

Challenges to Collaboration in International Research: Lessons from Terrestrial Laser Scanning

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1. Introduction

Terrestrial laser scanning is a method of remote sensing with applications to ecological research. A relatively young research method, the first literature demonstrating the application of ground-based laser scanning technologies to ecology and forestry was published in the early 2000s (Lovell et al. 2003). Over the past 20 years, advances in instrument technology and data processing have enabled the development of novel measurement approaches and expanded the application of terrestrial laser scanning beyond traditional structural metrics. The data generated through terrestrial laser scanning is now used, amongst others, to estimate aboveground biomass, model branch architecture, conduct habitat assessments, generate vertical profiles of vegetation structure and quantify fuel loads (Beland et al. 2019, Calders et al. 2020, Disney 2019). Terrestrial laser scanning also has potential applications to other forms of remote sensing measurement systems (Beland et al. 2019) and 3D modelling (Disney 2019). Such developments are fostered by working and sharing with colleagues (Laudel 2001).

International collaborations play an important role in terrestrial laser scanning. The diverse range of disciplines and countries that collaborations in terrestrial laser scanning bring together builds not only connections between researchers but also encourages the standardisation and sharing of algorithms, data and best practices for field work (Beland et al. 2019). However, terrestrial laser scanning research has also struggled to attract expertise from across many disciplines, such as remote sensing, physics, engineering and computer science, and has instead focused on training forest ecologists to perform these functions (Calders et al. 2020). Terrestrial laser scanning is therefore an interesting and unique context in which to study international collaborations.

Terrestrial laser scanning, like all of science, is an increasingly international and collaborative endeavor. International collaborations across science are driving research (Adams 2013), with high-impact research papers increasingly authored by international teams (Adams 2012). Collaborating in international research is facilitated by advances in communications technology, which increase the interconnectedness of researchers (Wagner and Leydesdorff 2005). International research collaborations are however complex and diverse in terms of structure, coordination and purpose (Katz and Martin, 1997). Researchers who collaborate internationally must overcome political, logistical and cultural barriers and negotiate a range of challenges, including lack of funding for international research, restrictions on material and data sharing and differences in academic standards (Matthews et al. 2020). These challenges to collaborative international research are also potentially applicable to terrestrial laser scanning.

This research paper seeks to improve our understanding of the collaborative dynamics in terrestrial laser scanning by exploring how researchers experience collaborations involving terrestrial laser scanning. In doing so, this research project aims to address the following research questions: How do the challenges and barriers identified by Matthews et al. (2020) manifest in terrestrial laser scanning and what strategies do researchers employ to overcome them? How does the structure and coordination of international collaborations reinforce or mitigate the challenges and barriers? What are the consequences of the challenges, barriers and strategies for the scientific output? Ultimately, the results of this research will hopefully support terrestrial laser scanning researchers and inform more effective organisation and coordination of international research collaborations.

2. Data and Methods

This study draws on data collected from 17 (at present) semi-structured interviews with researchers whose current or previous research activities are associated with terrestrial laser scanning. The

interviewees were initially drawn from participants in an international network focused on terrestrial laser scanning and expanded through a snowball sampling technique. The interviewees were based in 11 different countries across Europe, North America and Australia. The interviewees were asked a series of questions designed to create data about their own background as well as to provoke stories about their experiences in international research collaborations involving terrestrial laser scanning. Particular attention was paid to any challenges the interviewees experienced and how these challenges were addressed.

After transcribing the interviews, the language and stories shared by the interviewees were analysed and thematically coded according to the research questions using the qualitative analysis software Atlas.ti. The initial coding framework was based on the barriers and challenges introduced by Matthews et al. (2020) and elaborated on throughout the coding process following an inductive, grounded theory approach (Charmaz 2014). The coding framework was judged as complete when no new themes emerged from the data. In addition to the interviews, documents from an international network associated with terrestrial laser scanning were also coded. The resulting thematic codes were then compared and analysed to identify any patterns or trends within the data.

3. Results and Discussion

Researchers who participate in international collaborations in terrestrial laser scanning tend to fall into one of four categories (see Table 1). The categories are not exclusive; it is possible for an individual to exist within multiple. Each category of expert offers different skills and has different demands from collaborations. The four categories differ in their understanding of the goals and the state of development of terrestrial laser scanning. When two or more different categories participate together in a collaboration, they must negotiate these sometimes-conflicting perspectives, even when the collaboration has a clear, shared goal.

Table 1: Typology of experts in terrestrial laser scanning.

	Tool Developers	Data Gatherers	Data Analysers	Data Users
Role:	Build the equipment	Operate the equipment in the field to collect data	Make sense of the data collected in the field	Use the generated data for their own applications
Disciplines:	Engineers; physicists	Remote sensing specialists	Modellers; mathematicians	Ecologists; Forest managers
See TLS as a(n):	Engineering problem	Research field	Research field	Tool
Development status:	Advanced	Advanced	Intermediate	Early days

Amongst the many reported challenges to international collaborations in terrestrial laser scanning, the most common was funding, which echoes the findings of Matthews et al. (2020). Many interviewees reference the constraints that available funding has on their ability to engage with international collaborations. In general, experts join international research collaborations in terrestrial laser scanning for the following seven reasons: data sharing, instrument sharing, networking, learning, obtaining funding, conducting fieldwork and bridging expertise. The further goals of this research is to understand how these motivations differ across the four expert categories.

The structure and coordination of the international collaborations can be reduced to four ideal collaboration types (Figure 1), based on the degree of formality and number of countries involved. The collaboration types differ in terms of funding, pre-existing relationships between members and shared research interests. These differences give each type their own set of coordination, organisational and management challenges. The preliminary findings suggest that some of the collaboration types are more suited for certain goals than others. Moving forward, this research hopes to shed light on how the emerging challenges and reasons to collaborate differ across the types of collaborations.

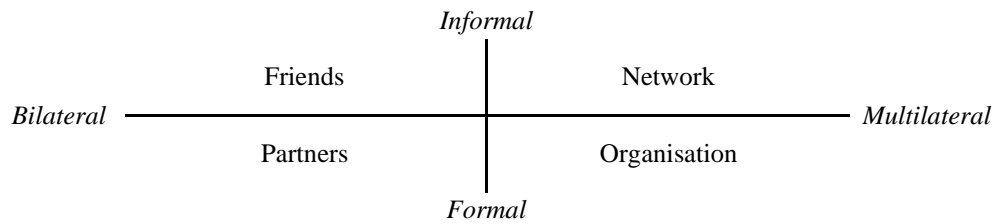


Figure 1: Typology of international research collaborations.

4. Conclusions

Terrestrial laser scanning is a unique case study for investigating the collaborative dynamics of international research. International research collaborations in terrestrial laser scanning connect diverse researchers and facilitate the standardisation and sharing of algorithms, data and best practices for field work. Researchers involved in international collaborations in terrestrial laser scanning can be grouped into four categories of experts, which differ in terms of their role, discipline and view of terrestrial laser scanning. Researchers participate in these international collaborations for a variety of reasons. Participants in international collaborations in terrestrial laser scanning also face a range of challenges, the most common being funding. The differences between four categories of terrestrial laser scanning experts can cause tensions, which the participants must negotiate. The structure of international collaborations can be divided into four basic types, distinguished by formality and number of involved countries. Each type has their own advantages and disadvantages. As this research project moves forward, it will explore how the reasons for participating, the challenges the participants face and the categories of experts differ with the four types of collaborations. Understanding how the different types of collaborations constrain or support researchers in their everyday work is essential to building more effective international collaborations in the future. This research is still ongoing and feedback on the direction and preliminary findings is extremely helpful.

Acknowledgements

This research is conducted as part of a project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 819533).

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