NORDRESS
Nordic Centre of Excellence
On Resilience and Societal Security

Icelandic Met Office

Flood Monitoring in Iceland: Challenges and Early Warnings

NORDRESS Annual Meeting, Copenhagen
21th November 2019

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Purpose of today’s presentation

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- In this presentation, I explain the efforts made to incorporate public observations into IMO’s monitoring, warning and assessment procedures.


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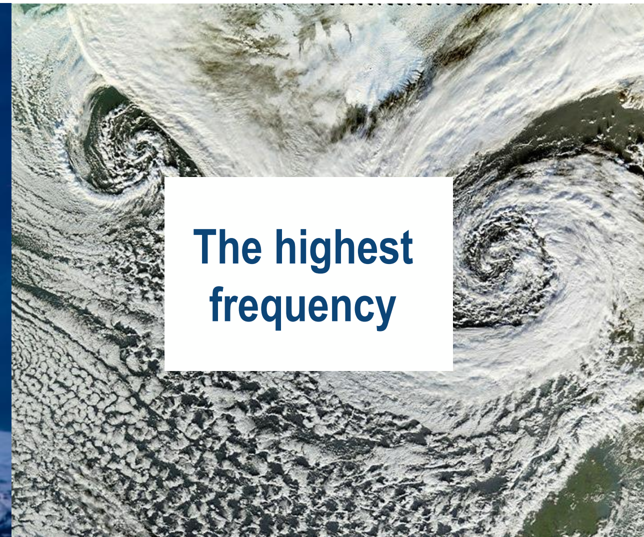
The greatest asset damage

The highest frequency

The greatest loss of life

Significant property damage

High frequency

Considerable damage

Spatial distribution of four types of natural hazard in Iceland

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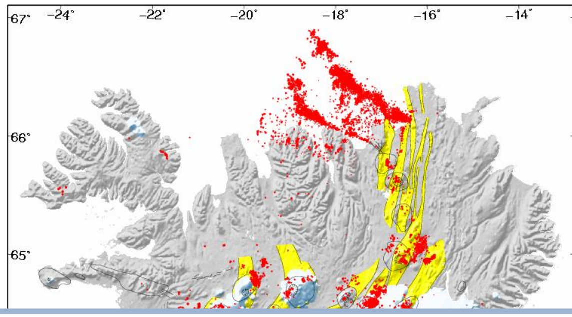
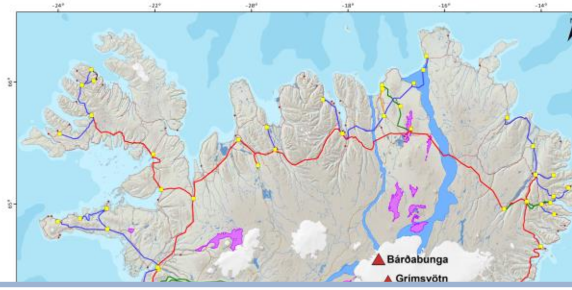
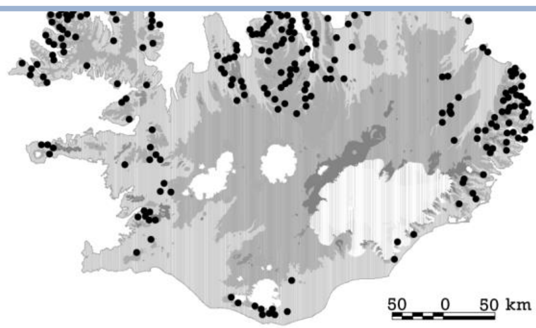
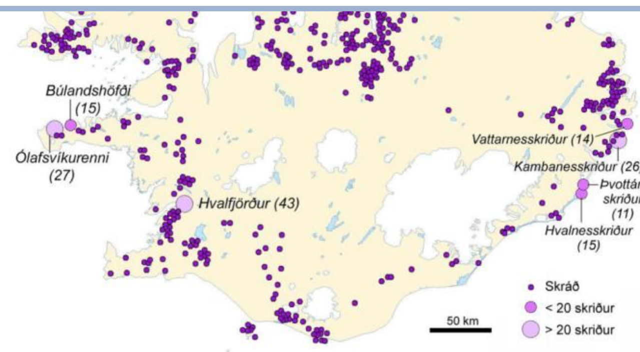




Natural hazards are of major public interest. Important to use public observations as a form of citizen science



Fatal snow avalanches: 900 AD – present



Landslides: 1900 – 2000

Integrated monitoring of natural hazards at IMO

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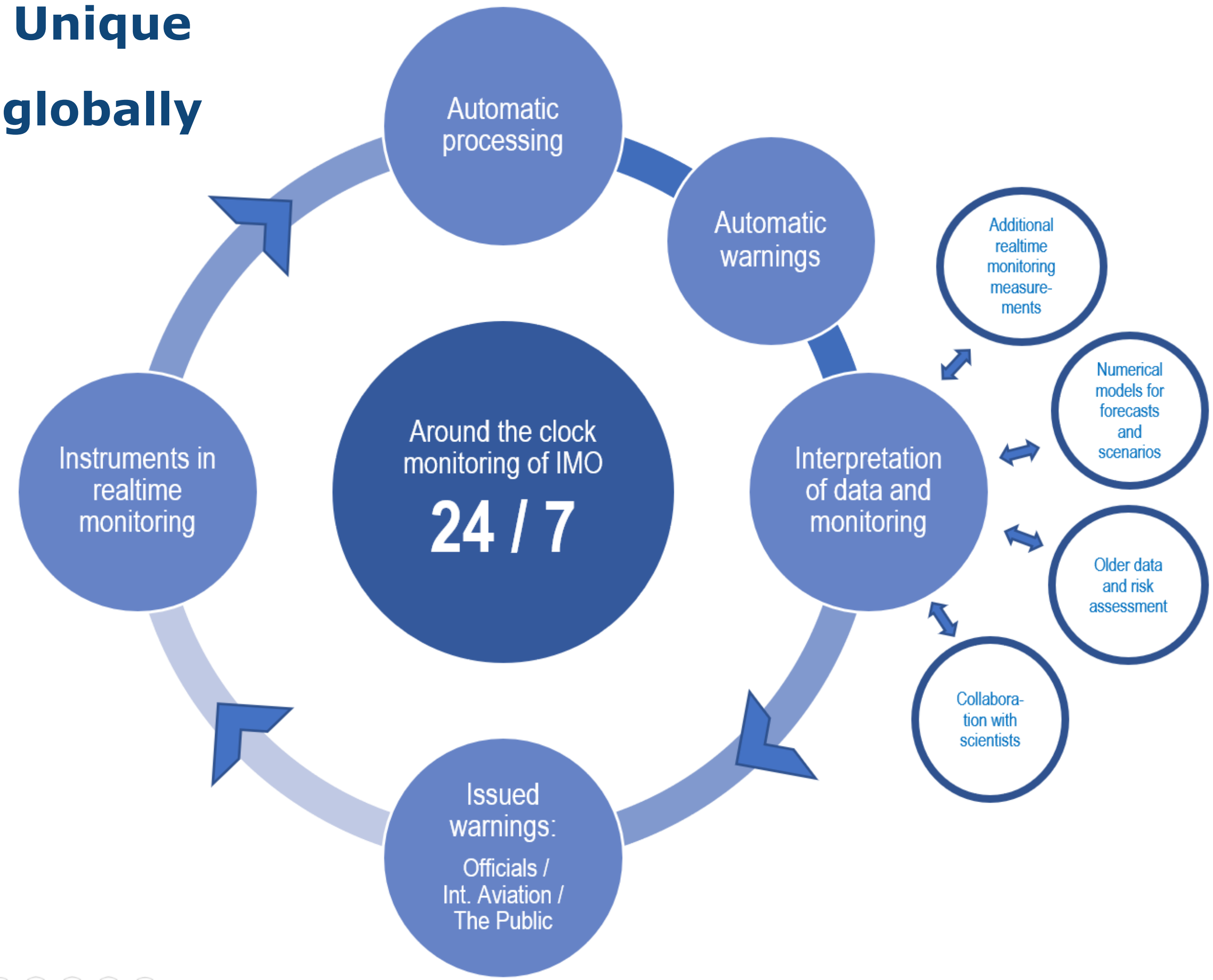
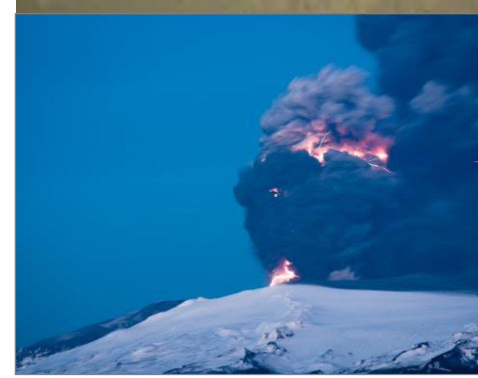
Unique globally





Varied monitoring networks but unavoidable gaps

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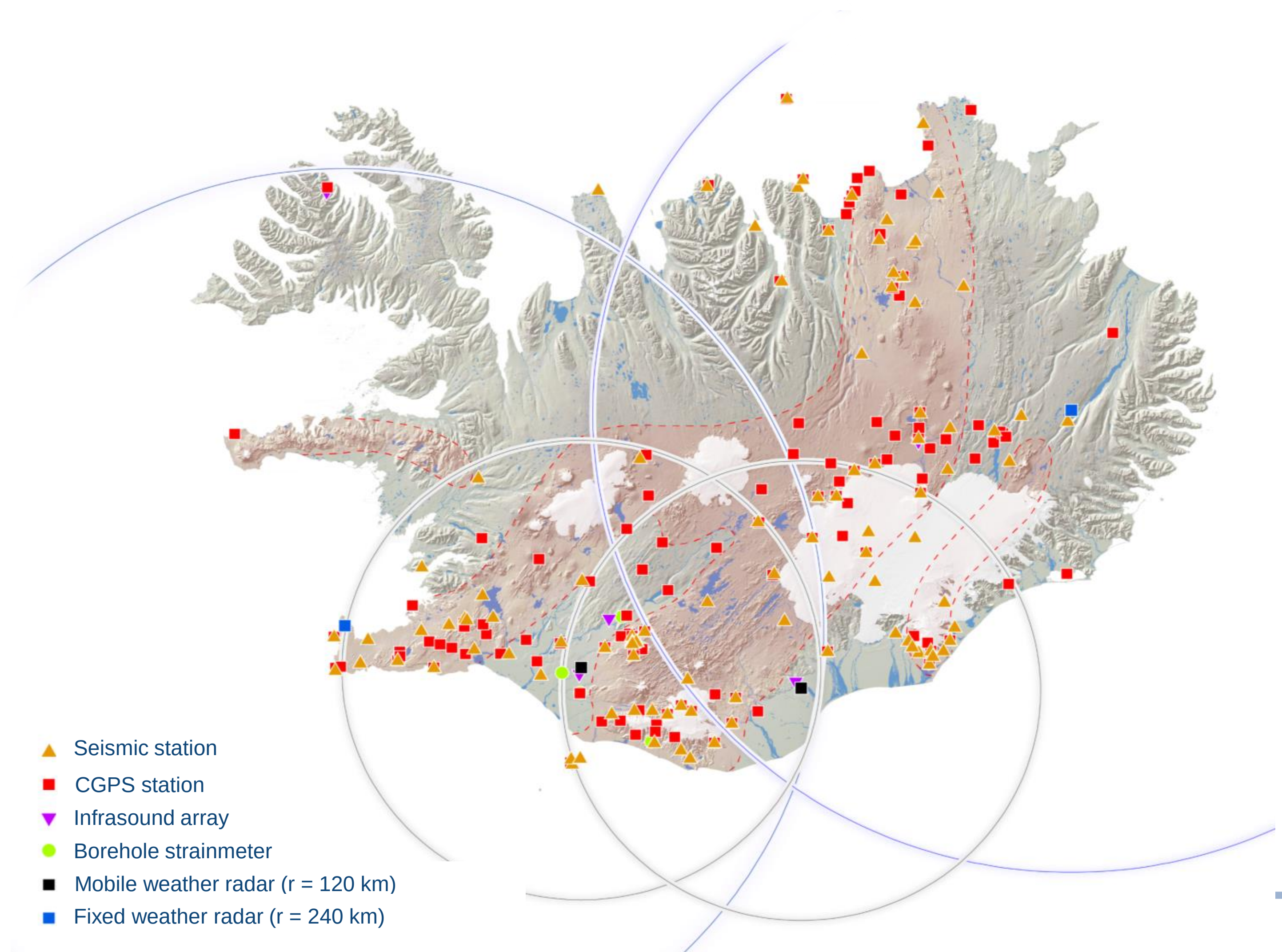

Jökulhlaup on Skaftá, Oct 2015. Riverbank measurements can be challenging!

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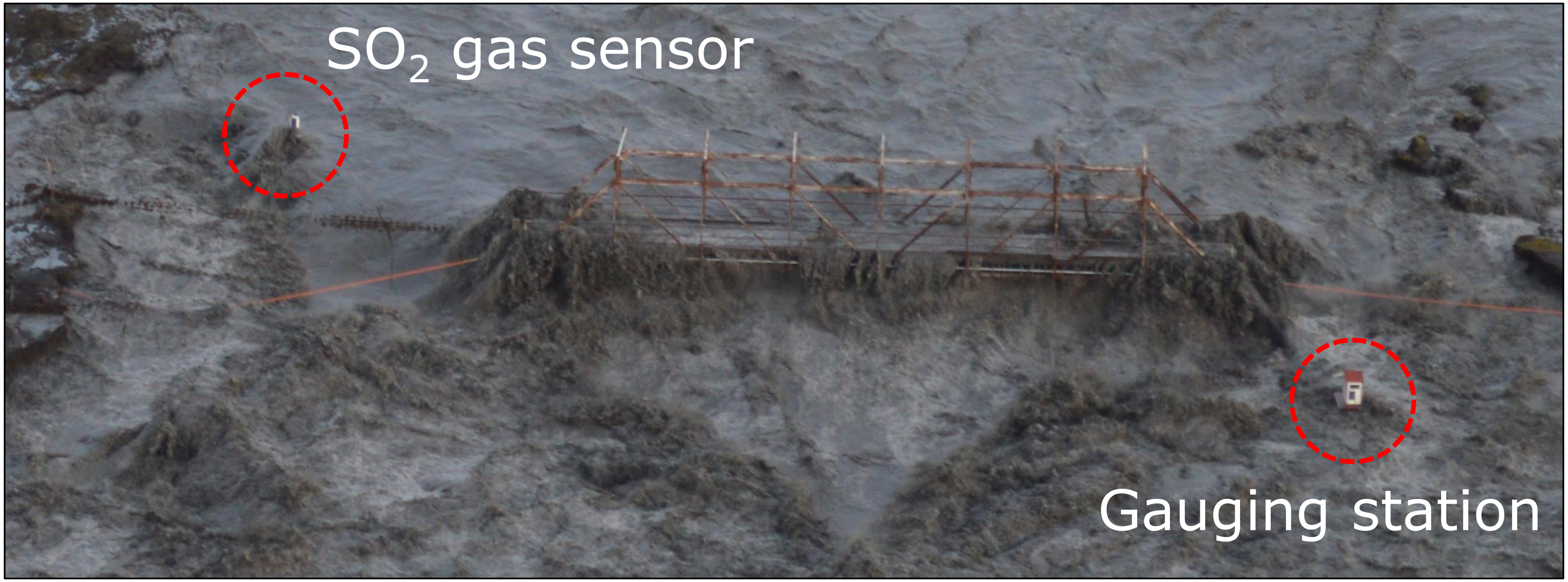
Floods take their toll on IMO's monitoring equipment!



Acceptable risk – our working definition

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Acceptable risk deals with statistical calculations about the value of life, economic losses and other forms of negative impact.

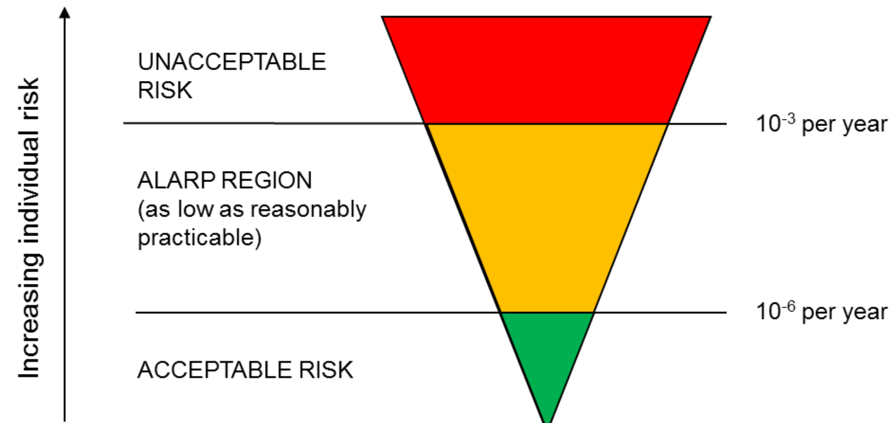
The risk of flooding is acceptable when:

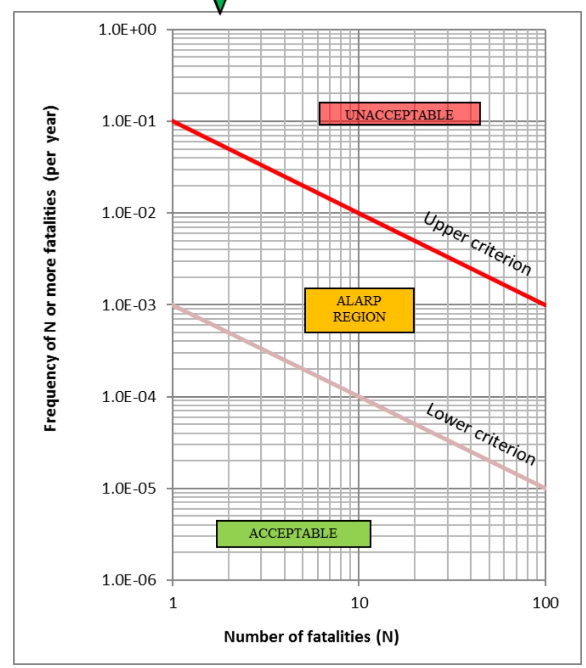
- **it remains below an arbitrarily defined probability**
- **it remains below some level that is tolerated already**
- **the cost of reducing the risk would exceed the costs saved**

Acceptable risk – our working definition

Ultimately, whatever thresholds are decided on, they reflect a societal, time-dependent standpoint on acceptable risk.

Taking the UK as an example, the upper limit of risk tolerability for floods is of the order of one fatality in 100,000 per year. This is equivalent to an individual's risk of being killed as a pedestrian.





Causes of river flooding in Iceland

- **Meteorological floods** (overtopping of riverbanks)
  - Intense rainfall / snow-melt (exacerbated by frozen ground)
- **Flash flooding** (mountain gullies; ephemeral watercourses)
  - Steep coastal slopes; localised, intense rainfall; rapid run-off
- **Ice-jam flooding**
  - Freeze-up jams; frazil ice; break-up of ice-jams by upstream flooding
- **Glacial outburst floods (jökulhlaup)**
  - Ice-dammed lakes
  - Volcanic eruptions

Flash flooding in Siglufjörður, 28 Aug 2015
Credit: Sveinn Þorsteinsson,
via http://hedinsfjordur.is/

Main flood hazards during a typical Icelandic winter

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- Heavy, wet snowfall followed by sudden thawing and / or rainfall. Hazards include flooding and slush-flows.
- Deep atmospheric lows, bringing mild, moisture-laden air to the south of the country.
- Ice-jamming is a possibility, but this depends on the severity of the winter.

Image courtesy of MODIS Rapid Response Project at NASA/GSFC

Two types of flood
Useful for public awareness of flood risk

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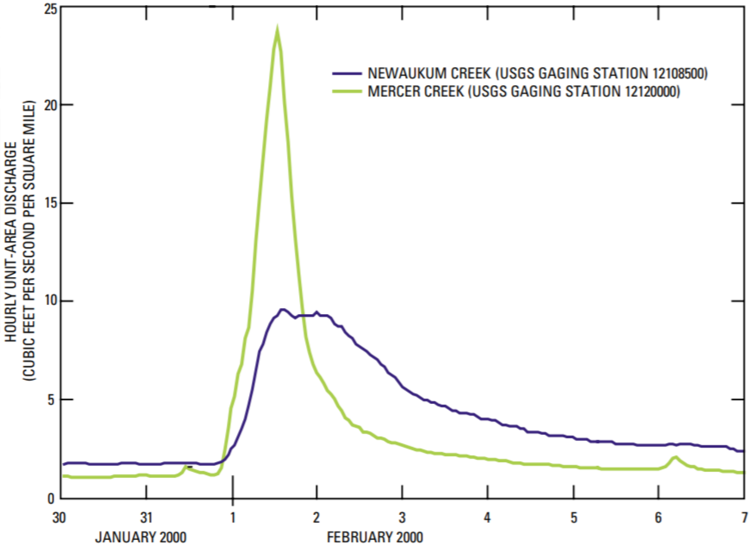
Example from Norway

Low probability but high consequence

High probability; economical losses

Fast rising:
Short timescale – little potential for a warning; increased impact; possibly life-threatening

Slow rising:
Longer timescale – opportunity for warnings; physical damage but, typically, no loss of life



The timescale of rainfall and/or snowmelt defines the severity of a flood

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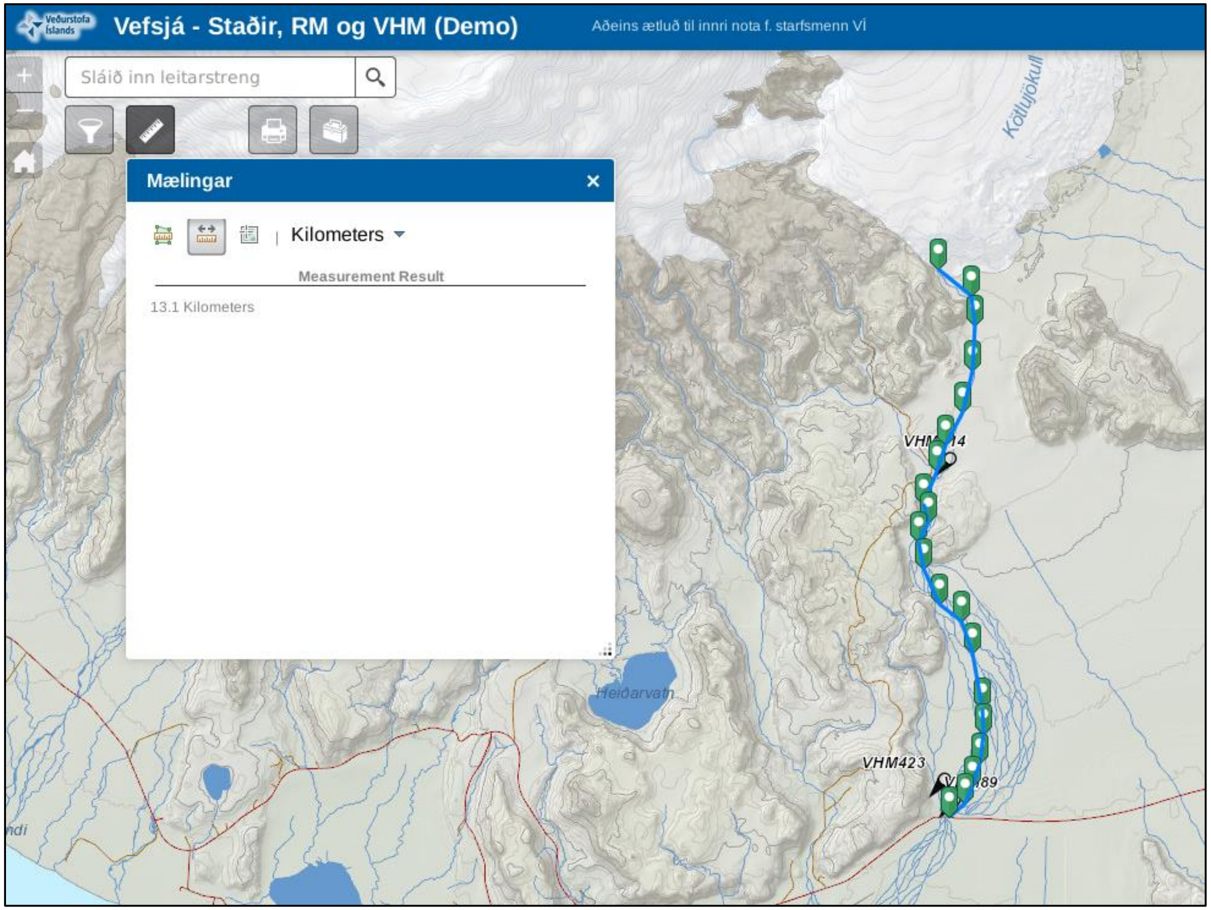
CHARACTERISTICS	SLOWLY RISING	RAPIDLY RISING
Cause	Prolonged rainfall and / or rapid snowmelt	Extreme rainfall and or sudden snowmelt; ice-jam
Frequency	Yearly occurrence	Seldom occurs (> 5 years)
Duration	Days	Hours to less than a day
Lag-time	Days	Hours
Warning opportunity	1 – 2 days	<1 day / no warning
Hazards	Gradual increase in water level	Fast-flowing water; debris
Overall level of risk	Low	Higher but not life-threatening

In the US and Europe, a threshold in lag-time of approximately six hours is often employed to distinguish a flash flood from a slow-rising flood.

Forecast lead-time and river length

- For short, glacial rivers such as Múlakvísl, the time-frame for issuing a warning is <40 minutes!
- 13.1 km river length and propagation velocity of 5 m s^{-1} = 44-minute travel-time



Múlakvísl: July 2011

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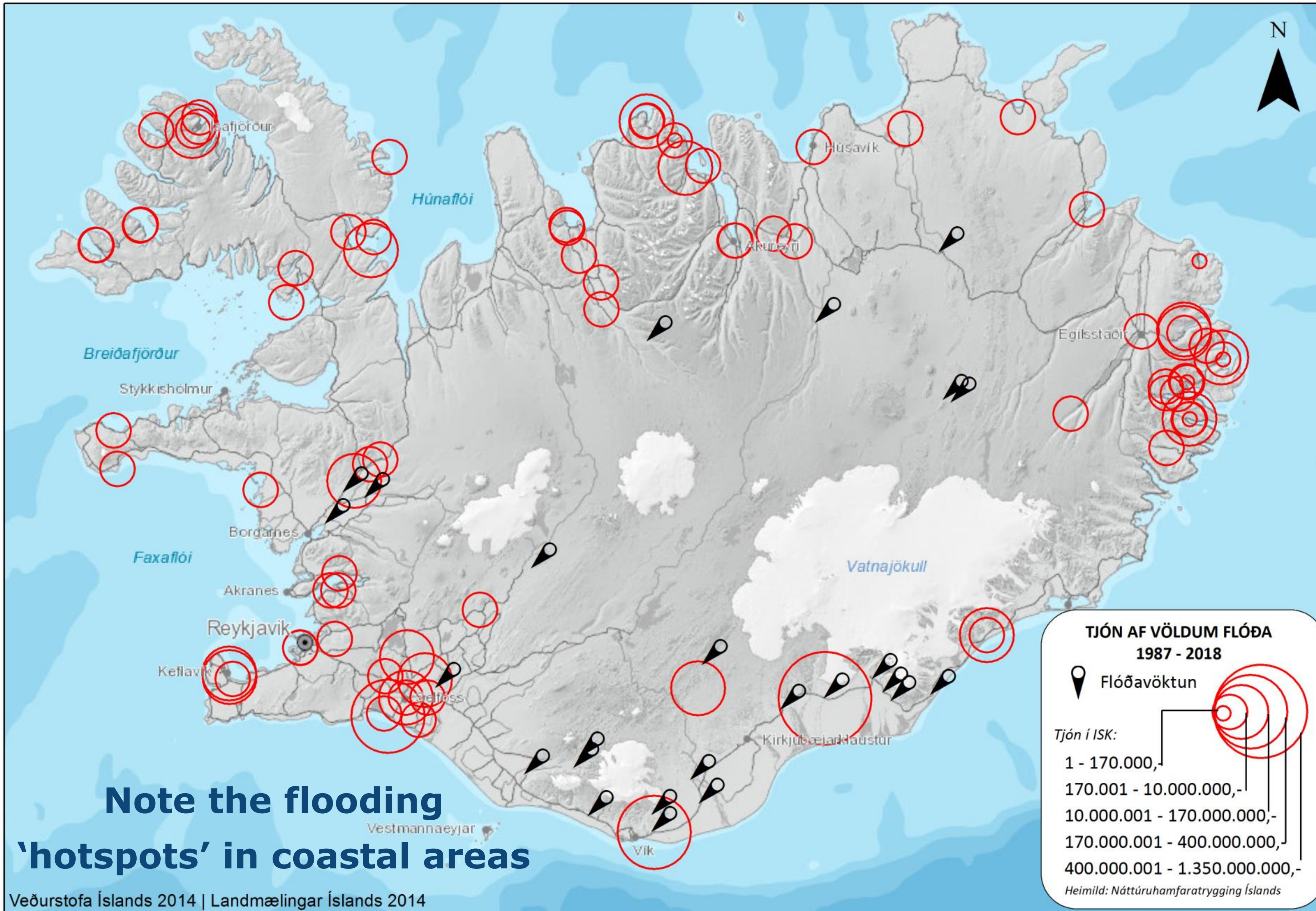
State-insured losses due to flooding: 1987 – 2018



Note the flooding 'hotspots' in coastal areas

Why do observations from the public matter? Verification of impact!

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Public observations can be incorporated into existing monitoring networks and forecasting systems so that:

i. more timely and accurate warnings can be issued;

ii. more comprehensive compilations of damage impacts are received; and

iii. hazard awareness and perception of risk are improved.

Flash flooding in Siglufjörður, 28 Aug 2015

Conceptual view of typical monitoring and forecast system

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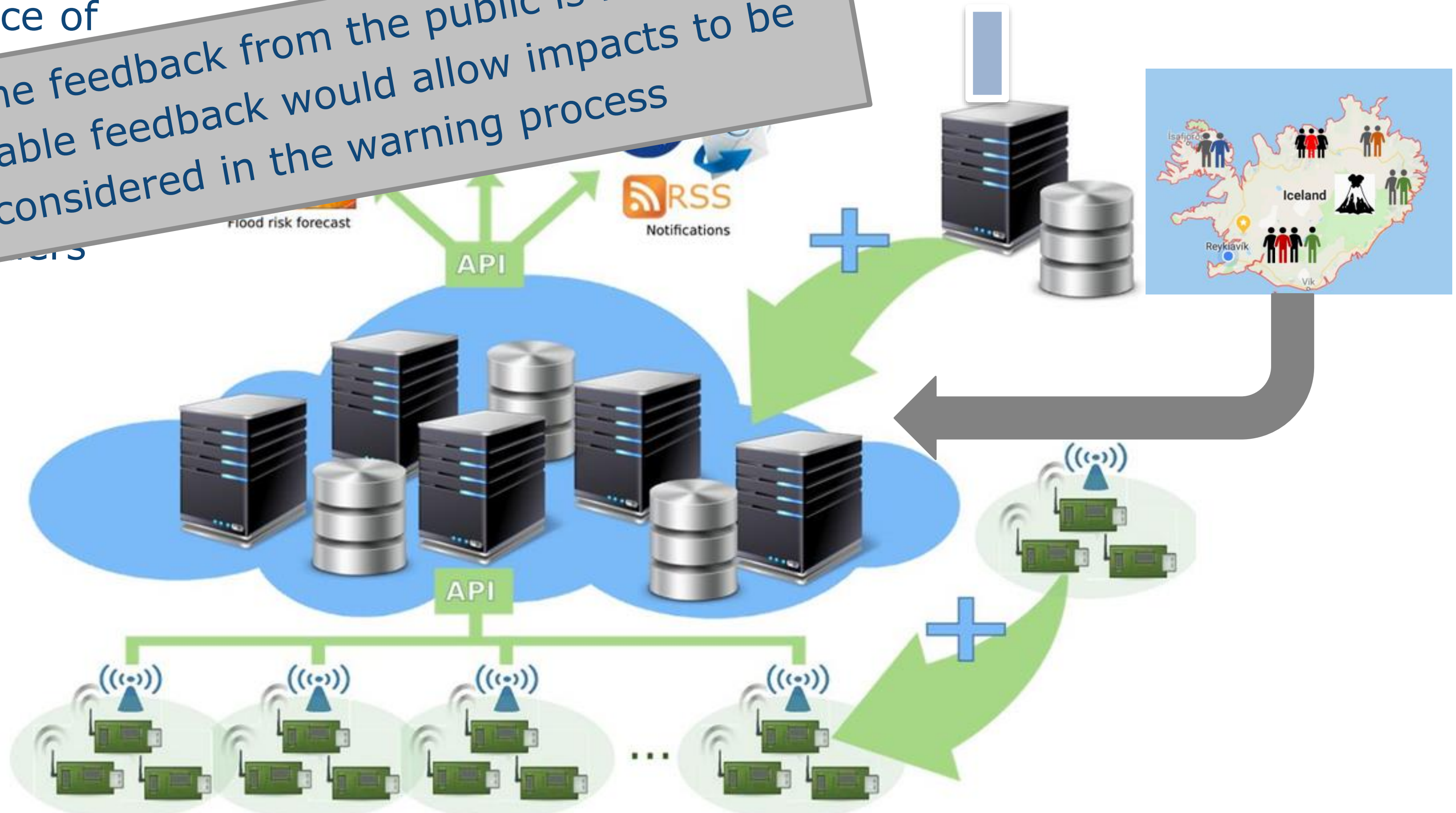
Dominance of

ers

Real-time feedback from the public is lacking – quantifiable feedback would allow impacts to be considered in the warning process



Source: http://www.wesenseit.eu/

A case in point: Sólheimajökull and the Icelandic tourist boom

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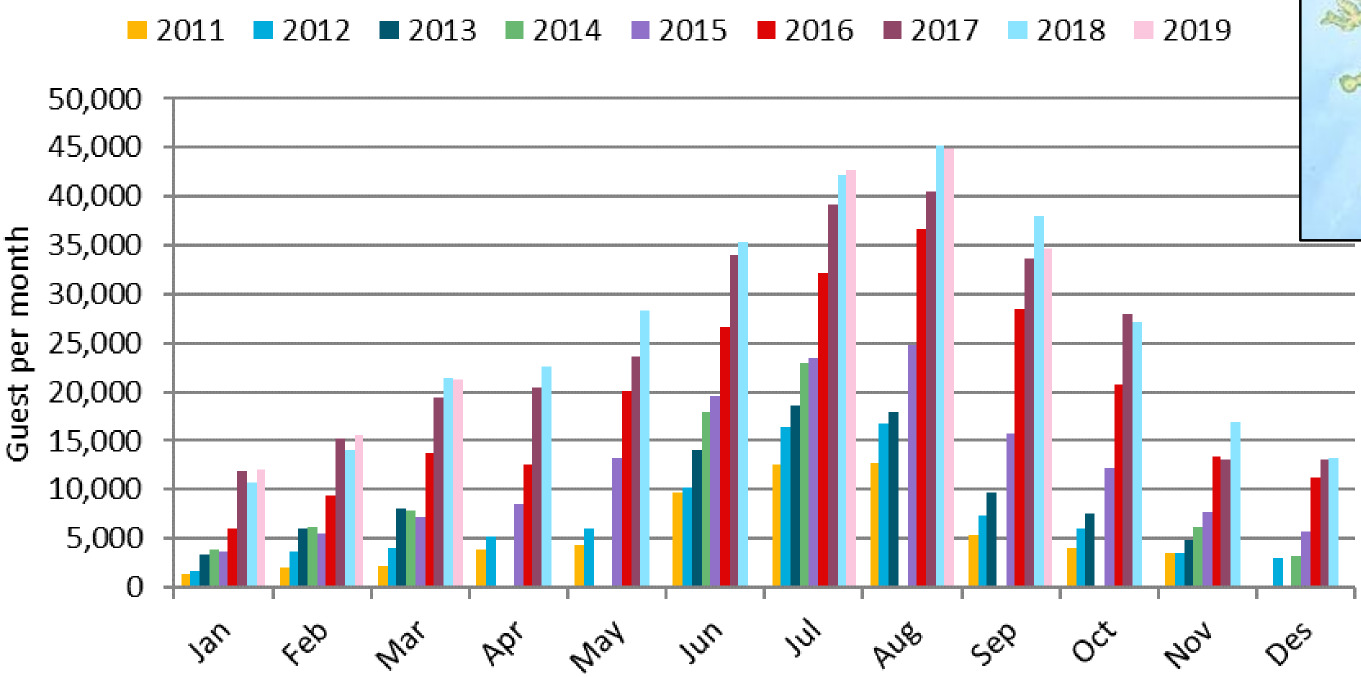
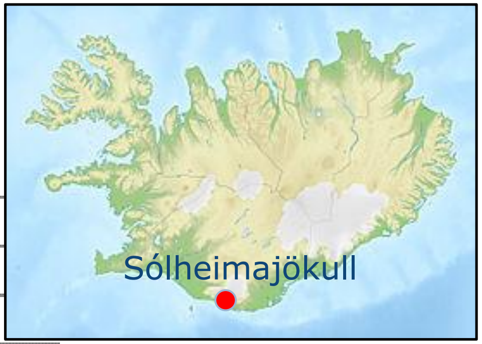
A boom in nature-based tourism in recent years

- Glaciers are one of the main attractions
  - Sólheimajökull the most popular site





UNIVERSITY OF ICELAND

Rögnvaldur Ólafsson
Gyða Þórhallsdóttir

Sólheimajökull and Jökulsá á Sólheimasandi

Icebergs and flood marks from a jökulhlaup in July 1999

Photograph: Oddur Sigurðsson

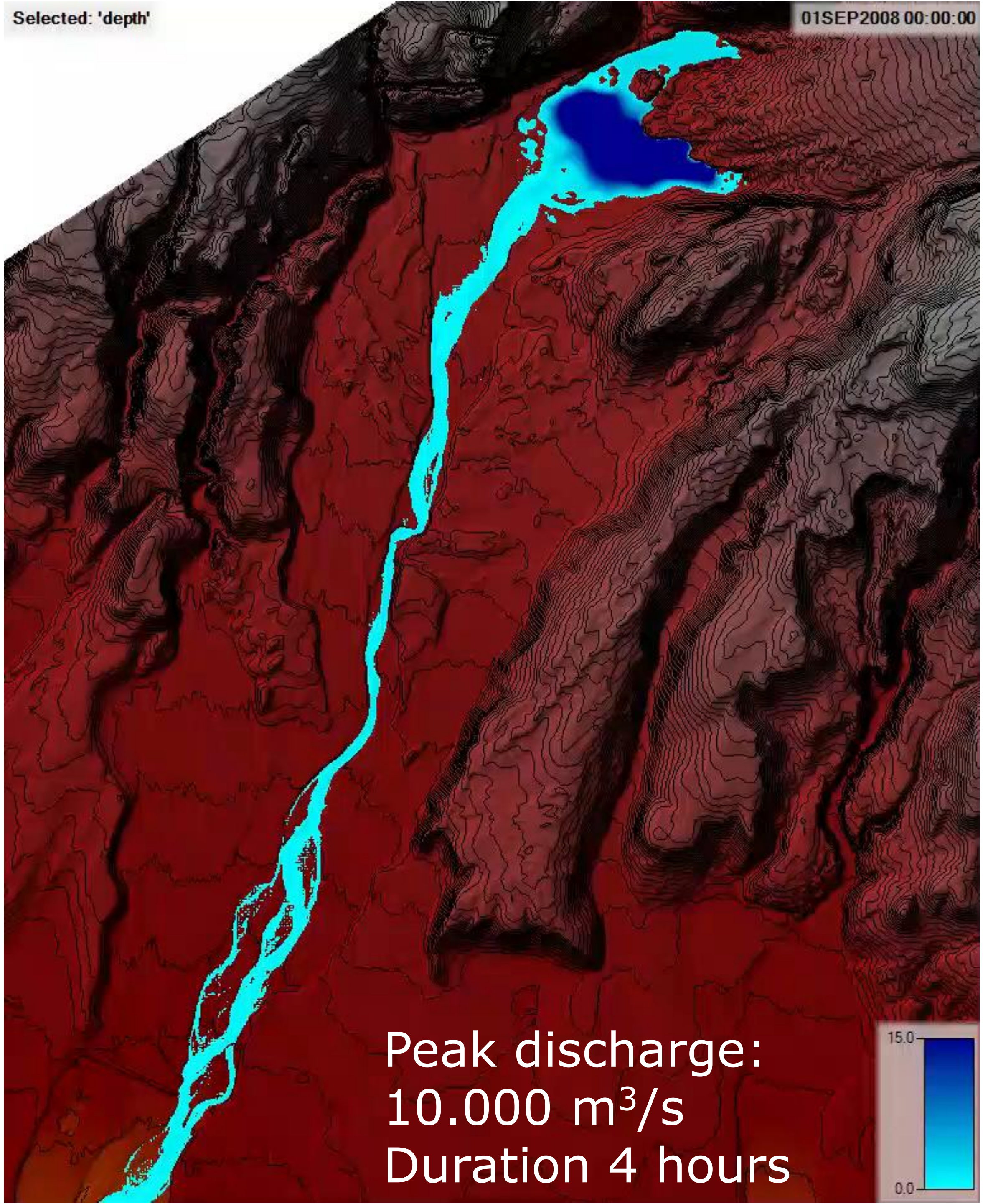
Jökulhlaup hazards and a booming tourist industry

A worrying combination

Risk to people and infrastructure

- *Sólheimajökull, hazard assessment for small and medium sized jökulhlaups* (Guðmundsson and others, 2015)
- *Volcanogenic floods at Sólheimajökull. Hazard identification, monitoring and mitigation of future events* (Bergsson, 2016)

Eyjafjallajökull 14. April 2010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01SEP2008 00:00:00
Peak discharge:
10.000 m^3/s
Duration 4 hours
15.0
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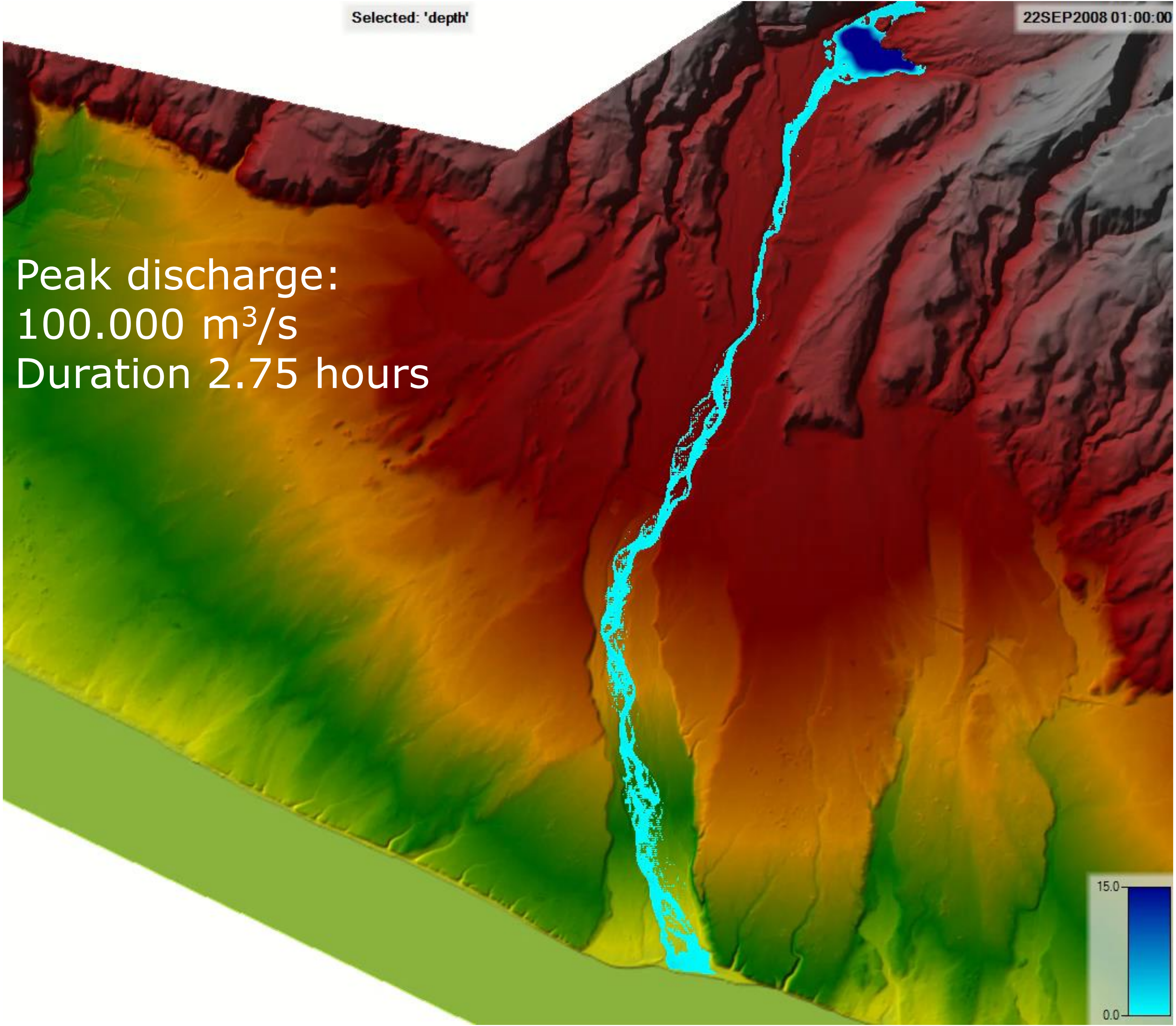

Selected: 'depth'
22SEP2008 01:00:00
Peak discharge:
100.000 m³/s
Duration 2.75 hours
15.0
0.0

Conclusions

Veðurstofa Íslands

Participatory early warning systems take advantage of people-centred observations via a two-way exchange of warnings and local feedback, helping to:

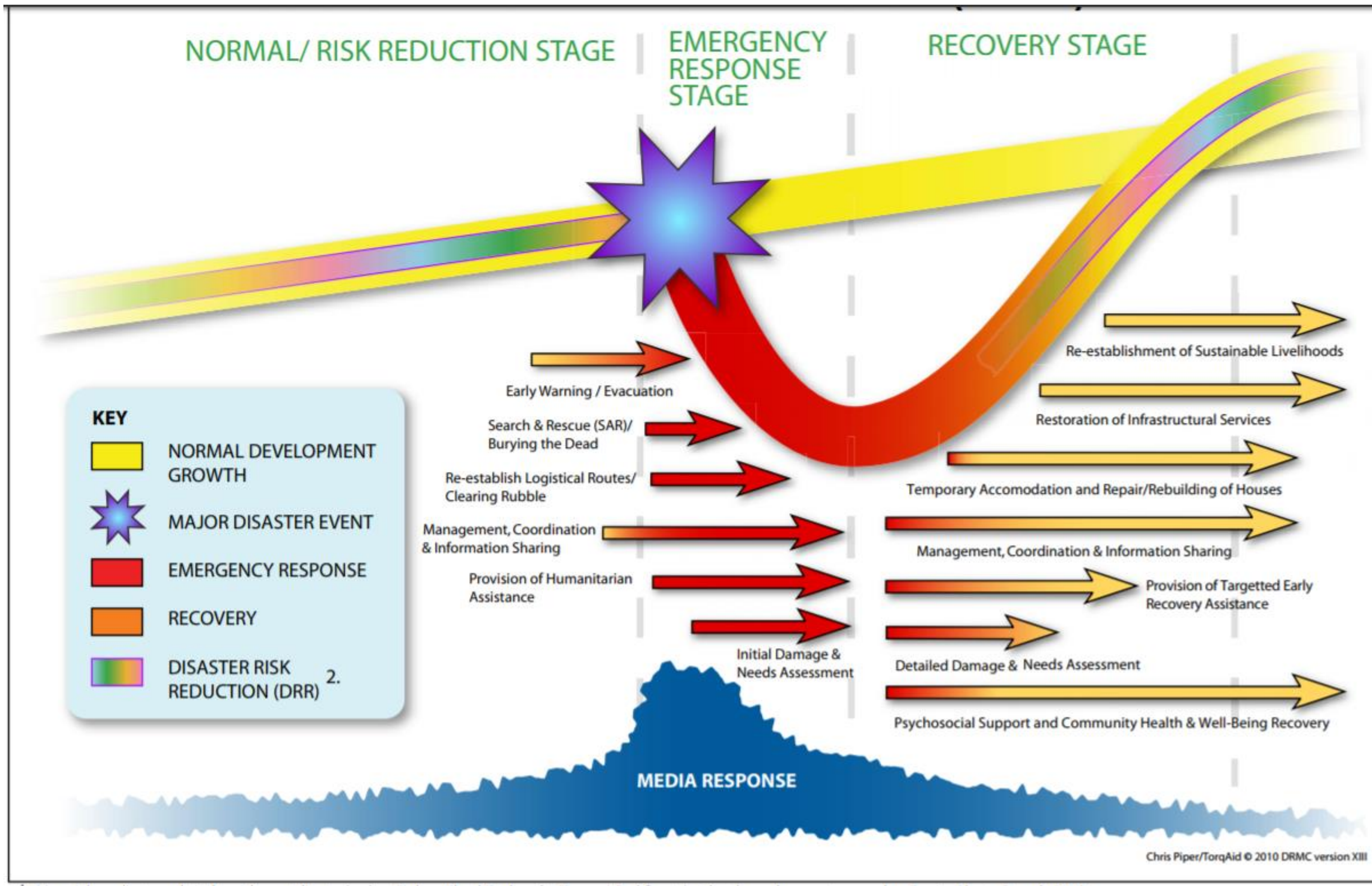
i. improve risk awareness within the affected region;

ii. increase the technical capacity to monitor, model and forecast with **higher accuracy**;

iii. improve the content and timeliness of public warning, thereby helping to maintain trust; and

iv. heighten response capabilities, both during the hazard itself and in the long-term recovery between recurring events.

Risk awareness is central to reducing the societal impact of nat. haz.



ALNAP: http://www.alnap.org/resource/5839