

Immersed: a VR experience about flood and resilience

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Project name: Immersed: a VR experience about flood and resilience

Project owner: Federal Emergency Management Agency (FEMA)

Release date: 2016

Locale: USA

Languages: English, Spanish, French, German, Russian, Turkish

URL: <https://www.fema.gov/immersed>

XR medium: Virtual Reality: fully immersive

Hazards: Floods

Activity: Simulation

Age group: 13+



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#1

Project Background

Immersed is the Federal Emergency Management Agency's (FEMA) flood risk visualisation immersive virtual reality tool targeted at US local officials. It helps to educate community leaders about the value of flood preparedness by fully immersing users at the center of a flood crisis, allowing them to assess damage in a community and see the benefits of mitigation actions. It is the first large-scale virtual reality tool developed by FEMA and was produced in 2016 in partnership with Resilience Action Partners, a Michael Baker and Ogilvy joint venture, and Brightline Interactive¹. FEMA's communications team led on the project and used the expertise of behavioural scientists and designers.

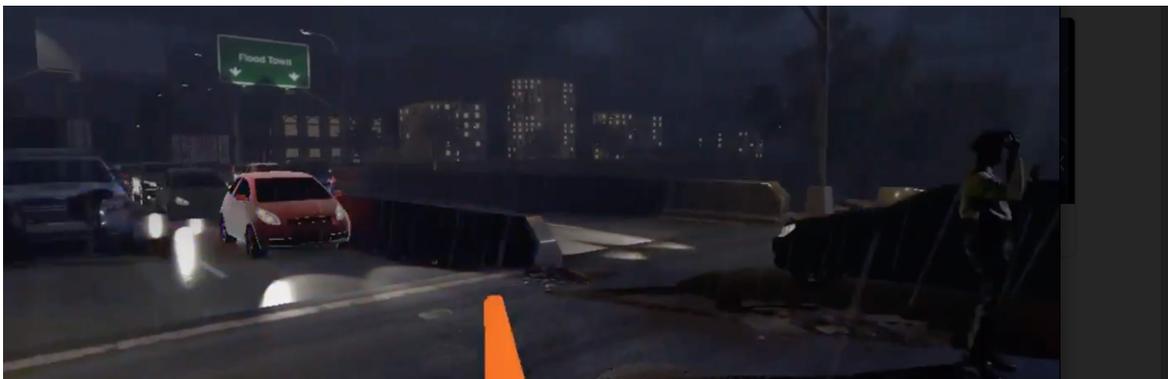
Immersed puts the viewer in different flood situations including a flooded home, a washed-out busy traffic intersection and a flooded school. The simulation plays through these scenarios, showing what happens to an unprepared community when a flood hits. It then replays the three

scenarios, showing the user how flood-mitigation steps could have prevented each situation. The goal is for community officials to walk away inspired and armed with the information needed to start mitigation action projects, such as installing proper drainage systems or porous pavements in areas with a flood risk. Users can act out scenarios in the virtual environment like directing traffic on a flooded road or walking around a home flooded with three feet of water.

Immersed is part of a larger community-engagement program on flood mitigation that also includes community meetings, informational materials, partnerships, and training sessions. It contributes to FEMA's mission to "lead America to prepare for, prevent, respond to and recover from disasters with a vision of "A Nation Prepared."²

1 <https://www.brightlineinteractive.com/>

2 <https://www.fema.gov/about-agency>



#2

Aims & Rationale

The aim of *Immersed* is to change behaviour by urging local officials to take steps in flood preparedness. Flooding is the United States' most common and costly natural disaster and the one that FEMA receives the most funding from congress for - this is the rationale behind the focus on flooding. They recognised the necessity for community leaders to be equipped with the information, tools and skills needed to take mitigation action and that doing so can provide a positive return on investment in terms of lives, property and money saved³.

Virtual reality (VR) was chosen as a medium for this message delivery in order to create a more visceral reaction and emotional connection to the issues linked to flooding. Flood risk is difficult to visualise and to understand, and *Immersed* allows the user to experience a major flood event in a real, personal way. Virtual reality was also chosen, according to FEMA, because “VR helps us to create and control the story.”

³ Every \$1.00 spent on mitigation saves a community an average of \$6.00, according to the Multihazard Mitigation Council

#3

Audience

Immersed is specifically targeted at community officials because they are the people that decide funding levels and drive action across the country to combat flood risk. In future versions of the project, FEMA aim to target the general public.

The age range of 13+ was established by following HTC Vive's age requirements for VR experiences.

#4

Experience

Immersed takes a constructivist learning approach, one in which learners are not passive receivers of knowledge but instead interact with their environment to construct new knowledge. It is a six minute long VR experience set in four different virtual locations:

1. School
2. Home
3. Road intersection
4. Emergency operations centre

From the perspective of a community leader in a flood-affected town the user can:

- ▶ Explore the damage in a flooded neighborhood
- ▶ Witness the challenges of an evacuation
- ▶ Lead a stranded teacher to safety at a flooded school
- ▶ Experience mitigation decisions being

made and the impact that they can have

- ▶ Discover which preparations can lead to positive results

As the community official user goes through the experience, the experience encourages them that they are able to make a difference and that it is in their power to take meaningful action and effect change.

The experience has three different stages:

1. The user goes through the three scenarios (home, school, intersection) for the first time
2. Users explore additional information about mitigation action from the virtual emergency operations centre, including:
 - ▶ Descriptions of and specifications for the different types of action



- ▶ Details on grants and other programs that are available to support communities in taking action
- ▶ Information about a variety of related topics, including the National Flood Insurance Program, hazard mitigation planning and community engagement.

3. The user is then taken back to the three scenarios where mitigation actions have happened to show the impact of these actions.

The user makes choices and selections by



using a menu controller, which is represented as either a flashlight or a traffic cone.

The experience is fully immersive, with basic 3D graphics. However FEMA states that users forget about the quality of the graphics once they are in the simulation and the immersive experience continues to work well. The graphics are generic enough to look like a typical US school, home and road intersection. *Immersed* is only available in English.

#5 Technology

Immersed is built in Unity. To play it, a gaming computer is required along with HTC Vive headsets. The audio comes through headphones that users wear. The poles that are stationed around the experience hold the sensors to create the 3D environment.

At the time it was designed in 2016, it was cutting edge.

FEMA is working on a smartphone app version on Samsung Gear to make it more portable and accessible and available on the Google Play and Apple App stores.

FEMA would like users to be able to download and use it themselves without being reliant on them to deliver the experience. At time of writing the experience is only delivered by FEMA to community officials, never independently.

FEMA fully owns the content and therefore has no licensing issues. The app does not gather or store information on users. Maintenance is conducted by external contractors.

#6

Production & Distribution

Process & team

Immersed was produced over the course of 2016 by a team comprised of FEMA and contract support in a joint venture called Resilience Action Partners. Agencies Michael Baker International and Ogilvy lead the creation of the experience, including cultivating the narrative, behavior science principles it is based on, storyboarding, national roll out and promotion. Brightline facilitated the technical design elements

of the experience. FEMA was responsible for the technical storyline development and used experts from their insurance and mitigation, external affairs and community engagement teams. The storyline process was an iterative one lasting approximately four months. FEMA field staff reviewed the script for accuracy. Non-technical decision makers were able to provide feedback during the initial stages of the development through user testing.

Distribution

Immersed is delivered by FEMA staff who take the equipment (computer, headsets and sensors) on the site, most commonly at national and regional events and conferences. It is not integrated into any specific training sessions or curricula.

The experience is often used as part of discussions on updating national flood maps to take people beyond merely looking at the map to understanding what it really means. FEMA uses the experience to start a dialogue and then to discuss how to empower flood management actors at the regional and local levels.

After users experience *Immersed* they are given a flyer to take away to support next steps and turning the new knowledge into mitigation actions. The flyer lists some of

the options such as installing flood warning signs, protecting or restoring natural

TURN A VIRTUAL FLOOD CRISIS INTO REAL-LIFE ACTION.

Thank you for taking a few moments today to put yourself at the center of a flood crisis. Now that you've experienced *IMMERSED*, we encourage you to take your findings back home with you and turn them into mitigation action. There are a wide range of precautions your community can take to reduce losses during a flood. Some options include:

FLOOD WARNING SIGNS	Installing flood warning signs are a relatively inexpensive way to help your community understand where the known flood risk exists.
BIOSWALES	Adding or restoring naturalized features like vegetated channels, called bioswales, that capture and hold water help soak up excess water and protect homes and businesses.
PERMEABLE PAVEMENT	Using permeable pavement when designing parking lots, sidewalks, and streets reduces stormwater runoff and can lower the intensity of flash flooding events by slowing water down and allowing it to be absorbed into the ground.
HOUSE ELEVATIONS	Sponsoring home elevation projects and requiring freeboard, an extra level of protection above the base flood, in building codes and ordinances adds a level of safety by effectively lifting structures and contents above the anticipated flood height.
NATURAL WETLANDS	Restoring or preserving natural wetlands can filter pollutants, store carbon, and provide a natural barrier to the impacts of storms and flooding.
BUYOUTS	Removing structures and preventing building in high-risk areas can help citizens decide to live and work in safer areas.

LEARN MORE ABOUT MITIGATION AND PREVENTATIVE MEASURES LIKE THESE AT [FEMA.GOV/MITIGATION](https://www.fema.gov/mitigation)

wetlands, and using permeable pavement.

Immersed is part of a larger FEMA community-engagement program on flood mitiga-

tion that also includes community meetings, informational materials, partnerships and training sessions.

User feedback

FEMA do not currently have feedback mechanisms built into *Immersed* above and beyond gathering anecdotal information post-delivery and have recognised that this is an area for improvement. FEMA is currently in discussion with their measure-

ment team to decide how to build a monitoring and feedback system into the new app version of *Immersed*. This will include both passive feedback, for example based on how long users stay in the app, and active feedback, for example a post-experience survey of five questions.

Challenges

FEMA identified various challenges in the production of *Immersed*.

- ▶ **Scalability:** The current version of *Immersed* on HTC Vive is hard to share given the software and hardware requirements, and need FEMA to deliver it. Building a new version in an app compatible with Samsung Gear will overcome this issue, however performance might be compromised
- ▶ **Privacy and security issues:** This was the greatest challenge in the production of *Immersed*. Government privacy laws have restrictions and there is a need to limit data exchange. FEMA were required to find ways for the app to only gather minimal user data and not interact with internal servers or data. No information on the user is stored by FEMA. This issue is predicted to delay the release of the app.
- ▶ **Challenges between HQ and regional level:** FEMA reported some internal challenges between HQ and regional levels that impeded the roll out of the tool.
- ▶ **Reputational issues:** One of the drivers behind the production of an app version of *Immersed* is to allow use without FEMA being involved. Reputational issues have been a barrier to more widespread dissemination of the experience.

#7

Outcomes and Future Planning

Future plans

Immersed

For the current version of *Immersed* for community officials, FEMA plans to:

- ▶ Continue the roll out of *Immersed* at the regional level in conferences and events and as part of the delivery of the updated flood map and continue to empower community officials to have conversations about flood risk mitigation.
- ▶ Put a monitoring and measurement system in place.
- ▶ Work on a mobile app version for Samsung Gear VR to make it more portable and accessible, that will be available on the Google Play stores.
- ▶ Provide each of the ten FEMA regional offices with headsets to allow more autonomy of roll out from HQ.

New VR and AR experiences

FEMA has two new XR experiences: *Flood-walk*, an augmented reality application that has already launched, and *Immersed 2.0* that is intended to be released at the end of 2019. The new VR and AR experiences are targeted at the general public.

This shift in audience is based on work with behavioural scientists that highlighted the need to create a demand for change at the community level because the largest

barrier to meaningful change is convincing community members to make those changes. Once FEMA had decided to target the public, in 2018 they conducted studies to see what the public would find most useful out of a virtual reality experience. The results indicated a desire for more gamification features, such as a points system or to be able to compare scores with neighbours. However FEMA's behavioural scientists cautioned against too much emphasis on gamification given that this is not what drives action or outcomes, as key message(s) can be lost. As FEMA explains, "*The danger with gamification is that it becomes more about doing damage than about what to do about the risk and the damage. It can increase engagement and numbers of participants and users, but does not lead to the same result.*" They do however recognise that with youth gamification of serious topics may be more appropriate.

Immersed 2.0

FEMA is working on a new VR experience, *IMMERSED 2.0*. It is currently in production and should be complete by the end of 2019. It will be built as a smartphone VR app for Samsung Gear because the durability and cost effectiveness, recommended by Brightline Interactive. The second version builds off the first virtual environment and story and will be produced with the same agency Brightline. FEMA plan to build *Immersed 2.0* into the same *Immersed* app

rather than designing a new one.

Immersed 2.0 will no longer target community officials, but the general public and will be five - seven minutes in length. The aim is to challenge homeowners to make decisions for themselves in a flood and see the impacts their decisions and consequences of inaction have across the whole neighbourhood. For example, how to ensure you can still commute in a flood or pick the kids up from school. *Immersed 2.0* is centered around a family in a home and uses techniques to increase emotional connection with the storyline, such as seeing the personal impact of a flood through images of family photos floating in the water, or the water rising above your childrens' height marks on the wall.

FEMA discussed customising *Immersed 2.0* to different areas of the US or different types of homes, however this was ultimately not possible given the elevated cost of this level of customisation. It is designed to be representative but not fully customised though FEMA recognises that the experience would be more impactful if this customisation was possible. FEMA built a diverse family into the experience, for example with mixed-race family members

and an adopted child. *Immersed 2.0* will be available in English and may be translated into Spanish and French. It will contain a high level voiceover and audio effects, for example the sound of rain.

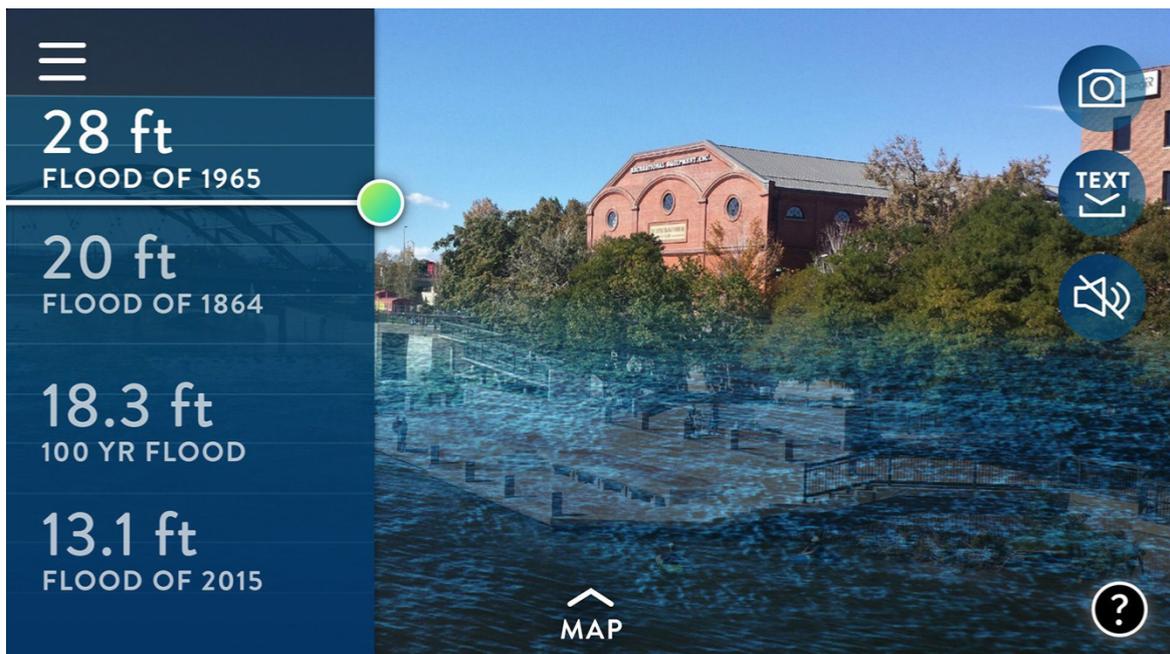
Floodwalk AR

In collaboration with agency Bajibo⁴ based in New York, FEMA have also recently produced an augmented reality experience called *Floodwalk*. The *FloodWalk App* is produced specifically for Denver, Colorado in the US and uses augmented reality to educate and engage users about flood risk and hazard reduction. It allows the user to visualize historic floods, learn about how to reduce risk, and see what has already been done to make Denver safer and more resilient to natural hazards.

Features include:

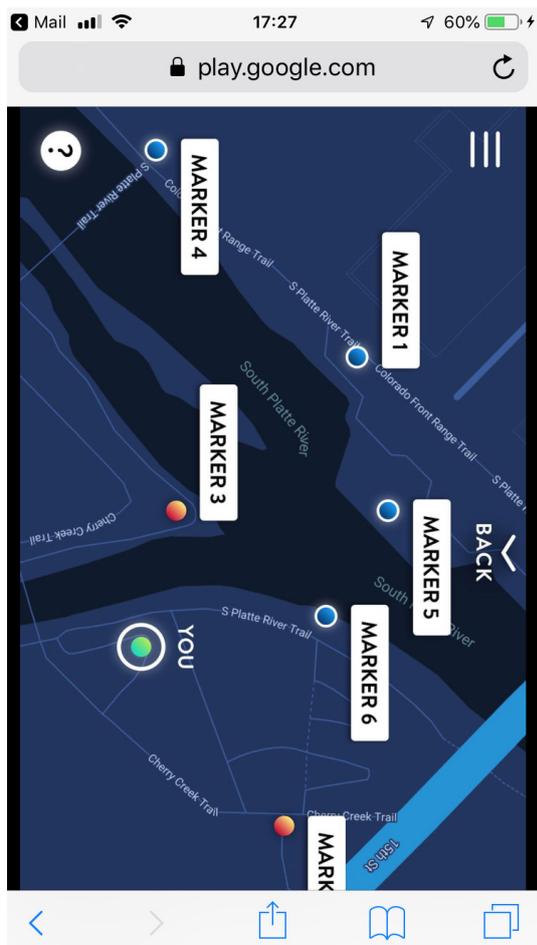
- ▶ On-screen text and audio voiceover narration
- ▶ Historic photos and research that overlay damage from actual events
- ▶ 6 totems show areas of historic flood risk and mitigation actions [see image]

⁴ <https://www.bajibot.com/>



- ▶ A slider allows the user to see different levels of flooding
- ▶ Video to show the value that mitigation brings, to some of the public areas that people might not realise are designed to reduce their risk
- ▶ Shows what areas look like before mitigation and what they look like now
- ▶ Users can enjoy each experience from within the predefined locations or from home
- ▶ There is an option to take and share photos
- ▶ Connect through linked resources to learn more about what can be done at home to further reduce risk

In the future FEMA will be able to add in different locations to the same app if other communities are interested in developing a similar tool.



Floodwalk was released on June 13 2019 on the [Apple Store](#)⁵ (for iPhones 6s and newer) and [Google Play](#) (for Androids) stores in English and Spanish. It has an age rating of 4+. A total of nine consumer ratings to date give the experience five out of five on both app stores.

Floodwalk is a collaboration between: Resilience Action Partners⁶, The City and County of Denver, Urban Drainage and Flood Control District (UDFCD), The Greenway Foundation, and the Chatfield Reservoir Mitigation Company.

Other future plans

In the future, FEMA would like to use augmented reality to show property-specific flood risk information in a visually compelling manner. The technology is already available for this feature, as is the ability to predict increased risk in the future like sea level rise, but the FEMA predict it will take several years before this is possible. They would also consider using real time data from, for example, FEMA Flood Risk Data and the US Geological Survey, to represent real time flood risk. FEMA predicts that the challenge will be how to build this functionality in a way that is acceptable on the legal and IT sides for data privacy. *“This [AR and real time data] is the solution of how to educate people on risk in their community but we have a lot of groundwork to lay internally before we can even have that conversation.”*

⁵ Requires iOS 11.0 or later. Compatible with iPhone, iPad, and iPod touch

⁶ Resilience Action Partners JV is comprised of Michael Baker International and Ogilvy Public Relations and is funded by FEMA

Key learnings

FEMA state that they have had “lots of eye opening learnings from the process...” of creating *Immersed*. These have been gathered and reflected on informally as there has been no formal evaluation of *Immersed*.

Learning points include:

- ▶ *Focus on the outcome and not the cool factor*: It can be easy to lose the outcome in some of the cool factor. It is important to identify what outcome you are striving for and continue to evaluate it throughout development.
- ▶ *Immersion works*: The immersive part resonates very well. People actually start to understand their flood risk and it spurs the right conversation afterwards.
- ▶ *Balance realistic vs overwhelming*: Getting the balance of the realism of the content to motivate community officials to take action, and not being overwhelmed by the intimidating nature of the content was a process that took some time. This was even more relevant to the development of *Immersed 2.0* that targets the general population and possibly younger audiences. FEMA's advice is,

“Don't be too afraid of using less realistic graphics, it will help with some of the separation. You're not trying to scare people, you want an emotional connection but don't go Hollywood-esque.”

- ▶ *The importance of user testing and evaluation*: FEMA highly recommend user

testing throughout development and evaluating the experience through the lens of the desired outcome.

- ▶ *Showing the value of mitigation is not enough - you need to empower action*: Feedback from community officials on *Immersed* highlighted that *Immersed* sparks the right conversations among community officials and that they learnt the value of mitigation actions but questioned how to do something about them afterwards. Therefore FEMA realised they needed to offer a way to empower people to connect and take action. *Immersed* is not designed to solve risk, but to kick start the conversation and get community officials to demand action and change. FEMA need to be able to empower community officials to have a better conversation with the people who can make those changes.
- ▶ *Need to make the experience more personal and emotive*: The community official experience works for that specific target audience but not for the general public who do not see community-wide risk as their responsibility. Therefore when FEMA decided to create a virtual reality experience targeted at the general public (*Immersed 2.0*) they knew they needed to make the new experience more personal and emotive. Therefore *Immersed 2.0* is centered around a family in a home that shows flood damage with everyday items that create a sense of connection around them. This emotional connection can change behaviours, particularly when combined with the analytical side of the brain.

#8

Internal Evaluation and Learnings

Process

The design process was resource intensive given the work with high profile external creative and PR agencies. It involved a wide range of stakeholders from both within FEMA to inform the storyline content and ensure accuracy, and externally for both the technical expertise and behavioural science. The specific inclusion of behavioural scientists in the production process was a strength for ensuring *Immersed* would have the greatest impact on com-

munity officials. In *Immersed 2.0* this also balanced requests from the end user, in this case increased gamification, with the techniques that would have the most impact on learning outcomes and behaviour change.

Looking forward, reusing assets from *Immersed* to build *Immersed 2.0* will increase the cost effectiveness of the new virtual reality simulation.

Product, features and content

Immersed is highly customised for the niche audience it serves. Although the graphics no longer appear cutting edge, *Immersed* was ahead of its time and one of the first disaster management virtual reality simulations produced. It is a testament to the quality of the product that it is still effective today to incite behaviour change in community officials. The most out of date components and barriers to scaling up, such as the computer connected headsets and cost, are being replaced by FEMA with the new Samsung Gear app version, therefore ensuring relevance going forward, however performance might be affected, as Samsung Gear VR does not offer high-end VR performance as it is tied to a smart-phone's features.

Immersed 2.0 will bring the experience to a new, much larger group of users. A missed opportunity, recognised by FEMA, was not incorporating more decision making and branching scenarios into the experience. It focuses on flood impacts and household mitigation actions and the user is able to see the consequences of these - however the user is not put into the position of having to make decisions themselves.

“Because of funding constraints, one thing we are not doing in the new one enough is to make it more interactive and have people make more decisions. We know people make bad decisions in disasters, but we haven’t come away from the story line too much.”

There are some safety concerns in the school scenario of *Immersed* when the user has to evacuate a teacher and has to walk across a small board. A number of users have felt so immersed in the experience that they jumped and nearly hit a real wall in the room where trialing the simulation. When this is turned into an app and FEMA

is no longer present at the demos, health and safety should be considered.

FEMA has plans to build a monitoring and feedback system into the new app version and this will be important to be able to better evaluate *Immersed* and understand impacts.

Scalability

The ability to distribute *Immersed* more widely above and beyond conferences and events with representatives from FEMA HQ was compromised until the arrival of standalone VR headsets that increase scalability exponentially. FEMA recognised this potential as soon as the technology was available and planned the launch of a smartphone version of the app and a roll out plan of providing headsets to the regional offices to give them more flexibility to scale the reach of *Immersed*. Samsung Gear headsets retail at approximately 35 USD and can be run with the users own

smartphones. Together the phone and headset are significantly cheaper than the gaming computer headset combination and also provide more flexibility to use the headsets at events and meetings without the need for computers, poles and speakers.

The augmented reality app *Floodwalk* was expensive to produce but now offers the ability to integrate other locations at a lower cost if partnership arise in the future. The app itself is highly scalable among users with access to smart phones with iOS 11.0 and up as it is free.

Effectiveness

Despite a lack of thorough evaluations, FEMA has been able to gather anecdotal feedback from users that indicate that the virtual reality experience is achieving the awareness raising aim of being aware

what mitigation steps community officials can take. They have also recognised that to achieve their aim of behaviour change, they need to find ways to facilitate next steps and actions.

Key Learnings

Although *Immersed* is not targeted at teachers or students, there are many key learnings of relevant for SBDRR from this

hazard focused virtual reality experience.

- ▶ Immersion works to help understand flood risk and other concepts that are

- hard to imagine unless they have been previously experienced.
- ▶ The combination of emotional connection with analytical tasks like decision making in virtual reality experiences increases behaviour change.⁷
 - ▶ Augmented reality allows more personalisation or customisation of an experience and virtual reality allows for more control of the narrative.
 - ▶ Identifying key outcomes from the start and regularly checking they are being achieved in the design is key to not being distracted by the “cool factor” of new technologies. User testing can help with this process.
 - ▶ Sacrificing on the realistic quality of graphics in virtual reality does not automatically mean a less realistic or immersive experience, and can help to separate the immersive experience from reality. This can be useful for younger audiences.
 - ▶ While compromising some of the quality of the experience, choosing to build experiences for mainstream platforms, especially those powered by smartphones, enables reaching a wider audience and empowering them to use it by themselves.
- ▶ Balancing the requests of users with behavioural science is important to ensure learning outcomes can be achieved.
 - ▶ When planning an immersive experience to ensure behaviour change is achieved it is necessary to think beyond the end of the delivery of the experience to what happens next. For example to empower action for mitigation tips

⁷ For examples of analytical decision making, see the case study of Ania Design Lab’s Philippines Disaster Preparedness Simulator, and the example of Auckland City hospital earthquake preparedness simulator: <https://arxiv.org/abs/1802.09119>



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