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Bearing Witness: A commentary on climate action and immersive climate change exhibitions

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This commentary focuses on a new wave of virtual reality and immersive exhibitions on climate change, and the opportunities of such virtual reality experiences in strengthening climate change awareness, climate literacy and more active forms of participation in climate action. In this context is the evolving and crucial role of museums and cultural organisations in shaping and supporting our response to this urgent crisis through immersive and dynamic forms of narrative.

Climate change. Virtual Reality. Extended Reality. Digital culture. Digital cultural heritage. Museums. Climate literacy.

1. INTRODUCTION

With the scale and urgency of climate change as a global challenge, museums and cultural organisations are recognizing that they have a crucial role to play in shaping and supporting society's response to the crisis (Newell et al. 2016; McKenzie 2019). In the lead up to COP26, museums and cultural organisations increasingly became involved in climate action through supported activism and audience participation through events and exhibitions (Harrison & Sterling 2021). A highlighted event in 2022 was the *Reimagining Museums for Climate Action* competition hosted at Glasgow Science Centre in Scotland.

The diverse exhibitions and narratives gathered there suggest that museums can have a vital role to play in shaping a more just and sustainable future for people and planetary health. There are already precedents, for example, in the establishment of the first museum in the USA dedicated to climate change in 2015 – the *Climate Museum* in New York (climatemuseum.org/), and the activist museum organisation *Climate Museum UK* (climatemuseumuk.org/) which has no venue but works across distributed teams, collections, and sites through activations and events. There are several emerging international networks affiliated with the museum community as well, such as the *Museums and Climate Change Network* (mccnetwork.org/) and *Museums for Future* (museumsforfuture.org/).

At the centre of these developments are progressive and proactive approaches to social, cultural and public engagement through dialogue and exhibition. This commentary focuses on two related explorations, namely the existing ways in which climate change narratives in immersive virtual reality (VR) are being incorporated into museum and gallery physical and online exhibitions spaces, and how museums can engage this medium as a vehicle for reflection and mobilization.

2. VR AND SIMULATED NATURE

VR usually combines video, sound and images into immersive environmental simulacra. Within these virtual environments, there is the capacity to encounter multisensory and spatial modalities aligned with nature (Williams et al. 2021). These can include binaural and spatially located audio; touch and haptic feedback; vision via stereoscopic graphics including 360° video, animation, drawing, and 3D scanned objects (Soccini & Marras 2021). Movement with up to six degrees of freedom can allow self-directed exploration in the virtual space, such as weather patterns and time-based environmental changes.

Combined VR technologies can become transformative when we are able to experience environmental processes that would otherwise be invisible because of their scale or the timeframe in which changes occur across night /day and seasonal, or complex processes, such as erosion and carbon sequestration (Markowitz et al. 2018). VR can provide visitors access to locations they could not otherwise explore due to geographical barriers, including distance, and safety. Access to ecologically sensitive areas such as coral reefs or wetlands is restricted in order to preserve them. VR can offer an alternative way to experience these places. For instance, VR can help students connect to global and local environmental issues.

An educational research study on the use of Google Expeditions, a smartphone-based VR application (now merged into Google Arts & Culture), provided students with an opportunity to engage in a 360-degree field trip through the Borneo rainforest and to learn about deforestation (Tudor et al. 2018). The lessons were then applied to a local conservation area affected by railway construction and the students worked with a local charity to protect them.

The Stanford Ocean Acidification Experience (https://stanfordvr.com/soae/) allows students to experience the impact of a century of ocean acidification on reef biodiversity by "walking amid corals that are losing their vitality" and observing how increasingly acidic water is affecting marine life.

The VR application has been downloaded and/or used in over half of countries worldwide (Fauville et al. 2020; 2021). When researchers measured the effect of this simulation by comparing the students' test scores, they found that knowledge about ocean acidification increased by nearly 150 percent and persisted after several weeks (Fauville et al. 2021).

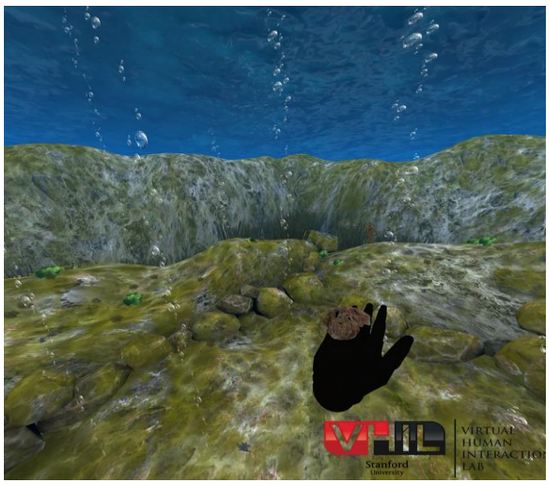

Figure 1: *Snapshot from the Stanford Ocean Acidification Experience VR application available at: https://store.steampowered.com/app/409020/The_Stanford_Ocean_Acidification_Experience/*

In this way, VR has shown to help promote learning achievement (Chien et al. 2019), problem solving and communication (Markowitz et al. 2018), and particularly pro-environmental attitudes or behaviours (Markowitz & Bailenson 2022).

Pro-environmental behaviour that involves conscious action to mitigate adverse environmental impacts, has long been considered a key determinant and outcome of successful environmental education (Steg & Vlek 2009).

There is a concurrent growth of research which examines the role of VR immersive nature experiences when used either in-situ with nature, or as a replacement for nature, as in health promotion and well-being (Browning et al. 2020; Williams et al. 2021). Mattila et al. (2020), for instance, studied restorativeness effects in participants immersed in a VR forest environment, and results were compared to the restorativeness of physical forests. The VR forest was overarchingly perceived as either more or equally restorative and had a positive effect on mood and vitality.

Improved access through virtual simulations may also promote empathy (Herrera et al. 2018; Martingano et al. 2021) and overcome inaction brought on by the psychological distance that some might feel, such as nature spaces hit hardest by problems like climate change (Trope & Liberman 2010).

VR can support opportunities to engage diverse knowledge and multiple perspectives, such as the integration of indigenous knowledge (Jerowsky and Borda 2022). Australian artist/film-maker Lynette Wallworth created a VR film experience entitled *Collisions* (ACMI 2016) which brings audiences into the world of indigenous elder Nyarri Morgan and the Martu tribe of Australia, exploring issues of environmental conservation and sustainability.

Practitioners of critical approaches to environmental education can take this opportunity to engage with stories produced by marginalized communities about their experiences with nature and climate change. This process can encourage self-reflection while highlighting broader issues related to social and environmental justice (Petersen et al. 2020; Markowitz & Bailenson 2022).

3. SELECTED CLIMATE CHANGE EXHIBITIONS IN VR

Several VR immersive climate change exhibitions appeared physically and virtually online in various museums and galleries over the course of 2019-2022 and across different countries. The timings of such events can be viewed at a time of global convergences, such as youth climate change activist Greta Thunberg amplifying the global scale

of the threat of climate change, grass-roots protests, such as the Extinction Rebellion, the release of The Intergovernmental Panel on Climate Change (IPCC6) report in 2022 (IPCC 2022), and the United Nations COP'25, '26 and '27 events, among other developments. The COVID-19 pandemic further highlighted both a digital divide and critical need for digital inclusion within the cultural sector. According to a UNESCO report, institutions that had 'invested heavily' in digital activities prior to the pandemic, provided a vital resource to those who could access these (UNESCO 2020).

As the format of this paper is a commentary, the following examples are not intended to be exhaustive, but meant to profile different types of audience engagement, VR immersiveness, climate change content and communication approaches:

(1) Natural History Museum, Los Angeles County. *Beyond the Diorama: Caribou World* – ongoing exhibition . Release date of VR app – January 2021. https://beyondthediorama.com

The Natural History Museum of Los Angeles County in partnership with the University of Southern California incorporated game design, computer science and journalism and a high-tech 3D scanning tool to design "Beyond the Diorama: Caribou World, an interactive VR experience which takes an existing physical diorama in the Museum to create a revised narrative on climate change. Users can download the "Beyond the Diorama" content on the Steam service and watch it on a VR headset, including interactive quiz questions about climate change and its impact on caribou. Viewers can also enter the diorama through their handheld device using an augmented reality version.

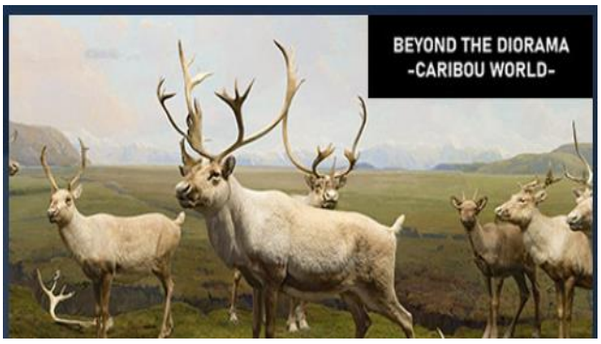

Figure 1: *Beyond the Diorama: Caribou World. Snapshot of the VR landscape with caribou from the gaming application available at: https://store.steampowered.com/app/1488050/Beyond_The_Diorama_Caribou_World/*

(2) Saatchi Gallery London – 7 Dec 2018 – 5 May 2019. *We live in an Ocean of Air* https://www.saatchigallery.com/exhibition/salon_009__we_live_in_an_ocean_of_air

We Live in an Ocean of Air, developed by Marshmallow Laser Feast – a UK digital creative collective, is a multi-sensory, multi-user, immersive installation that illuminates the invisible ('air') connection that underpins life on Earth. Standing in the liminal space between art, science and technology, it blurs the boundaries of installation, live performance and VR, in order to give audience participants a more intimate sense of the natural forces that exist around us. To experience the installation, visitors use HTC Vive headsets as part of an individual VR rig with backpack to hold a laptop connected to a VIVE Pro and with VIVE trackers around the wrists for more fine-grained movement and control.

Figure 3: *We-Live-in-an-Ocean-of-Air-Saatchi-Gallery-2018. Photo-Credit: Barnaby-Steel-Marshmallow-Laser-Feast-1920x1280*

(3) ArtScience Museum, Singapore, 10 Jul – 14 Nov 2021. *Hyperrealities*: Marina Abramović. https://www.marinabaysands.com/museum/exhibitions/hyperrealities.html

In 2021, the newly launched VR Gallery at the ArtScience Museum, hosted Hyperrealities – a trio of contemplative VR artworks about the self, the environment and the future. The environment is the focus of Marina Abramović's Rising (2018) which addresses the effects of climate change by transporting viewers to witness rising sea levels.

Wearing an immersive headset, viewers enter an intimate virtual space, where they come face-to-face with the artist, who beckons from within a glass tank that is slowly filling with water. Participants are invited to make contact with the virtual Abramović, and then find themselves surrounded by dramatic scenes of melting polar ice caps and must choose whether to support the environment, which lowers the water in the tank. A mobile app was commissioned by The Nobel Prize for Nobel Week Dialogue in 2018, and developed by Acute Art.

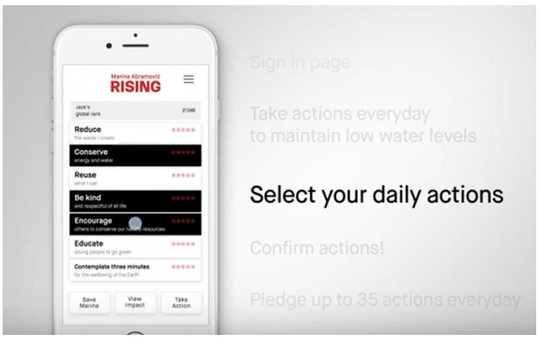

Figure 1*: Marina Abramovic Rising mobile app supporting water conservation actions. Trailer (Nov 28, 2018) accessible at: http://www.youtube.com/watch?v=l7R4le_a464*

(4) Jockey Club Museum of Climate Change,

Hong Kong, Chinese University of Hong Kong. *Humanity–Climate–Nature: A Future Museum Curators' Exhibition* (13 Oct 2022 – 31 Jan 2023) https://www.mocc.cuhk.edu.hk/en-gb/humanity-climate-nature-a-future-museum-curators-exhibition

The Museum of Climate Change hosted the result of an 18-month community engagement project (2021–2022), ECF Mobilizing Community Climate Action by Future Museum Curators supported by the Environment and Conservation Fund (ECF) and partners, such as the Australian Museum in Sydney. The project recruited 70 secondary school students and, through experiential and problem-based learning, including augmented reality skills, they became the inaugural 'Future Museum Curators'. The project comprises 10 virtual exhibitions (AR phone app) dealing with various sustainability challenges, such as climate change, carbon reduction and waste management, and how the public can respond.

Figure 2: *Jockey Club Museum of Climate Change promotional image for Humanity-Climate-Nature exhibition. https://www.cpr.cuhk.edu.hk/wp-content/uploads/submitevent/CPRO-promotion-1.jpg*

(5) *Arcadia Earth* – Valentino Vettori – Manhattan, New York. March 2020-September 2022. https://www.arcadia-earth.com/

Created by New-York-based experimental artist Valentino Vettori, *Arcadia Earth* is an immersive, interactive art exhibition enhanced through augmented and virtual reality and 3D holography – each of 15 rooms showcasing art by twelve different environmental artists. Together, they evoke the landscapes, marine depths and life-forms that global warming threatens.

For example, in "Oxygen Oasis," featuring the work of Justin Bolognino, Eric Chang and other artists from the company META (https://meta.is), visitors experience using augmented reality orbs of light float upward and proliferate, a metaphor for how phytoplankton make oxygen. The Arcadia Earth installation includes statistics about environmental degradation and climate change, and ways visitors can respond, for example, using public transportation and avoiding single-use plastic containers.

Figure 3: *Arcadia Earth installation, New York, NY. Photo credit: Georgiana M. Aug. 28, 2021. https://foursquare.com/v/arcadia-earth/5d67ffd092ab450008253d98/photos*

(6) Portland Art Museum Center for an Untold Tomorrow (PAMCut)

November 2022-February 2023 – *Symbiosis.* https://portlandartmuseum.org/exhibitions/symbiosis/ *Symbiosis* created by the Netherlands experience design collective, Polymorf (https://www.polymorf.nl/), fuses art and technology in a multi-user VR experience situating participants in a world that reflects the impacts of global warming. Audiences can visit several imaginary worlds, taking on a persona/character and can experience a symbiotic human-animal relationship. *Symbiosis* is designed as a fully sensory Extended Reality (XR) storytelling experience—including individualized haptic suits for each participant, soft

robotics, VR audio and visual enhancements, as well as taste and smell-based story elements.

Figure 4: *Individualised haptic & soft robotic suit worn by a Symbiosis participant. Photo credit: Portland Art Museum, 2022. https://pamcut.org/screenings-experiences/symbiosis/*

4. BEARING WITNESS – REFLECTION AND MOBILISATION

The study of VR and how it can engage as a vehicle for reflection or for mobilization in climate action is yet an emerging area of research. In the design of the VR climate change exhibitions outlined above, a few of them described their respective installations as an alternative platform to address the challenges facing our planet and to help participants reflect on the dependence and responsibility to the lifeforms with which we share the planet; for example, *Beyond the Diorama*, *Ocean of Air, Rising, Arcadia Earth* and *Symbiosis*. The majority of these exhibitions reveal the invisible yet symbiotic connections across animal, plant, human and ecosystems. All exhibitions also interweaved scenarios of possible 'futures' invoking a sense of what might happen if certain courses of action or inaction took place, e.g. human non-intervention in the polluting of oceans.

An emphasis towards mobilization and the mitigation of adverse environmental impacts appears in the *Human-Climate-Nature* exhibition, and to some extent in *Arcadia Earth*. In both these exhibits, communication in the form of curatorial text and social messaging appears alongside the VR and augmented reality segments. In *Rising*, Abramović directly urges viewers to reconsider their impact on the world around them, asking them to choose whether or not to save her virtual self from drowning by pledging to support the environment, which lowers the water in the tank.

Across these examples, there is a challenge in determining impactful differences between the more educational directed exhibitions and artist-led and futuristic ones. At the broadest level, current research suggests that exposure to VR environments may increase environmental awareness independently of design choices, suggesting that conceptual and less cutting-edge VR environment designs may be sufficient to increase pro-environmental attitudes (Thoma et al. 2023).

Among the gaps in our understanding concern the level(s) of climate literacy a participant has when entering into an exhibition, and if this is improved post-visit to a point of activation. In brief, climate literacy describes essential educational principles of climate science, supported by fundamental concepts and benchmarks. According to the US Global Change Research Program (2009, p.4), a climate-literate person has the following attributes:

- Understands the essential principles of Earth's climate system.
- Knows how to assess scientifically credible information about climate.
- Communicates about climate and climate change in a meaningful way and is able to make informed and responsible decisions with regard to actions that may affect climate.

Associated with climate literacy is the concept of being environmentally literate as essential to building a sustainable relationship with the environment and to understanding the threat posed by pressing issues, such as climate change (Limaye 2019). However, both are challenging because they encompass many complex dimensions (Fauville et al. 2020; 2021). Moreover, there is often a further gap in understanding the connections between individual actions and their consequences on the environment.

In the Fauville et al. study (2021) 13 papers addressing the use of VR to promote environmental literacy are examined and highlights how VR can be approached to better address such literacy. Another comparable study (Iyer 2022) explored nine VR media productions covering climate change available on Oculus TV, a VR application created by Meta Platforms Inc. (formerly Facebook Inc.). Findings suggest they used limited layers of media, such as interactivity, immersion, multisensory presentation, and first-person perspective.

These studies acknowledge the potential of VR in supporting multisensory qualities in climate change storytelling – that is to enable users to potentially experience the climate change phenomenon virtually and understand the gravity of the global climate change crisis from a multidisciplinary standpoint. At this stage, VR applications and VR installations are utilising limited framing and

contextualisation, rather than multiple perspectives (Fauville 2021; Lyer 2021).

What is characteristic of the selected VR exhibitions is that most of them appear to be 'standalone' exhibitions in which the immersive experience is seen to be sufficient to provoke reflection or awareness. In the majority of examples, these exhibitions are limited by the number of participants who can engage with the experience, there is limited supporting information for self-guided learning post-experience, and there is an additional cost associated with them to participate.

In an analogous development, art about climate change is becoming increasingly activated in museums and galleries, but beyond these confines, too, widening reach and debate (O'Grady 2021). This brings to the foreground other fundamental barriers if VR is to be perceived as an important vehicle for supporting climate literacy and potentially climate action. Ideally, it needs to be accessible across different platforms, beyond the VR headset, such as a mobile phone, laptop or desktop computer.

VR itself has broad parameters in the extent of its immersive opportunities – from semi-immersive interaction without a head mounted display, for instance, to fully immersive requiring head mounted display with head and hand tracking and tethered to a computer. Examples of how museums can support a range of immersive and multi-modal spaces opening them up to different voices and stories has many precedents. The Our Time on Earth exhibition held at the Barbican in London (5 May —Mon 29 Aug 2022) featured 18 artworks backed up by research and scientific collaborations aiming to connect visitors with the natural world and the power of creativity to transform the conversation around the climate crisis. Semi-immersive artworks could be explored such as Marshmallow Laser Feast's Unseen Forest installation.

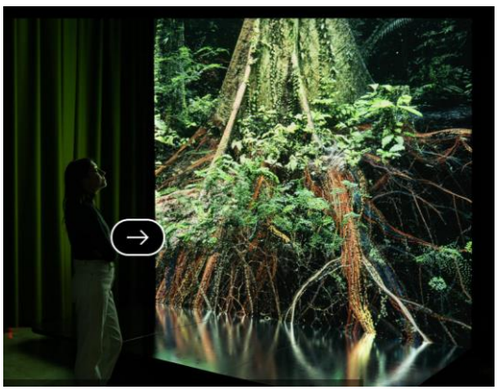

Figure 5: *Credit: Marshmallow Laser Feast – Sanctuary of the Unseen Forest, 2022. Courtesy of MLF and Sandra Ciampone. https://www.barbican.org.uk/whats-on/2022/event/our-time-on-earth*

With accessible platforms, more engaged forms of participation with different audiences are possible, e.g. through co-design (Boiano et al. 2019). But wider accessibility issues still require addressing for disability groups (Franks 2017; Philips 2020). Representation alone is also not enough if diversity and identity are not integrally part of the design-making (Mackay et al. 2019), or linked issues of racial justice are ignored (Thomas & Haynes 2020).

Virtual worlds are increasingly becoming part of the 'land on which we meet' for First Nations' storytelling, decolonisation, and as a means to welcome traditionally underrepresented groups (Barba et al. 2022). VR project *Biskaabiiyaang: The Indigenous Metaverse* (www.biskaabiiyaang.com) brings together virtual worlds, traditional Anishinaabe storytelling practices, and intercultural learning produced by and in support of Indigenous Peoples.

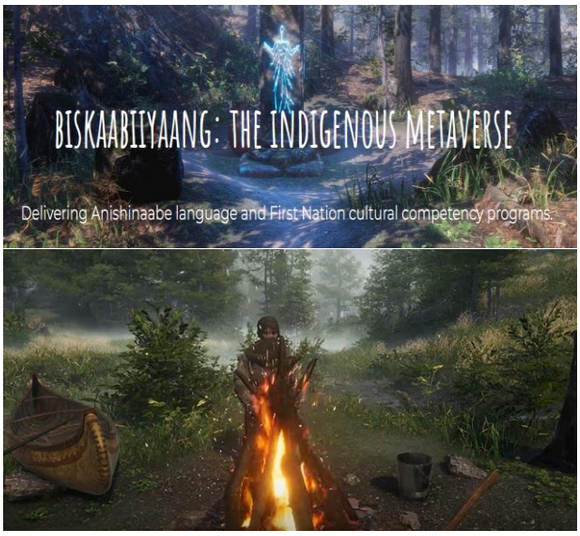

Figure 6: *Top: Home page banner (https://www.biskaabiiyaang.com/) Below: screenshot from Biskaabiiyaang: Indigenous Metaverse Trailer (https://www.youtube.com/watch?v=6prnuLKt1fI&t=153s).*

Museums and cultural organisations are at a particularly critical juncture to re-imagine themselves to fill in these gaps and as potential stewards of both the future and the past (Mckenzie 2019; Harrison & Sterling 2021). Critically in the latest IPCC report (2022), there is a powerful call for collective action. While the urgency of this message is growing in the public sphere, there are challenges to communicate it effectively and to prompt activation at different levels of creative and inclusive participation. Museums and cultural organisations are well-positioned to lead on this (Kelly 2006; Simon 2010; McKenzie 2019). Findings suggest that VR offers another multi-modal pathway for museums to support discovery, activation and climate discourse engaging key communities and bolstering evidence-informed contexts (Newell et al. 2016; Harrison and Sterling 2021; Markowitz & Bailenson 2022).

5. CONCLUSION

VR immersive exhibitions have a unique capacity to communicate the severity of climate change and the current environmental crisis to participants, and potentially to prompt further reflection, and even action. In this context, museums themselves are increasingly becoming activated in the climate justice space. However, in order to integrate immersive VR mindfully when engaging diverse communities in climate change, there is a need to fill in the gaps. Museums must take into account the broader social, economic, scientific and cultural changes needed to shape our understanding and 'bearing witness' of such complex challenges as embodied in climate change, and equally support an environment of trust in addressing these.

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