GC Insights: Enhancing inclusive engagement with the geosciences through art-science collaborations

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Abstract. Art-science partnerships offer valuable opportunities to enhance inclusive engagement with research through
10   collaborative creative practice. Here, we present two case studies of interdisciplinary approaches to contextualising environmental science for wider audiences. We synthesise lessons learned from these case studies and associated stakeholders to provide advice for conducting successful art-science collaborations that help to broaden interactions with environmental geoscience research.

1 Introduction

15   The adverse impacts of climate change and biodiversity loss are increasingly apparent, disproportionately affecting disadvantaged and socially vulnerable populations (Arkema et al., 2013). Now is consequently a timely opportunity for engaging wider audiences in environmental geoscience as public awareness of climate and biodiversity research has also intensified (Simis et al., 2016; Rossi et al., 2020; Lee, 2021). Art-science approaches offer an alternative to the traditional linear communication of research, providing a platform for participatory dialogue that may build trust in science outreach
20   (Mach et al., 2021).

Art-science partnerships have become increasingly popular and can take many forms (Tooth et al., 2019), ranging from more conventional 'artist as the communicator' to truly collaborative initiatives whereby projects are co-conceived, conducted, and evaluated by cross-disciplinary participants. The latter supports knowledge co-production, whereby the concept of 'seeing double' (Mould et al., 2019) - through both an art and science lens - can help scientists to understand different perspectives
25   and relations to their subject matter (Risner et al., 2019; Marlton and Robson, 2020). A recent Geoscience Communication Special Issue provided insight into the diversity of art-geoscience projects already occurring, demonstrating where geoscience and art have successfully collaborated to study topics such as climate change, geotourism, or cultural heritage (Lanza et al., 2020).

Art-geoscience projects may also capacitate audiences to 'experience' landscapes and geographic concepts they have not been
30   exposed to (Gates, 2017). This has significant implications for inclusive outreach, as empowering viewers to (virtually or

physically) interact with subjects allows for the individual interpretation of information, instead of acting as a recipient (Stewart and Lewis, 2017; Mould et al., 2019; Locritani et al., 2020). Emotional engagement with previously impalpable concepts is important in shifting public perceptions and responses to environmental change (Schneider and Simon, 2014; Lee, 2021).

Here, we share experience-based advice for conducting successful art-science collaborations that enabled wider public
35 engagement within the environmental geosciences. Art is broadly defined to include many forms of creative expression, including painting, photography, film, poetry, and music (Tooth et al., 2016). We scoped environmental geoscience as the study of ecological and geophysical processes that influence our environment and the impacts of associated human activities. We provide two case studies of collaborative art-geoscience projects and the results of interviews with an artist, art-scientist, and an exhibition officer from these examples to synthesise experience-based recommendations for successful partnerships.

2 Methods

We sought to reveal enabling conditions for multi-stakeholder collaborations using an illustrative case study approach. The objective of this study was to evaluate two retrospective case studies through a series of semi-structured interviews for in-depth analysis of factors contributing to successful art-science partnerships (Thomas, 2011). The case study examples were selected from our networks for their collaborative nature and outreach activities. Representatives from the case studies were
45 invited for interview to represent three common stakeholder groups in art-science partnership: an artist, scientist, and an exhibition officer. We conducted semi-structured interviews with the case study representatives using a set of preliminary questions which were pilot tested with two researchers in the team (Kallio et al., 2016). Interview results were thematically analysed and categorised according to establishing, conducting, and post-partnership stages. The results were summarised into key recommendations for building art-science partnerships, alongside contextual information on aims and motivations for
50 partaking (Supplementary Material). The synthesis was iteratively co-developed with each stakeholder's team to ensure findings reflected a collective opinion.

Case study 1 – Connecting biodiversity and immersive art

An art-science exhibition hosted at the Oxford University Museum of Natural History titled 'Biodiversity' featured work by contemporary artist and environmentalist, Kurt Jackson (https://www.kurtjackson.com/about/). This exhibition displayed
55 Jackson's artworks amongst the Museum's collections, showcasing interlinkages between art, science, and natural history. Selected works were accompanied by responses from Oxford University scientists to highlight connections with research and encourage viewers to consider what biodiversity means to them. Figure 1 features 'Taxonomy of a Cornish Foreshore' and the researcher's response as displayed in the exhibition. Integrating artwork with museum specimens and contemporary research created a unique environment in which visitors could connect with the natural world in their immediate environment whilst
60 positively engaging with research that tackles the wider biodiversity crisis.

Case study 2 – Coupling art and climate negotiations

In order to share outcomes of the recent COP26 climate negotiations (https://ukcop26.org/) in a more accessible and memorable format, artist and scientist Dr Cécile Girardin collaborated with mural painter Lisa Curtis and youth activist Arnaud Girardin-Potts to create a 4m-long mural within the COP26 negotiation zone (Fig.S2, Supplementary Material). The piece was intended to build bridges between the many activists and civil society representatives demonstrating in Glasgow and globally, and the thousands of negotiators debating within the conference centre. This mural captured the main takeaways of COP26, deploying a digestible combination of vibrant colours, shapes, and pithy statements. The dynamism of the artwork invites viewers to interpret the interconnectedness of nature, climate, and society, explore the complexities of the climate negotiations, and alludes to key debates that shaped COP26 talks.

3 Results

These findings summarise key lessons learned from interviews with each stakeholder directly involved in the case studies above, specifically relating to the establishment and fulfilment of art-science partnerships for inclusive engagement. The interview participants (art-scientist, artist, exhibition officer) each reported communicating to wider audiences as a primary motivation for partaking in these collaborations. To achieve this, interviewees highlighted the benefits of engaging other disciplines to connect multiple viewpoints, in addition to considering the contexts in which an art-science partnership is shared. For example, according to the exhibitions officer, the Museum of Natural History setting for Case Study 1 attracted new audiences "who may be engaged with the arts but less likely to visit a science museum, by offering different perspectives on natural history." Regarding Case Study 2, the art-scientist reported that creating a mural during COP26 conference proceedings facilitated a piece that reflected the complexities of climate negotiations, as this allowed for dynamic incorporation of key debates and diverse perspectives in real time.

In terms of establishing art-science partnerships, interviewees recommended developing strong relationships between project stakeholders for collaborations that are founded on trust and respect. The artist from Case Study 1 highlighted the necessity of being well informed by those active in the relevant scientific field, as "[o]nly then can an artist facilitate the understanding of the environment. For the final work to have any profundity or agency the creativity needs to be underpinned by genuine research and knowledge." The art-scientist interviewee from Case Study 2 similarly emphasised the importance of communicating research in digestible ways without oversimplifying the science, finding that "[s]ynthesising complex concepts into illustrations" helped to communicate their research better and to wider audiences. Further, strong partnerships accommodate for honest dialogue and consequently support the critical process of collectively evaluating and adapting art-science projects. The exhibitions officer from Case Study 1 evidenced how impact should be monitored with specific metrics that evaluate both the process of collaboration and the short- and long-term impacts of an inclusive engagement project,

contributing further to the evidence base on conducting art-science partnerships. A table of further recommendations along with additional data on the aims and motivations for collaborating can be found in Supplementary Material.

4 Discussion and Conclusions

This work presented two case studies of interdisciplinary partnerships for wider engagement in the environmental geosciences.
95   These examples demonstrated different approaches to facilitating knowledge exchange with communication tools co-developed through art-science partnerships. The stakeholder interviews corroborated that art-science collaborations can provide a platform for knowledge co-production, with each representative emphasising the value of cross-disciplinary partnerships for encouraging self-reflection and interacting with new viewpoints. The importance of mutual trust and respect in building these relationships has been reflected in other art-geoscience collaborations (Risner et al., 2019), allowing for the
100   greater appreciation of other disciplines (Marlton and Robson, 2020). Significantly, interviews with the artist and art-scientist revealed cautions against the oversimplification of science for communication purposes, emphasising the importance of taking time to foster collaborations based on a genuine understanding of the research, similarly highlighted by Locritani et al. (2020).

Our research activity revealed that each stakeholder representative was predominantly motivated by a common goal of engaging new audiences, a finding reported in a previous survey of participants in art-geoscience partnerships (Archer, 2020).
105   An interesting result of the interview with the exhibitions officer is the opportunity to situate art-science partnerships in varied contexts to enhance inclusive engagement, such as the Museum of Natural History exhibition, Case Study 1. By situating the exhibition amongst museum specimens, the art-science project connected visitors to both contemporary research and multiple perspectives on natural history. Visitors reported feeling predominantly inspired by the exhibition, commenting on how the artist made "the everyday and ordinary seem so extraordinary", and provoked attendees to reflect on concepts of biodiversity
110   and habitat loss. As explored by Van Loon et al. (2020), combining artistic practice with conventional methods for building resilience to natural hazards may provide a more holistic understanding of social as well as ecological risks, leading to more comprehensive preparation for natural disasters (Van Loon et al., 2020). In responding to Kurt Jackson's work, the researchers in Case Study 2 were encouraged to situate their science and explain the social relevance. Such knowledge exchange is an asset in the development of effective solutions to the climate and biodiversity crises we are facing. In Case Study 2, the art-
115   scientist was able to co-create the mural with perspectives of those attending and speaking at the COP26 conference and found this to be a widely accessible and engaging format. This co-development of science communication is pertinent to publicly contested and politicised matters, such as biodiversity loss and climate change (Suldovsky, 2017).

In conclusion, enhancing inclusive engagement within the geosciences can be achieved through art-science partnerships. Our findings suggest that enabling conditions are important to create safe spaces for the knowledge exchange and reflective
120   practice. Starting with relationship building based on mutual respect was found to support the successful development of equitable partnerships and co-production of ideas. Further, our case studies underscored that considering different contexts for

sharing art-science partnerships (e.g., a museum) can contribute to the success of inclusive engagement initiatives. This work explored two case studies in which the team had been involved; the next step would be to increase the number of interviews with a wider group of stakeholders from a diverse range of case studies. These results are experience-based suggestions for practising a successful art-science partnership and represent a preliminary example of the value of investigating enabling conditions of interdisciplinary collaborations for inclusive knowledge exchange.

Author contributions

RW conceived the article and led the writing process, supported by LW. KJ and NS designed and ran the exhibition. CG designed and co-created the COP26 piece. All authors contributed to the development of the understanding and ideas presented.

Competing interests

The authors declare that they have no conflict of interest.

Financial support

The work was supported by the University of Oxford, ESRC IAA Knowledge Exchange Dialogues Award.

Acknowledgements

We thank Poppy Menzies Walker for her encouragement and sage advice on this paper.

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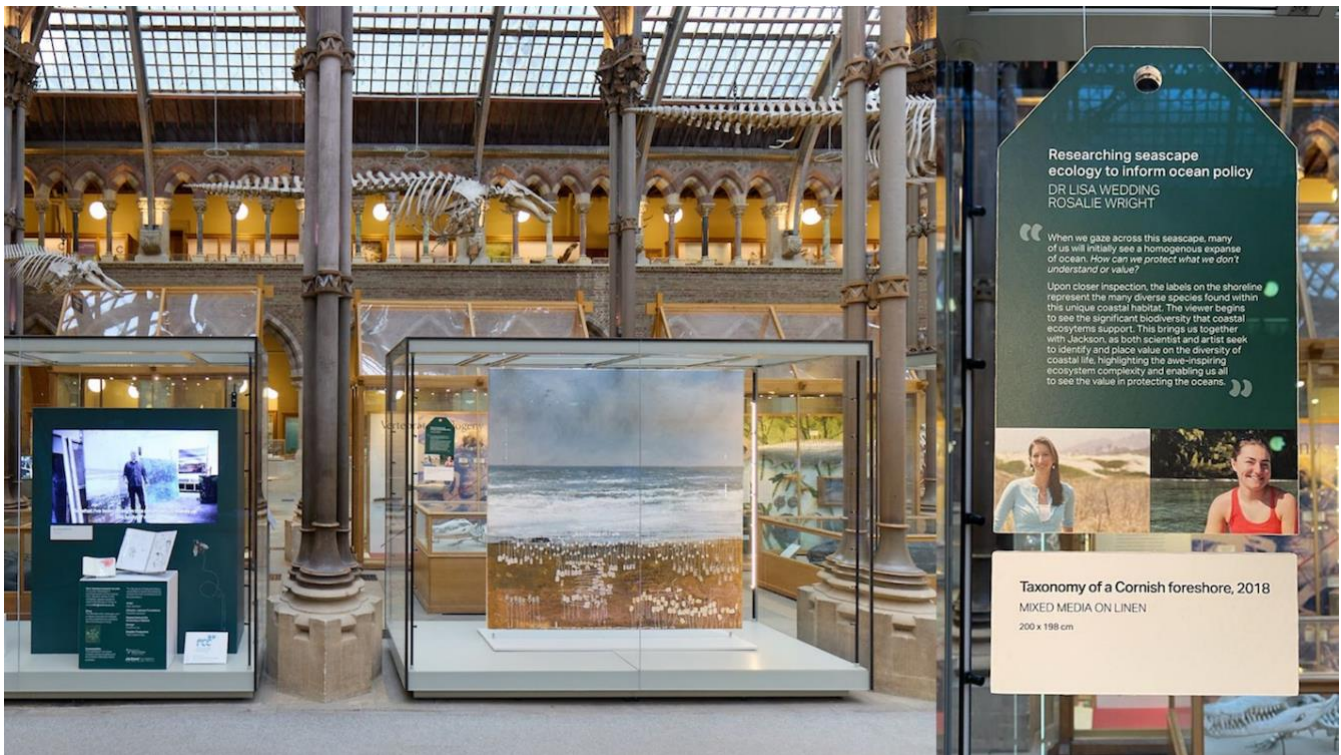
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Figure 1: 'Taxonomy of a Cornish Foreshore' by Kurt Jackson, on display as part of the Biodiversity exhibition at the Oxford University Museum of Natural History. The piece shows how the beach, the foreshore, has a particular resonance to many whilst also being a biodiversity hotspot, a liminal zone and the meeting point for ecosystems. As Jackson explains, "*a coastline is the front line where our impact is tangible and alarmingly visible - if we allow ourselves a moment we can see and be aware of the fragility, diversity and complexity of this world, but*
190 *crucially also the beauty*". This work was on display featuring the following response from authors Rosalie Wright and Dr Lisa Wedding: "*When we gaze across this seascape, many of us will initially see a homogenous expanse of ocean. How can we protect what we don't understand or value? Upon closer inspection, the labels on the shoreline represent the many diverse species found within this unique coastal habitat. The viewer begins to see the significant biodiversity that coastal habitats support. This brings us together, as both scientist and artist seeking to identify and place value on the diversity of coastal life, highlighting the awe-inspiring ecosystem complexity and enabling*
195 *us all to see the value in protecting the oceans.*" (Image credit: Museum of Natural History by Ian Wallman, pixieset.com)