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# EXAMINING UNITED NATIONS VIRTUAL REALITY CONTENT PRODUCTION USAGE OF EXPERIENTIAL MEDIA IN CLIMATE CHANGE COMMUNICATION: A QUALITATIVE ANALYSIS

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## ABSTRACT

Existing literature indicates the vast potential of Virtual Reality (VR) in climate change communication, including VR's role in increasing pro-environmental behavior, knowledge gains, and climate actions. From a qualitative standpoint, this study seeks to explore the uses of VR in climate change communication by examining how the twelve United Nations VR (UNVR) content production produced as part of the UN's Sustainable Development Goals (SDGs) utilize experiential media (EM) in climate change communication. The study also explores to understand to what extent do the UNVR content productions utilize six qualities of experiential media (EM) as outlined in the EM theoretical framework; how such VR productions frame and contextualize climate change issues; whether the VR productions take a multidisciplinary approach similar to the IPCC 2018 special report; and finally what dominant themes such as UNVR productions highlight about climate change.

*Keywords: Virtual reality, climate change, experiential media, United Nations*

## INTRODUCTION

The United Nations (UN) has declared climate change as a global emergency that goes beyond national borders, a sentiment that is also seen echoed in the people's climate vote, conducted in 50 countries in 17 languages involving 1.2 million people worldwide by the UN Development Programme, (UNDP, 2021). In an attempt to inform, create awareness, tackle and mitigate the devastating impact of climate change on people and the natural world, the UN has produced over sixteen key climate reports since 2014 (UN, 2022), including the landmark Intergovernmental Panel on Climate Change (IPCC) report published in 2018 that highlights the increase in global temperatures of above 1°C (relative to pre-industrial levels) and heading towards 2°C, (IPCC, 2018). The IPCC 2018 report also takes a multidisciplinary approach to frame and contextualize climate change from a range of perspectives, including causes and effects such as poverty, hunger, health, and well-being, social justice, inequality,

socio-cultural, socio-economic, socio-technical, education, institutional, governance, clean water and sanitation, industry and infrastructure, consumption and production, agricultural management, social-ecological systems, indigenous knowledge systems, in addition to framing climate change as CO<sub>2</sub> emissions, global warming, rising sea levels, loss of biodiversity, extreme weather events, droughts, acidification, coral reefs bleaching, lack of environmental protection. Furthermore, such comprehensive climate reports, which are the key part of the UN and its specialized agencies (UN Blue Book, 2022) climate change communication, have also been widely studied, including existing literature exploring how such reports and summaries for policymakers frame climate change (Wardekker & Lorenz, 2019; Budescu et al., 2011; Poortvliet et al., 2020; Barkemeyer et al., 2015). Further, studies have also explored dominant frames in traditional (newspapers and television) and social media coverage of such climate reports (O'Neill et al., 2015; Freudenburg & Muselli, 2010; Asayama & Ishii, 2014; González Cortés, 2014; Pearce et al., 2014).

### **Virtual Reality and Climate Change**

Considering the broader goal of using the power of immersive storytelling to inspire people towards increased empathy, action, and positive social change, the UN, as part of its Sustainable Development Goals (SDGs), also seen utilizing newer and more Experiential Media (EM) forms of technologies as part of their storytelling practices (UNITE, 2018). Experiential Media can be defined as newer forms of mediated communication technologies such as Augmented Reality (AR), Virtual Reality (VR), or Mixed Reality (MR) that allow users to engage with content productions as a participant or virtual eyewitnesses in immersive, multisensory, and interactive narratives (Pavlik, 2019).

A growing body of research literature indicates the vast potential of VR in climate change storytelling, such as how VR content/simulations can help overcome climate change communication challenges, including visualization, i.e., communicating sea level rise, a phenomenon that is a slow and temporally distant process (Calil et al., 2021) or potentially bringing the environment to the classroom to provide a close to the real-life situation of the devastating impact of flooding or prolonged drought in a remote corner of the world (Adanin, 2020; Warvik, 2019). Further, the existing body of literature also highlights VR's role in increasing pro-environmental behavior (Ahn, 2011), knowledge gains and driving information-seeking on climate change (Markowitz et al., 2018); and climate actions among people (Petersen et al., 2020).

While the above body of scholarly work has focused on the potential of VR in climate change communication and VR effects on people's behavior and actions after exposure to VR content productions, from a qualitative content analysis standpoint, limited studies have focused on how and to the extent to which EM is utilized in climate change communication. In particular, there is limited scholarly work exploring the UN's VR content productions on climate change storytelling, despite the UN's active role in creating global awareness of climate change and its attempt to utilize EM technologies such as AR and VR as immersive storytelling tools (UNVR, 2022; UN News, 2018).

## Experiential Media Theoretical Framework

In explaining how experiential media forms of technology such as VR enable the user to experience stories as a participant in a first-person perspective than as an audience member who tends to passively watch, listen or read the narrative from a third-person's perspective, Pavlik (2018) highlight the six primary qualities of EM that offers such transformative user experience. The six primary qualities include (1) *interactivity*, where there is a form of exchange or communication dialog between users and the content experience or with others simultaneously (or asynchronously) engaged in the experience, whether remotely or in physical proximity; (2) *immersion*, which refers to the envelopment of the user, whether visually, aurally or via other senses (e.g., haptic); (3) *multi-sensory presentation*, where communication typically takes the form of visual and aural. But with newer VR platforms, haptic or tactile user engagement is also available. Taste and smell are also possible in a virtual environment, although most current VR platforms do not include technology to enable user taste or smell experiences; (4) *algorithm and data* where data-driven AI takes the form of advanced algorithms (programmed instructions or coding) and sensors that track user actions (e.g., gestures, eye movement) and support the generation of an experience with near-zero latency. This means the delay between user action and a response from the system or virtual experience is imperceptible to the user; (5) *first-person perspective*, where the user enters the virtual experience as if present as a participant or virtual witness to events or experiences; and finally (6) *natural user interface*, where the user engages the system and interacts using intuitive means of communication, including voice, gesture, touch or gaze. This enhances the user's sense of presence within the virtual environment and enables participation without the need for training, literacy, or other more technical means of interaction and experience navigation.

Using Pavlik's (2018) EM theoretical framework and insights from the IPCC 2018's framing and contextualization of climate change issues, the current study seeks to fill this gap in the literature by focusing on VR, a subset of EM, and exploring twelve VR content on climate change produced by the UN and its specialized agencies as part of its sustainable development goals (Table 1). The current study specifically seeks to explore the following research questions:

- **RQ1a:** How do the twelve UNVR content productions frame and contextualize climate change issues?
- **RQ1b:** Do the twelve UNVR content productions take a multidisciplinary approach similar to the IPCC 2018 report in framing and contextualizing climate change?
- **RQ2:** To what extent do the twelve UNVR content productions utilize six qualities of experiential media as outlined in the EM theoretical framework?
- **RQ3:** What important themes do the twelve UNVR content productions highlight pertaining to climate change?

## METHODOLOGY

The current research involves mixed methods, i.e., content analysis based on the experiential media theoretical framework (Pavlik, 2018) and thematic analysis (Saldaña, 2015; Charmaz, 2014). This part of the research is taken up in four phases: Phase 1 of the methodology involved identifying the twelve UNVR productions from multiple UN channels on YouTube VR (as

illustrated in *Table 1*) based on a combination of keywords such as climate change, climate crisis, sustainable development goals, and 360-degree VR. Phase 2 of the research involved the author using Oculus Quest 2, a VR Head-Mounted Display (HMD) with 3D positional audio and haptic controllers to experience and observe the VR productions to explore *RQ1a and RQ1b*. In Phase 3 of the research, all the twelve UNVR content were experienced and observed per the EM theoretical framework (i.e., six qualities of EM: 1) *interaction*, 2) *immersion*, 3) *multisensory presentation*, 4) *algorithm and data*, 5) *first-person perspective*, and 6) *natural user interface*) to explore *RQ2*. Phase 4 of the research explores *RQ3* to identify the dominant themes and sub-themes UNVR content highlights about climate change. Phases 1 to 3 were conducted in Jan 2022 and early March 2022, and Phase 4 was conducted in April 2022.

**Table 1: List of VR content productions from UN made available on YouTube VR.**

Title	Month & Year	Length	Produced by
<i>Climate Change in Fiji in VR: 'Our Home, Our People'</i>	Nov, 2017	6:26 mins	World Bank
<i>Meet your carbon footprint</i>	Jun, 2020	4:46 mins	United Nations Environment Programme (UNEP)
<i>Saving our island - Youth from the Pacific</i>	Sept, 2019	7:00 mins	United Nations
<i>Penguins of Antarctica</i>	Jan, 2017	1:27 mins	United Nations Environment Programme (UNEP)
<i>What impact do you have on the planet?</i>	Apr, 2018	6:14 mins	United Nations Environment Programme (UNEP)
<i>Capturing the Ghost - Snow Leopard</i>	Dec, 2019	1:31 mins	United Nations Environment Programme (UNEP)
<i>Life in a Green Smart City</i>	May, 2018	2:45 mins	World Bank
<i>Solid Waste Management – Extracting Value From Solid Waste For More Sustainable Cities</i>	Jun, 2019	3:50 mins	World Bank
<i>Clean Cooking in Rwanda: See Development in Action with Ci-Dev</i>	Apr, 2019	3:23 mins	World Bank
<i>Growing a World Wonder</i>	Nov, 2019	5:14 mins	United Nations Convention to Combat Desertification (UNCCD)
<i>Ground Beneath Her</i>	Mar, 2017	6:25 mins	United Nations Development Programme (UNDP)
<i>Panama's Guardians of the River</i>	Aug, 2020	4:44 mins	World Bank

## UNVR Content

1. *Climate Change in Fiji in VR: 'Our Home, Our People'* is six minutes and twenty-six seconds long VR content production produced by the World Bank and UN's Climate Change (COP23) Program in 2017. The VR content production offers snippets of the life of the people of Fiji. The VR content production opens with a third-person point of view, a story of an 11-year-old girl named Catalina and her experience living in a remote village called *Vunisavisavi* in Fiji. Through Catalina's narration (orally) and 360-degree visual envelopment, the user gets to experience the remote village virtually and the girl's daily life, including helping her mother with daily chores and cooking. The scene transitions to a ground-level shot where the user can experience virtually the flooded parts of the village – which is submerged at least twice a year by King tides and continues to be threatened due to the increasing sea-level rise. Here the girl Catalina and other village children can be seen playing and swimming in the dangerous flooded waters. Similarly, the VR production features the life of a 43-year-old man named Raivolita Tabusoro from *Nabukadra* village in Fiji. Here too, the user gets to see Tabusoro's daily life and hear the story through oral narration of the consequences of a 2016 Category Five Cyclone Winston that hit Fiji and killed around 44 people and affected more than 60% of the population. In this part of the VR content production, the user gets to virtually witness how Tabusoro and his family are making a living in a makeshift tent in the village – as Tabusoro and his family were one among the 20 families in *Nabukadra* village to lose their homes along with many farm animals including pigs and beehives due to cyclone. The narration highlights how Tabusoro is determined to help provide a house for everyone in the village before building his own. The story transitions back to the 11-year-old girl Catalina and highlights through the use of graphic overlays and oral narration the fear of rising sea-level and scientific data, such as how the Pacific could rise by up to 18 centimeters by 2030, thereby bringing larger and more frequent storm surges. The VR productions also offer hope by showing how Fijians are taking the lead in protecting and conserving their environment and are preparing for more frequent and intense weather events. The examples include the Bayly Memorial school, which was damaged by the cyclone and now stands as a key source of knowledge on climate change, where students at a very young age get to learn the issues of climate change; and how a 75-year-old man named Rupeni who has lived through cyclones (such as Bebe which hit Fiji in 1972 and Winston in 2016) continues to offer community support to rebuild the nation, i.e., in his words, "*veilomani*" meaning caring for each other. The VR experience concludes with glimpses of local village people coming together to help each other and not live a passive lifestyle. Furthermore, from an economic standpoint, the graphics in the VR production highlight that significantly reducing Fiji's climate change vulnerability costs USD 4.5 billion over the next decade – where investments in adaptation and resilience with a reduction in global greenhouse gas emissions are critical for Fiji's future.
2. *Meet Your Carbon Footprint* is four minutes and forty-six seconds long VR production produced by the United Nations Environment Programme (UNEP) in 2020. The VR production offers an immersive graphical representation of a virtual environment that shows how individuals' daily choices can feed or fight climate change. The VR production is from the first-person point of view, where the user gets to experience their carbon footprint, contributing to the global greenhouse gas emissions that are warming the planet at an increased rate. The VR production offers insights into the threats due

to increasing greenhouse gas emissions, including rising sea-level, smog, and wildfires, and hopes for a climate-friendly environment if changes in individuals' daily choices are made. The choices include cutting down meat, dairy products, and animal-based food; consumption of imported food; and encouraging a plant-based diet; reduction in unsustainable packaging and encouraging reusable materials; climate-friendly buildings instead of unsustainable and fully air-conditioned structures; cultivating the habit of riding a bike or taking public transport or use of electric vehicles instead of vehicles running on traditional fuels including diesel or petrol vehicles; cutting down air travel and increased use of trains; and reduction of paper and other waste. The VR production also highlights scientific information, such as how these choices continue to contribute an average of over six tons of global carbon footprint per person in developing nations if changes in the daily choices of an individual are not made and how the numbers are even higher at around 38.3 tons per years per individual in developed countries or for wealthier individuals.

3. *Saving Our Island - Youth from the Pacific* is a seven-minute-long VR production by the United Nations produced in 2019. Similar to the "*Climate Change in Fiji in VR: 'Our Home, Our People,'*" this VR production also highlights the vulnerable and fragile regions of the Pacific Islands due to climate change, including the smaller island nations of Vanuatu and Tuvalu and Fiji. The VR productions use both first-person and third-person points of view where the VR experience puts the user in the remote regions of the island, including places in Tuvalu where the land is less than two meters above the sea level and the causeway is often seen submerged at high tides cutting off people from resources. The VR productions overlay the 360-degree visual envelopment with the oral narration of stories from children and young individuals who recollect their experiences of past climate change-driven disasters, including Category Five Cyclone Winston in the Pacific islands. The oral narration as part of the VR experience also includes a song titled, *Resilience*, where local musician Bobby Shing describes in the lyrics the horrors of the erratic weather events, including the Cyclone caused by climate change, and how the people of Vanuatu survived such past disasters. The VR production particularly highlights how the rising sea is swallowing the villages and shorelands, leading to crop withering and relocation of people, all due to climate change. The VR production features the current UN Secretary-General Antonio Guterres in conversation with the young people of Fiji, where the UN Secretary-General highlights how the Pacific islanders are on the front lines of the battle against climate change and the need for the world to be carbon-neutral to mitigate the impact of climate change and prevent planet Earth warming more than 1.5 degrees Celsius. This global temperature threshold is also highlighted in the landmark IPCC report. Though the Pacific islands have limited contribution to the cause of climate change, the VR production also highlights how the Pacific islanders are already taking required measures such as banning plastic and use of sustainable farming methods to combat climate change and set an example to the developed nations who have a crucial role to play in preserving and protecting the planet.
4. *Penguins of Antarctica* is a one minute and twenty-seven seconds long VR production produced by the United Nations Environment Programme (UNEP) in 2017. The VR production offers a first-person ground-level perspective of Gentoo Penguins and their habitat in the remote locations of Antarctica, including Neko Harbor, Port Lockroy, and Cuverville Island. The VR production puts the user virtually among the penguins that are classified as 'near threatened with extinction' in the UN's International Union for

Conservation of Nature (IUCN) red-list of species and feature varied climatic conditions in such remote locations, including stormy weather, sunny skies, and the melting glacier ice. The VR production also offers glimpses of explorers at work in Antarctica and their scientific vessels.

5. ***What impact do you have on the planet?*** is six minute and fourteen seconds long VR production produced by the UNEP in 2018. Similar to the *'Meet Your Carbon Footprint'* VR experience, this VR production also offers an immersive graphical representation of a virtual environment that shows an individual's impact on the planet. The narrative driven immersive experience focuses particularly on Asia and the Pacific region, highlighting how the growing population and changes in people's lifestyles indirectly impact the planet through their carbon footprints – close to 905 Tonnes of greenhouse gases emitted per second in Asia and the Pacific region alone. The VR production continues to offer scientific data also presented in the IPCC climate change assessment reports that shows how not every individual or country has the same carbon footprint; for instance, in India, the greenhouse gas emission is close to 3.40 Tonnes Per Capita, while the numbers stand at nine Tonnes Per Capita in the Netherlands, 11 Tonnes Per Capita in China, 17.50 Tonnes Per Capita in Japan, and 44 Tonnes Per Capita in Singapore – all due to the infrastructural investment that the governments make as well as the personal choices of the individuals. The VR production also highlights how the Asia and Pacific region is removing nearly 2000 trillion liters of water each year (close to 67 million liters per second) from the environment. The VR productions also highlight the importance of measuring resource use which is key to understanding a country's efficiency – as the unchecked use of a wide range of materials impacts the carbon footprints, including increased pollution (where the energy and transport sector is causing nearly 4million preventable deaths in Asia and Pacific region each year) as Air Quality Index (AQI) ranges from 38 in Beijing, China to 60 in Singapore where women, children and the poor are disproportionately affected. The VR production also offers glimpses of marine litter (where over 8 million Tonnes of plastic enter the ocean every year, the equivalent of 20,000 plastic bottles per second) and the rising sea level, which can amount to 132 centimeters by the end of the century. The VR production concludes with insights into the need for individuals to choose public transport, to carpool, cycling, or walking as an option to make a difference and help achieve lower carbon emissions, lower waste, and a pollution-free climate.
6. ***Capturing the Ghost - Snow Leopard*** is one minute and thirty-one seconds long VR production produced by UNEP in 2019. The VR production uses a mix of first-person and third-person point-of-view narratives to show the world's most elusive wildlife species, the snow leopard, and its critical habitat. The VR production also highlights the mountainous terrains that can only be accessed via foot or horseback and the challenges involved in capturing on camera the ghost of the mountains in the Kyrgyz Republic to create awareness about such wildlife species. Meanwhile, snow leopards are classified as vulnerable species in the UN's International Union for Conservation of Nature (IUCN) red list of threatened species.
7. ***Life in a Green Smart City*** is two minute and forty-five seconds long VR production produced by the World Bank in 2018. The VR production offers glimpses of a day in a smart city in South Korea. As part of this VR experience, the user gets to virtually follow a middle-aged Korean businessman commuting from his residential complex to his workplace and experience the city's smart features. The VR journey starts from a residential

complex with innovative environmental facilities, including a waste management system that is completely automated, where the compost from garbage is utilized as renewable energy in the residential complex. The scene transitions to smart transportation, offered as part of the urban transportation information system. The VR experience highlights how these innovative features help individuals track their bus via GPS Service, get real-time traffic updates, and pay the bus fare through wireless card readers installed inside the bus, thereby making a contact-free experience. Further, the VR production also highlights the smart energy features of the city park that adopts roof garden solar LED lighting systems and smart green space management service. Further, regarding energy consumption, the VR production highlights how the city's buildings and skyscrapers adopt solar power generation systems and feature energy management systems, including sensors that gather and track energy usage information from buildings in real time for energy optimization. Finally, the VR production concludes by showing how safe and secure the city's walkways are due to the smart streetlamps with built-in WIFI-enabled cameras for offender location tracking.

8. ***Solid Waste Management – Extracting Value From Solid Waste For More Sustainable Cities*** is three minute and fifty seconds long VR production produced by the World Bank in 2019. Similar to the '*Life in a Green Smart City*' immersive experience, this VR production also highlights the solid waste management strategies in South Korea. However, unlike directly offering a virtual experience of the new and innovative technology used by South Korea in the present day, the VR productions take the user on a journey from the past to the present, i.e., the remarkable changes achieved in solid waste management with examples of Nanji landfill (which was Seoul's official garbage dump site) in the 1960s and how the country transformed the landfill that was prone to cause diverse environmental problems including CO<sub>2</sub> emissions into an environmentally friendly dream ecological park with wildflowers and abundant green cover offering scenic beauty for visitors of the park. The VR production also highlights how South Korea has been at the forefront in resource circulation technology where safe disposal of waste, including policies to reduce and recycle waste generate energy from waste through Metropolitan Landfill Gas Power Plants, are achieved and thereby putting an end to the unsustainable and hazardous practice of open dumping of garbage.
9. ***Clean Cooking in Rwanda: See Development in Action with Ci-Dev*** is a three minute and twenty-three seconds long VR production produced by the World Bank in 2019. The VR production highlights the importance of clean cooking compared to cooking food on coal that emits toxic smoke and contributes to the ill health of nearly 3 billion people worldwide, including a large population in Africa where women and children health are affected the most. To convey this important message, the VR production takes the user virtually to a remote village in Rwanda in East-Central Africa. It puts the user among the villagers inside their homes filled with smoke, where women can be seen cooking food for their families using the traditional cooking method on the coals. The scene transitions to Kabera Lea, a village woman who explains the drawbacks of such cooking practice and how this tradition has continued to remain in practice from generation to generation across Africa despite the causes of long-term illness among the women and children and increased hospitalization due to such cooking practice. In contrast, the VR production also puts the user inside a family's home that has adopted clean cooking, where a woman in a clean and smoke-free environment shares her success story. The VR production also

highlights the need for clean cooking for the socio and economic development of African nations and how the clean cooking practice can put an end to the health issues the villagers face, reduce greenhouse gas emissions and prevent deforestation and help vulnerable people live a healthier and happier life and help in the global battle against climate change.

**10. *Growing a World Wonder*** is five minute and fourteen seconds long VR production produced by the United Nations Convention to Combat Desertification (UNCCD) in 2019. The VR production highlights how a community in Senegal, Africa, is building a 'great green wall' (an ambitious project that will stretch across Africa and is dubbed the wonder of the world) to reverse the impact of climate change and halt the rapid desertification of land. The VR production puts the user in the heart of the Senegalese wilderness, and through the narrative story of a young Senegalese girl named Binta illustrates how the country, which once had healthy lands that offered food for the local communities, is now witnessing prolonged drought which is, in turn, causing the land to become hard and dry, thereby offering limited food and water for people and their farm animals. The VR production also highlights how the impacts of climate change are forcing young villagers to make challenging attempts to migrate to Europe by boat on the rough seas to help their family members in Senegal financially. Unfortunately, many individuals have gone missing in the sea, including Binta's brother. The VR production ends by offering hope on how people in Binta's village and thousands of villages in Senegal and the rest of Africa are making relentless efforts to build the great green wall, a multi-country afforestation project spanning across the African continent to preserve and protect the fragile ecosystem and mitigate climate change impacts.

**11. *Ground Beneath Her*** is six minute and twenty-five seconds long VR production produced by the United Nations Development Programme (UNDP) in 2017. The VR production highlights the consequences of a 7.8 magnitude earthquake that struck across Nepal in the Himalayas, damaging and destroying millions of homes and claiming nearly 9,000 lives, injuring 22,000 people and forcing nearly 3 million Nepalese (half of them are women and children) to live in sub-standard temporary shelters). The VR production, similar to the '*Saving our island - Youth from the Pacific*' or '*Growing a World Wonder*' follows a narrative structure – where the user follows virtually the story of a 14-year-old girl named Savita narrating her family experience of the 2015 horrors and how the family continues to struggle to recover from the natural disaster. The VR production uses a mix of first-person and third-person points of view to show the gravity of the problem. The VR production puts the user in some of the damaged sites, including parts of Savita's village and her house filled with rubble due to the damage caused by the higher magnitude earthquake. In other cases, the VR experience offers the user to passively witness the daily life of Savita's family, including performing the daily chores such as cooking, washing clothes, cleaning the house (their temporary shelter), Savita taking care of her siblings, attending school, taking care of cattle and farm animals, work as a blacksmith in their makeshift tent to earn money for their living.

**12. *Panama's Guardians of the River*** is four minute and forty-four seconds long VR production produced by the World Bank in 2020. The VR production highlights how the Chagres River, the primary water source to the Panama Canal, connects the remaining Embera people (indigenous communities) living in the remote forests of Panama. The VR production, similar to the VR experience on South Korea's dream ecological park, offer some historical context and the deep-rooted connection of the Embera peoples' rich

tradition and cultural significance with the region. In terms of the historical context, the VR production shows how in the past, the river was used for the transportation of gold in colonial times and how the indigenous communities have, until recently, remained largely neglected, including decision-making and government investments. The VR production shows how the indigenous communities, from generation to generation, have been the river's guardians and still lack access to essential services like healthcare and education. Further, the VR production highlights how nearly 80 percent of the indigenous community in Panama live in poverty and how health crisis like COVID-19 has exacerbated their challenges as the communities entirely depend on the informal sector and become more susceptible to the spread of the disease due to the lack of primary healthcare. As part of the VR experience, the user can virtually visit Puru Biaquiru, a remote indigenous community village about 30 kilometers north of Panama City, which can only be accessed by canoe. Here the VR production offers some glimpses of the local indigenous community gathered together to celebrate and take part in their Comprehensive National Plan for Indigenous Peoples of Panama, a co-conceived and co-led project by the communities themselves where the seven indigenous groups participate in their development and help define access to services that are aligned with their cultural, economic, political, social systems and the indigenous community's needs including education in the native language, traditional medication/healthcare based on ancestral knowledge and natural remedies, and sustainable infrastructure.

## FINDINGS

Per the *RQ1a* and *RQ1b*, the findings suggest that the twelve UNVR content predominantly framed, and contextualized climate change causes from the point of view of lifestyle, transportation, poverty, agriculture, and farming practices as the drivers of climate change, and the effects of extreme weather conditions, drought, melting sea and land ice, rising water levels, flooding, and cyclones in the remote location around the world and its devastating impact on the rural communities and natural habitats including critically endangered species such as the Himalayan snow leopard. The UNVR films were also found to showcase scientific data on the current status of the world regarding climate change and the future in store for humanity in the following decades. This approach is evident in the UN's IPCC 2018 climate change report. The findings show that the UNVR content productions also predominantly offer hope by presenting solutions (adaptation and resilience and strategies to reduce greenhouse gas emissions – including changes to one's transport choices to reduce carbon footprint) to climate change issues and emphasizing sustainable lifestyle and climate change education. Further the findings show that the UNVR productions also highlight how indigenous people's traditions, customs, and knowledge, which have long been underrepresented in policy discussions, now offer key solutions to climate change and act as guardians of tropical forests. The findings also showed that the UNVR content productions emphasized fear by offering 'threat information,' i.e., the scientific data on the current status of our planet, which was also the case in Poortvliet et al.'s (2020) study that explored how IPCC summaries framed climate change for policymakers, where they found threat information to be prominently present. And, unlike Fløttum et al.'s. (2016) findings that highlight how the main victims of climate change, i.e., particular groups of vulnerable people,

who remained virtually invisible in the UN's IPCC summary reports on climate change, the current findings from the observation of UNVR films show that the focus was predominantly given to the groups of vulnerable people and communities including indigenous people and communities from Pacific Islands who according to the Secretariat of the Pacific Regional Environment Programme is the extremely vulnerable region in the world impacted by climate change. Such an emphasis on vulnerable communities and regions will help decision-makers assess the scope and nature of the crisis and respond effectively (Mansoor & Ahmad, 2020). Finally, the UNVR productions highlighted issues of fossil fuels more elaborately in contrast to findings from Eriksson & Reichl's (2019) study that shows how IPCC key documents only marginally discuss energy needs and fossil fuels.

Further, per the **RQ2** exploring the extent to which the twelve UNVR content productions utilized six qualities of experiential media as outlined in the EM theoretical framework (Pavlik, 2018), the findings showed that all the twelve UNVR productions utilized limited qualities of EM, and offered only 360 degrees of visual and auditory envelopment and lacked *interactive* and *multisensory* engagement that VR technology potentially offers, such as haptics (touch) or gestures, i.e., movements of the hands, arms, head for *immersion* in the narrative. Further, the twelve UNVR productions also lacked presenting climate change *data* in an interactive form and did not feature auditory interaction as part of the immersive experience. Furthermore, the observation showed that the UNVR productions utilized *first-person perspectives* (as if the user is part of the story) and/or offered the user to experience the narrative from a third-person point of view.

Further, the findings from Phase 4 of the research exploring **RQ3** offer more elaborate clues on the dominant themes and categories the UNVR content highlight about climate change. The findings revealed four broad thematic categories, namely (1) *Biodiversity and Conservation*, (2) *Human Impacts and Environmental Disasters*, (3) *Indigenous and Vulnerable Communities*, (4) *Climate Friendly Lifestyle and Policies*, and many sub-themes as illustrated in *Table 2*.

**Table 2: List of important categories and themes highlighted by the twelve UNVR content productions pertaining to climate change.**

<i>Biodiversity and Conservation</i>	<i>Human Impacts and Environmental Disasters</i>	<i>Indigenous and Vulnerable Communities</i>	<i>Climate Friendly Lifestyle and Policies</i>
Climate change education at schools, taking up community work, rebuilding of natural habitats and villages destroyed by environmental disasters, caring for the vulnerable communities and the natural world, encouraging active instead of passive lifestyle, encouraging projects to achieve carbon-neutral planet, carbon capture, the great green wall, fertile land, action against desertification, afforestation, banning plastics, encouraging sustainable farming practices, protecting mangrove forests, resilience, limiting climate below 1.5 degrees Celsius, melting glaciers, Gentoo penguins, Gentoo penguins habitats, Neko Harbor, Port Lockroy, Cuverville Island, Antarctic expeditions, Snow Leopard, Snow leopard habitat, mountain ranges of Kyrgyz Republic, wildlife conservation photography, filmmaking, and documentation, creation of ecological parks, Panama Chagres river, education and healthcare services to indigenous communities, socio-economic opportunities, cultural and nature tourism, inclusion of indigenous peoples' perspectives in government policies and environment conservation projects, offering education to indigenous communities in native languages, incorporation of indigenous ancestral knowledge and natural remedies in health care.	Burning of fossil fuels, Global warming, deforestation, flooding, King tides, sea-level rise, cyclone, loss of shoreland habitat, destruction of homes, flooding of coastal cities, destruction of coastal wildlife habitats, prolonged drought, shortage of rain, hard and dry land, shortage of food, hunger, poverty, migration, increased mortality, ill health, impact on livestock, lack of clean water, extreme weather events, storm surges, carbon footprint, greenhouse gases, carbon dioxide gas, smog, wildfires, unsustainable consumption of resources, impacts of meat, dairy and imported food, unsustainable packaging, processed food and juice, unseasonal food, animal based food, food waste, dripping tap, increased energy consumption, incandescent bulbs, air conditioning, wastage of paper, withering of crops, earthquake, destruction of villages, relocation of people, extraction of water from the environment, excessive use of metal ores, water pollution, increased waste, material footprint due to unsustainable lifestyle, air pollution, air quality index, increase in marine litter, plastic waste, disposal of waste in sea, ocean dumping, ocean pollution, open garbage dumping, landfill, toxic and hazardous waste, unsustainable cooking practices, cooking food on coal, smoke and toxic waste, COVID-19 pandemic.	Emberá people (indigenous communities), Puru Biauquiru village in Panama, Pacific islanders, people of Fiji, remote villages of Vunisavisavi and Nabukadra in Fiji, island states of Vanuatu and Tuvalu, disproportionate impacts of climate change on women, children, and the poor particularly in Africa, Asia, and Pacific regions.	Sustainable food, local and seasonal food, reusable materials, plant-based food, growing local food, cleaner, and efficient cooking, affordable clean cooking solutions, clean cooking stove, public transport, train, e-bus, electric vehicles, riding bicycles, carpool, walk, changes to transportation choices, avoiding diesel, petrol vehicles, and air travel, sharing workspace, measuring resource use for efficiency and limited usage, waste segregation, safe disposal of waste, collection of recyclable waste, safe treatment of waste, converting waste to energy, energy recovery, extracting value from the waste, odorless, accident-free discharge of wastewater, conversion of landfills into an ecological park by planting trees, encouraging resource circulation, LED lights to save energy, use of solar power, renewable energy, energy-efficient buildings, use of building sensors to monitor energy consumption, sustainable infrastructure.

## DISCUSSION AND CONCLUSION

In conclusion, the current findings suggest that the UNVR productions framed and contextualized climate change from a multidisciplinary standpoint similar to the IPCC 2018 special report's framework, i.e., the UNVR content framed and contextualized climate change from a range of perspectives, including causes and effects such as poverty, hunger, health, and well-being, social justice, inequality, socio-cultural, socio-economic, socio-technical, education, institutional, governance, industry and infrastructure, consumption and production, agricultural management, social-ecological systems, indigenous knowledge systems. However, the findings also suggest that the VR experiences offered limited insights into what extent the world is currently witnessing the loss of biodiversity, particularly the extent to which wildlife species are declining and the rate at which species are going extinct; the rate at which the world is witnessing extreme weather events including droughts, acidification, coral reefs bleaching; and to what extent the natural world (including forest land, rivers, and marine ecosystems) is protected and the area or regions worldwide that still lacks environmental protection?

Further, it should be noted that climate change communication is currently a 'perfect communication storm' due to the increasing number of challenges it poses from multiple fronts for science communicators. One of the challenges in science communication, particularly on topics such as climate change is that scientific content has many describable attributes, and prospective learners or lay audiences cannot pay attention to all extant facts about the phenomena; hence scholars argue there is a need for science communicators, in this case, UNVR content producers, to make choices about what parts of climate change topic they should emphasize for consumers of scientific information. In explaining this challenge, Druckman and Lupia (2017) contend that it is important to understand how framing affects communicative outcomes as it can help science communicators offer more insights. Druckman & Lupia further add that framing researchers and science communicators have the potential to clarify the conditions under which certain frames are necessary or sufficient to help target audiences learn new facts on the topic. Further, it is also clear from existing research, such as O'Neill & Smith's (2014) work that highlights how visual framing holds particular power for engaging people and potentially for effective communication of science around climate change. O'Neill & Smith's (2014) work also highlight how lack of diversity of imagery can lead to some particular types of climate imagery gaining dominance and marginalizing others. An increasing number of science communicators, including scientists, journalists, and policymakers, are using framing as a technique for effective climate change communication and evoke stronger emotion, increase perceived usefulness, draw greater interest (Milkman & Berger, 2014). The current study in the context of VR and climate change has highlighted the importance of framing and contextualizing climate change causes from various point of view. The findings from the twelve UNVR content offer further insights into understanding the role of VR in climate change communication.

Further, along with framing and contextualizing climate change, it is important to highlight that the UNVR productions offered virtual experiences of remote regions worldwide, including Africa, Asia, and the Pacific Regions, Pacific Islands, which are the hardest hit regions due to climate change. While the thematic analysis taken up as part of this study shows that the UNVR productions highlight four broad categories as *Biodiversity and Conservation, Human Impacts and Environmental Disasters, Indigenous and Vulnerable*

*Communities, Climate Friendly Lifestyle and Policies*, and many sub-themes, the current findings do suggest that in terms of the steps the world can take to mitigate climate change, the UNVR productions, similar to the IPCC report can further emphasize on the six key areas (Kaplan & Dennis, 2022) namely: (1) switching on renewable energy, (2) making buildings more efficient, (3) turning cities clean and green, (4) revving up electric vehicles or promote walk or bike commute, (5) sinking carbon back into the land, and (6) investing in a fairer world where wealthier countries help poorer nations to achieve growth using renewable energy sources and sustainable practices.

Finally, the findings indicate that VR productions could fully utilize VR's affordances, including multisensory engagement as part of the immersive story for more interactivity and engagement with the climate change narrative, as a growing body of research indicates VR's potential in pro-environment behavior and climate action. For instance, O'Neill & Smith (2014) highlight that participants who experience VR visualizations positively evaluate such visualization experiences and find the scenarios credible, adding that such visualization of climate change increases self-assessed knowledge of climate mitigation and adoption.

Furthermore, by applying the EM theoretical framework, the study highlights how UNVR content can potentially transform the role of the audience to a more active user who experiences stories as a participant (*first-person perspective*) rather than an audience member who tends to passively watch and listen or read the narrative from a third-person's perspective. Further, the study shows how the UNVR content can potentially enable the user to experience the medium and participate or engage in a story or content as a virtual phenomenon, including engagement through haptics and spatial audio (*interactivity and multisensory presentation*). The findings show the need to situate the UNVR experiences or the design of the stories in the virtual environment to six degrees of freedom (DoF) to allow the user to look about and move about, traveling forward/backward, up/down, and left/right in the virtual environment (*natural user interface*) instead of only 3DoF, which is the case with many 360-degree video simulations. Such design components of the story should also include other sensory experiences, such as *touch* and 360-degree *auditory* envelopment, and not just be limited to *sight*. Further, considering climate change communication stories are data-driven, the VR experiences need to situate the data-driven virtual experience and include reactive or responsive displays and haptic capability to track and respond to the user's interaction in the virtual environment (*algorithm and data*). Finally, such a VR experience can give the user a complete sense of immersion and presence (*immersion*).

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