Drones, Fire, and VR:

21st-Century Tools for Sustainable Development

Dace A. Campbell, AIA, LEED AP

Construction Account Manager in Education, Autodesk

@DaceCampbell

Anthony Lamanna, PhD

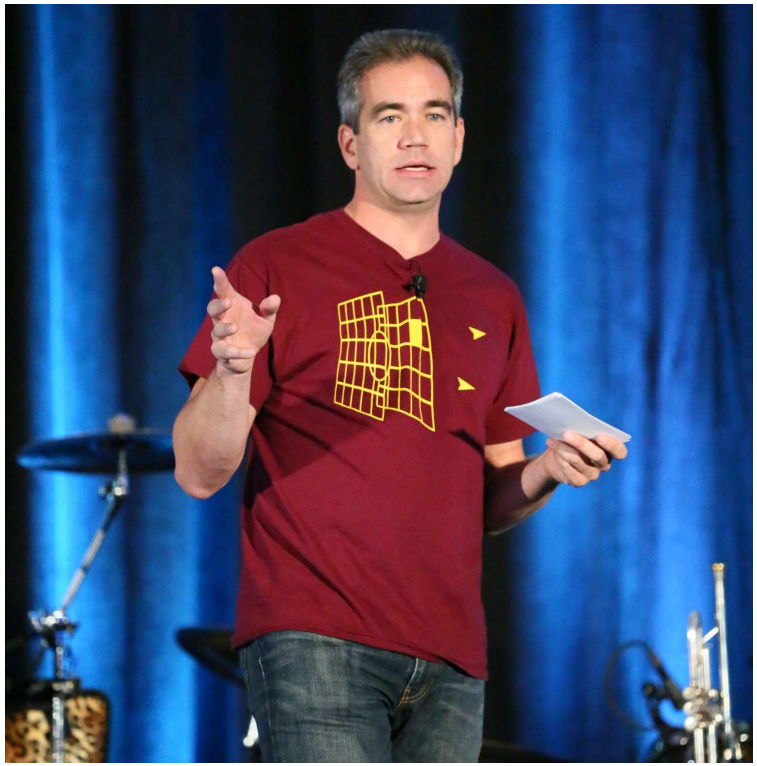
Program Chair of the Dell E. Webb School of Construction at Arizona State University

AUTODESK. UNIVERSITY

Sustainable Development in Fiji

Development is coming

- Indigenous people are eager to develop and modernize
  - Diversify skills and industries
  - Educate their children
  - Evolve beyond subsistence living
- Some countries “investing” in development
  - Quarrying
  - Deforestation
  - Destruction of reefs
- Local chiefs are desperate for *sustainable* development
  - Culturally sustainable
  - Environmentally sustainable



About the speaker

Dace A. Campbell, AIA, LEED AP

Dace is a Construction Account Manager in Education at Autodesk and a nationally recognized expert and thought-leader in innovative tools and processes, including Building Information Modeling, Lean Construction, and Integrated Project Delivery. He is a licensed architect with almost 30 years of experience in design, construction, innovation, collaboration, and business consulting, and over 25 years of applied research in virtual reality and augmented reality in AEC. Dace's projects have won four AIA BIM awards, and he is a winner of the 2011 Building Design + Construction "40 under 40" award. His work and writing about BIM, Lean, IPD, and VR and AR have been published internationally, and he is an active member of local and national BIM and Lean communities.

About the speaker

About the speaker

Anthony Lamanna, PhD, PE

Tony has expertise in building repair, rehabilitation, adaptive reuse, and retrofit – also known as “hardening” of buildings, making them more resilient to hazards such as high winds, storm surge, earthquakes, fire, or blast. Through his role as Chair of the Del E. Webb School of Construction and the Construction in Indian Country program, he assists indigenous tribes with sustainable development plans. His dedication to advancing the engineering and construction fields, he earned election as Fellow of the American Concrete Institute (ACI) and the American Society of Civil Engineers (ASCE) and a commission as a Kentucky Colonel by the Governor of Kentucky. In his “spare” time he makes homemade wine, mead, and beer, and serves as a certified beer judge.

Drones, Fire, and VR:
21st-Century Tools for Sustainable Development

AGENDA

- BACKGROUND
- PROJECT
- PROCESS
- RESULTS
- CONCLUSIONS
- NEXT STEPS

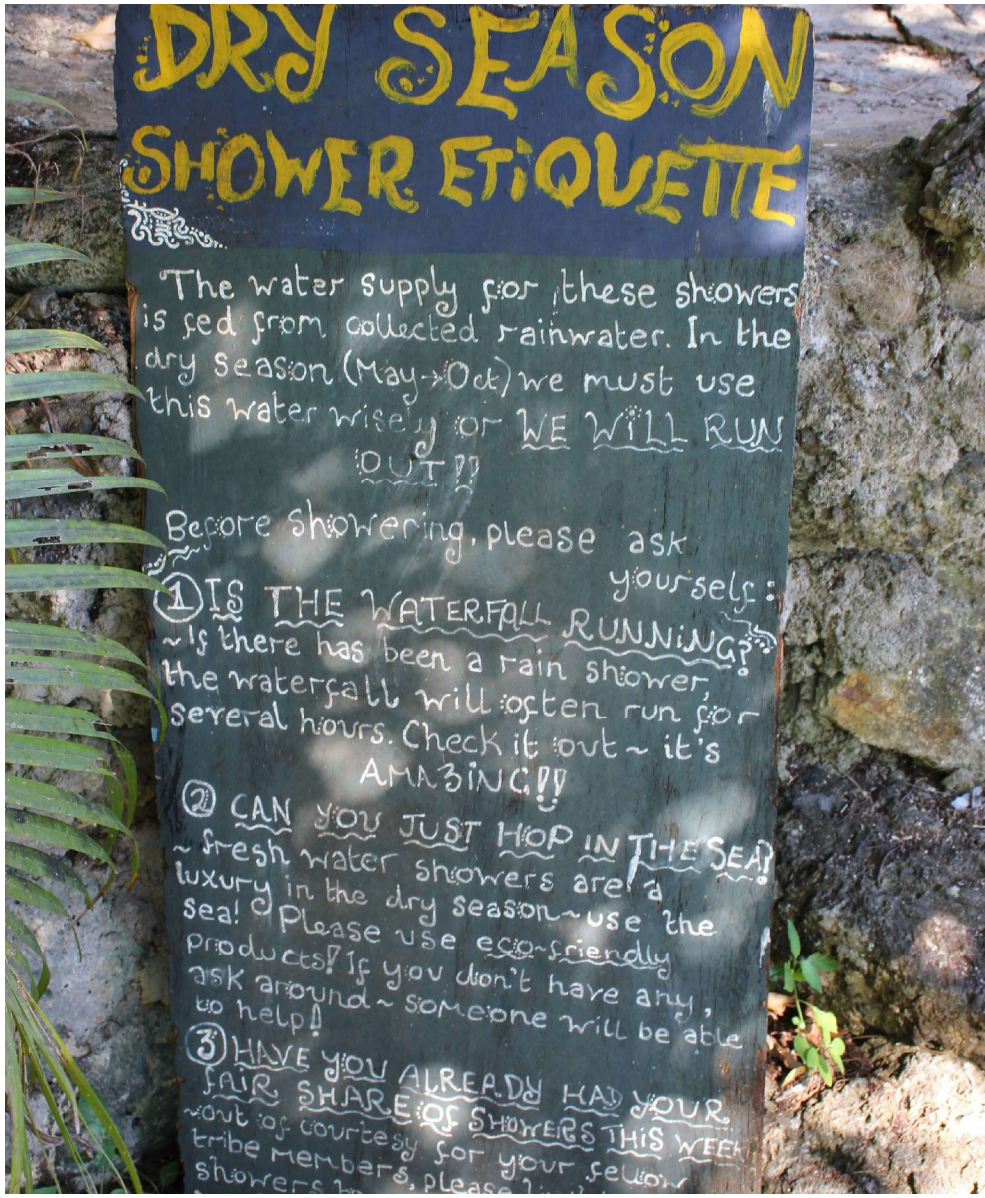
Learning Objectives

1. **Apply a comprehensive process and workflow** to perform reality capture, and prepare recap data to be experienced in VR

2. **Identify typical data management challenges** encountered in photogrammetry/reality capture, and ways to overcome them

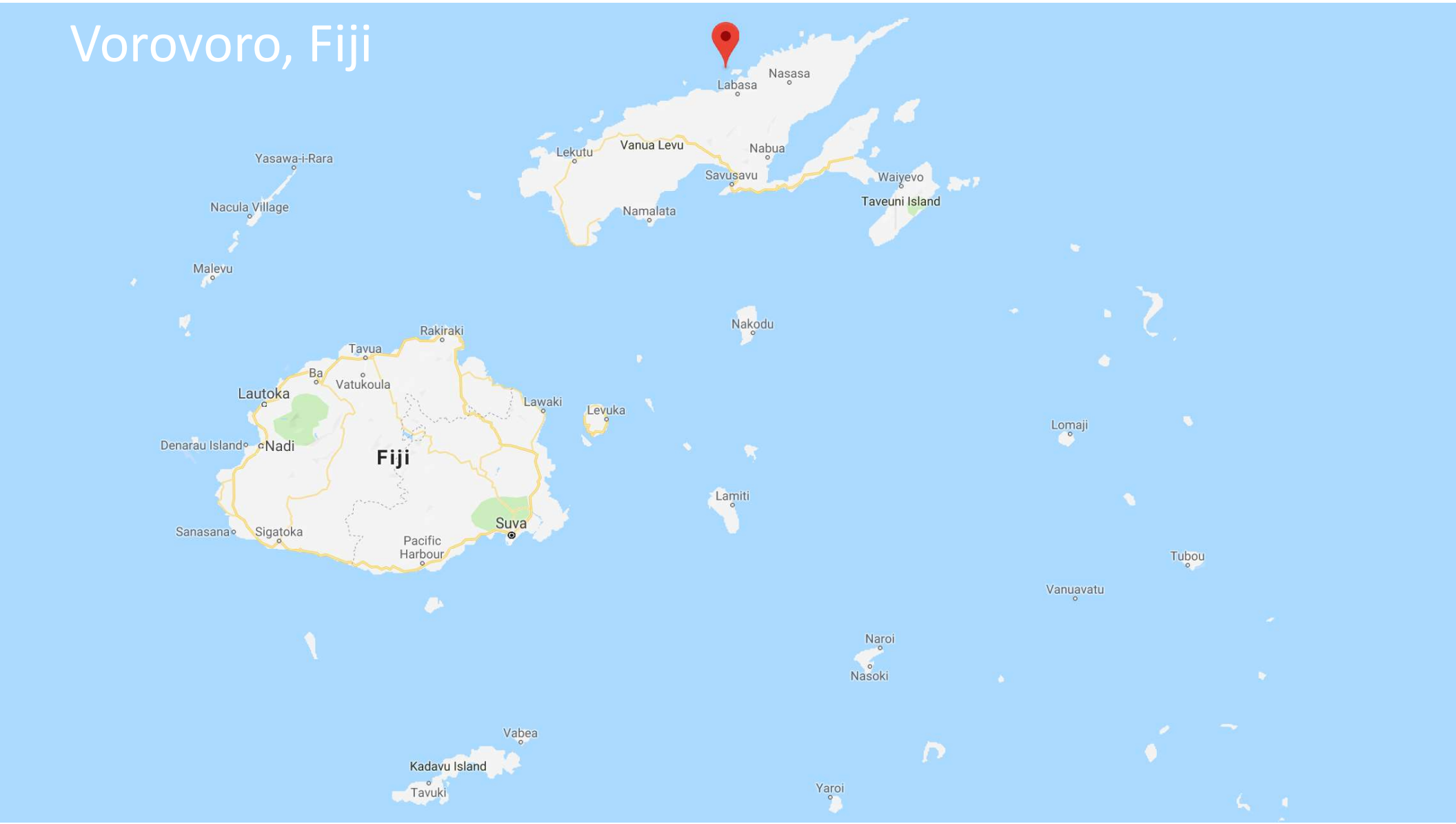
3. **Explain practical lessons and tips** for executing drone-based photogrammetry in the field

4. **Articulate the various use cases** where virtual reality can be applied to photogrammetry and feasibility studies



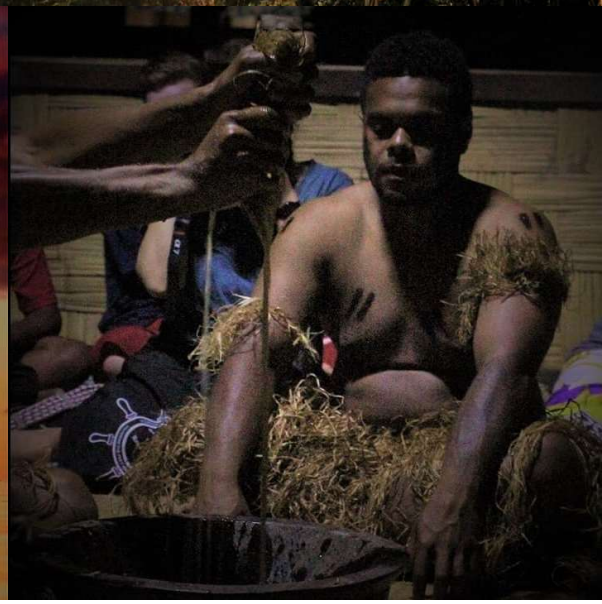
Background

Vorovoro, Fiji



Vorovoro, Fiji

- Small, remote island in northern Fiji
- Home of the chief of several villages
- Chief Tui Mali has established a cultural center to teach, share, learn traditional Fijian way of life: ceremonies, crafts, food, and culture
- Emphasis on social cooperation and collaboration, with global partners to support development



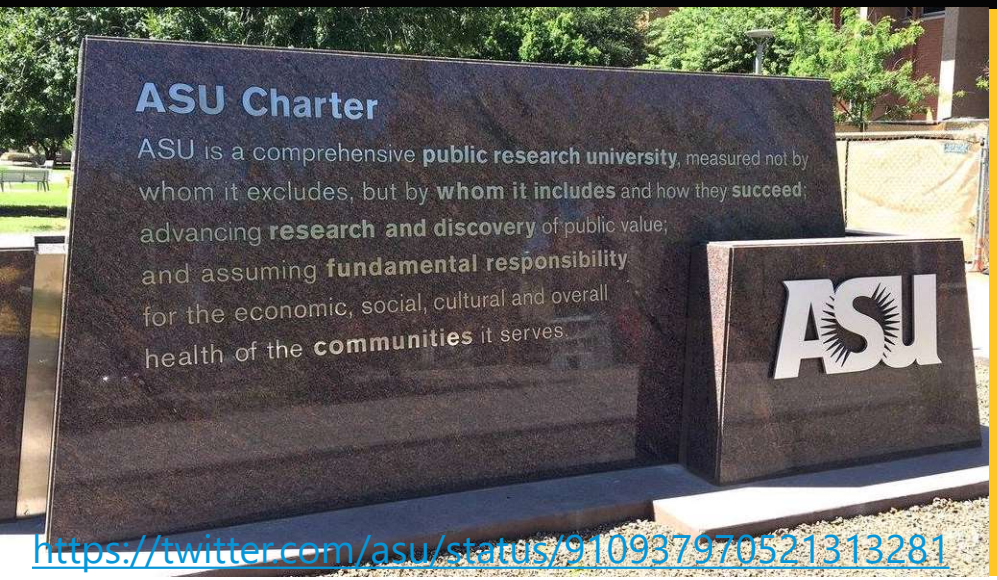
Bridge the Gap

- US-based company that works with the Mali tribe in northern Fiji to identify sustainable ways to diversify their livelihood
- Seeks to pair those goals with universities, families, and individuals who can have a mutually beneficial experience with the people of Vorovoro

We built that.

Del E. Webb School of Construction

ASU Ira A. Fulton Schools of Engineering
Arizona State University



https://twitter.com/asu/status/910937970521313281

- National leader among construction management programs
- Works with indigenous populations
  - Construction in Indian Country
- Patrick Vizard's MS Project

Autodesk Education Experiences

Engage “Education Lighthouse Accounts” to become the trusted partner for job-readiness in construction

1. Engage **executives** and establish Autodesk as a thought-leader in construction
2. Engage **faculty** to enable students to demonstrate job-readiness in Future of Construction workflows
3. Connect **students** and faculty with Autodesk commercial customers

Sustainability Challenges in Vorovoro

"You can't grow without water"

~Jenny Cahill, Bridge the Gap

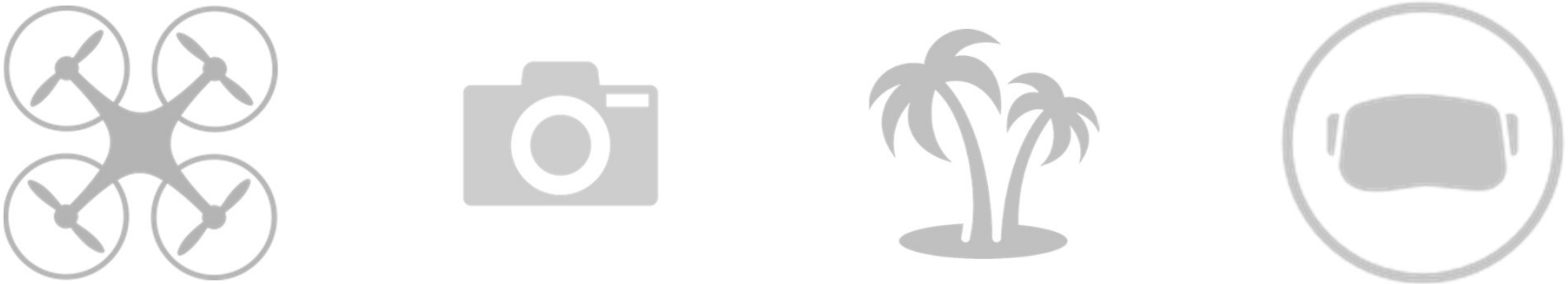
- Vorovoro gets enough water in the wet season to sustain year-round development
- Insufficient means to retain it to sustain development through the dry months
- Dam project started many years ago, but failed due to improper planning and execution
- Need for feasibility study of project practicality: cost, schedule, materials and methods, impact

Desired Capabilities for Sustainability on Vorovoro

- To continue to build the Cultural Center and infrastructure on the island, sustainably and responsibly
  - To create sufficient **water** retention capacity
  - To have sufficient, decentralized, renewable **electrical power** to sustain development
  - **Wireless** internet transmitter tower

- To create global awareness and partnership network
  - To **better understand** potential problems and **communicate** them quickly and with fidelity
  - To have tools that **supports conversations and consensus-building**

Solution: Photogrammetry and VR



Solution: Photogrammetry and VR
and the cloud

Project

Project Objectives

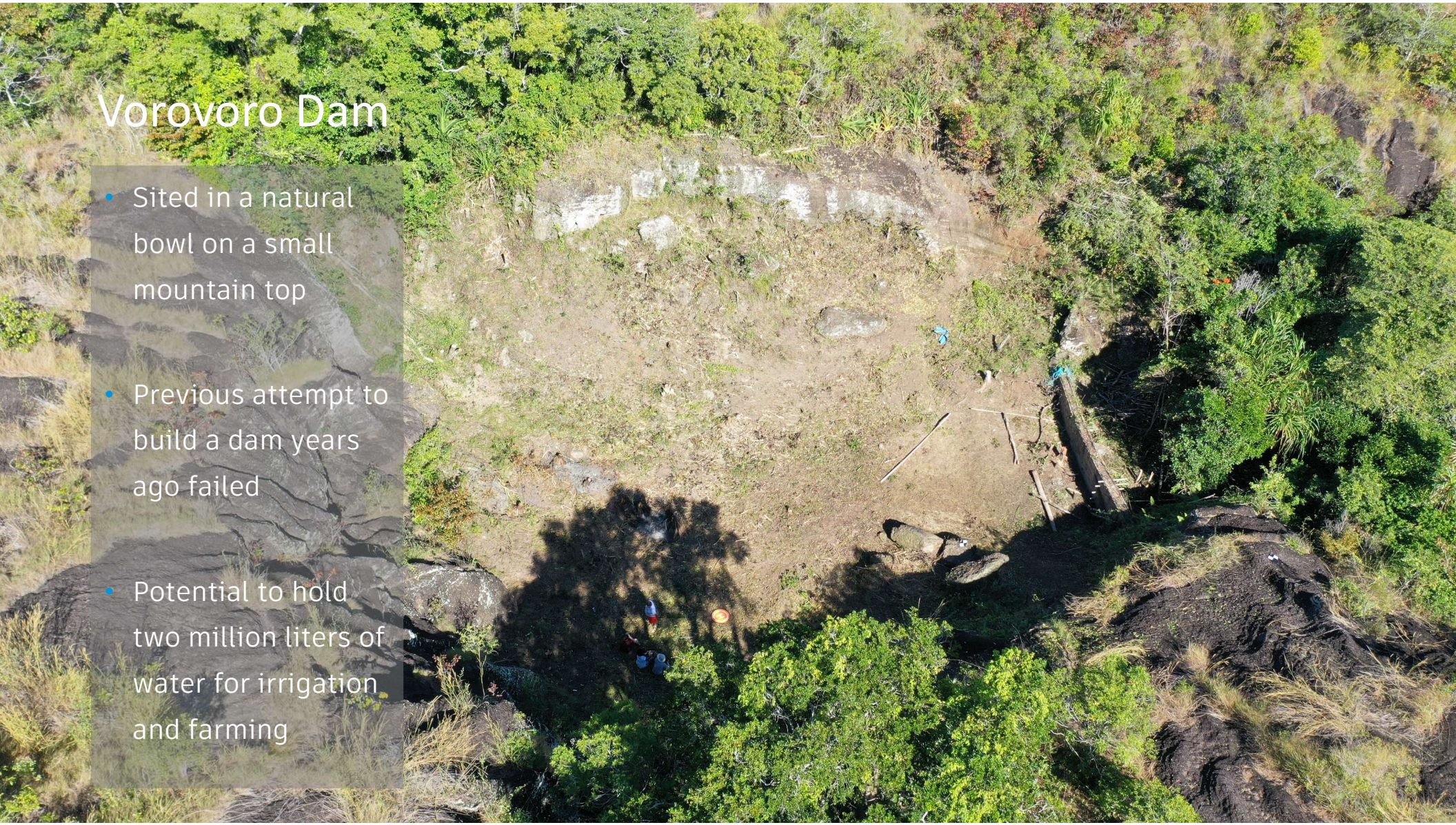
1. Provide new **data, points of view, and experiences** in order to **support effective decision-making**

2. Accurately **document and study a natural site** with potential to support **sustainable development**

3. Develop workflows and apply technology including **drones, photogrammetry and VR** to support a **feasibility study**

4. Leverage **cloud-based construction document management software** to support global collaboration in a “live fire” project context

Vorovoro Dam



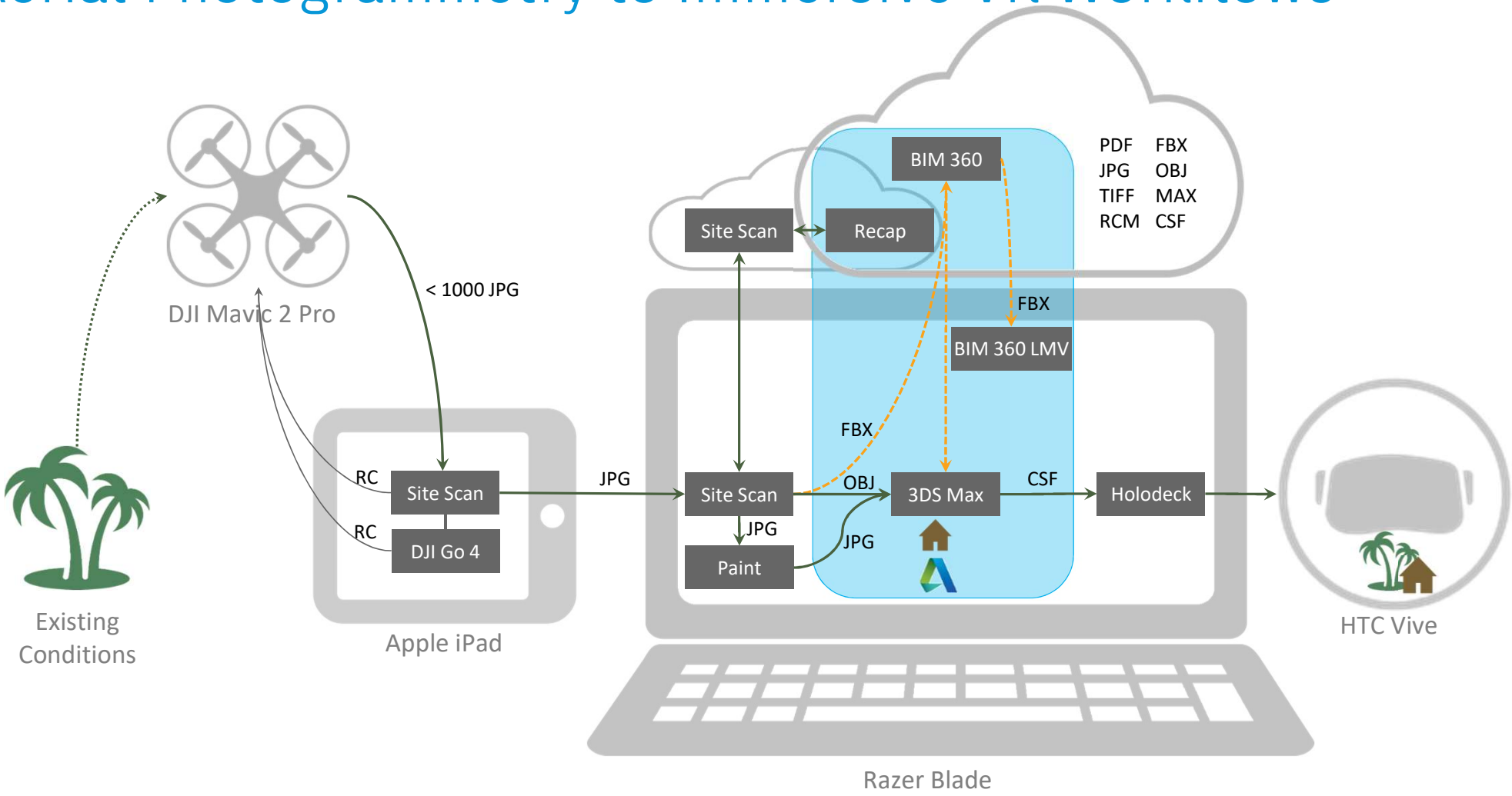
- Sited in a natural bowl on a small mountain top
- Previous attempt to build a dam years ago failed
- Potential to hold two million liters of water for irrigation and farming

Process

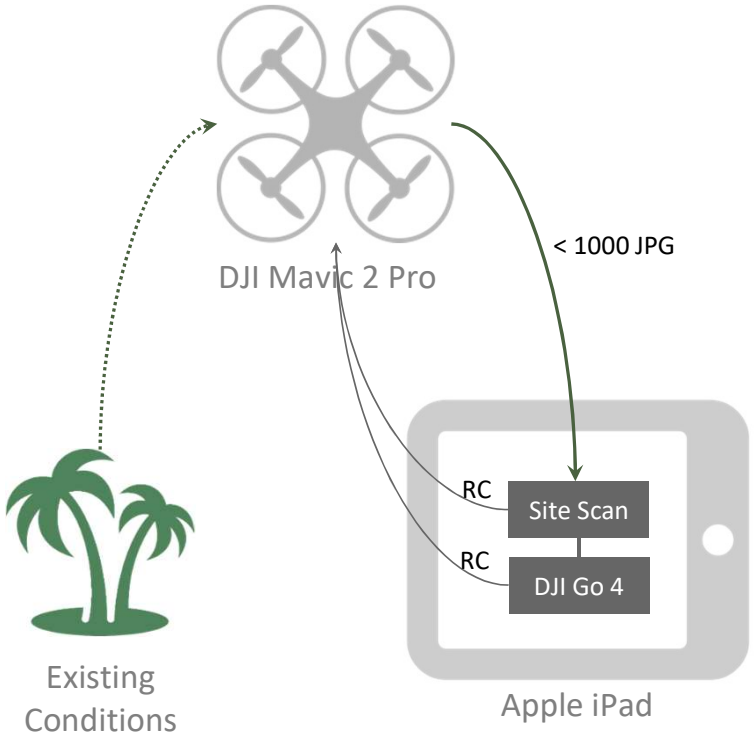

Preparation

Packing

Aerial Photogrammetry to Immersive VR Workflows



1. Drone-Based Aerial Photography



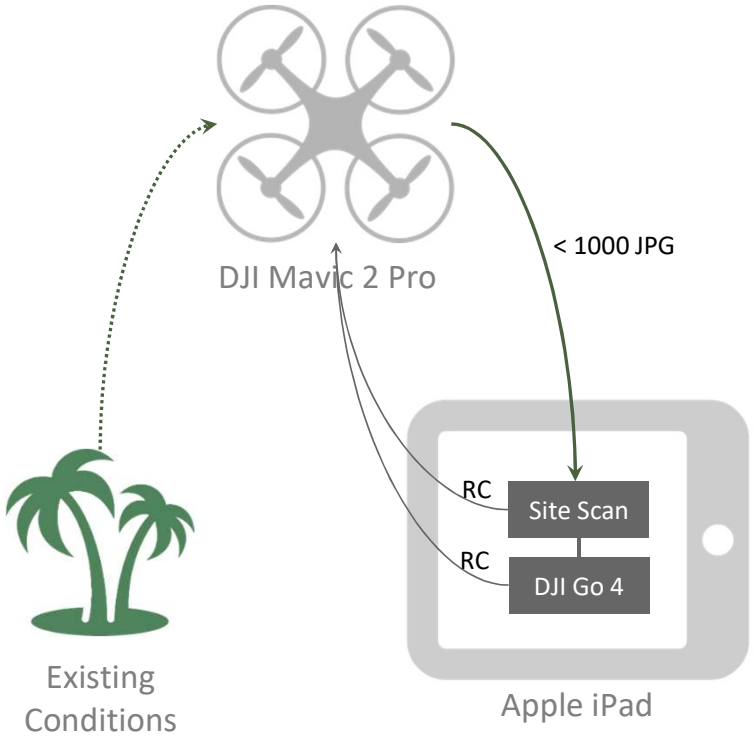
0. Clear the Site!

Existing
Conditions

Clearing

Clearing

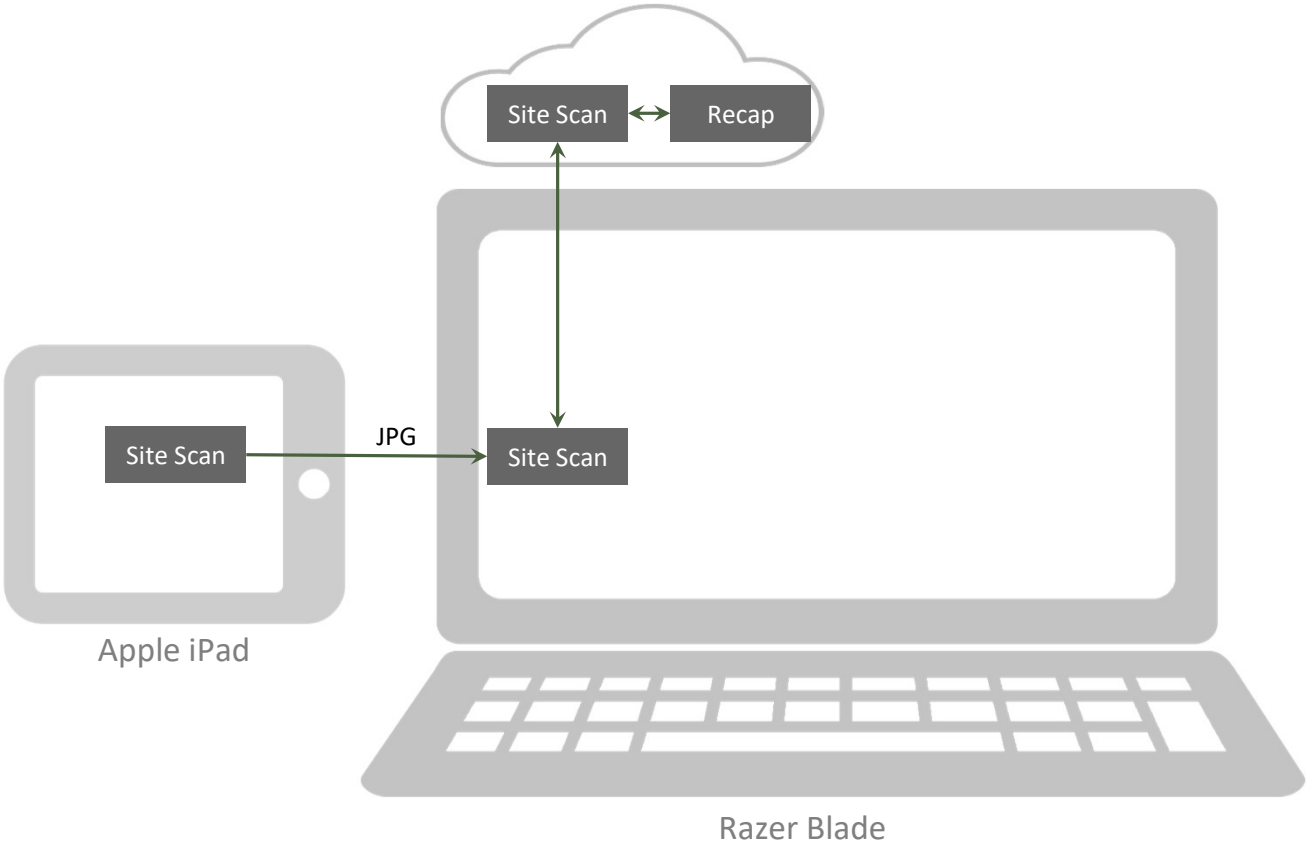
1. Drone-Based Aerial Photography



Drone Time!

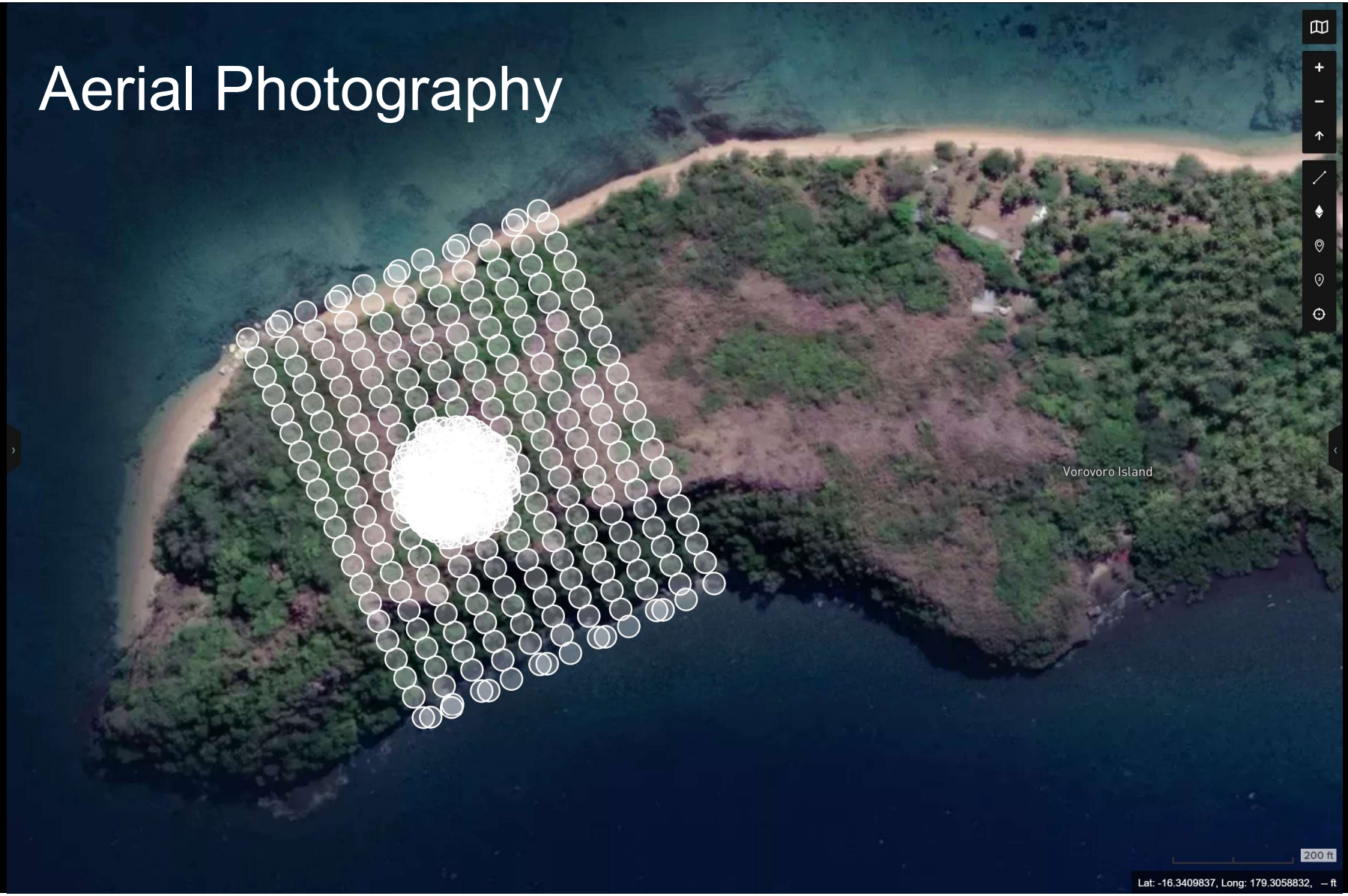

NEW ORLEANS
H

2. Process Photogrammetry



Existing Conditions

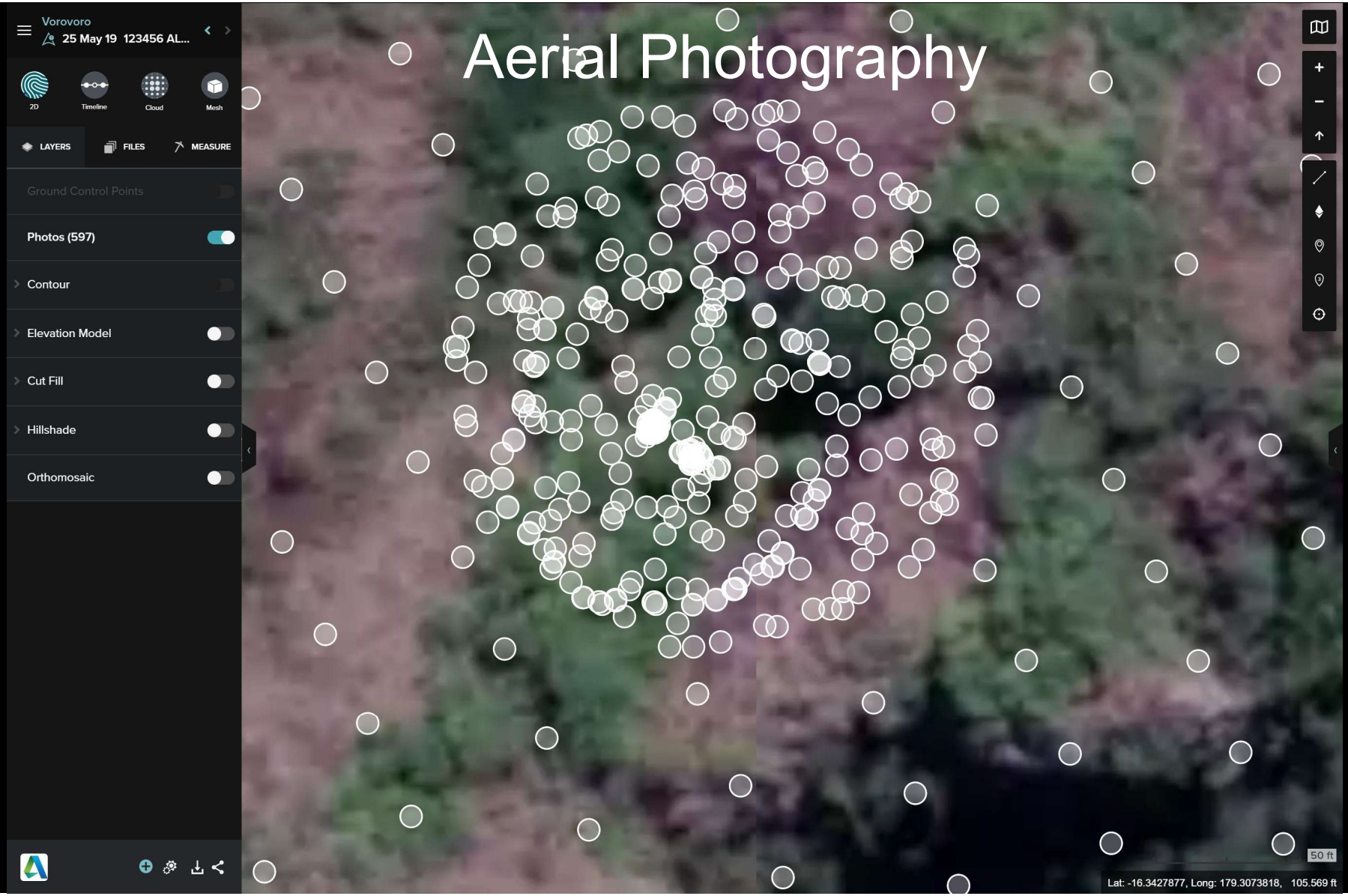
Aerial Photography

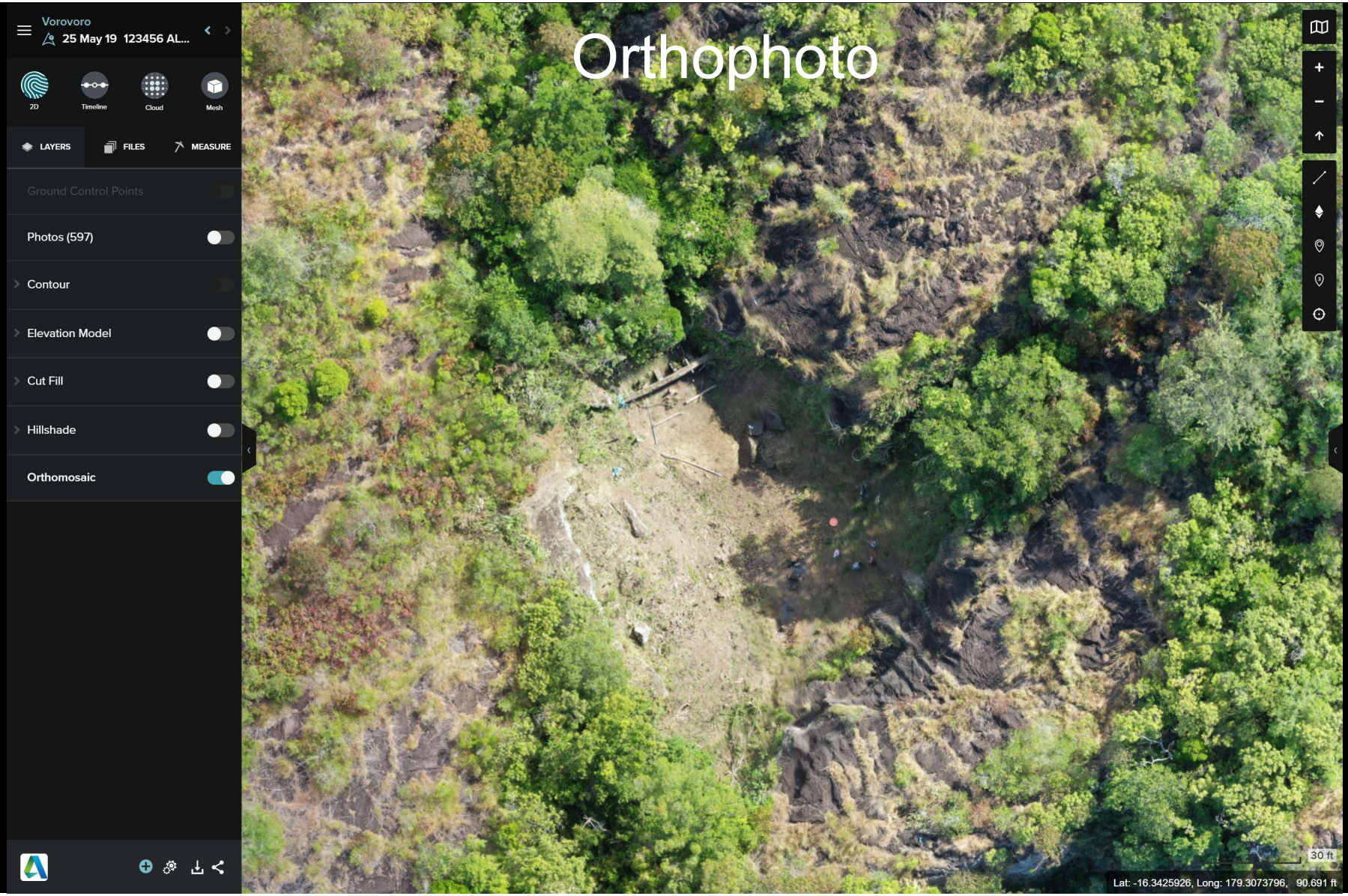



Aerial Photography
Vorovoro Island
200 ft
Lat: -16.3412570, Long: 179.3106605, -- ft


Orthophoto
Vorovoro Island
200 ft
Lat: -16.3413414, Long: 179.3059696, -- ft


Vorovoro
25 May 19 123456 AL...
2D
Timeline
Cloud
Mesh
LAYERS
FILES
MEASURE
Ground Control Points
Photos (597)
Contour
Elevation Model
Cut Fill
Hillshade
Orthomosaic
Existing Conditions
50 ft
Lat: -16.3433805, Long: 179.3084261, 44.406 ft


Aerial Photography
Vorovoro
25 May 19 123456 AL...
2D
Timeline
Cloud
Mesh
LAYERS
FILES
MEASURE
Ground Control Points
Photos (597)
Contour
Elevation Model
Cut Fill
Hillshade
Orthomosaic
50 ft
Lat: -16.3427877, Long: 179.3073818, 105.569 ft


Orthophoto
Vorovoro
25 May 19 123456 AL...
2D
Timeline
Cloud
Mesh
LAYERS
FILES
MEASURE
Ground Control Points
Photos (597)
Contour
Elevation Model
Cut Fill
Hillshade
Orthomosaic
30 ft
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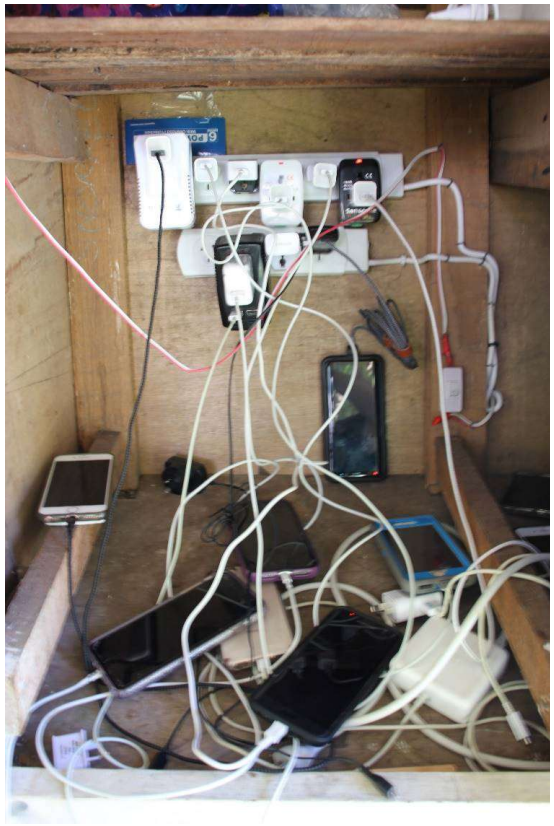
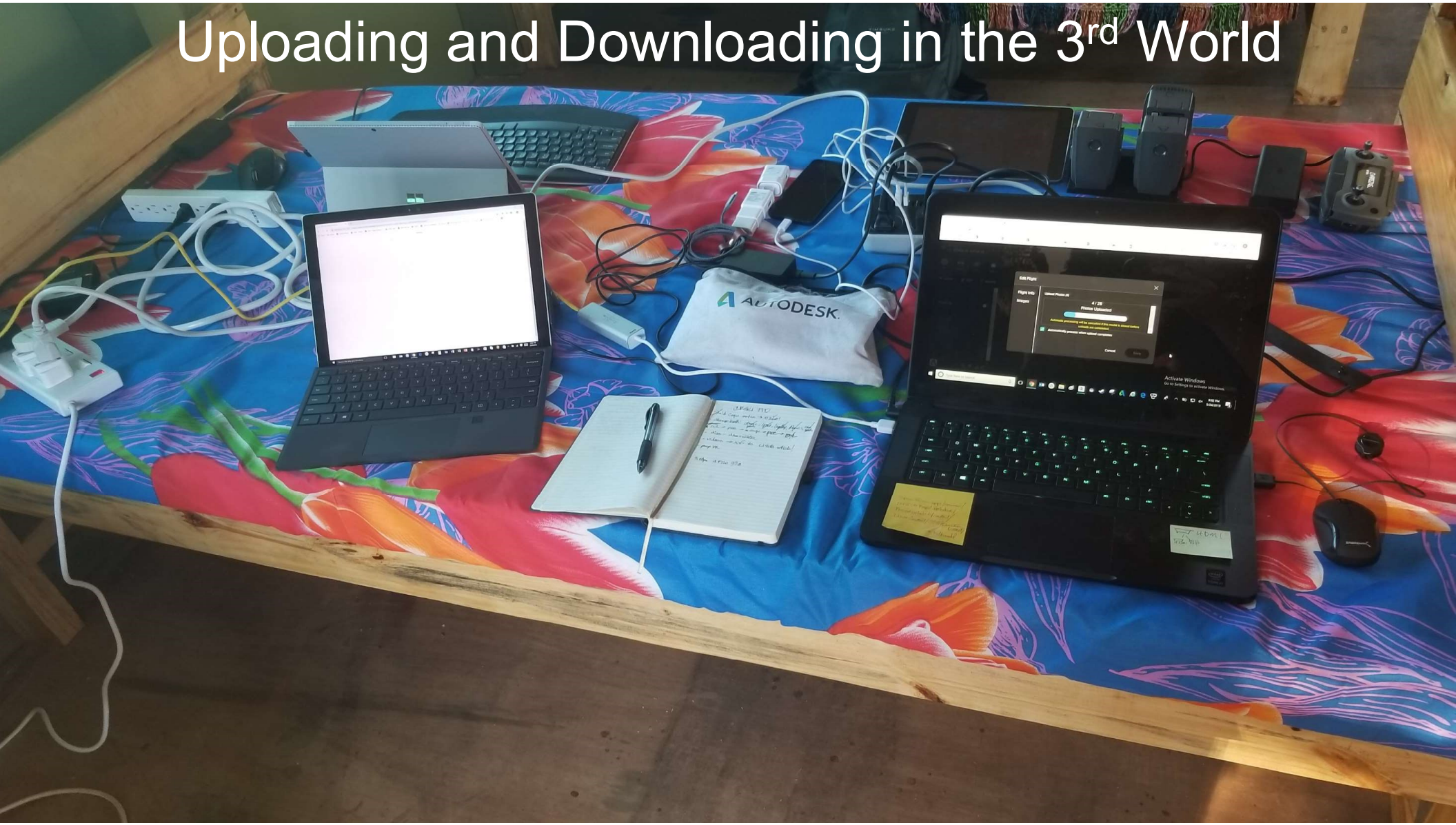
Electrical Power in the 3rd World



Uploading and Downloading in the 3rd World



Plan Your Work and Work Your Plan

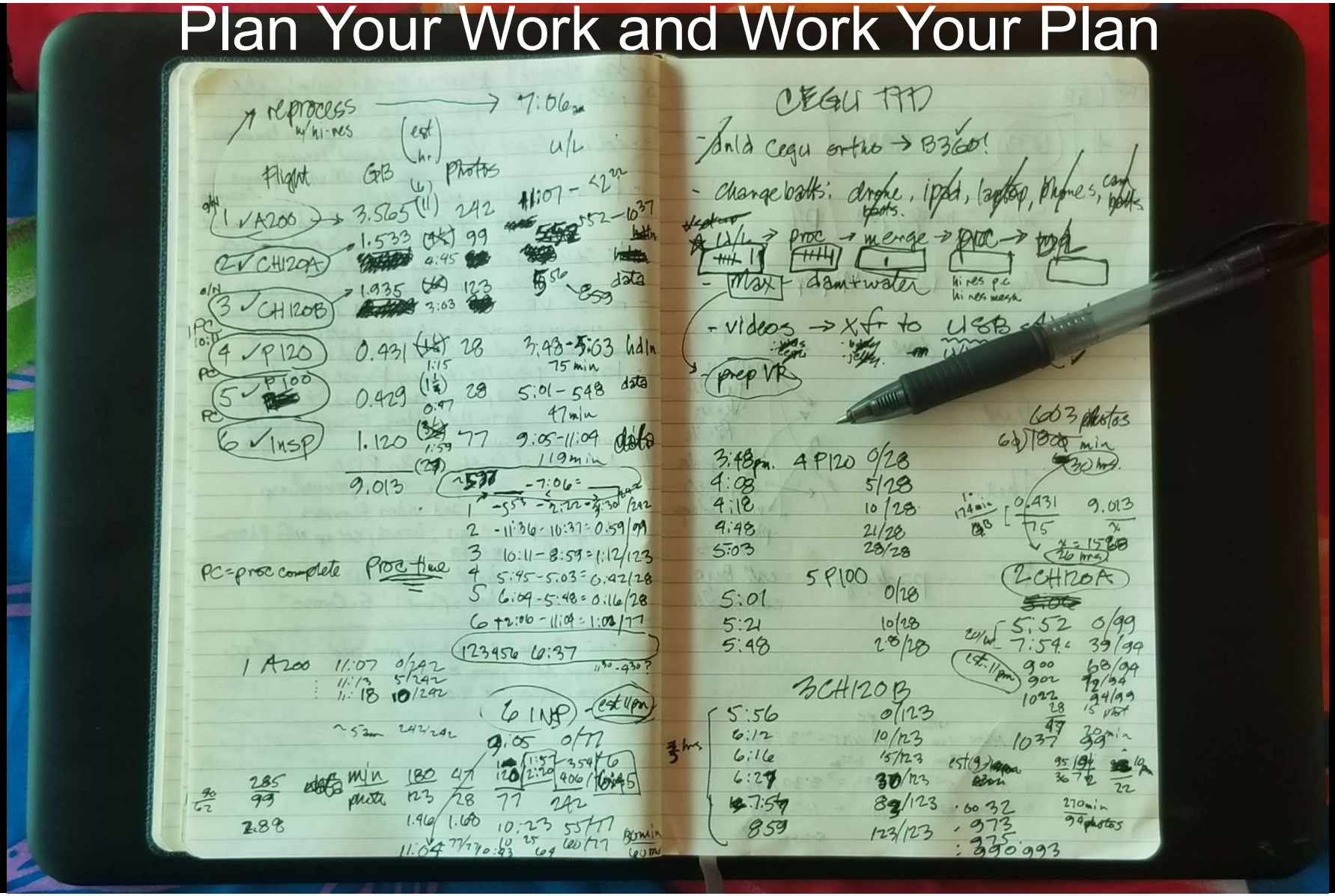
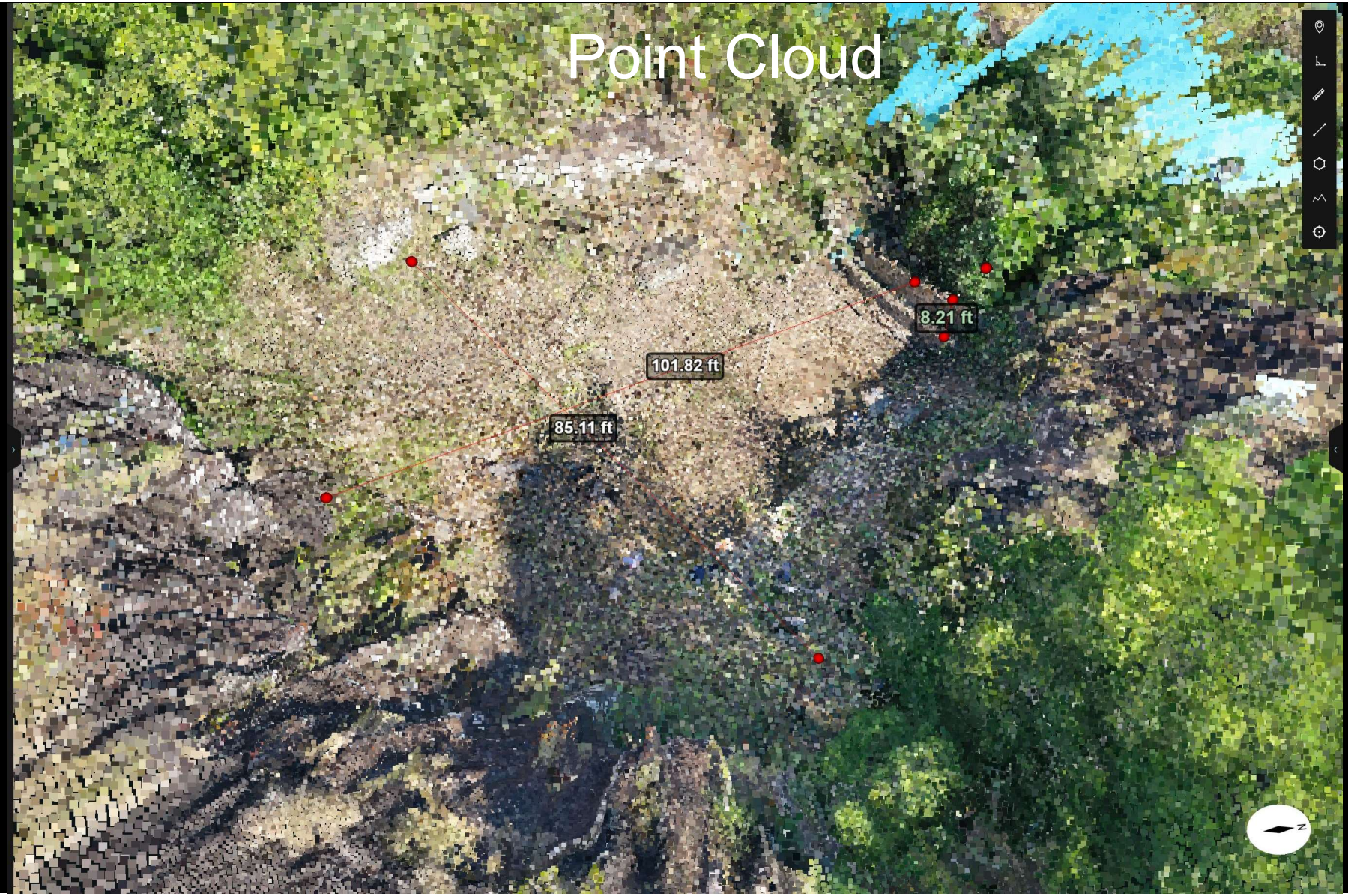


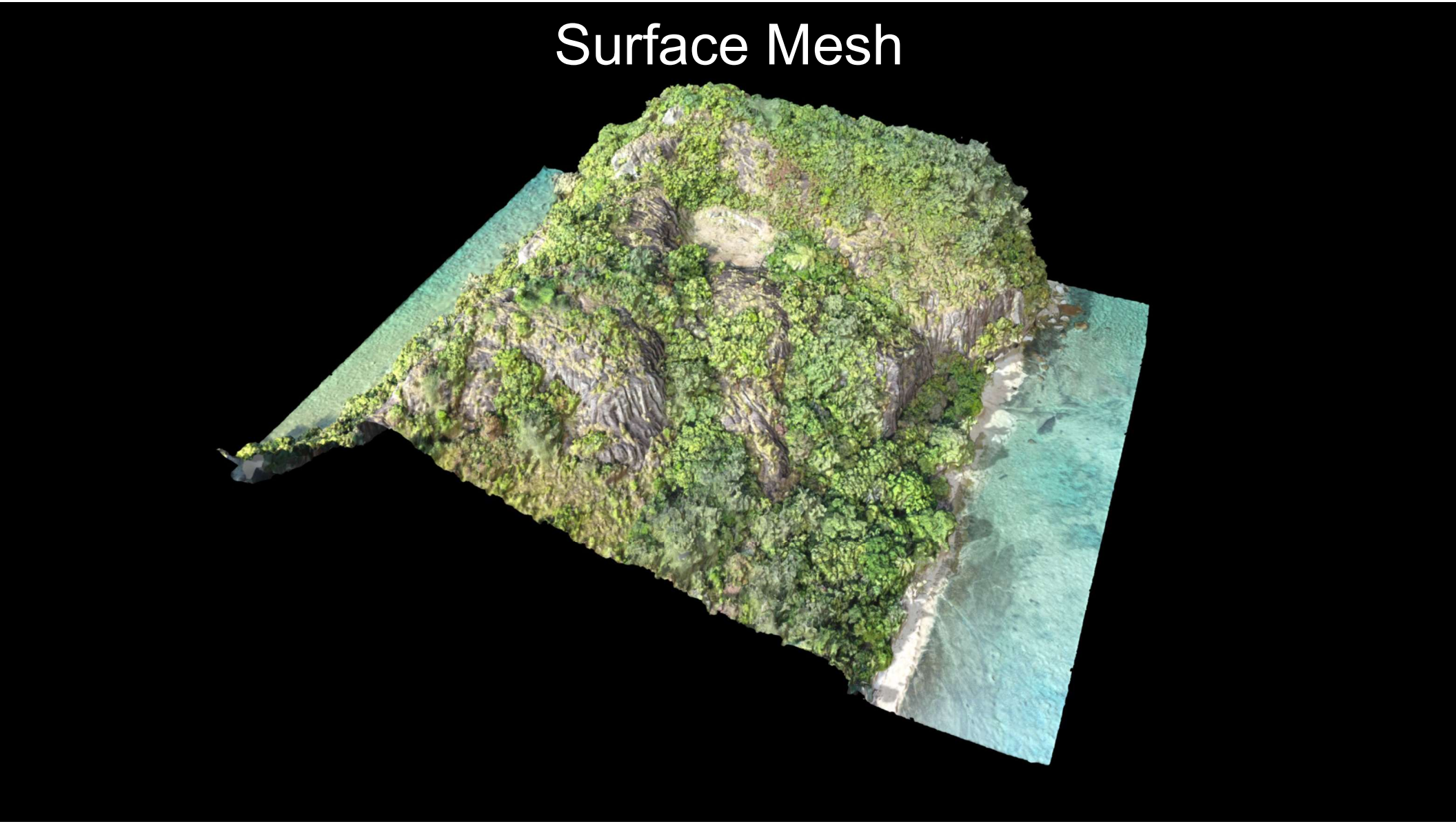
Image Limits and Implications

- Complex image limits…
  - **20**: Minimum number of images to process
  - **300**: Limit of Recap Photo “object” processing
  - **500**: Limit of 3DR Site Scan use of background Recap Photo, switches to Pix4D
  - **1000**: Limit of Recap Photo “aerial” processing
  - **2500**: Maximum number of images to process
- …Require carefully planned WBS

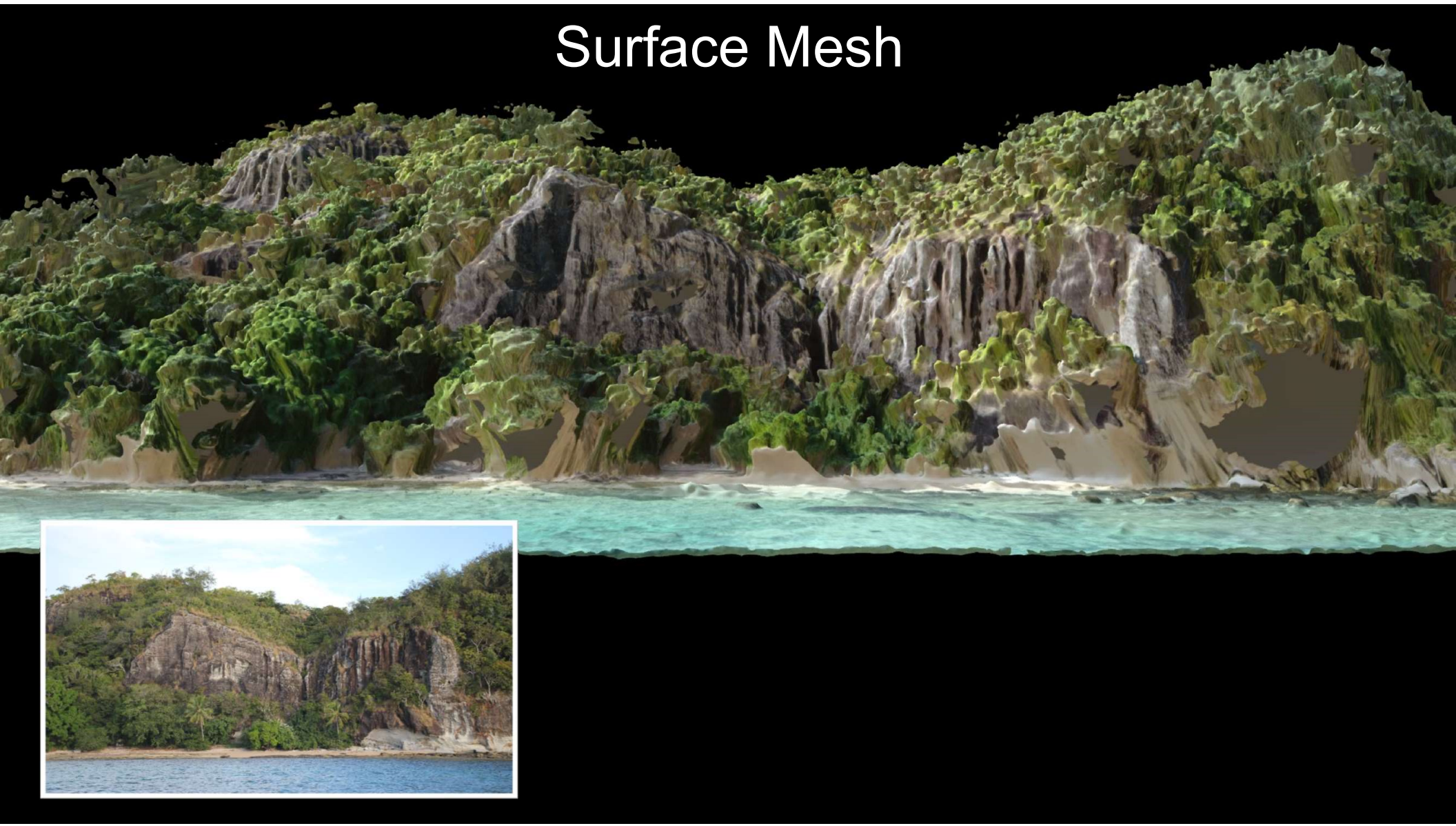
“DIGITAL HYGIENE” IS PARAMOUNT!


Point Cloud
8.21 ft
101.82 ft
85.11 ft

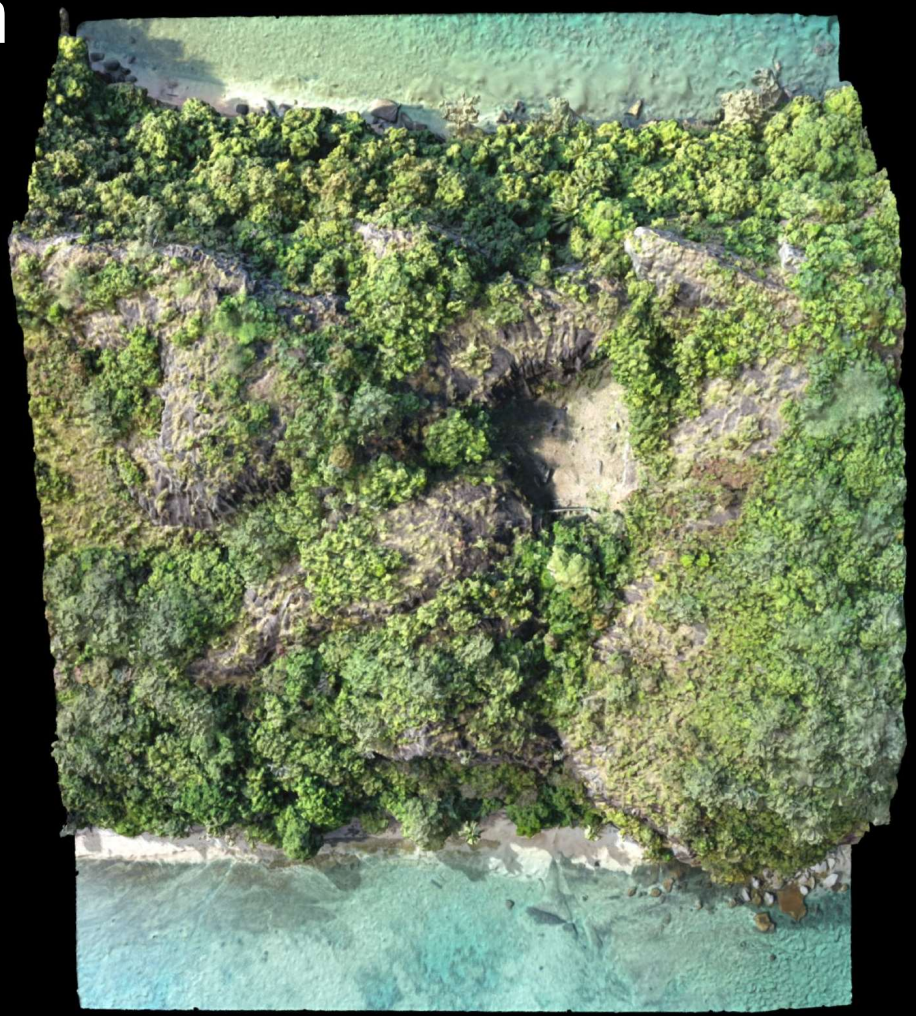
Surface Mesh



Surface Mesh

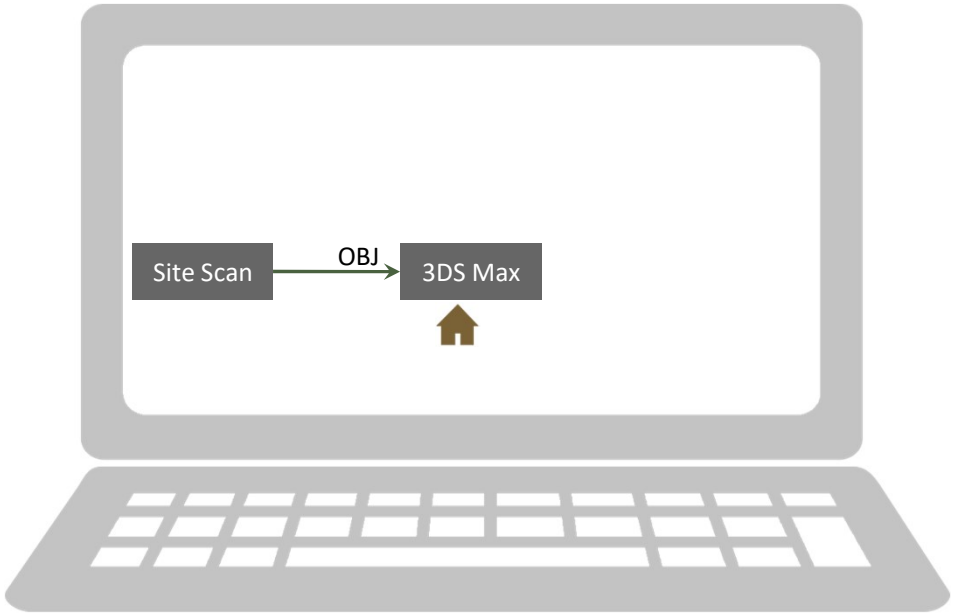


Surface Mesh



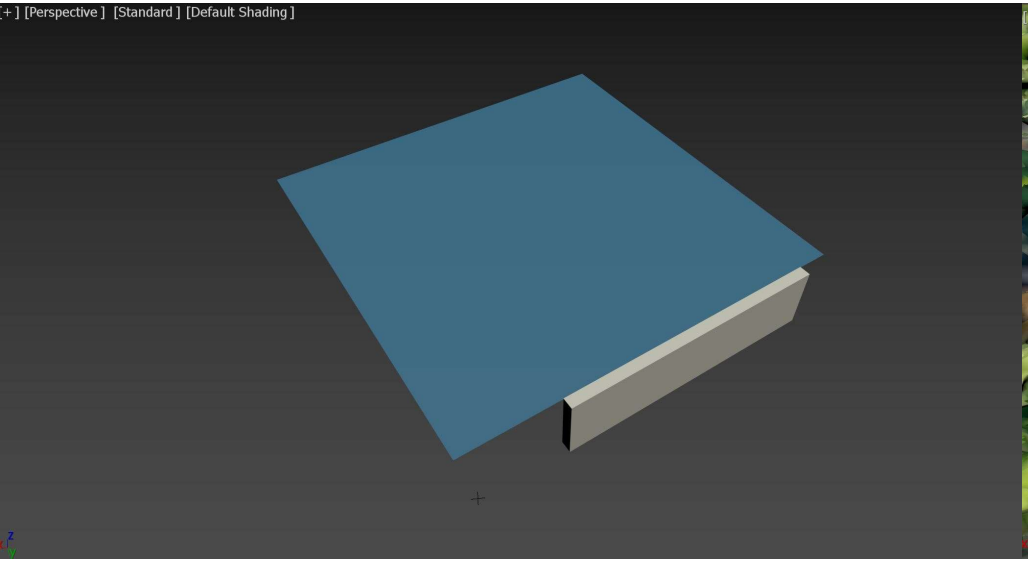

Surface Mesh

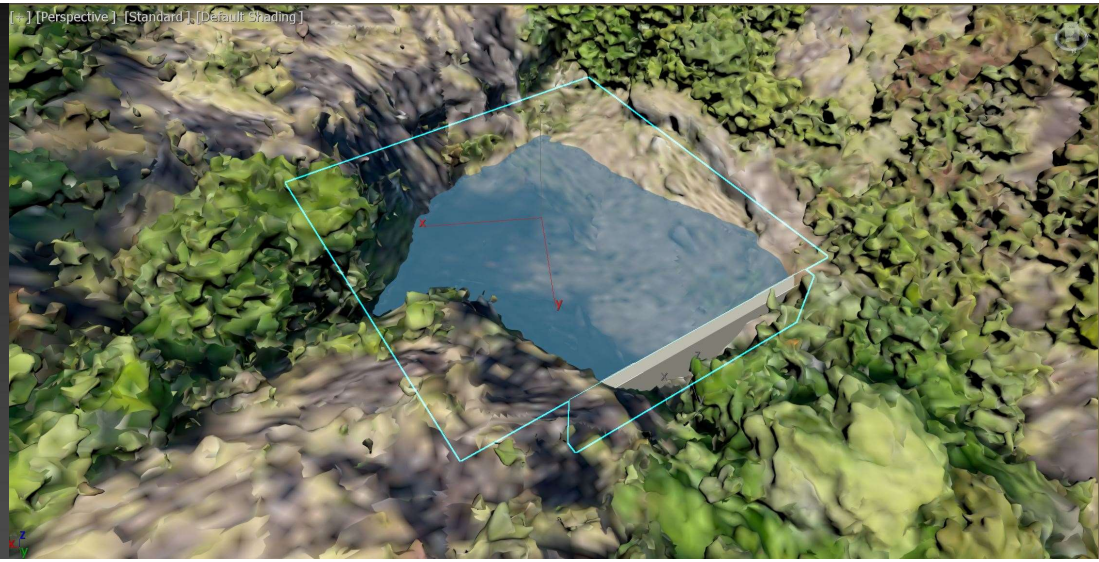
3. Manually Build Model Geometry



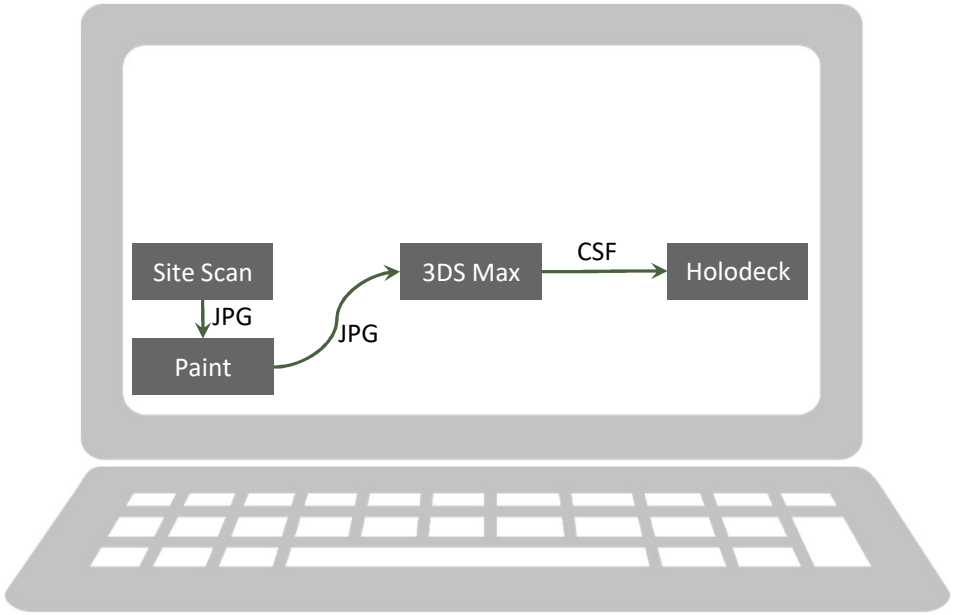
Razer Blade

3ds Max


[+] [Perspective] [Standard] [Default Shading]


[+] [Perspective] [Standard] [Default Shading]

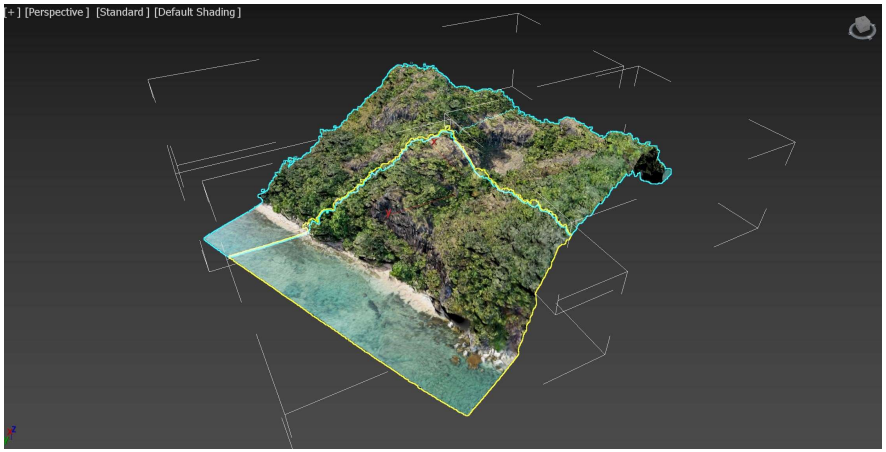
4. Prepare the VR Scene

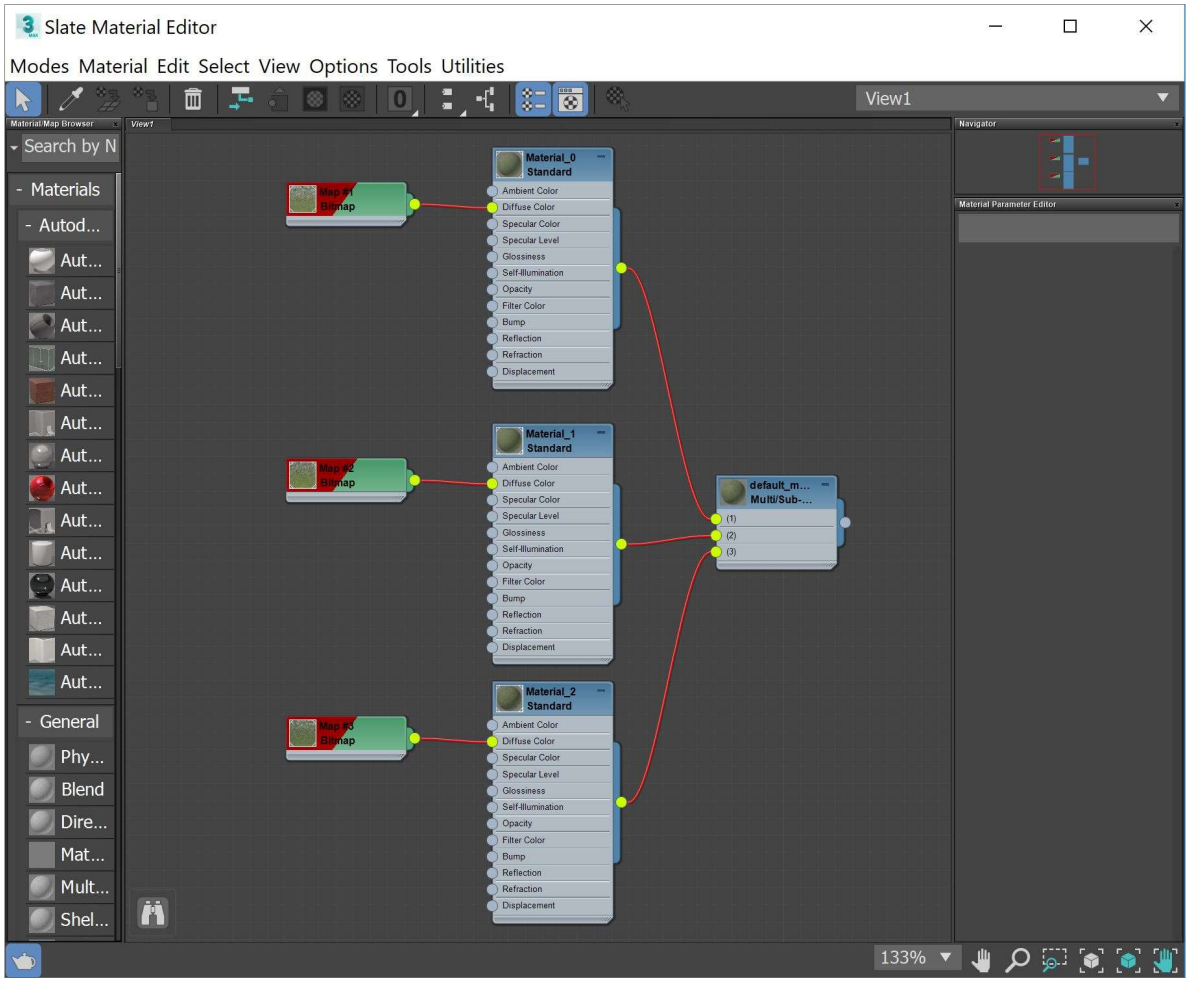


Razer Blade

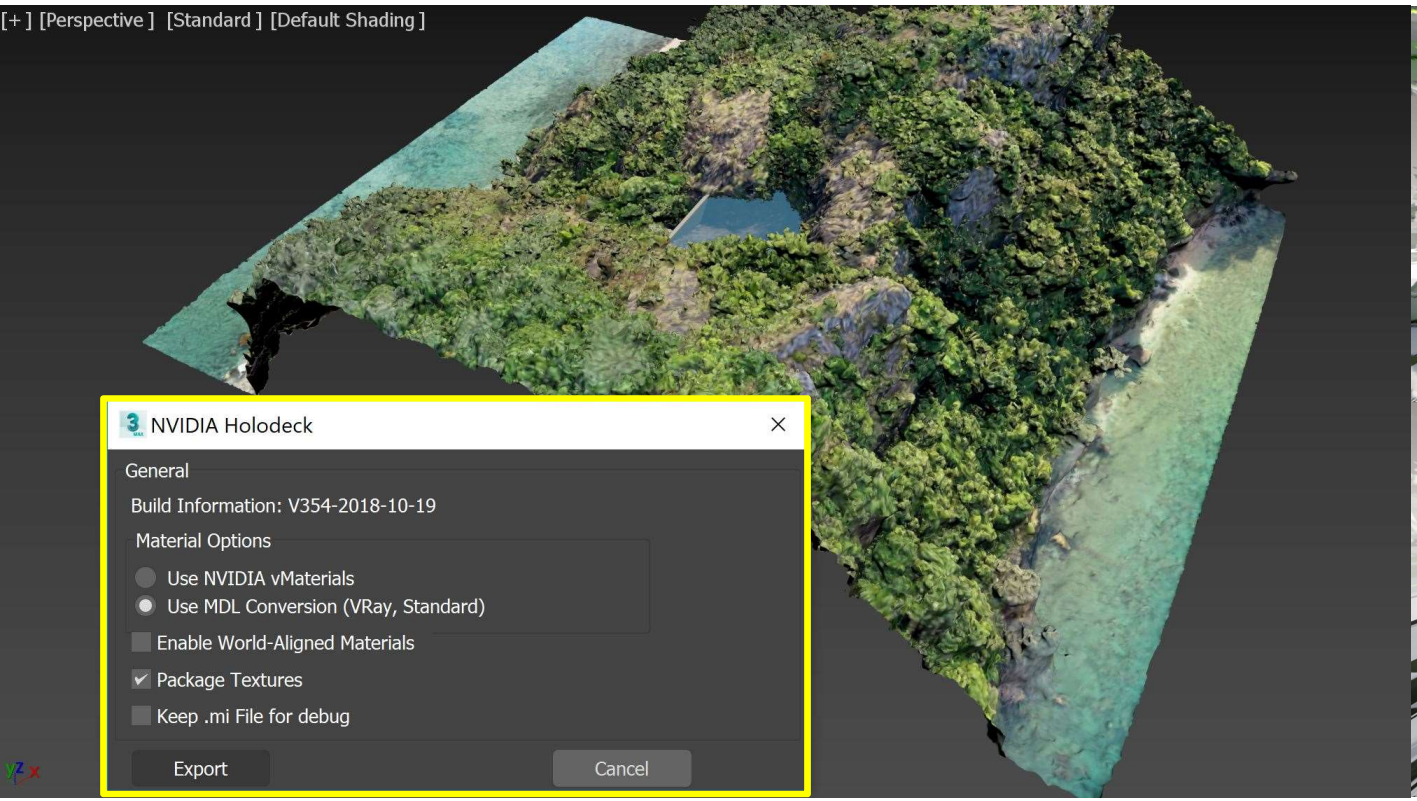
Accommodate Holodeck Material Limitations

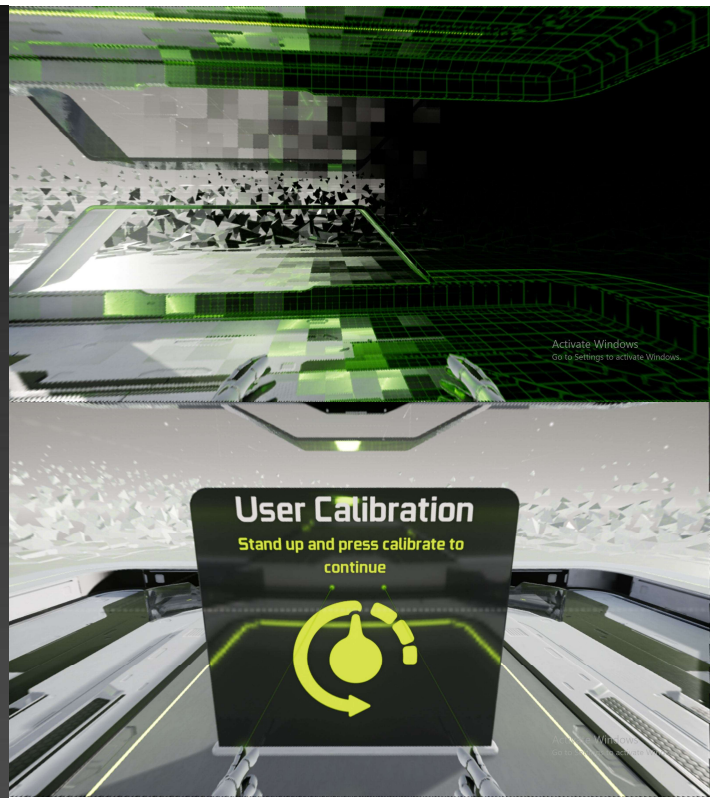
- 4K textures only
  - Decrease image resolution
- No “multi-sub” materials
  - Split/Detach geometry by selecting ID of surface mesh
  - Assign single material to each part



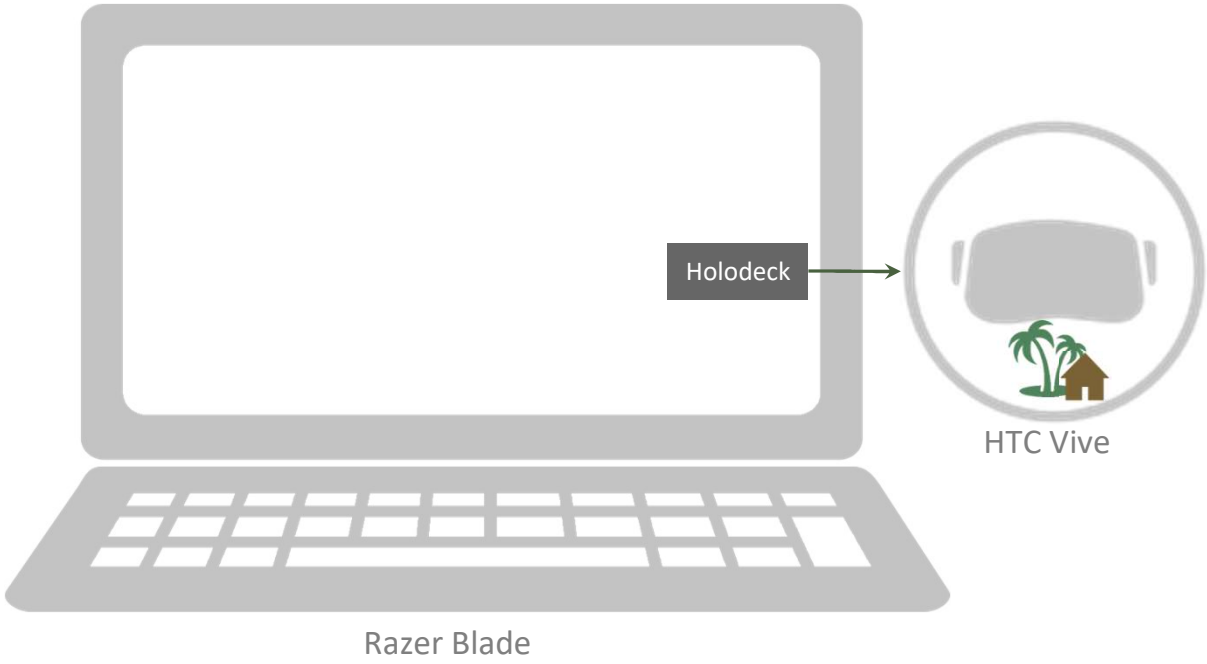


Export to nVIDIA Holodeck





5. Immersive Virtual Reality

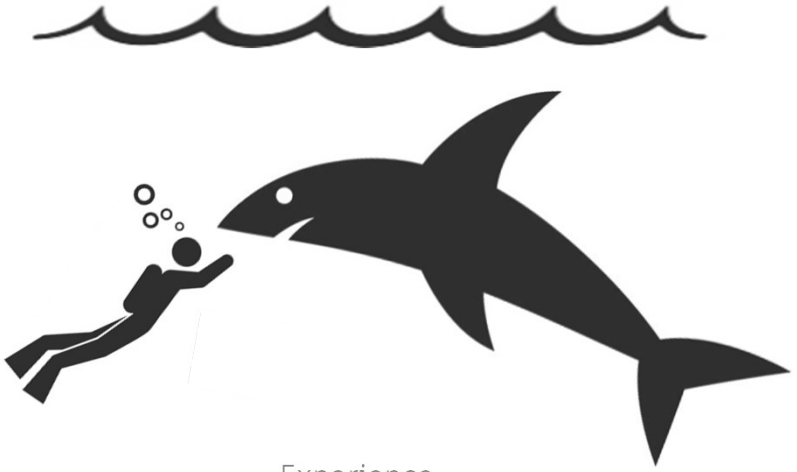


Virtual Reality

SUPPORT EFFECTIVE DECISION-MAKING BY *EXPERIENCING* A SPACE

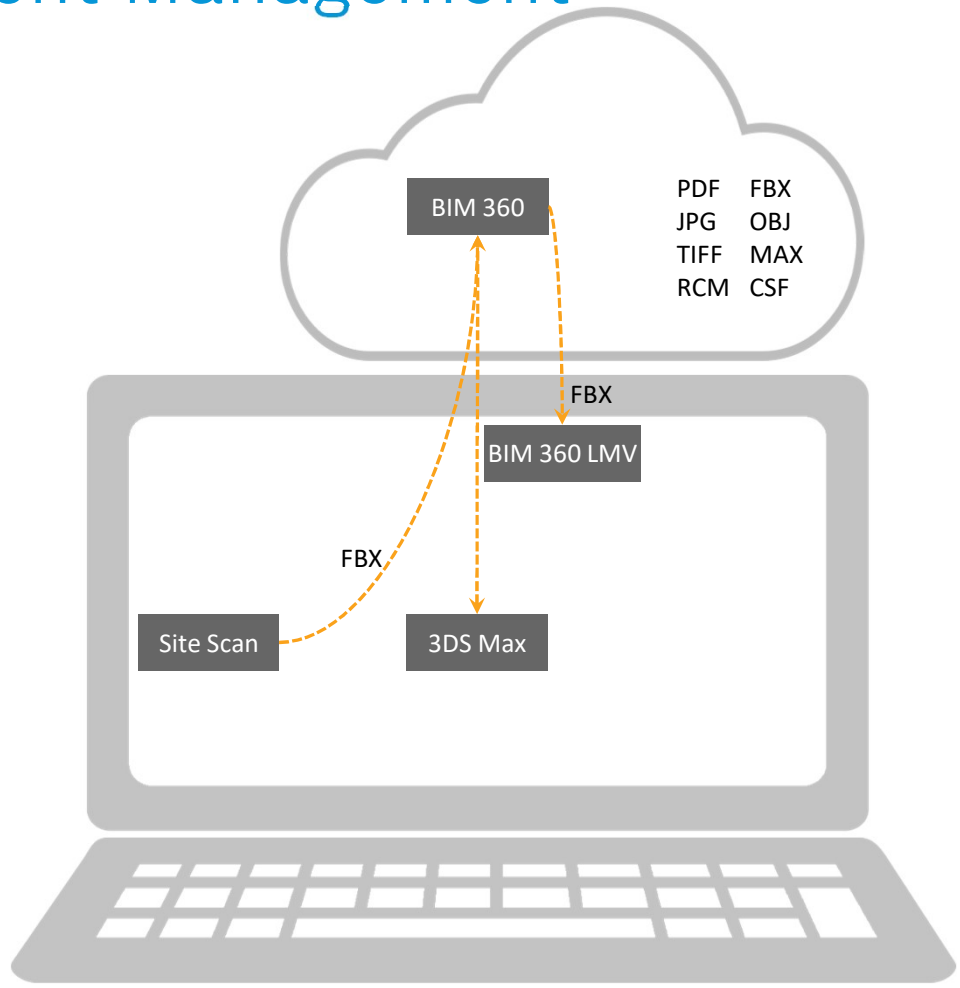
- Immersive
- Interactive
- Intuitive

Representation

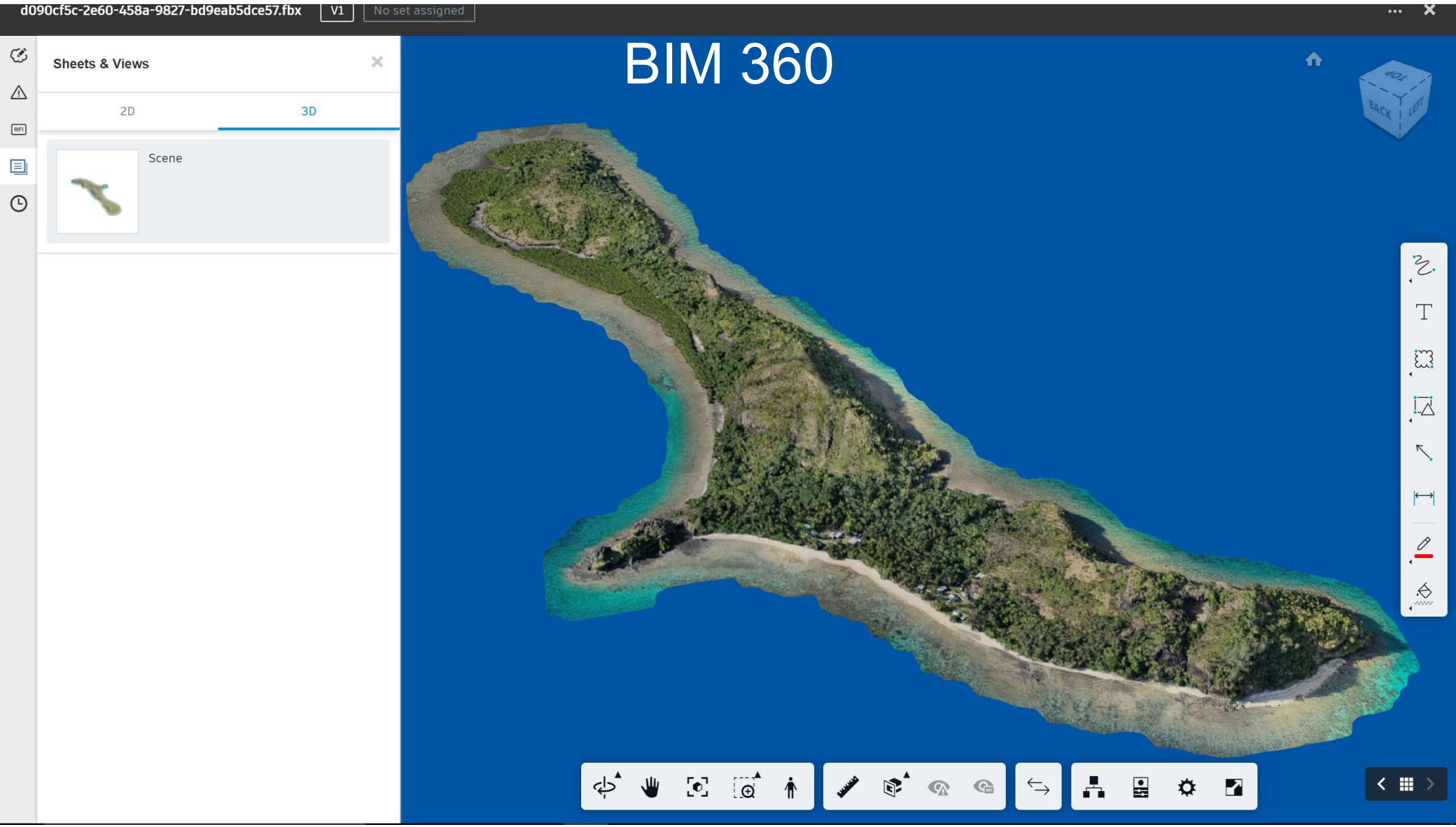


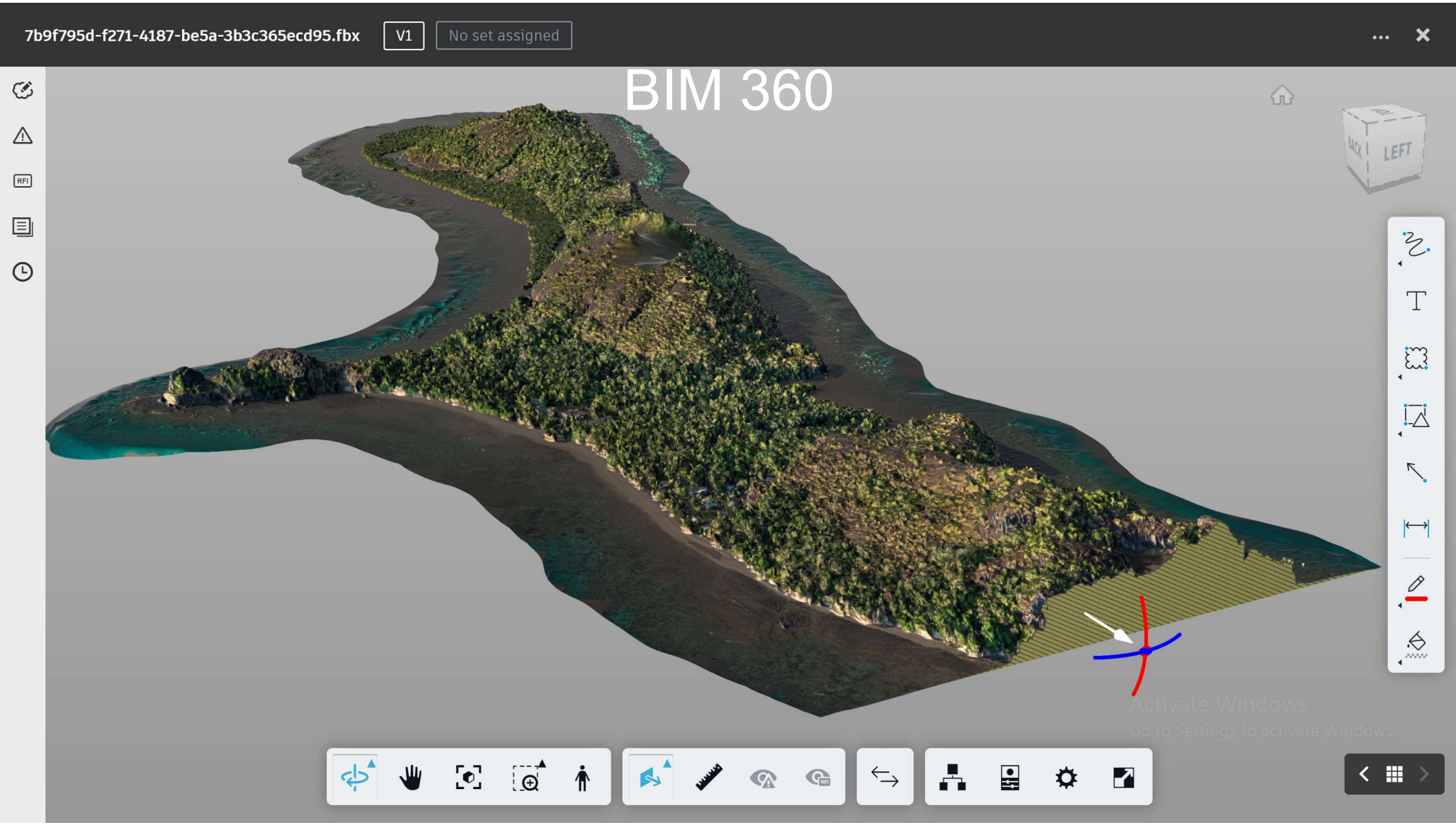
Experience

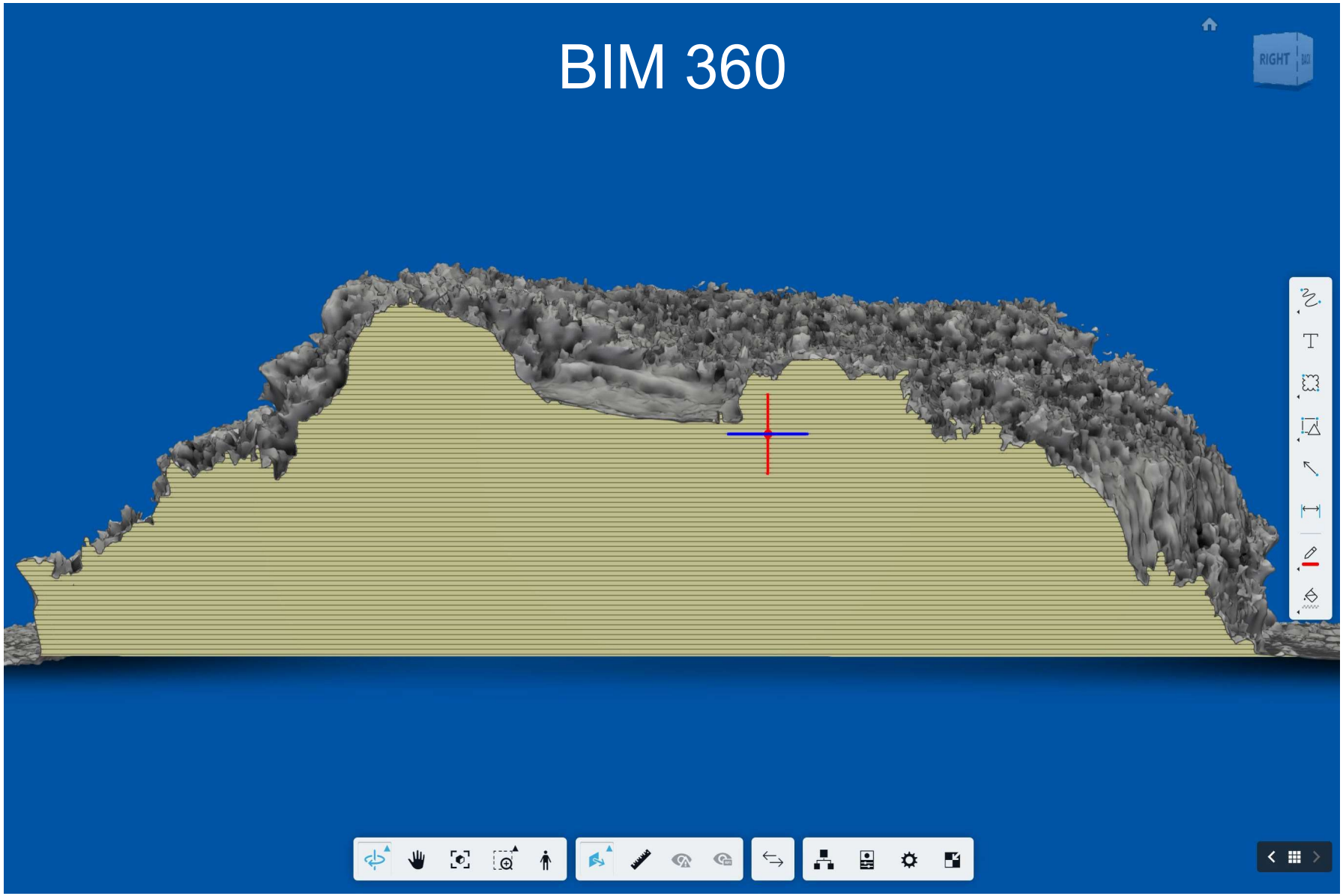
6. Cloud-Based Document Management

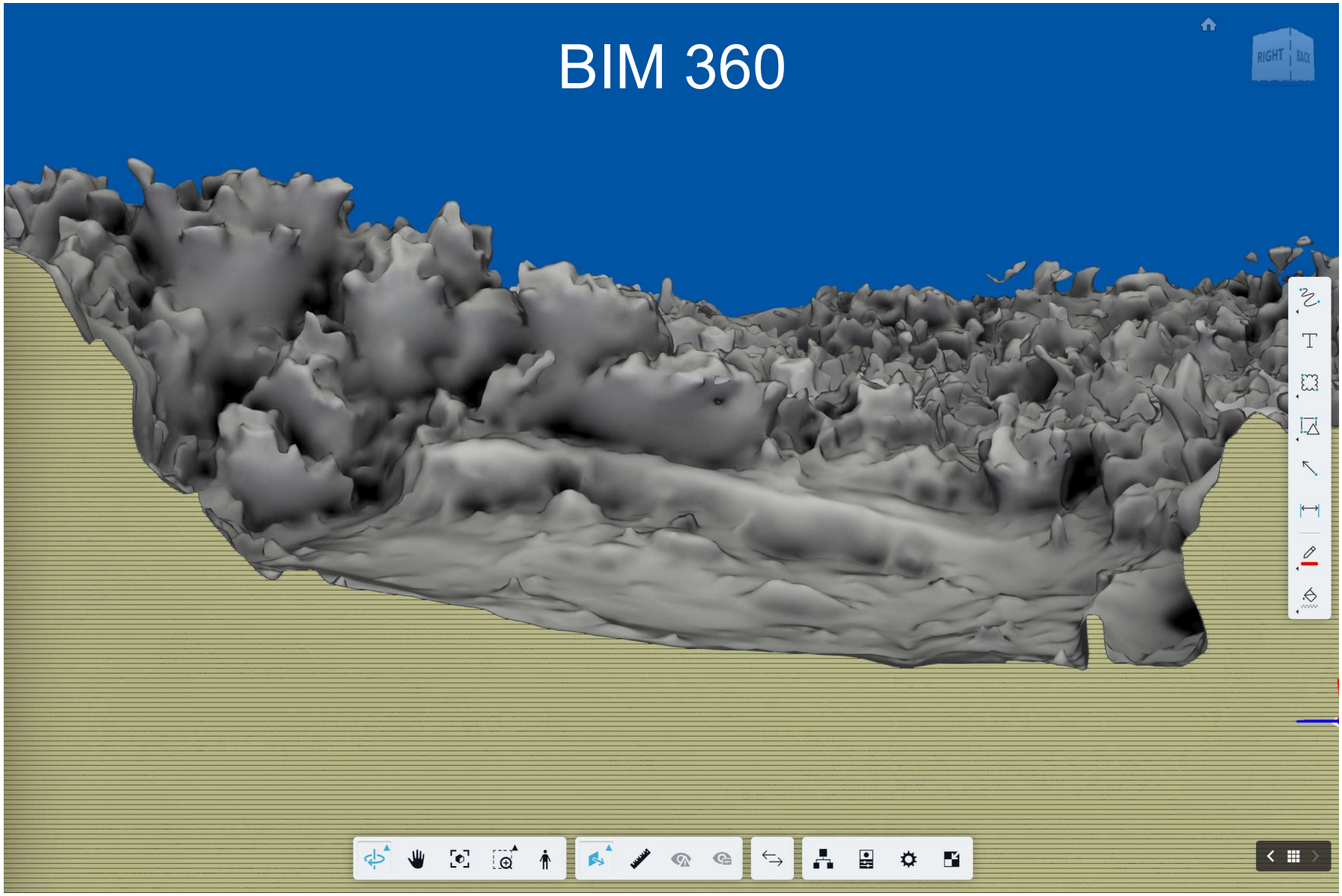


Razer Blade

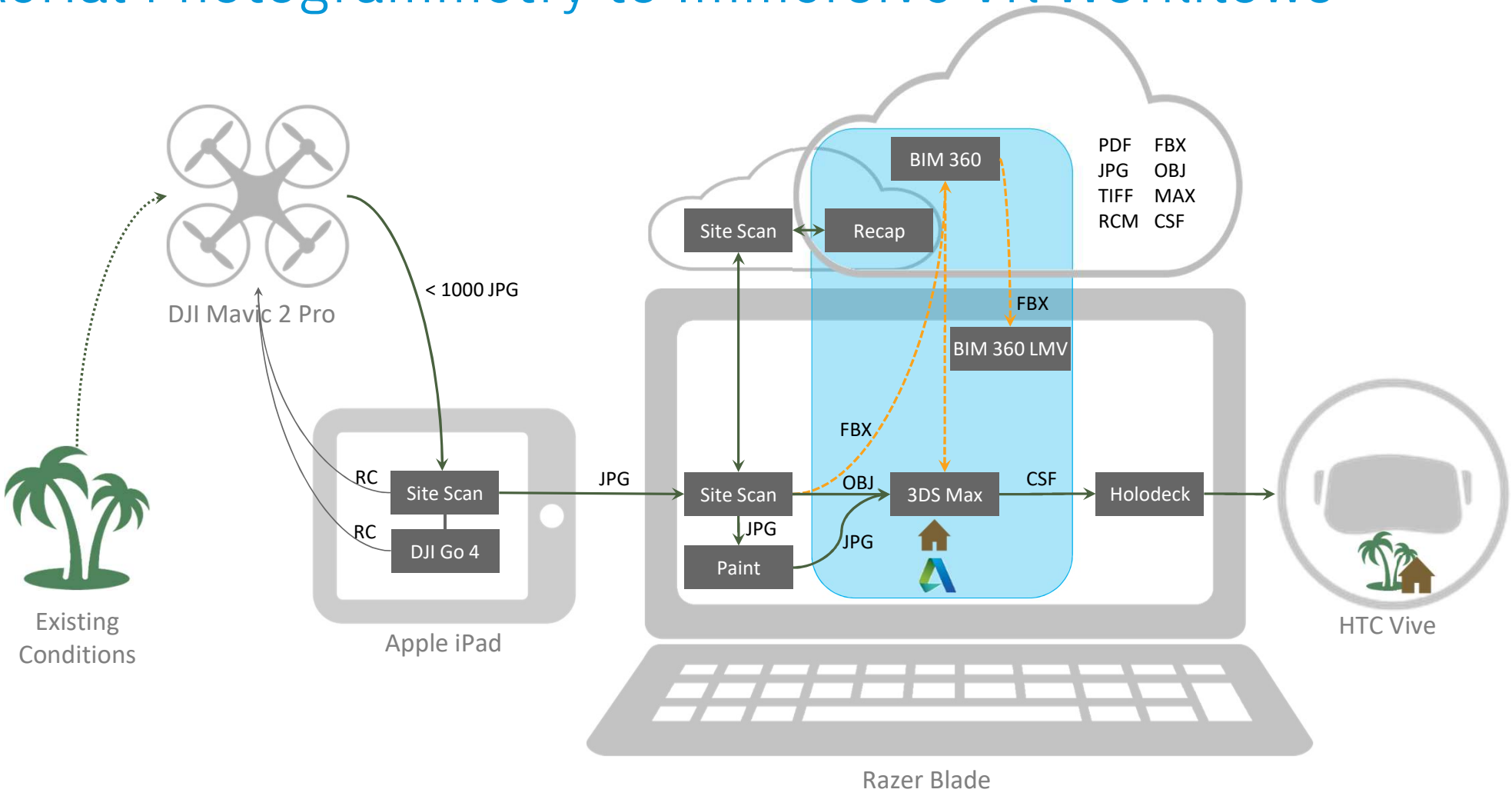

d090cf5c-2e60-458a-9827-bd9eab5dce57.fbx
V1
No set assigned
Sheets & Views
2D
3D
Scene
BIM 360
TOP
BACK
LEFT


7b9f795d-f271-4187-be5a-3b3c365ecd95.fbx
V1
No set assigned
BIM 360
BACK
LEFT
Activate Windows
Go to Settings to activate Windows.


BIM 360
RIGHT


BIM 360
RIGHT
BACK

Aerial Photogrammetry to Immersive VR Workflows



Results

Despite the Third World Challenges...

LIMITED DATA/WIFI

LIMITED POWER

MANUAL LABOR

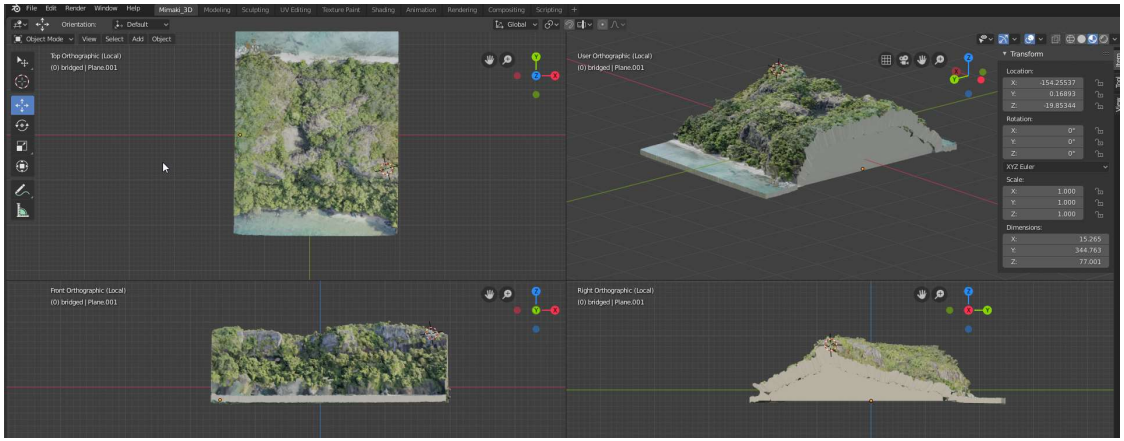
CULTURAL DIFFERENCES


nVIDIA
Holodeck
HoloTable
Controlled by:
Table
View
Sun Position
Clip
Activate Windows
Go to Settings to activate Windows.


nVIDIA
Holodeck
HoloTable
Controlled by:
SFOBY1703
View
Sun Position
Activate Windows
Go to Settings to activate Windows.

Vorovoro Dam VR Video
https://youtu.be/2g8yMQRBEMQ

Bonus: Color 3-D Printed Scale Models from Photogrammetry



Reactions to the Photogrammetry and VR

PHOTOGRAMMETRY

- Using the drone "creates tension and conflict, and challenges peoples' thinking of about the value of Vorovoro," who might not otherwise invest ~ Chief Tui Mali

- "A luxury you don't want to go without!" ~ Patrick Vizard, ASU

VIRTUAL REALITY

- "With VR, people can experience Vorovoro from afar, and ask themselves, 'What can I do? How can I help?'" ~ Chief Tui Mali

- "A tool that allows us to take the dam project home for visualization, and share with people who might be interested."
  ~ Jenny Cahill, Bridge the Gap

- "In construction, you never want to surprise the owner, unless it's their birthday!" ~ Patrick Vizard, ASU

Conclusions

1+1 = 1

Chief Tui Mali

Top 10 “Pro Tips” for Aerial Photogrammetry

1. **Use a spotter** to keep the drone in line of sight at all times
2. **Start with high-flight** at 300’ to create a base ortho photo
3. **Practice** and perfect drone flight **patterns**, to re-fly final flights automatically
4. **Fly** all flights at **same time of day**, for consistent lighting
5. **Fly in low wind and in overcast skies** or hazy sun to minimize dark shadows and glare
6. **Carefully plan flight times** to optimize battery use
7. Place visual markers for **Ground Control Points**
8. **Measure a known distance** on the ground for reference
9. **Bring an umbrella** to keep your tablet dry and cool/shaded
10. **Bring spare** cables, adapters, batteries, and propellers

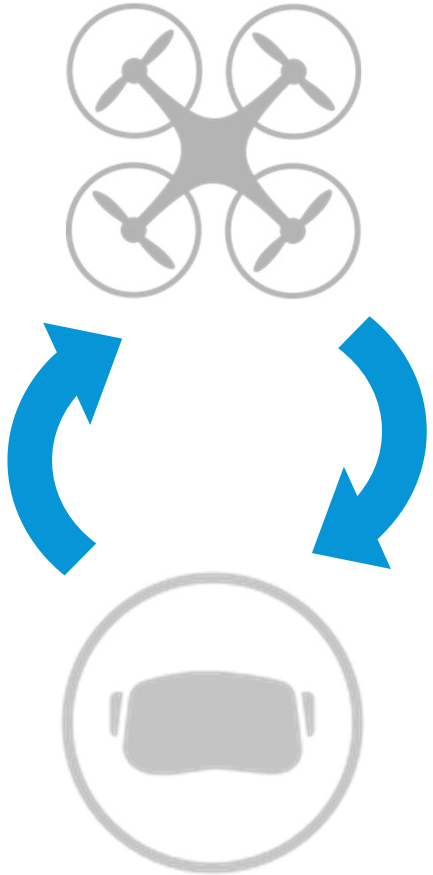
BONUS: Wind is unpredictable, and trees eat drones for breakfast…**be flexible and stay alert!**

Photogrammetry and VR

MUTUALLY BENEFICIAL TECHNOLOGIES & REITERATIVE PROCESSES

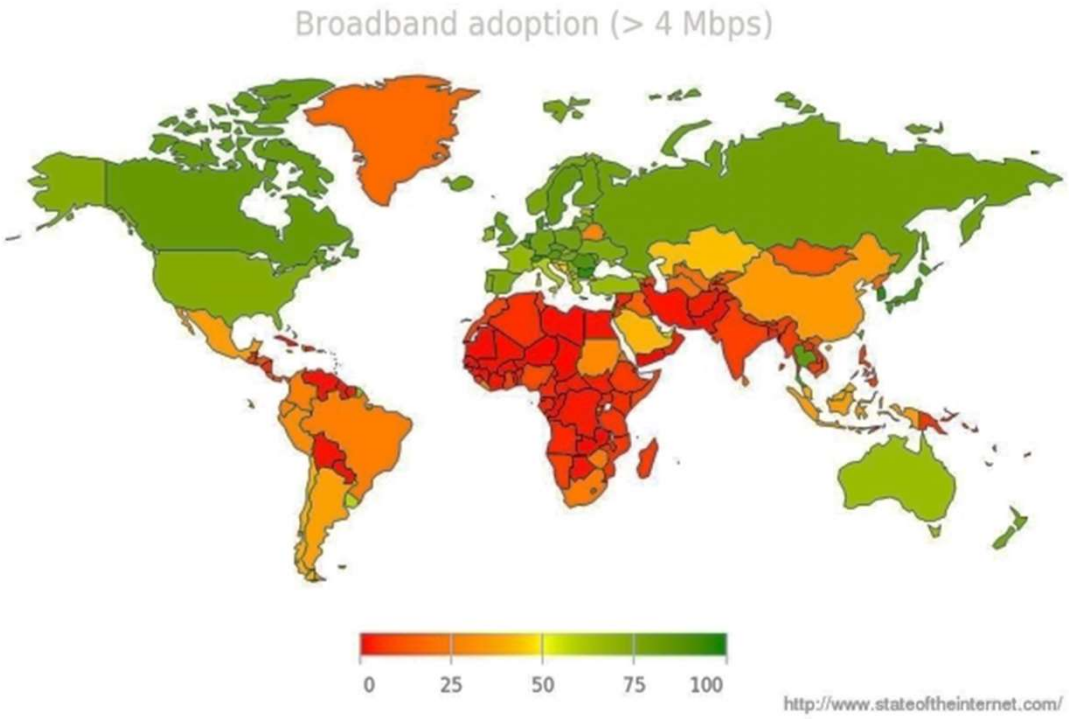
1. Use photogrammetry to create *realistic* VR experiences

2. Use VR *experience* photogrammetry
   - Final results
   - In process: for planning, analysis, and quality control



Cloud Processing

THE “CLOUD” MAY ELEVATE, *OR FURTHER ISOLATE*, THE THIRD WORLD



Cloud Platform for Global Collaboration

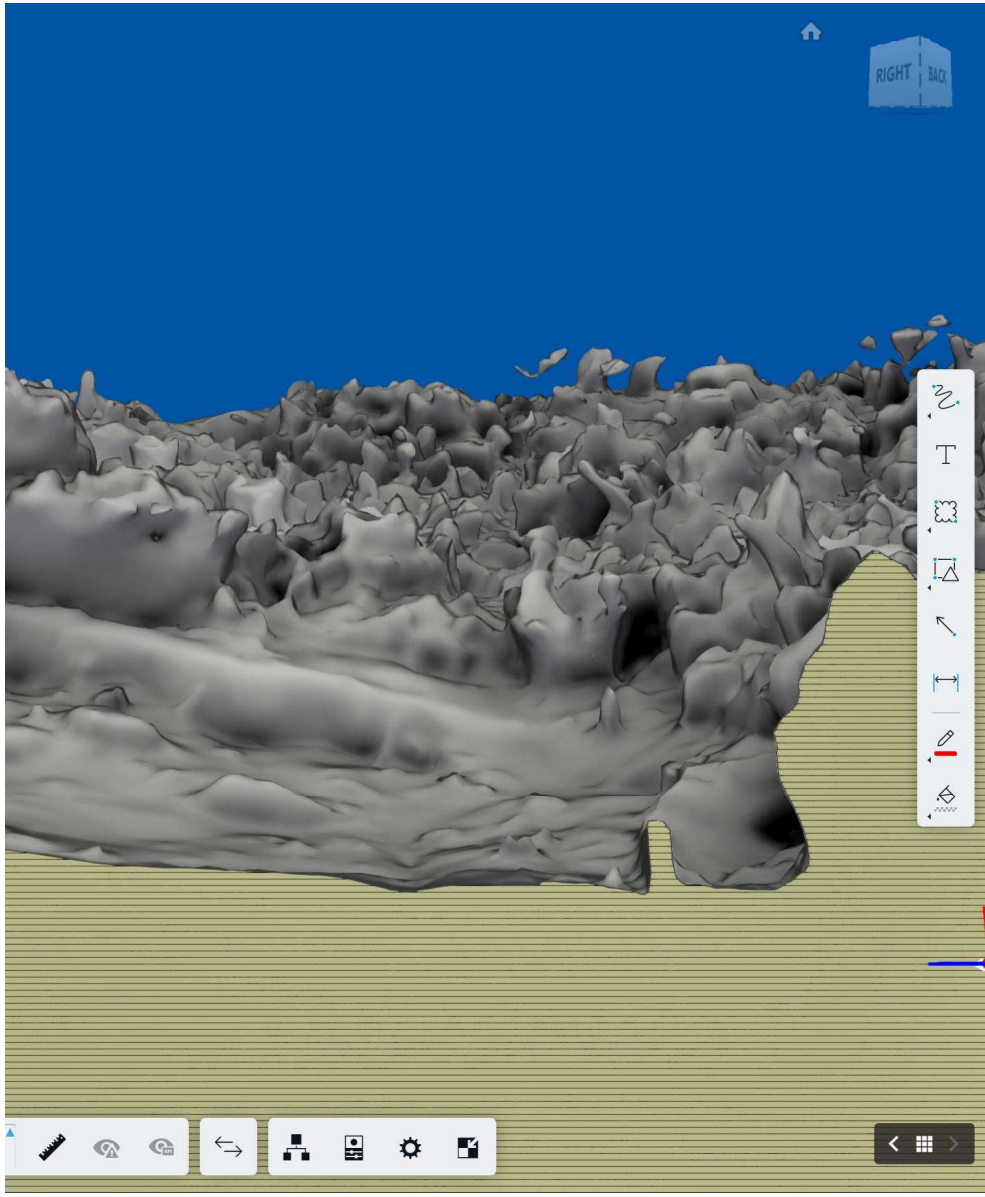
- **“True global collaboration requires a foundational respect for locals as experts in their land, weather, and interactions”**
  ~Jenny Cahill, Bridge the Gap

- Requires a medium that transcends distance and supports cultural expressions

- Today’s generation understands the need for collaboration and a “single source of truth” in a “common data environment”

- BIM 360 allows for global communication and document control

- Support remote design review, measurement and analysis, and resolution of issues



Shared Experiences Transcend Cultural Differences

- Trust: the accumulation of shared positive experiences
- Shared experience enables meaningful conversations with – and empathy for – the locals
- With experiential technology, can make the locals feel connected to the First World; makes them feel “worthwhile” and “equal” to outside experts by helping them visualize the project
- As the “ultimate empathy machine” VR can increase voluntourism and involvement

Next Steps

Next Steps

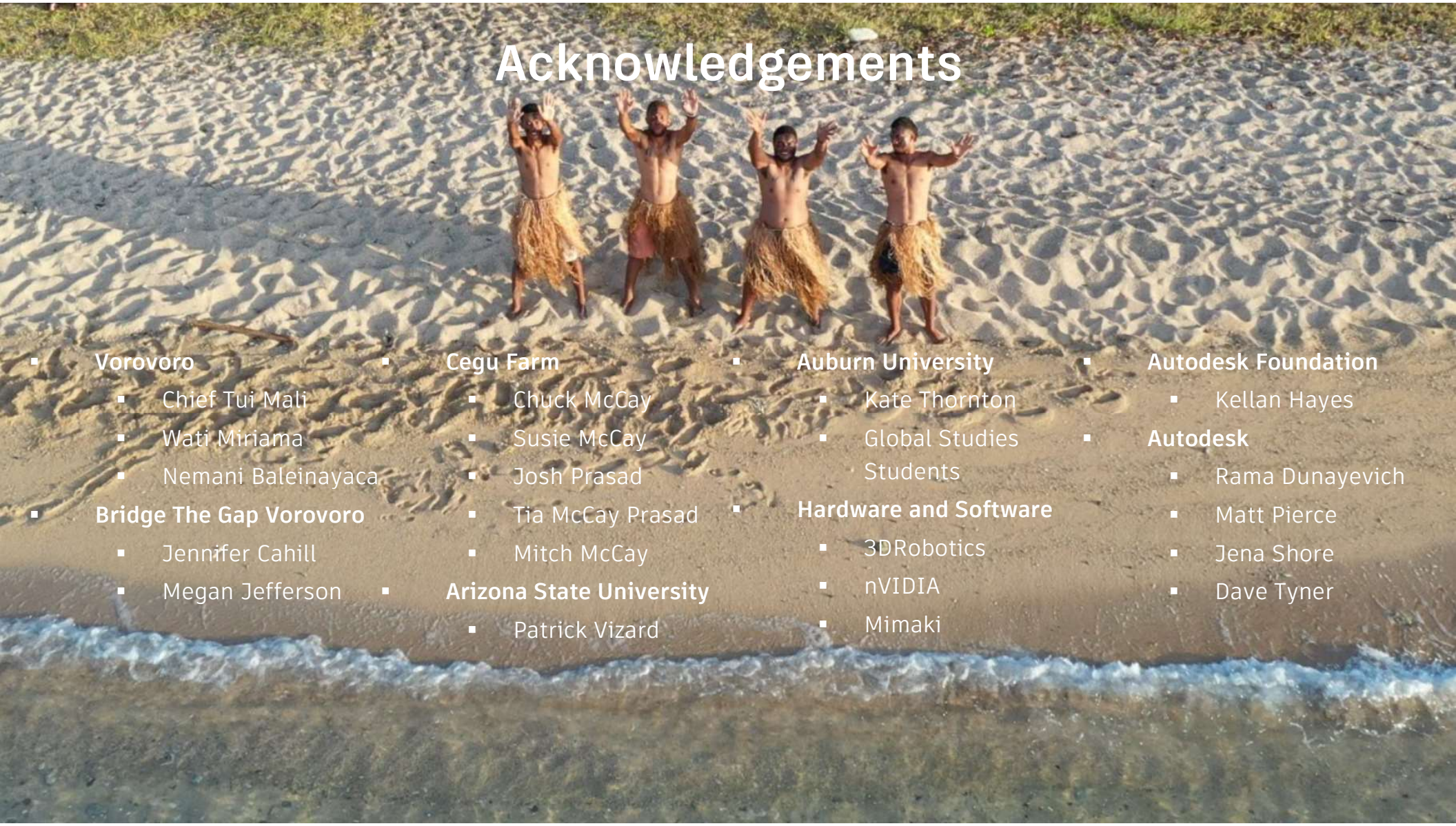
Wrap up **Sustainable Development Plan**
(Also Patrick Vizard's MS Project)

Pursue **funding** to create a guidebook
(State Department, INDOCAPCOM, Defense Department, NSC)

Earth's population is growing,
and with it comes development.

You can help others
develop sustainably.

Acknowledgements



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Vinaka vaka levu!

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