A collaborative Human-Centered Design approach towards new NASA products for satellite snow monitoring

Western Water Applications Office (WWAO) Annual Meeting

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Summary

- **Background**

  - Motivation

  - Research Area

  - Comparing Snow Data Products

- **Human Centered Design**

- **Proposed Work**

- **Objectives & Timeline**

Proposal Motivation

"When determining water supply forecasts or allocations to Federal water contractors, the Secretary, acting through the Commissioner of the Bureau of Reclamation, shall incorporate, to the greatest extent practicable, information from emerging technologies for snowpack measurement, such as—

(1) **synthetic aperture radar**;
(2) **laser altimetry**; and
(3) **other emerging technologies** …"

Snow Water Supply Forecasting Program Act
(S. 4530, 116th Cong. , 2020)

Research Area
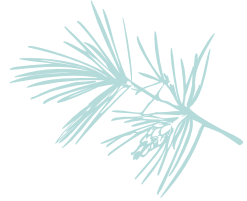
- Navajo River Catchment, San Juan Mountains, Southern Colorado

- Upstream of the Oso Diversion of San Juan-Chama Project (Project)
  - Operated by Bureau of Reclamation (Reclamation)

- 70% of 'Project' water comes from Navajo River catchment

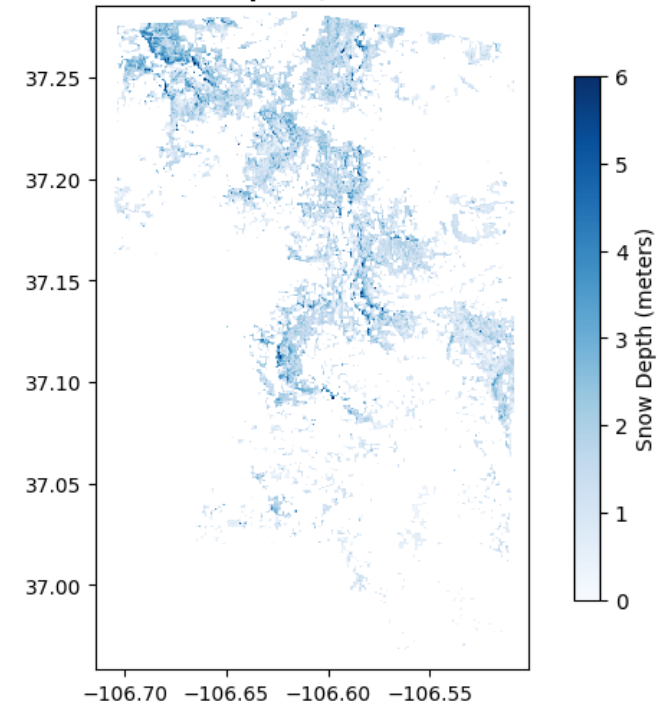- Total project: over 90,000 acre-feet

2024
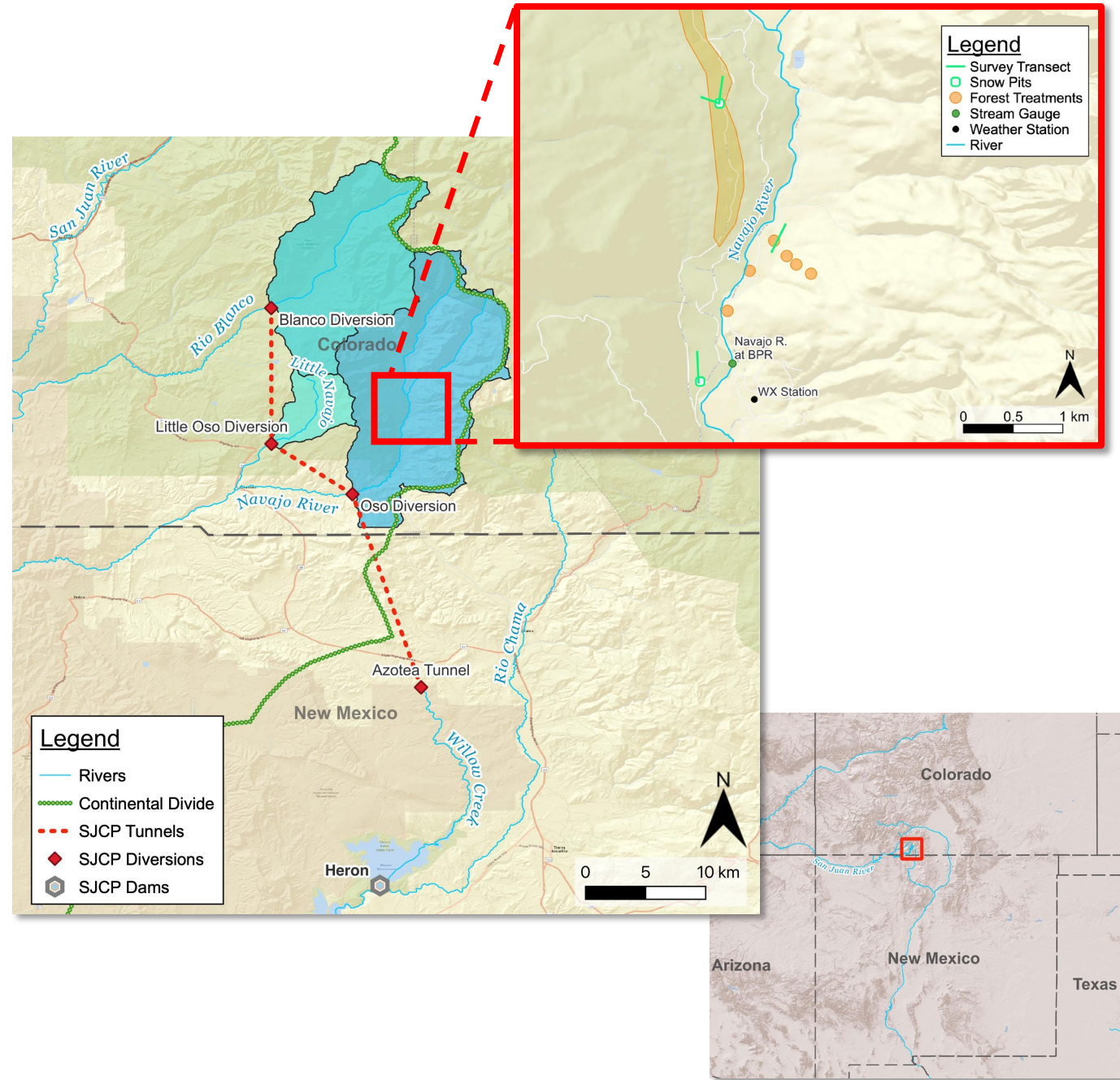
Comparison of Snow Depth Products

Funded by Reclamation's Science & Technology Program

**S1 snow depth after clipping
April 5, 2021**
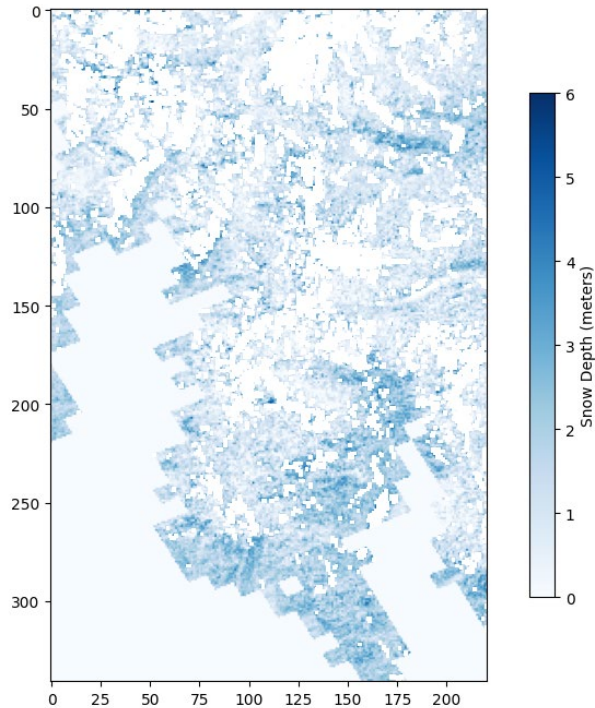
**Downsampled VHR
April 9, 2021**

S1 snow depth retrievals processed utilizing Lievens (et al., 2022) SAR backscatter method (Hoppinen et al., 2024)

VHR snow depth retrievals processed by U. of Washington collaborators (Hu & Shean, 2022).

Comparison of Snow Depth Retrieval Methods

Sentinel-1 (S1) SAR Snow Depth

- Newer method

- Current debate on use of C-band (S1) for snow retrievals (Nolin et al., 2010)

- Potential for L-band retrievals (Tarricone et al., 2023), interferometry for change in SWE products (NISAR launch)

- Can be processed at night, through clouds, and during light precipitation

- C-band doesn't penetrate dense forest well

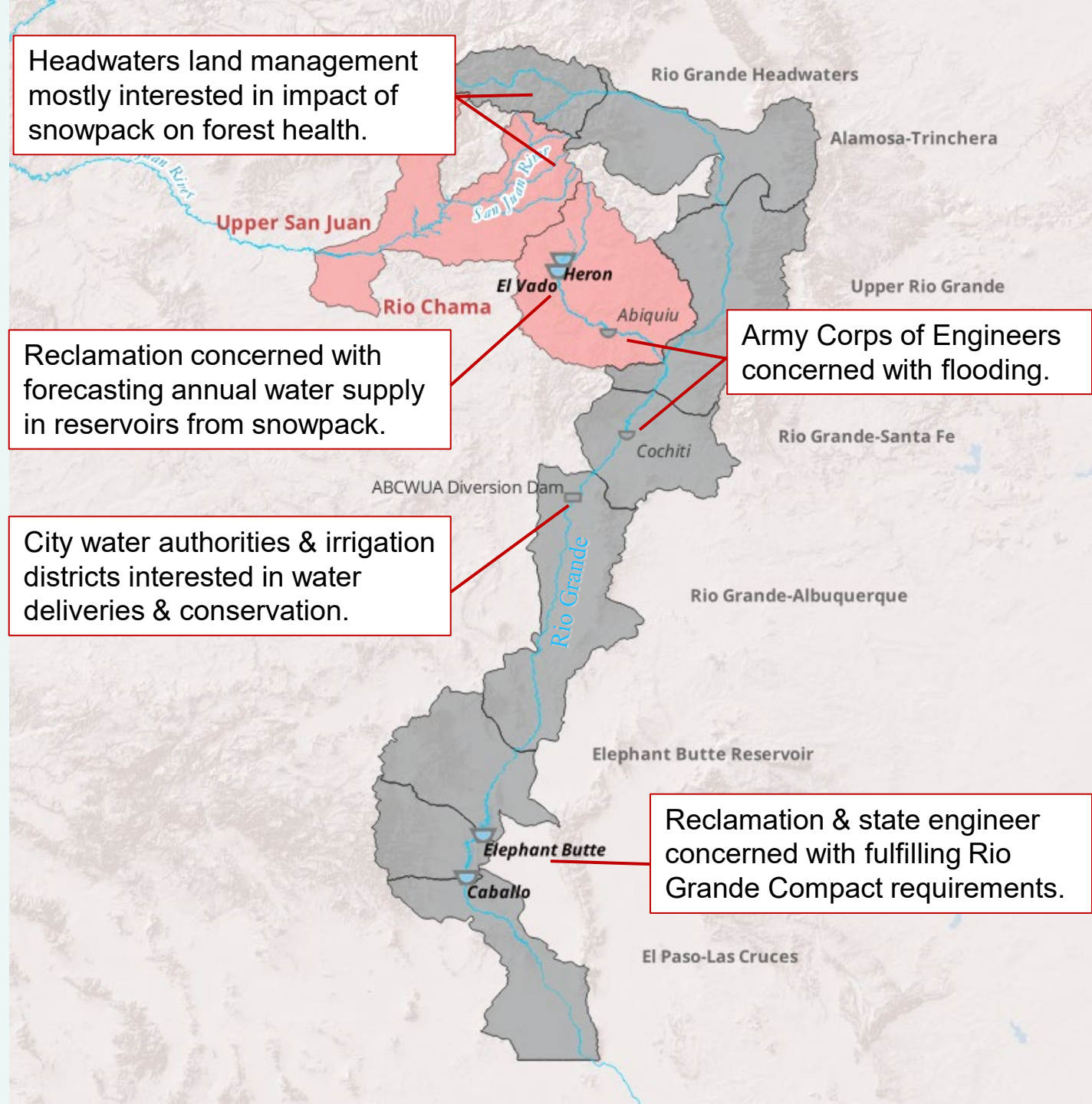## Very-High-Resolution (VHR) Stereo Satellite Photogrammetry Snow Depth

- More established method than S1

- Can be done with drones or satellite imagery

- Satellite procedure includes 2+ satellites
  - Typically need to be tasked

- WorldView offers **very** high resolution
  - Produces 3m snow depth product

- Vegetation cover, clouds, and night hinder performance (Shean et al., 2016)

Proposal Motivation

There appear to be different perspectives and needs for snow data throughout the winter and runoff seasons depending on the location of user along the headwater-dependent system.

SAR snow retrieval methods are at their infancy and currently being developed at experimental scale.

NISAR satellite launch coming soon!

2024

Headwaters land management mostly interested in impact of snowpack on forest health.

Army Corps of Engineers concerned with flooding.

Reclamation concerned with forecasting annual water supply in reservoirs from snowpack.

City water authorities & irrigation districts interested in water deliveries & conservation.

Reclamation & state engineer concerned with fulfilling Rio Grande Compact requirements.

Human Centered Design (HCD)

- Widely used approach to guide product development in close collaboration with product users

  - Shifts focus from product-led design to human-led design (Boy, 2013)

- *PROPOSAL GOAL*: Develop an HCD approach by leveraging an existing relationship with Reclamation to include recurring feedback during the data product design and development phases of the SAR snow product described above.

  - Put <u>agency</u> needs at forefront of snow data product design!

Human Centered Design (HCD)

TOP Model (Boy, 2023):

- Consider **technology**, **organizations**, and **people** throughout product development.

- View technology as an extension of people's abilities, which can influence how they organize themselves.

People
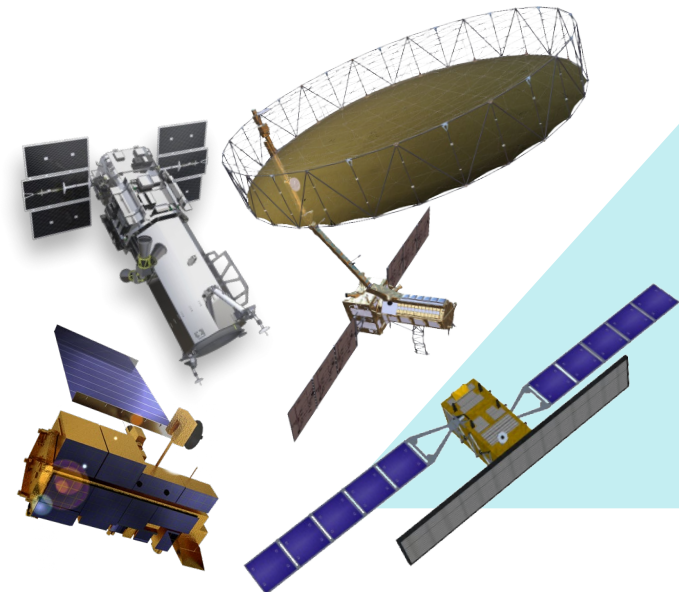
Human Centered Design

Technology   Organizations
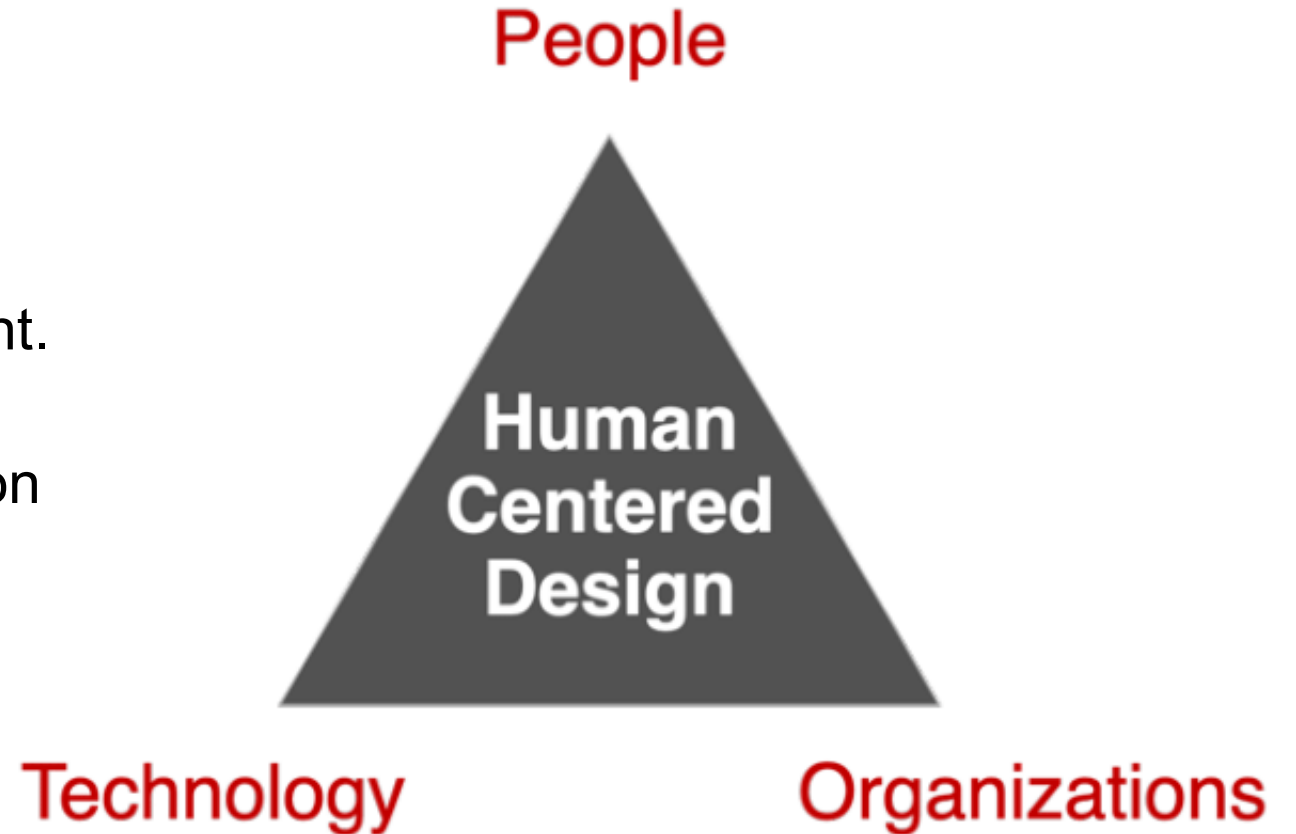
Interviews

Agency-Centered
Design

Focus Groups

Proposed Work

- Add **HCD component** to ongoing technology-centered snow remote sensing project for more integrated assessment of how SAR data could be used to monitor seasonal snowpack.

- Utilize HCD **focus groups** with key members of Reclamation to receive direct feedback on snow data for input into agency's operational decision making.

Proposal Objectives

- Better understand how snow data gets implemented into Reclamation's operations (water storage & delivery).

- Develop HCD approach to define and clarify needs for emerging technologies of snow monitoring data.

- Ensure HCD approach includes multiple opportunities for discussion and feedback during entirety of snow data product assessment.

- Bridge disconnect between scientific progress of emerging snow monitoring technologies and agency needs for decision making based on snow water supply forecasting.

Summarized Timeline

- Jun-Aug 2024: Organize focus group logistics, questions, submit IRB

- **Oct 2024: Focus group session 1**

- Mar 2025: Additional interviews

- **Jul 2025: Focus group session 2**

- Sep 2025: Additional surveys/interviews

- **Jan 2026: Focus group session 3**

- Mar-May 2026: Final reporting and publications

THANK YOU

References

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