



Exploring Evacuation Intentions Among Parents of School Children in Mt Rainier's Lahar Hazard Zone

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Problem:

In the event of a lahar emergency, some parents in local lahar zones want to collect their child from school during a school evacuation

► Background on lahars

► Risk to local communities

► Preparedness and evacuation concerns

► Research approach

► Summary

What is a Lahar?

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Flow of water, ash,
boulders, trees, debris

Flows ~water, but
dense ~wet concrete

Leaves behind layer of
hard, rocky sediment



2003 Semeru lahar

What is a Lahar?

4

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Flows ~water, but
dense ~wet concrete

Leaves behind layer of
hard, rocky sediment



1980 Mount St Helens lahar deposit



How Do Lahars Form?

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Source mechanisms

- Eruption
- Precipitation

View from Emerald Ridge of lahar deposits



Previous Deadly Lahars

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Nevado del Ruiz
Colombia, 1985

Pinatubo
Philippines, 1991

Marapi Indonesia,
2024



Previous Deadly Lahars

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Raymundo S. Punongbayan / PHIVOLCS



Previous Deadly Lahars

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Citation



Mt Rainier Lahar History

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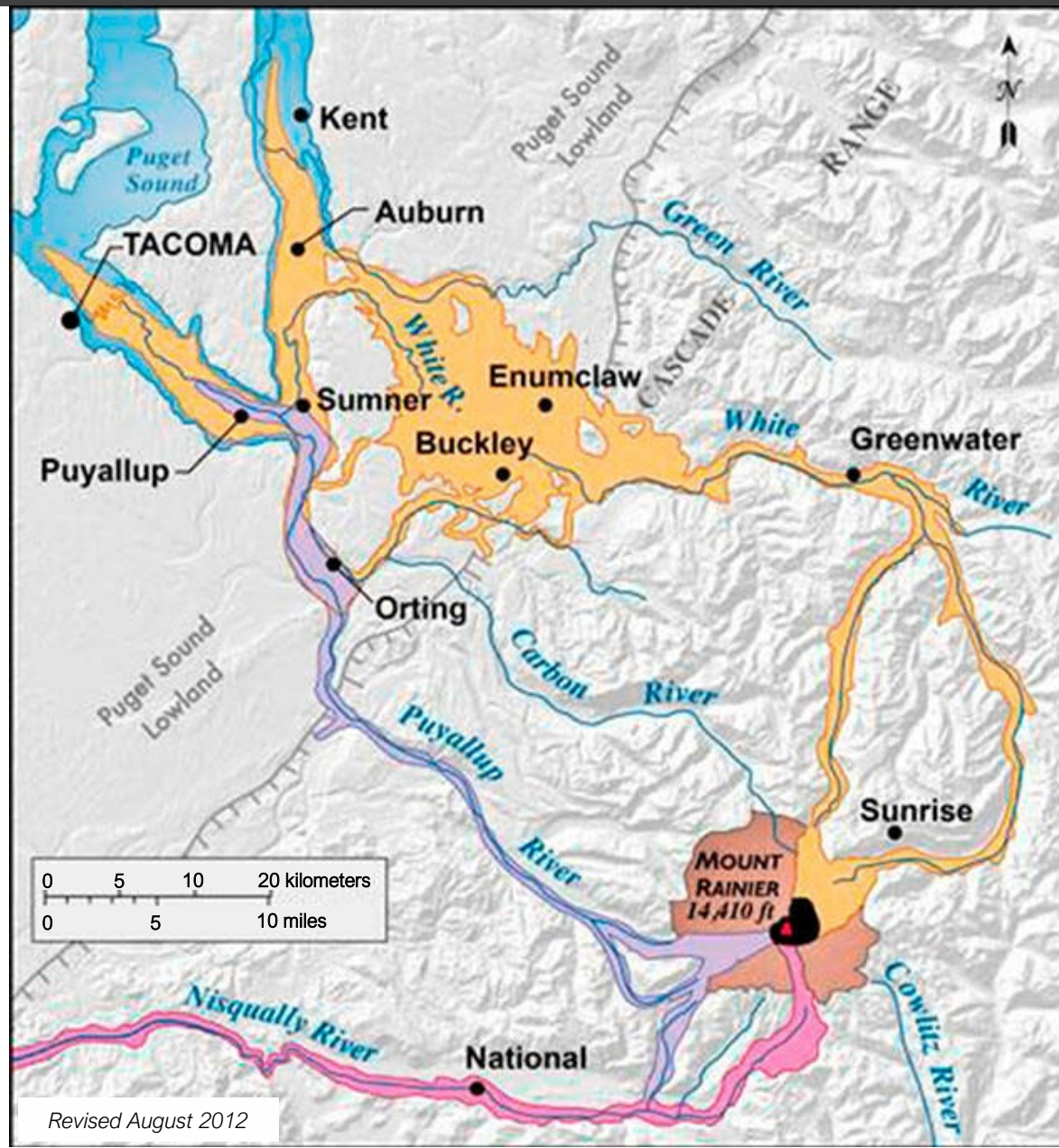
Heavily glaciated

History of large lahars

- Osceola flow ~6000 years ago reached Tacoma

Not always from an eruption

- Electron mudflow ~500 years ago
- No eruption in geologic record



Revised August 2012

Notable Past Lahars

Legend

- Osceola Lahar
- National Lahar
- Electron Lahar
- Inlets of Puget Sound
- Source of Osceola Lahar
- Cone of Mt Rainier
- Margin of Puget Sound lowland

USGS

Mt Rainier Lahar Risk

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Source mechanisms

- Eruption
- Precipitation
- *Landslide / flank collapse*

Electron flow deposits and Tahoma headwall from Emerald Ridge



Mt Rainier Lahar Risk

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Source mechanisms

- Eruption
- Precipitation
- *Landslide / flank collapse*

“No-notice lahar”

Still weak rock near summit

Electron flow deposits and Tahoma headwall from Emerald Ridge





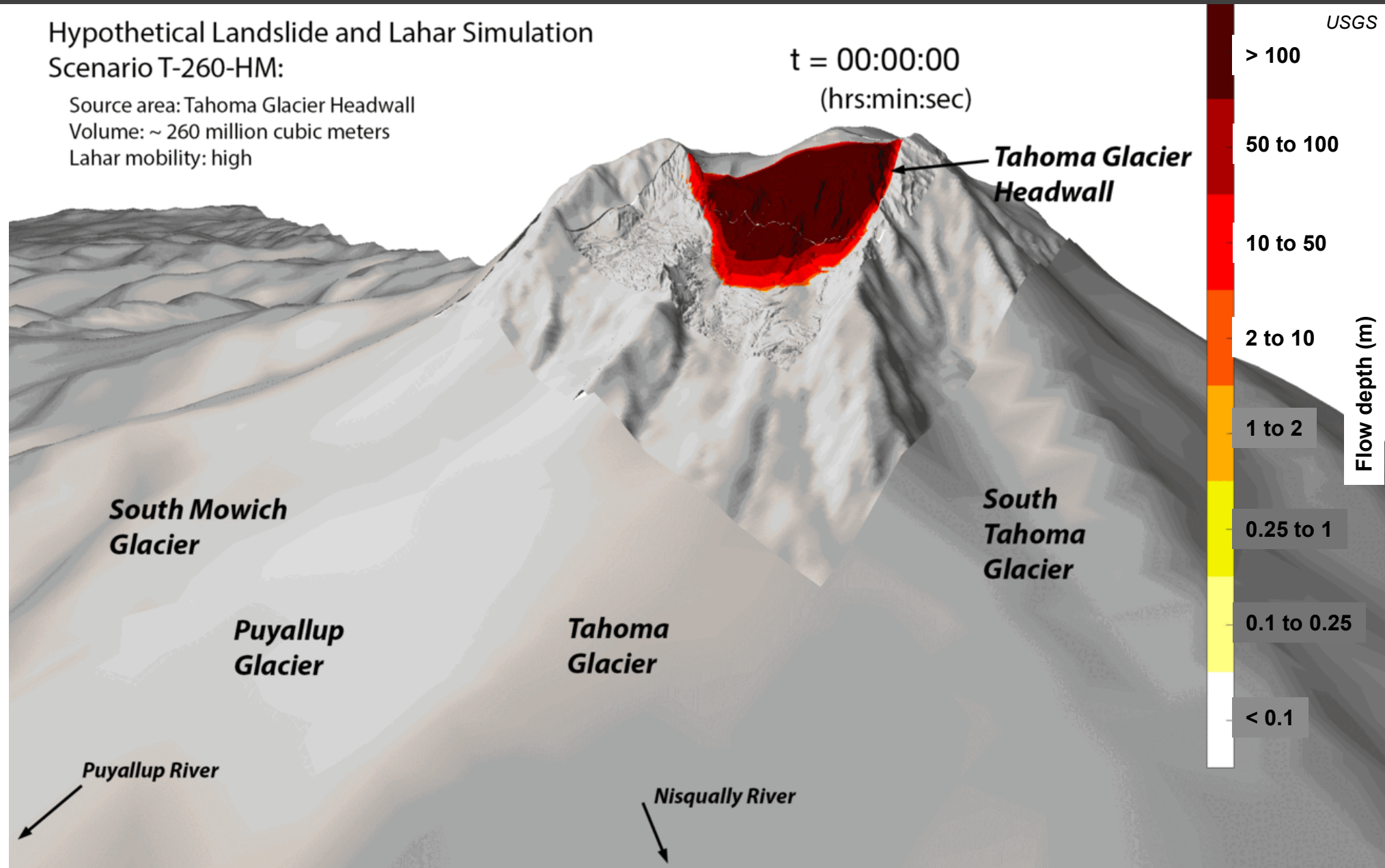
Mt Rainier Lahar Risk

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Hypothetical Landslide and Lahar Simulation Scenario T-260-HM:

Source area: Tahoma Glacier Headwall
Volume: ~ 260 million cubic meters
Lahar mobility: high

t = 00:00:00
(hrs:min:sec)



2022
simulation of
landslide and
lahar

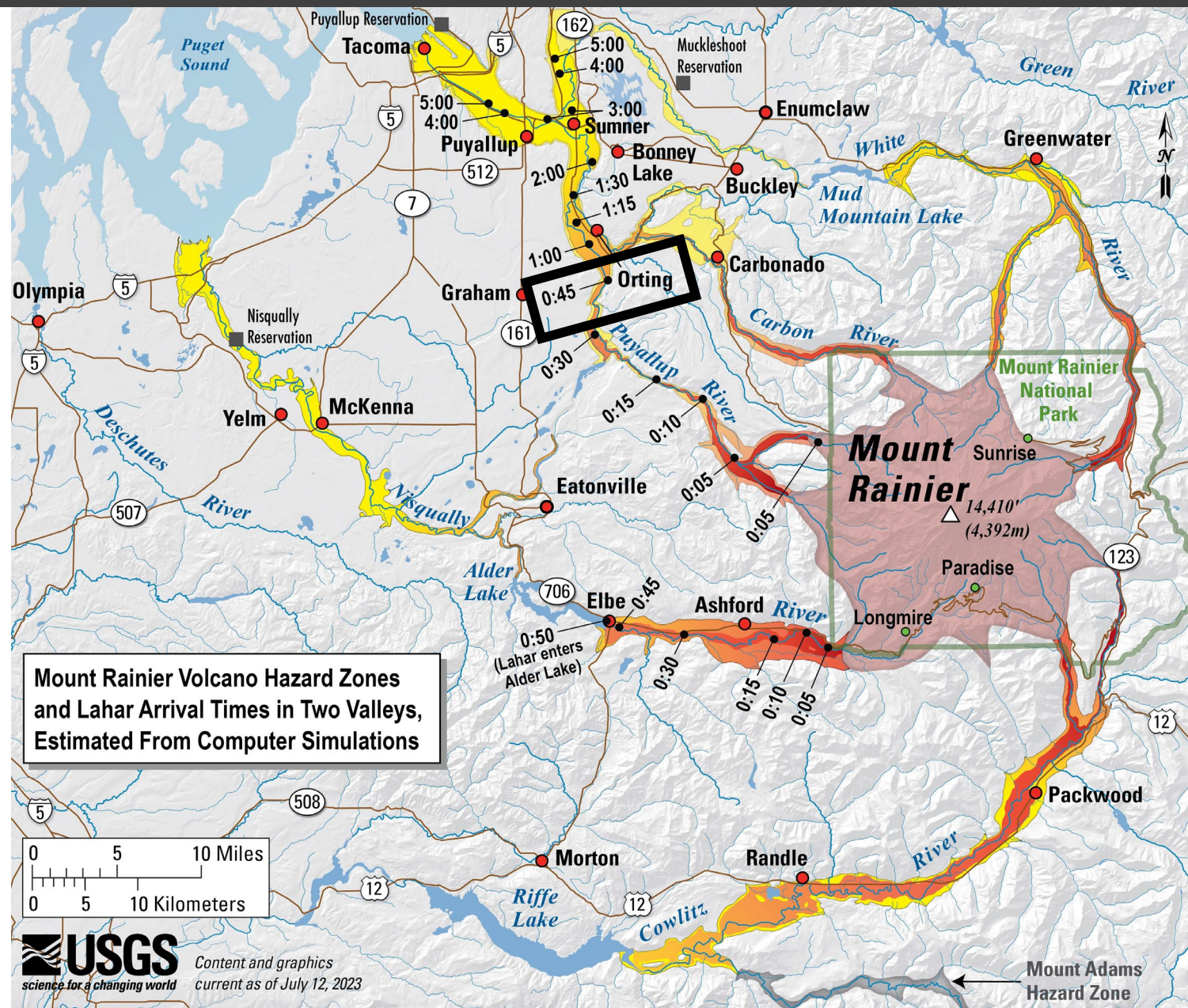
Note the
depths!

Mt Rainier Hazard Map

~150,000 residents

Orting, Puyallup, Sumner, Carbonado, etc.

Lahar could reach towns in <1hr!





Existing Preparedness Efforts

Rainier Lahar
Detection System

Warning sirens

Text alerting system

EM teams and coalitions

School evacuation drills



Pierce County





Preparedness Efforts: School Drills

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For ~20 years, schools have done lahar evacuation drills

Full-scale drills every few years
(Puyallup, Orting, Sumner, Bonney Lake, Carbonado, Wilkeson, Buckley)

~45,000 students and school staff participated in March 2024 drill

Aim for annual drills when possible
(Orting this May)

2002 Orting drill



C. Driedger / USGS

2019 Orting drill



Pierce County TV



Preparedness Efforts: School Drills

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PROBLEM: Parents still want to collect their children from school

Places parents in harm's way

- Traffic jams
- Driving into lahar zone

Family gathering in other emergencies

- 2011 Tohoku tsunami
- Active shooter situations

Why parents disregard evacuation guidance is poorly understood

2002 Orting drill



C. Driedger / USGS

2019 Orting drill



Pierce County TV



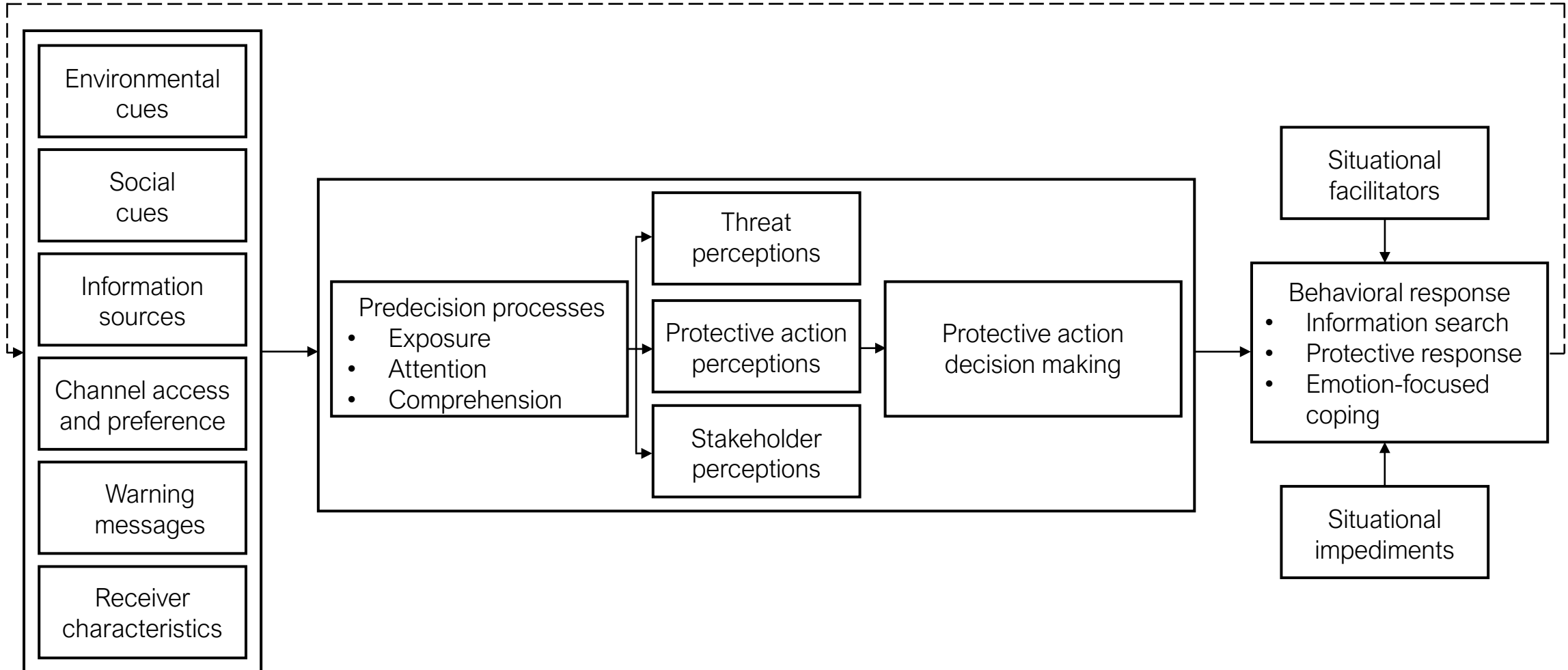
Protective Action Decision Model

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External Factors

Psychological Processes

Response



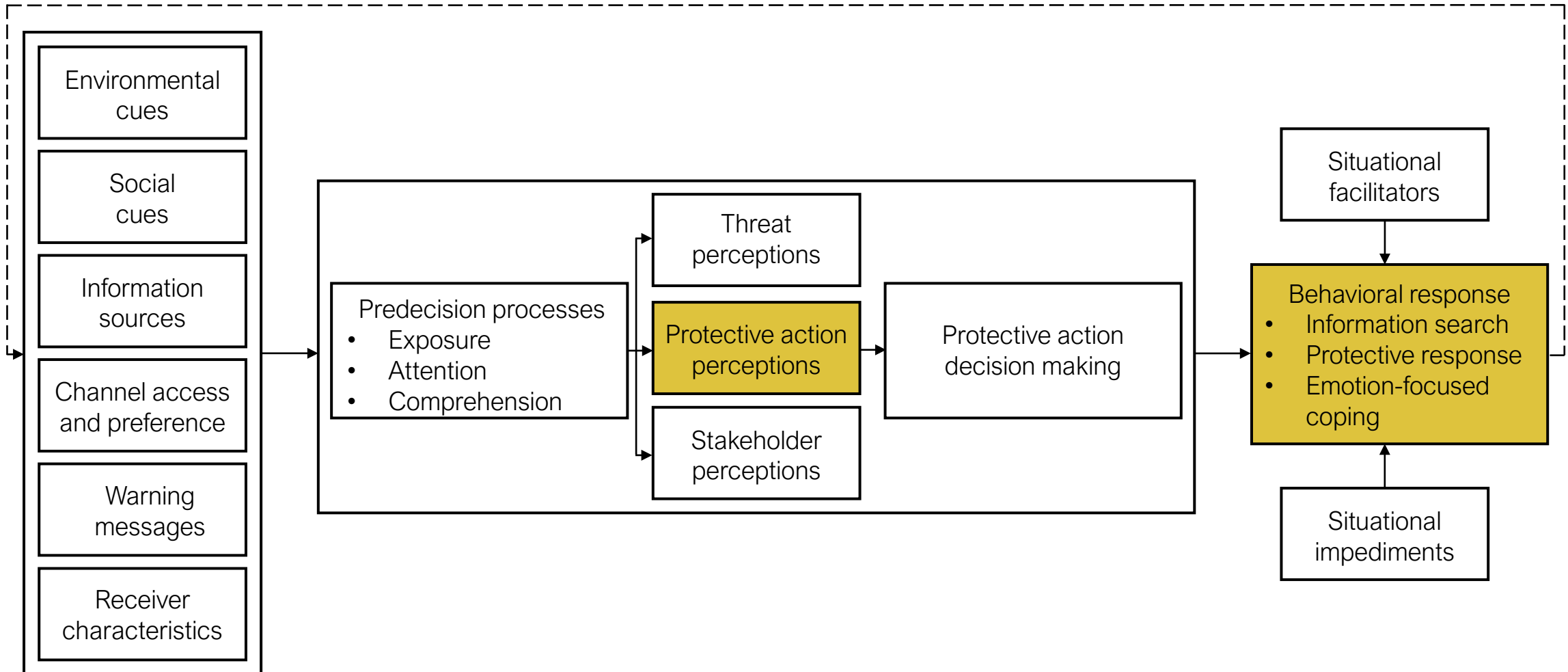
Protective Action Decision Model

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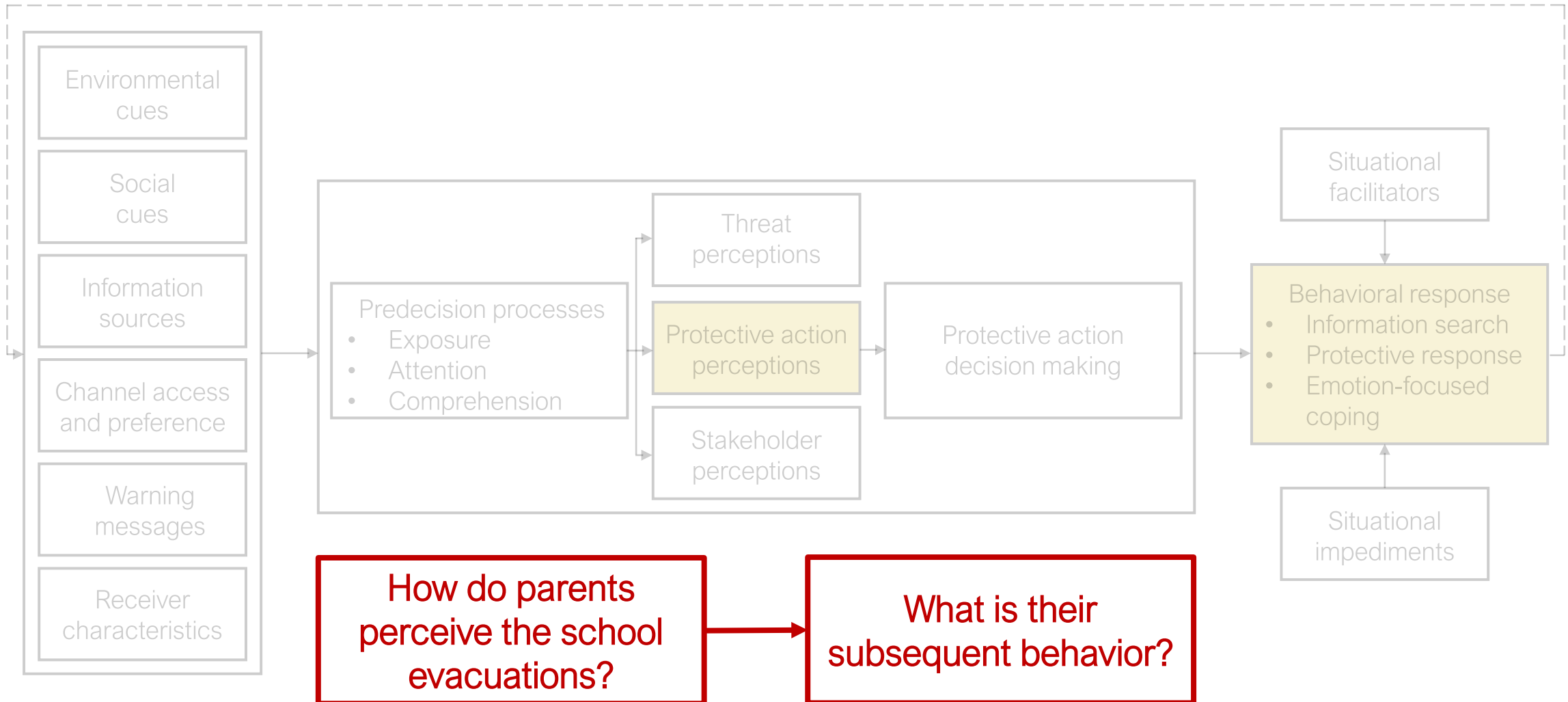
Protective Action Decision Model

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External Factors

Psychological Processes

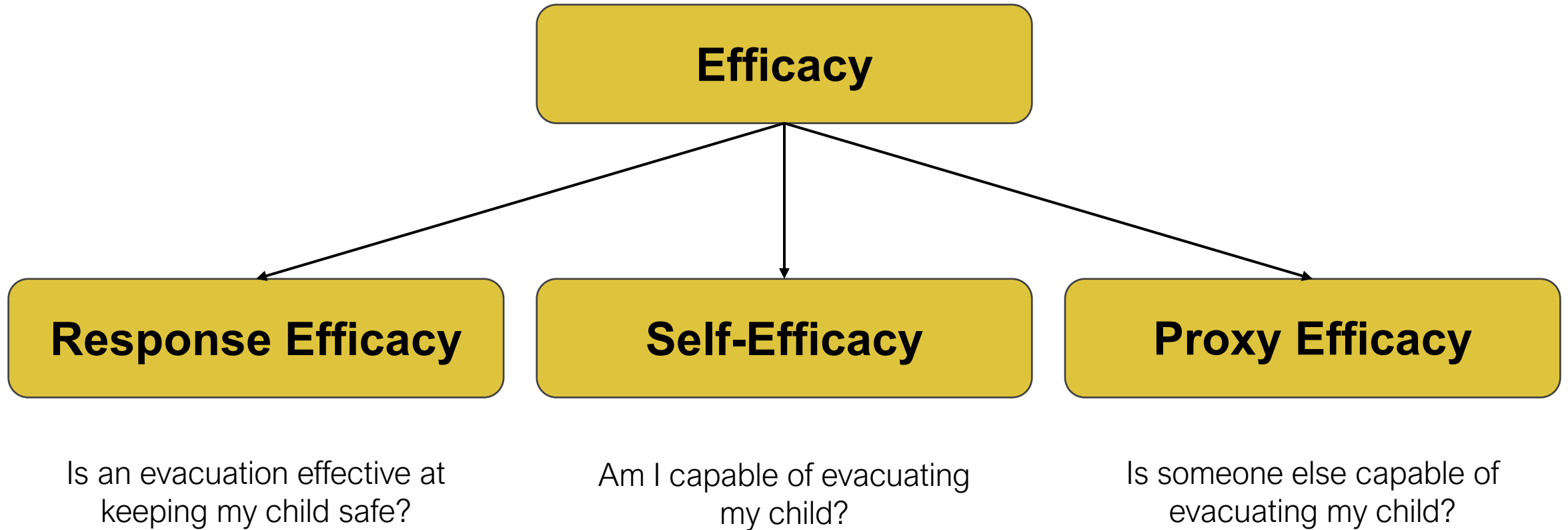
Response





Protective Action Perceptions: Efficacy

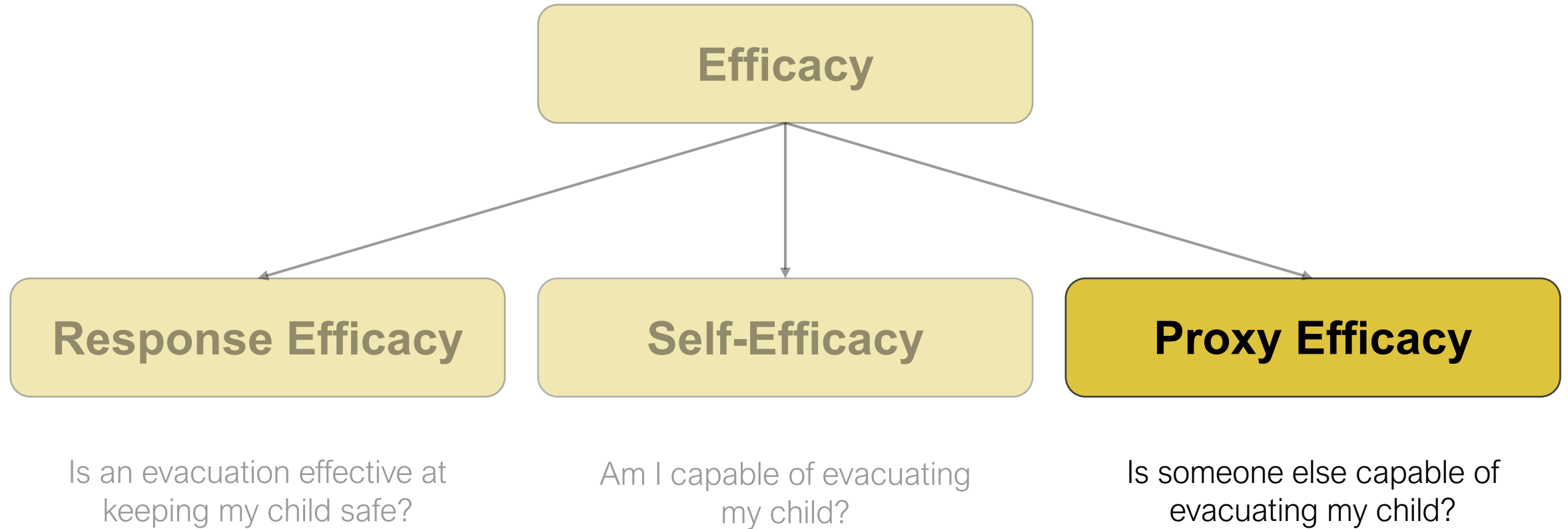
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Protective Action Perceptions: Efficacy

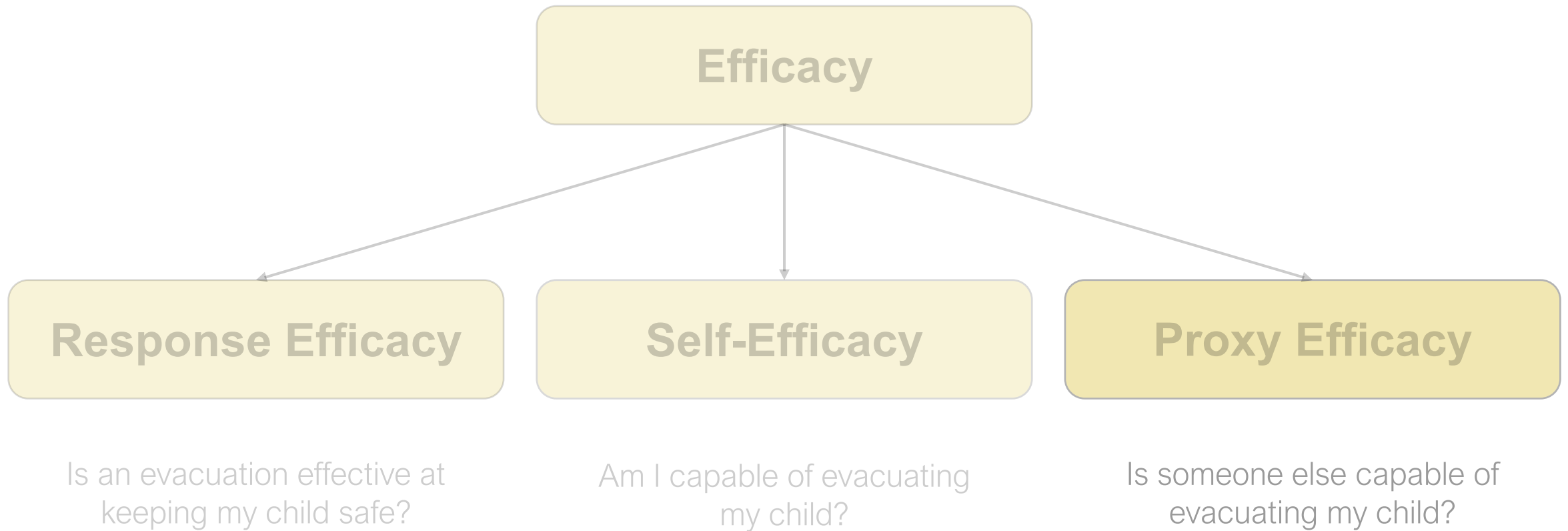
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Protective Action Perceptions: Efficacy

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Do parents think school evacuations can keep their child safe from a lahar?

Will parents try to pick up their child from school during a lahar evacuation?

What factors influence parents' confidence in the effectiveness of school evacuation plans during a lahar?

What are potential opportunities to increase parents' confidence in the effectiveness of these plans?



Research Questions

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What factors influence parents' confidence in the effectiveness of school evacuation plans during a lahar?

What are potential opportunities to increase parents' confidence in the effectiveness of these plans?



Mixed Methods Approach

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Quantitative

+

Qualitative

Survey

Interviews

Larger “dataset”

Smaller “dataset”

Make broad statements
about perspectives

Gain deeper understanding
of perspectives



Mixed Methods Approach

Phase 1:

- Survey parents
- Orting, Sumner, Puyallup (Cascade Christian Schools)
- Distribute electronically

▶ **Section 1: Mt Rainier and Lahars**

6 Questions

▶ **Section 2: Mitigatory Systems**

5 Questions

▶ **Section 3: Confidence and Intentions During Evacuation**

1 Question

▶ **Section 4: Factors Impacting Decision-making**

2 Questions

▶ **Section 5: Demographic Questions**

5 Questions

► Section 1: Mt Rainier and Lahars

What is a lahar? Choose the description you think is correct.

- ☐ A hot flow of molten lava that comes down from the mountain
- ☐ A very large river flood
- ☐ A concrete-like mixture of volcanic mud, rock, and debris that comes from the mountain
- ☐ A violent wind storm with a tube-like cloud that reaches down to touch the ground
- ☐ It is the word used to describe when the ground shakes violently.
- ☐ A rock that falls out of the sky from space and hits the ground
- ☐ None of the above
- ☐ I don't know

► Section 1: Mt Rainier and Lahars

Which of the following could cause a lahar? Select all that apply.

- ☐ Volcanic eruptions
- ☐ Large landslides
- ☐ Earthquakes
- ☐ Rainfall
- ☐ Snowmelt
- ☐ All of the above
- ☐ None of the above
- ☐ I don't know

► Section 2: Mitigatory Systems

What steps do you and your family currently take to stay ready for a lahar?

- ☐ I educate myself about Mt Rainier
- ☐ I educate myself about the risk of lahars
- ☐ My family and I have learned our evacuation routes
- ☐ My family and I practice using our evacuation routes
- ☐ I keep an emergency bag packed in case I have to evacuate
- ☐ I am signed up for mobile alerts
- ☐ My family has a person outside of the lahar zone that we will contact
- ☐ My family has a planned meeting place to reunite, should we become separated
- ☐ My child(ren) participate in school lahar drills
- ☐ Other (Please describe)
- ☐ None

► Section 2: Mitigatory Systems

Does your child's school have a lahar evacuation plan?

- ☐ Yes
- ☐ No
- ☐ I don't know

► Section 3: Confidence and Intentions During Evacuation

Please read the following statements and indicate to what degree you agree or disagree.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am confident in my ability to keep myself safe in the event of a lahar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident that the evacuation plan at my child's school will keep my child safe in the event of a lahar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident in the ability of my child's school to evacuate my child safely in the event of a lahar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will allow my child to be evacuated by the school when a lahar warning is issued.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

► Section 4: Factors Impacting Decision-Making

Please consider the following elements and indicate the extent to which they influence your willingness to ALLOW your child to be evacuated by their school during a lahar emergency.

	No influence – This wouldn't affect my decision at all	Slight influence – It might play a small role in my decision	Some influence – It would be one of the things I consider	Strong influence – This would impact my decision	Very strong influence – This would be a major factor in my decision
Knowing approximately how long it would take for a lahar to reach my child's school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uncertainty about the school's ability to get my child to their school evacuation site safely'	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uncertainty about provision of shelter at the school evacuation site	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Broader Project: “Lahar Ready”

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Prototype outreach materials for USGS, WAEMD, PCDEM, EPIC

Phase 1:

- Survey parents
- Orting, Sumner, Puyallup (Cascade Christian Schools)
- Distribute electronically

Phase 2:

- Hand out new educational materials
- Repeat survey



Broader Project: “Lahar Ready”

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Prototype outreach materials for USGS, WAEMD, PCDEM, EPIC

Phase 1:

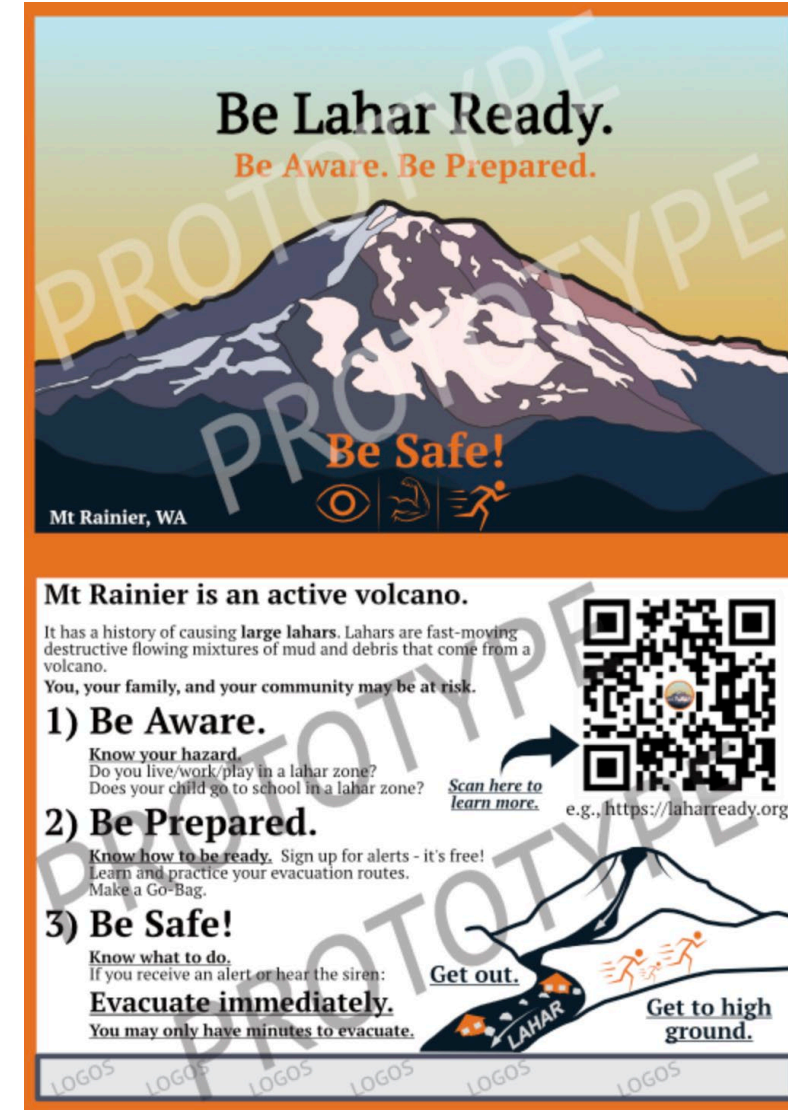
- Survey parents
- Orting, Sumner, Puyallup (Cascade Christian Schools)
- Distribute electronically

Phase 2:

- Hand out new educational materials
- Repeat survey

Phase 3:

- Interview parents





How Will Results Be Used?

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**Understand
parents' attitudes
toward school
evacuations**

**Evolve existing
outreach efforts
→ New materials**

**Increase local
lahar knowledge
and preparedness**

**Change expected
behavior of
parents who want
to go to school**

Summary

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Lahar risk for many communities west of Rainier

Goal: Understand parents' decision-making and change behavior

With preparedness, lives can be saved

**NATURAL EVENTS DO NOT
HAVE TO BECOME NATURAL
DISASTERS!**



Questions?

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Thank you to our collaborators,
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