, as the outcome could have been worse if there had not been a process of analysis, discussion, and participation.

Keys to success. The RPC, since its creation, has acted intensely to promote a sustainable project for the whole island. Its principal tool is the legal framework of the landscape management plan, promoted by the Lanzarote Council in 1991. This stipulated that, of the 350,000 tourist accommodation spots planned for that year, 240,000 should be eliminated, and various strategic plans and studies should be carried out, with external technical expertise, to provide rigorous criteria for the sustainability of the island. Since 2012, the RPC has also conducted informative talks and debates between the experts and other people responsible for all of the municipalities on the island.

4. Discussion

4.1 Profile of key actors and facilitators of processes toward sustainability

The path toward sustainability needs to link different actors and create opportunities for interaction through networks, which are critical factors in learning and developing responses to change (Olsson et al, 2007). Leadership is very important for networking, and the strength of a network depends on the capacity of key people to relate to other stakeholders. Some authors have pointed out that linking different levels and knowledge systems requires that individuals or organizations take an active role as coordinators and facilitators in co-management processes (Halls et al., 2005; Cvitanovic et al., 2016).

The experiences described here all point to the relevance of leadership roles in the five Spanish BRs, whether those of stakeholders or political-institutional champions. The key actors were the following: the manager of the BR, the entity responsible for the BR, local decision-makers (local governments), entrepreneurs, and local social leaders. Managers of BRs have always played a crucial role, generating trust-based relationships and prompting the involvement of people in actions toward sustainability. Another important concern for the BR managers was to obtain the necessary economic support to develop actions, as in the case of Sierra de las Nieves BR and Alto Bernesga BR.

The contribution of the actors to the success of a transition to sustainability action is associated with their know-how and to values or personal skills such as the ability to contribute to an atmosphere of trust, the willingness to collaborate, and commitment to a collective project. In addition to leaders, Folke et al. (2003) identified the following actor groups in building resilience and adaptive capacity in SESs: knowledge retainers, interpreters, facilitators, visionaries, inspirers, innovators, experimenters, and followers. Depending on the case, scientists may also play the role of facilitators in the co-creation of knowledge, as with the Spanish BRs, or may be visionaries, inspirers, and innovators in general (Reed and Abernethy, 2018).

The roles of scientists in the studied experiences were relevant, in collaboration with the other actors that operate in practice. One essential role of scientists has been to act as observers leading the process of collection and structuring the knowledge acquired throughout the development of each initiative. Consequently, scientists can draw conclusions about good practices towards sustainability in BRs, and share them with people concerned about this issue. Another important role is the function that scientists play as communicators and in inspiring local people to take action, as in the case of Lanzarote BR. Their knowledge and commitment to sustainability provided advice, encouragement, and confidence to local actors.

These examples demonstrate how different experiences contributed to various SDGs. Overall, across all the study sites, the work in the BRs contributed significantly to SDG 17 (Partnerships for the Goals) by creating innovative agreements to bring about sustainability.

4.2 Governance: Bottom-up and top-down approaches and cross-level effective interactions

The analyzed experiences have demonstrated that a transition toward sustainability involves collaboration between stakeholders and, through the establishment of participation mechanisms, modifications in the existing governance structures.

In the case of Alto Bernesga BR, the business association of entrepreneurs, initiated and managed by women, established a network of collaboration among all types of entrepreneurs. In Montseny BR, local governments became defenders of expanding the area of the BR, making decisions before the higher-level institutions did so, and promoting a participatory governance model. In Lanzarote BR, the commitment to the goals of the BR spread from the insular government to the municipal governments after 20 years of interaction. The experience of Area de Allariz BR transformed the model of municipal waste management and inspired transformations at the regional level. In Sierra de las Nieves BR, the initiative had an important impact on the practices of a large number of farmers, although it has not yet managed to generate collective governance structures for the sector, due to a lack of continuity in the necessary resources. All of these examples are the result of the empowerment of local actors through the participation processes toward sustainability.

The analyzed experiences have demonstrated that models of governance for sustainability must have the participation of competent actors at each level of action and must facilitate cohesion between levels. It is necessary to overcome the rigidities of the system and move toward new shared and socially agreed-upon rules. The actions carried out in the studied BRs demonstrate how actors can provoke new processes for relationships that can transform governance and induce a changes in policies and regulations. Interactions between management scales and hierarchical levels of decision are decisive (Cash et al., 2006). Decision makers, at different scales, need to have quality information in order to be able to contribute to the governance of sustainability. In this context, the involvement of scientists can also contribute positively to successful decision-making about the governance of the environmental common good.

5. Conclusions

The analysis of these five cases has contributed to the co-creation of generalizable knowledge, which may be useful outside of the limits of these concrete experiences. We advance here four generalizable propositions which may contribute to the conceptual body of sustainability science (see also de Lucio et al., 2019): a) a need or a crisis factor may trigger the introduction of new practices, advancing toward new socially agreed-upon, shared rules; b) building credible collective knowledge about social and ecological interactions underlies identification of the environmental common good; c) generation of shared community values can be achieved by means of active listening and good communication processes; and d) governance processes operating at different levels and scales may require fine tuning and integration of actors and initiatives (see also, DialogosRB.net).

The concept of the MAB Programme and the practices of the BRs as multi-level governance systems introduce innovative opportunities that bring multiple actors together to address the SDGs at local and regional levels. Additionally, BRs as territories in transition to sustainability are the source of important experiences that can provide basic information for building sustainability science. However, local communities have to understand and accept the general premises of sustainability. Sharing and disseminating local knowledge and know-how among people will help to transform public policies that may thwart sustainability toward achieving sustainability at the local, national, and global levels.

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7. Bibliography

- Cash, D. W., Adger, W. N., Berkes, F., Garden. P., Lebel, L., Olsson, P., Pritchard. L., and Young. O. (2006). Scale and cross-scale dynamics: Governance and information in a multilevel world. *Ecology & Society*, 11, Article 8.
- Cvitanovic, C., McDonald, J., Hobday, A.J. (2016). From science to action: Principles for undertaking environmental research that enables knowledge exchange and evidence-based decision-making. *Journal of Environmental Management*, 183: 864-874.
- De Koning, J. I. J. C., Crul, M. R. M., and Renee, W. (2016). Models of co-creation. *In ServDes*. Linköping Electronic Press, Copenhagen, Denmark.
- de Lucio, J. V., Herrero, C., Rodríguez, B., Barber, J., Varela, B., Miguélez, A., Rueda, T., and Pou, A. (2019). Claves de éxito de las experiencias de transición a la sostenibilidad: Investigación participativa de casos de estudio de ciclo adaptativo e intervención sobre sistemas ecológicos y sociales en reservas de la biosfera españolas. *Forum de Sostenibilidad*. Cátedra UNESCO sobre Desarrollo Sostenible de la Universidad del País Vasco UPV/EHU, ISSN: 1887-9810, nº 9 (*in press*).
- Folke, C., Colding, J., and Berkes, F. (2003). Synthesis: Building resilience and adaptive capacity in social-ecological systems. In: F. Berkes, J. Colding, and C. Folke (eds). *Navigating social-ecological systems: Building resilience for complexity and change*, pp. 352–387. Cambridge University Press, Cambridge, UK.
- Halls, A. S., Arthur, R. I., Bartley, D., Felsing, M., Grainger, R., Hartmann, W.,

Lamberts, D., Purvis, J., Sultana, P., Thompson, P., and Walmsley, S. (2005). Guidelines for designing data collection and sharing systems for co-managed fisheries. Part 1: Practical guide. *FAO Fisheries Technical Paper*. No. 494/1. Food and Agriculture Organization (FAO), Rome, Italy.

Herrero, C. (2016). DialogosRB. Madrid, Spain (<https://dialogosrb.es>)

Holling, C. S. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4, 390–405. <https://doi.org/10.1007/s10021-001-0101-5>

Kates, R. W. (2011). What kind of a science is sustainability science? *Proceedings of the National Academy of Sciences (PNAS)*, 108, 19449–19450. Available at: <https://doi.org/10.1073/pnas.1116097108> [Accessed 11 Oct. 2018].

McGinnis, M. D. and Ostrom, E. (2014). Social-ecological system framework: Initial changes and continuing challenges. *Ecology and Society*, 19. Available at: <https://doi.org/10.5751/ES-06387-190230> [Accessed 11 Oct. 2018].

Olsson, P., Folke, C., Galaz, V., Hahn, T., and Schultz, L. (2007). Enhancing the fit through adaptive co-management: Creating and maintaining bridging functions for matching scales in the Kristianstads Vattenrike Biosphere Reserve, Sweden. *Ecology and Society*, 12(1): 28

Peterson, M. N., Riley, S. J., Busch, L., and Liu, J. (2007). Reconciling wildlife management's conflicted purpose with a land community worldview. *Journal of Wildlife Management*, 71, 2499–2506.1. Available at: <https://doi.org/10.2193/2007-090> [Accessed 11 Oct. 2018].

Reed, M. G. and Abernethy, P. (2018). Facilitating co-production of transdisciplinary knowledge for sustainability: Working with Canadian biosphere reserve practitioners. *Society & Natural Resources*, 31:1, 39-56, DOI: 10.1080/08941920.2017.1383545

UNESCO. (2017) *A New Roadmap for the Man and the Biosphere (MAB) Programme and its World Network of Biosphere Reserves*, UNESCO Paris, <https://unesdoc.unesco.org/ark:/48223/pf0000247418>

UNESCO (2016). Lima Action Plan for 2016-2025. http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/Lima_Action_Plan_en_final.pdf [Accessed 11 Oct. 2018].

von Hippel, E. and Tyre, M. J. (1995). How learning by doing is done: Problem identification in novel process equipment. *Research Policy*, 24: 1–12.