NOTE #2

Responsible research and innovation for the conservation of biodiversity

By Elena Buzan

RRI IMPLEMENTATION IN BIOSCIENCE ORGANISATIONS

GUIDELINES FROM THE STARBIOS2 PROJECT

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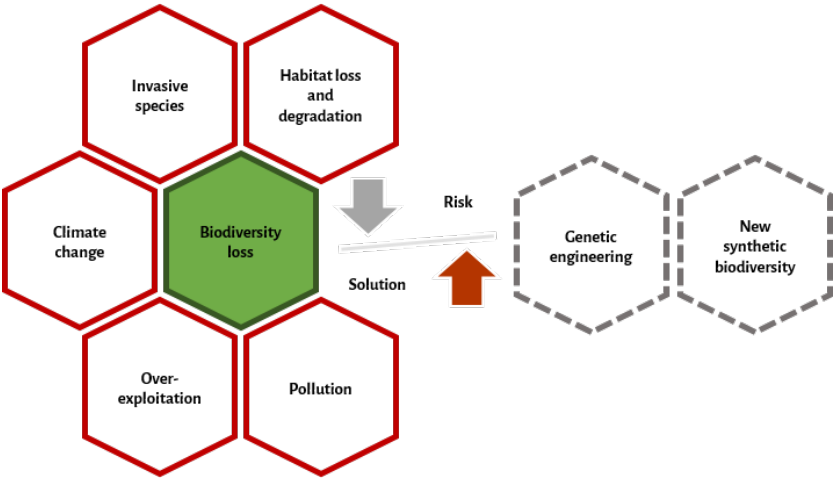
Biodiversity, the basis of the ability of ecosystems to provide services to humanity, has dramatically declined in past decades. The gravity of ongoing biodiversity loss is exemplified by the Earth's sixth mass extinction. Biodiversity loss is closely linked to human activities and has severe effects on growth and economic development.

Progress is being made in the research and development of environmental engineering and synthetic biology, with a growing number of advances in robotic manufacture, pharmacy, medicine, biotechnology, chemical engineering, agricultural and energy sectors. Also, these developments may provide solutions to many environmental challenges, such as climate change, scarcity of clean water and soil and biodiversity loss etc. Synthetic biology is a good example of how research and innovation could play a central role in growth and economic development. Although synthetic biology is beneficial for society, there are many scientific uncertainties surrounding the development of synthetic life, cells and genomes, especially in terms of their impact on the environment. Introduction of novel, synthetic organisms may pose a high risk for natural ecosystems and biodiversity (Figure 1). Therefore, risks and benefits of innovation for biodiversity are subject to debate, both in the field of research as well as in civil society.

Responsible Research and Innovation (RRI) is a rapidly evolving concept, with emphasis on motivation, theoretical conceptualization and translation into practice. RRI has lately included environmental sustainability as a key area for the social desirability of research and innovation. We believe that it is

essential to implement RRI in conservation biology, a discipline in crisis, protecting nature in all its complexity.

Figure 1. Major factors influencing biodiversity



It is crucial for society and its citizens to participate in the processes of RRI in biodiversity conservation. To ensure everyone's involvement, the public needs to be sufficiently literate about how science works. They need to be able to understand the benefits and risks of innovation in technology in order to participate in debates, evolve ethical thinking and make informed choices. Particular attention should be given to fostering new skills and knowledge by the education system; primary/ secondary schools and universities alike, centred on the use of science education with environmental ethics and bioethics. The education should develop many skills of scientific thinking, so that students are able to interpret evidence, evaluate innovation and technologies, make informed judgements, and argue their perspectives. By increasing awareness for the need for gender equity and for using sex as a key variable in research, one is teaching important scientific skills that are relevant in RRI.

By transforming the education system, the RRI culture of safeguarding biodiversity eventually spreads to influence both academic and non-academic groups.

In our work, five key principles (science education, public engagement, open access, gender equality and ethics) were used to design a framework (Figure 2a) for an impact assessment of RRI in biodiversity conservation. Our first step was to provide quantitative factors for promoting and monitoring RRI at a faculty (university) level, which is involved in the education of biodiversity conservation.

The second step was to assess the impact first on university employees and students and then on broader socio-economic indicators to ensure the durability of internationally sustainable nature conservation. Selected target groups were organised to explore five issues: professional development, policy change, open publications and data, gender in society and ethics of biological experiments and their environmental impacts (Figure 2b).

Figure 2. Framework to include RRI within conservation of nature's biodiversity

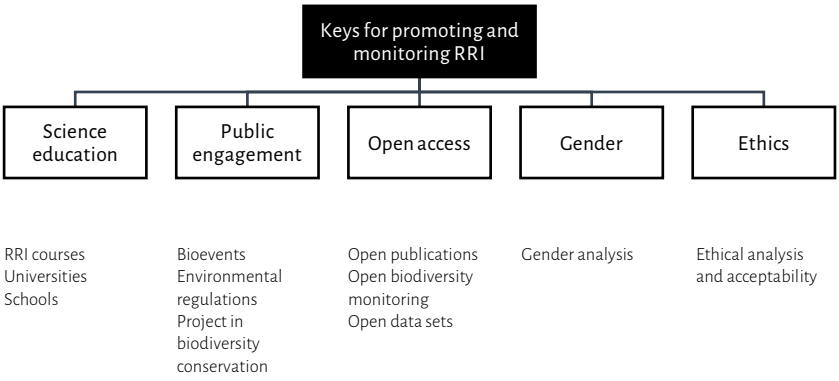


Figure 2a

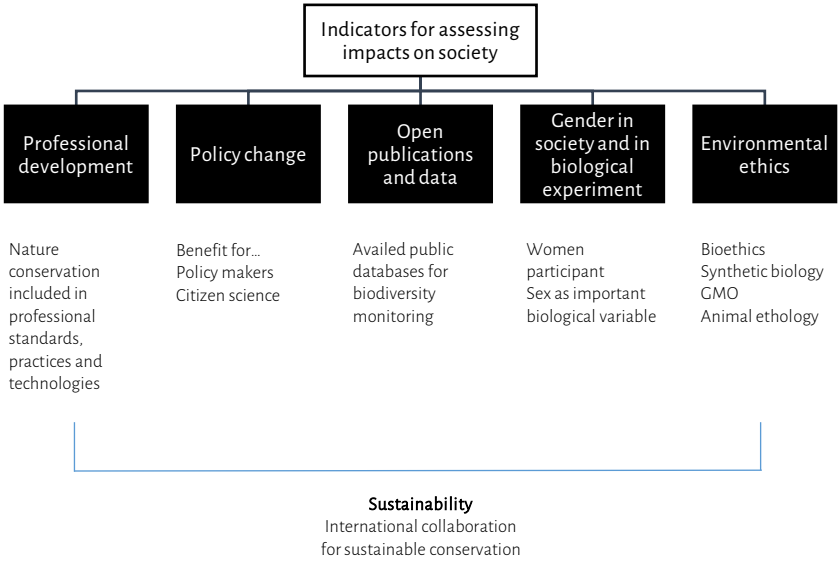


Figure 2b

Biodiversity data are highly heterogeneous due to the diversity of observed taxonomic groups, the methods used and different types of data produced. Ensuring data interoperability is vital to validate professional standards, practices and technologies. There is also an urgent need for data standardization for policy-makers and citizens. The standardization and data aggregation has to be prepared so that it is both human- and machine-readable. Universities and other education organisations should develop knowledge of inheritance using arguments pro and contra (example genetic modification of organism), and weighing up the benefits and risks that apply science to make a decision.

Citizen science is a form of public participation in scientific research which has gained significant momentum in recent years. This is particularly evident in biodiversity conservation and environmental sciences where input from citizen scientists has

greatly increased the number of publicly-available observations. Data collection starts with designing data forms, developing observation portals, communication of data collection methods and storing data by research institutions or government agencies, which allows an easy data presentation for different stakeholders. The partnership among academics, researchers, scientists, lecturers and society includes schools, students and families and is vital for opening up more opportunities for open education in environmental and biodiversity conservation. Promoting RRI can also enhance teachers' professional development by bridging formal and informal learning about innovation in synthetic biology and biotechnology while incorporating environmental ethics. Involving community through citizen science is vital for evidence-based pedagogical changes supported by knowledge, skills and a culture of RRI that involves all members of society in technological innovation and nature conservation.

ABOUT THE STARBIOS2 GUIDELINES

This guideline aims to help readers formalize and trigger structural change aimed at introducing appropriate RRI-related practices to their own organisations. This is not a series of prescriptions, but an itinerary of reflection and self-interpretation addressed to different actors within the biosciences. To support this itinerary of reflection and self-interpretation, the document provides...

- a description of a general RRI Model for research organisations within the biosciences, that is a set of ideas, premises and "principles of action" that define the practice of RRI in bioscience research organisations,
- some practical guidance for designing interventions to promote RRI in research organisations in the Biosciences, putting into practice the RRI Model,
- a set of useful practices in implementing the structural change process,
- and information on particular STARBIOS2 cases and experiences, as well as materials, tools and sources, are also provided in the Appendix and in the Annex.