Design and use of Online Geo-Forms for Public Observations of Natural Hazards in Iceland

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Icelandic Met Office

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Veðurstofa Íslands

GEUS

NORDRESS
Nordic Centre of Excellence
On Resilience and Societal Security

Purpose of today’s presentation

- At the Icelandic Meteorological Office (IMO), GIS-based registration pages have been developed to allow the public to send photographs and descriptions of an evolving hazard.
- The design and use of these pages will be outlined, with a focus on floods and volcanic eruptions.

Meteorological flood, southeast Iceland, 28 Sep 2017
Credit: Víðar Reynisson

Motivation and rationale

Icelandic Met Office

- Iceland is affected by many types of natural hazards, ranging from severe weather to volcanic eruptions (see next slide).
- Monitoring data and forecasting results provide the basis for most public warnings.
- However, **warning accuracy** is often difficult to assess, as the impact of the ongoing hazard may not be apparent immediately.
- For weather-related floods, the lag between rainfall and river-response could span several hours, hence there are opportunities to gather impact-related observations.

Eruptions in Iceland since 1991

In recent decades, an eruption has occurred every 3 – 4 years

1. Hekla 1991
2. Gjálp 1996
3. Grímsvötn 1998
4. Hekla 2000
5. Grímsvötn 2004
6. Fimmvörðuháls 2010
7. Eyjafjallajökull 2010
8. Grímsvötn 2011
9. Holuhraun 2014–2015

Background I: What constitutes an early warning service?

Icelandic Met Office

- Early warning and monitoring systems (EWMS) are defined as a set of "*capacities needed to generate and disseminate timely and meaningful information to enable individuals, communities and organisations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss*" (United Nations Office for Disaster Reduction, 2009).

UNISDR

The United Nations Office for Disaster Risk Reduction

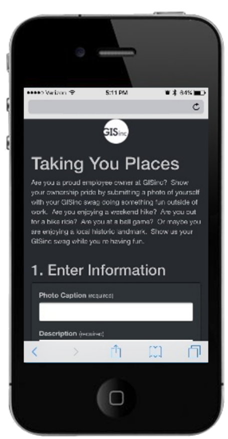
Background II: What is a geo-form?

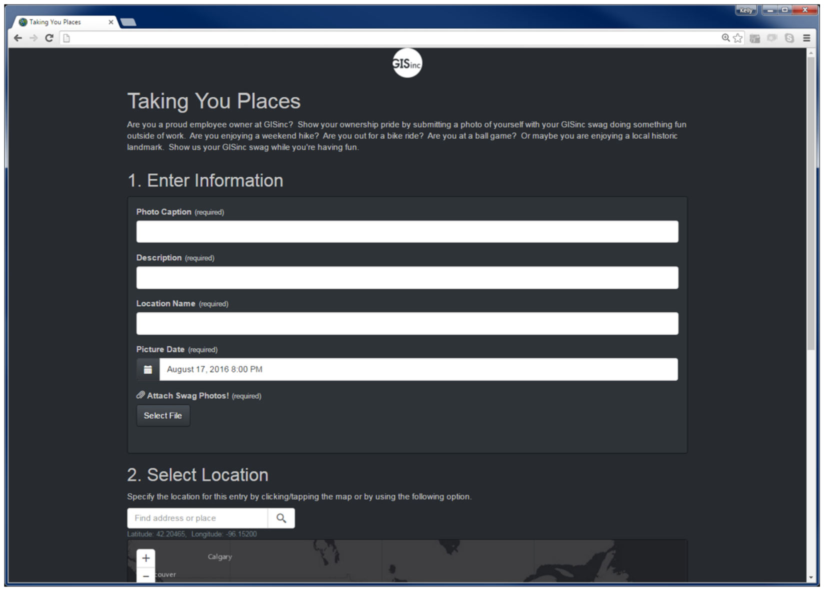
https://www.arcgis.com/apps/GeoForm/index.html

Icelandic Met Office

- An ESRI geo-form is a configurable template for form-based data input and visualisation.
- Users enter data via an on-line form, taking advantage of editable feature services such as automatic geo-location.
- The platform is straight-forward to set-up and publicise.
- Geo-forms are particularly useful for collecting data from a large audience of non-technical users.

Source: http://gisinc.com





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

Icelandic Met Office

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

Improving resilience to natural hazards via the NORDRESS project

Icelandic Met Office

- The R&D work presented here is part of the ongoing NORDRESS project (2015–2019).
- The project is funded by the Social Security Programme of NordForsk, and the overall goal is improved understanding of societal resilience to natural hazards.
- We contribute to community resilience by involving the public in the reporting of an evolving natural hazard, such as a flood.
- URL: http://nordress.hi.is/

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On Resilience and Societal Security

Causes of flooding in Iceland – a brief overview

Icelandic Met Office

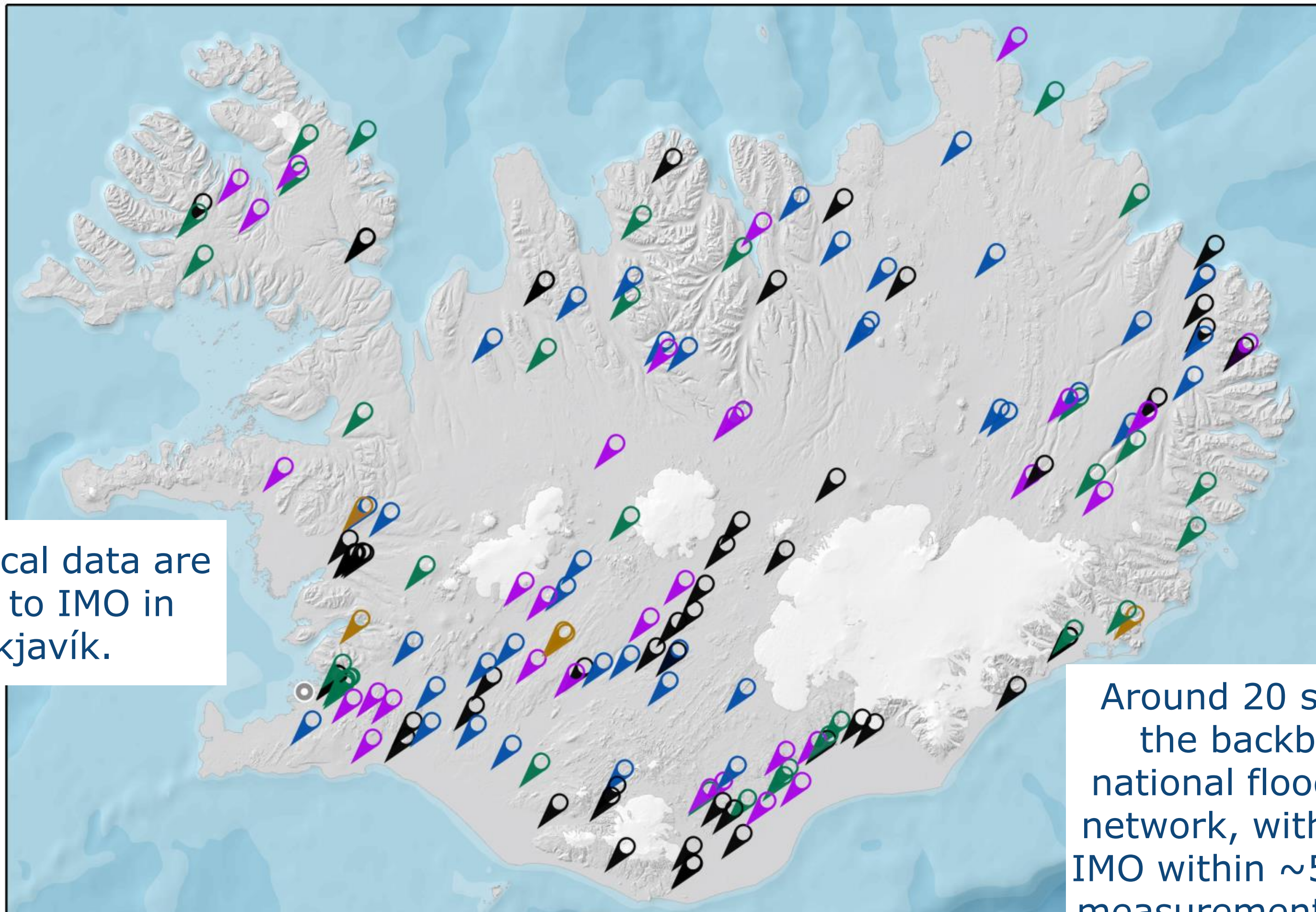
River flooding

- Meteorological floods (overtopping of river banks)
  - 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/

Automated hydrological observations: dense network but unavoidable gaps

Icelandic Met Office

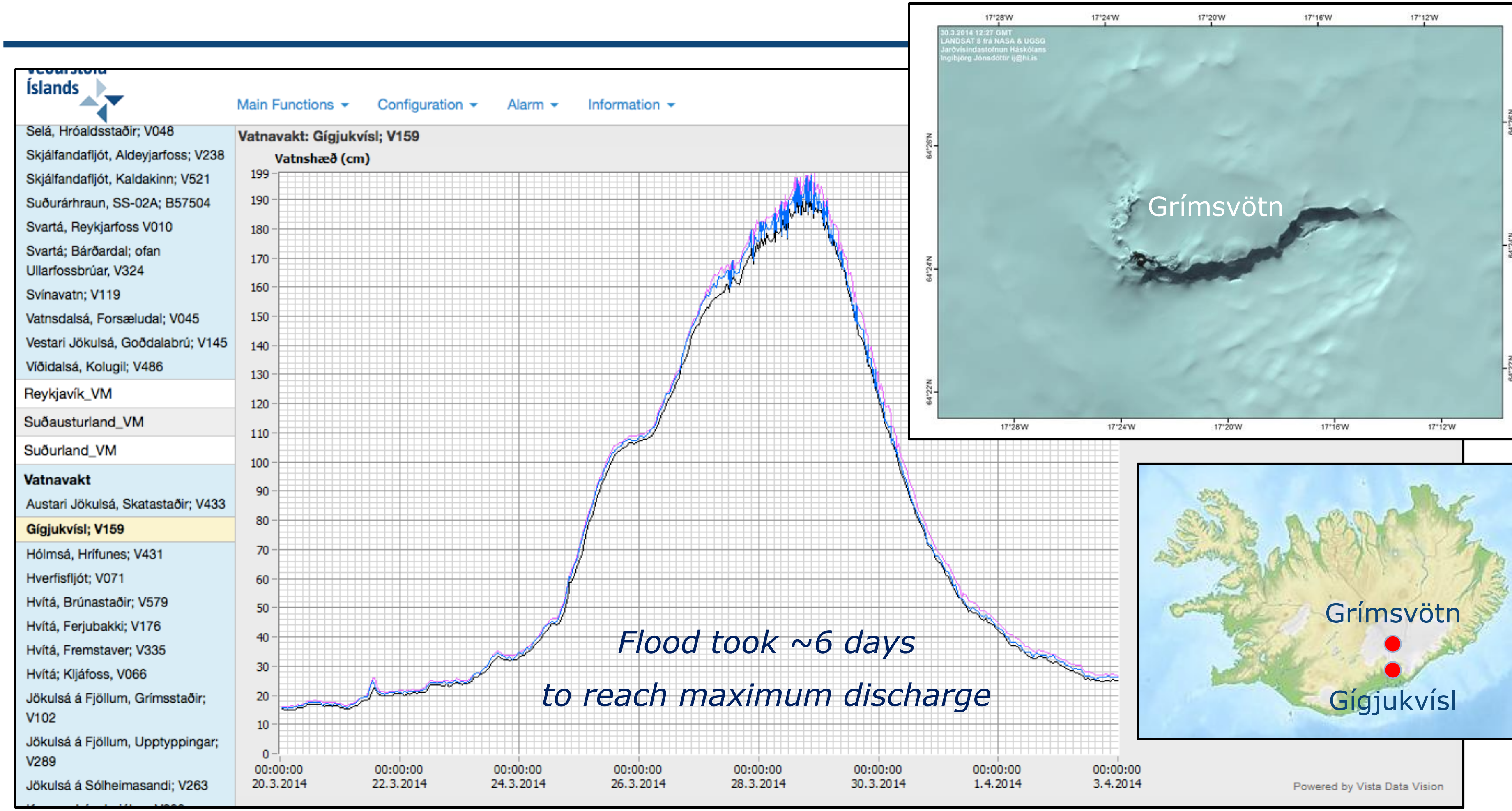


Hydrological data are relayed to IMO in Reykjavík.

Around 20 stations form the backbone of the national flood-monitoring network, with data sent to IMO within ~5 minutes of a measurement being made.

Hydrological interface at IMO
(*Vista Data Vision*, by Vista Engineering, Iceland)

Icelandic Met Office



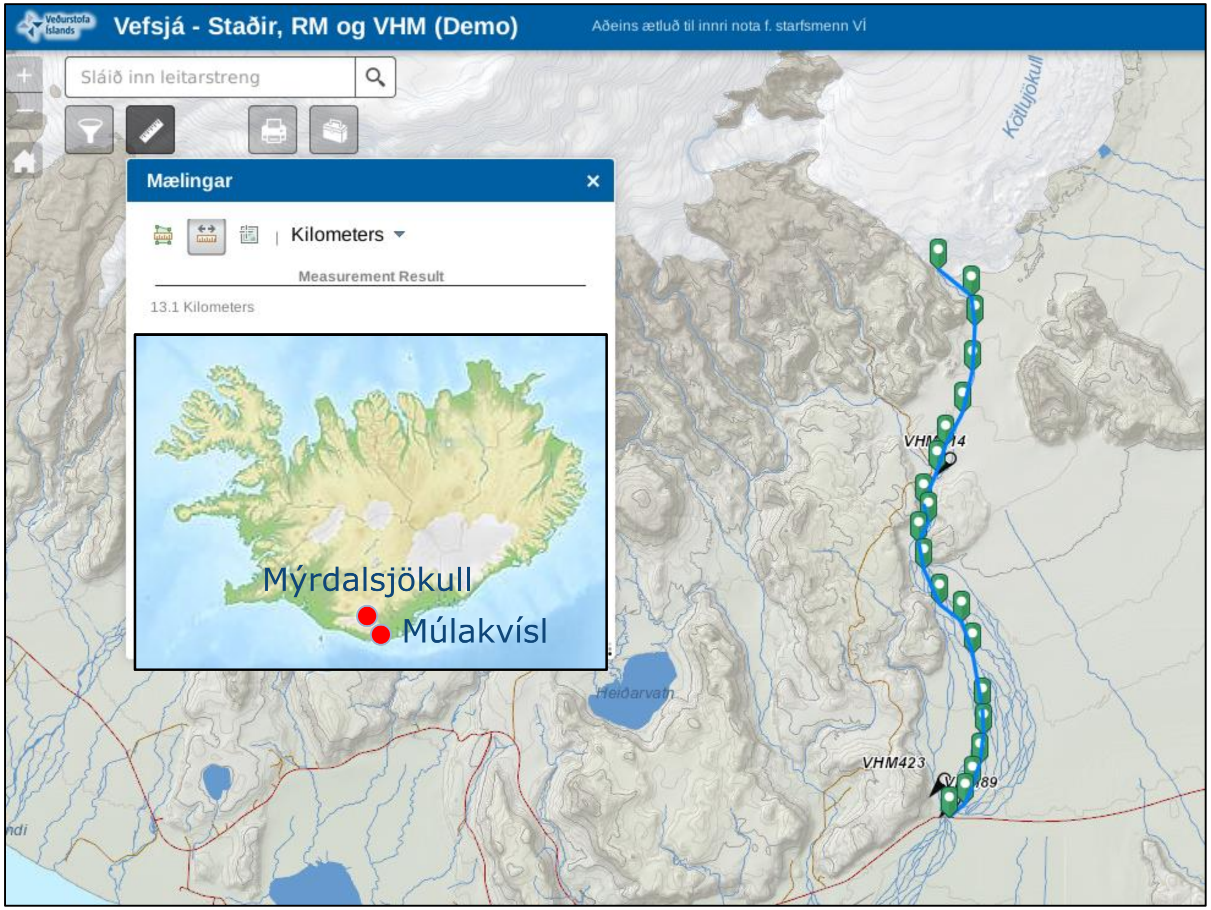
Example of a recent jökulhlaup from subglacial lake Grímsvötn. The affected river was Gígjukvísl, which originates from Skeiðarárjökull (Q_{max} ~680 m^3 s^{-1})

http://vmkerfi.vedur.is

Flood warning opportunities in relation to river-length: Short river, often little pre-warning

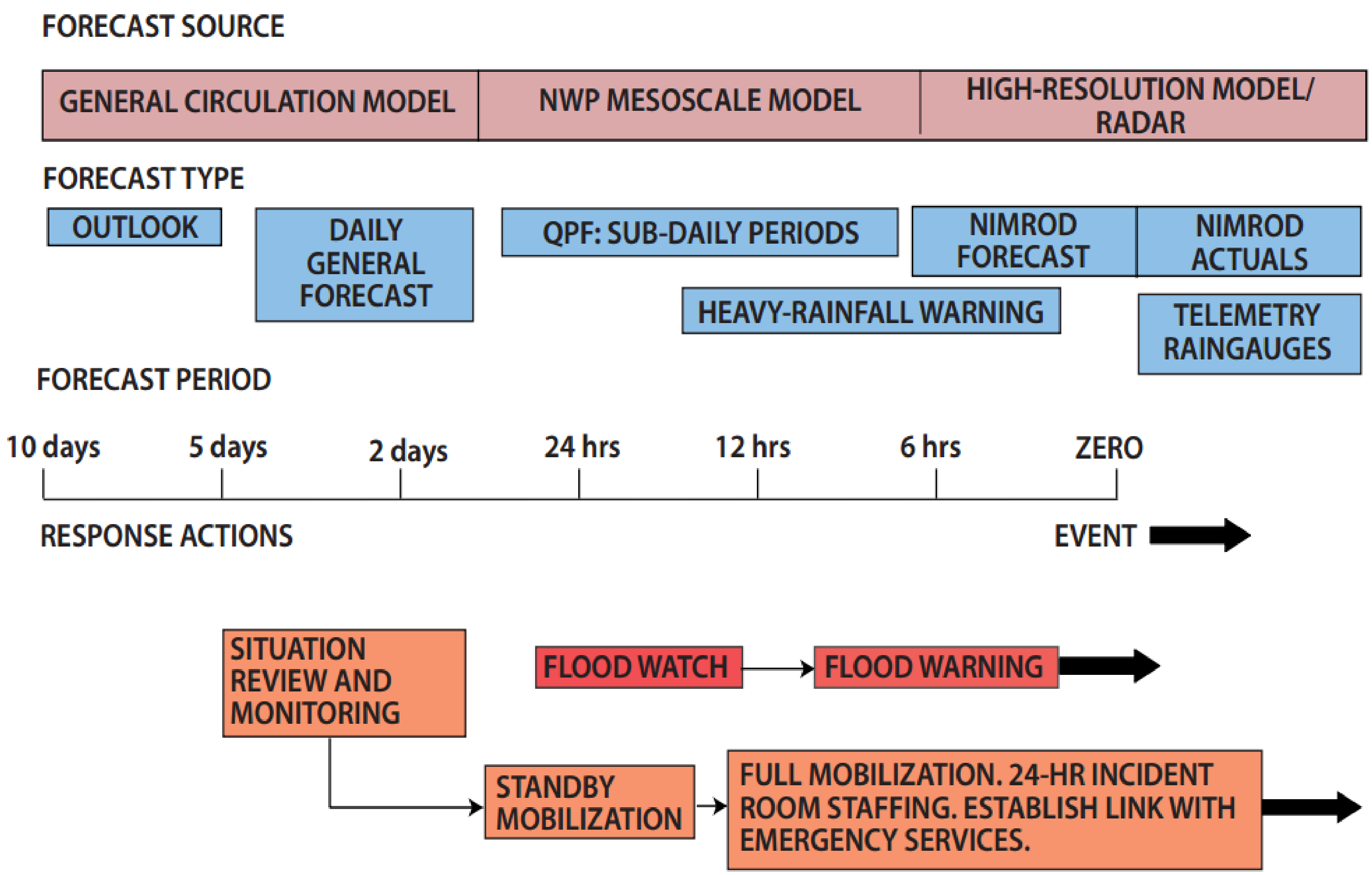
Icelandic Met Office

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



Flood forecasting lead-time

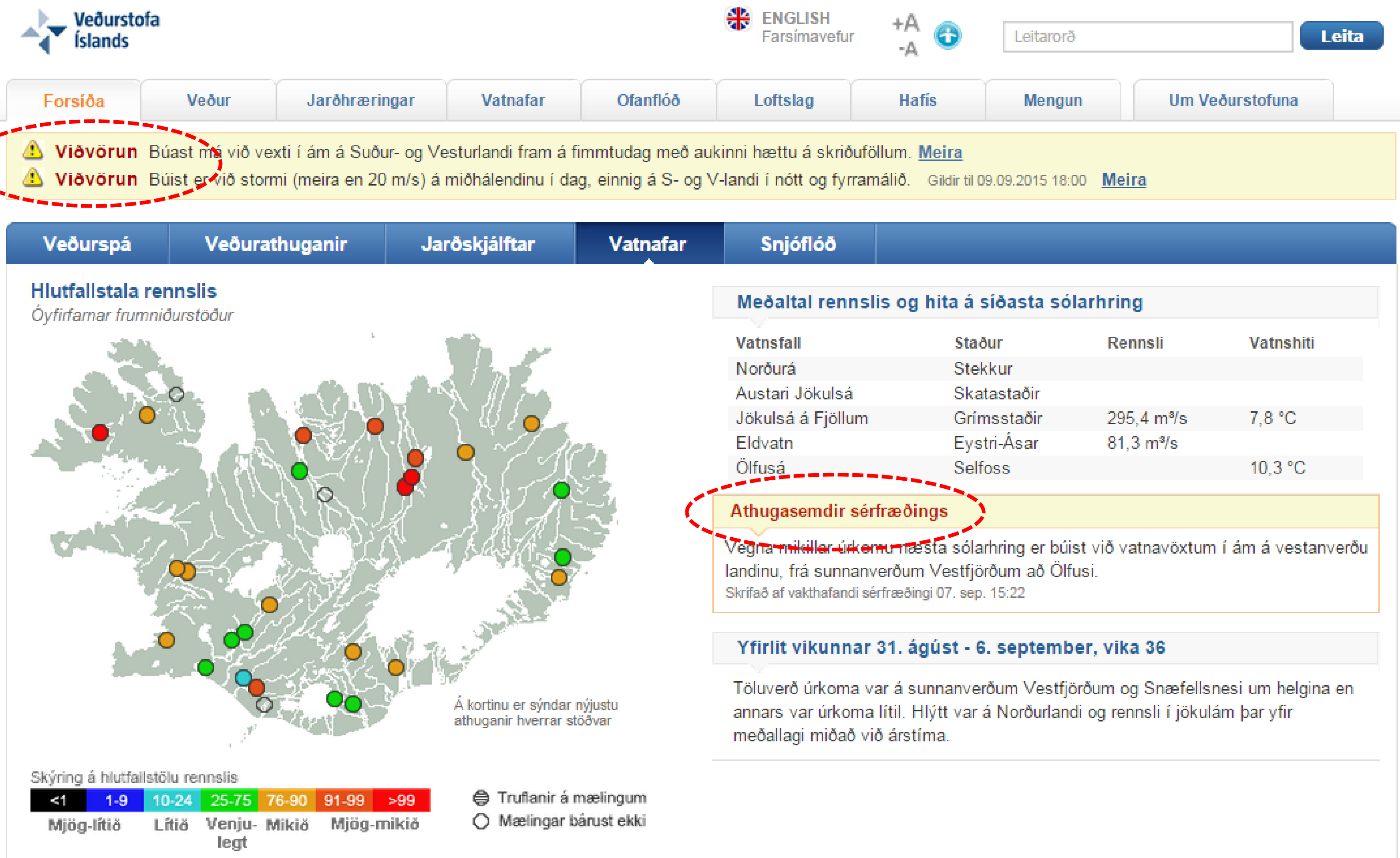
Notice how the approach is strictly one-way –
how are flood forecasts revised in light of impact reports?



Source: https://www.wmo.int

IMO’s web-site: Stream-flow results updated regularly

Icelandic Met Office

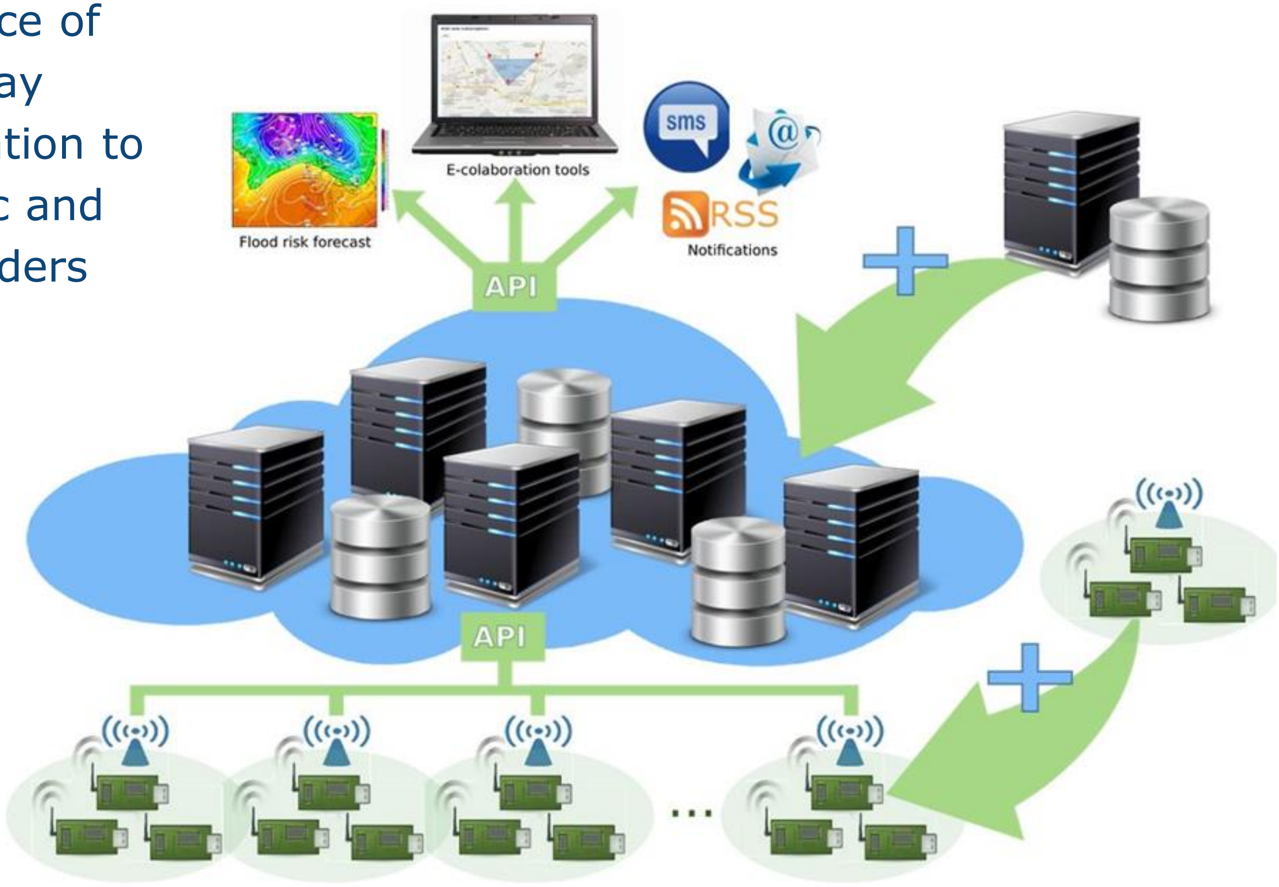


IMO’s hydrological monitoring page during autumn rainfall, 08-09-2015

Conceptual view of scalable flood-monitoring and forecast system

Icelandic Met Office

Dominance of one-way communication to the public and stakeholders

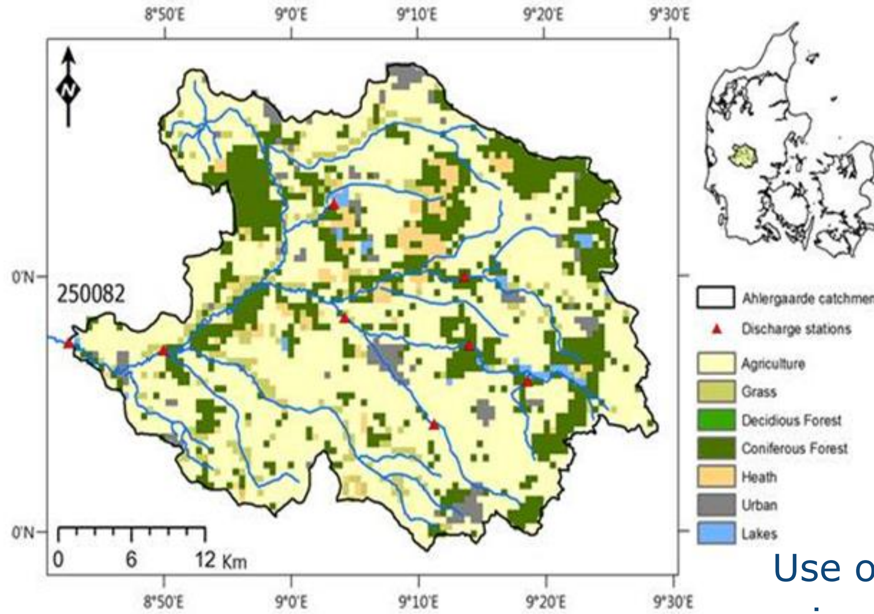


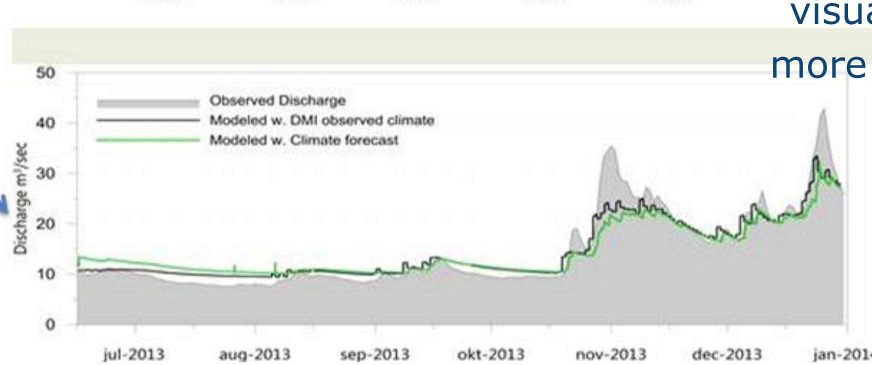
Scalable, yes, but how can impacts be taken into consideration?

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

Flood forecasting with in-built verification of river changes (NORDRESS)

Danish case-study from the NORDRESS project (Henriksen *et al*., submitted)

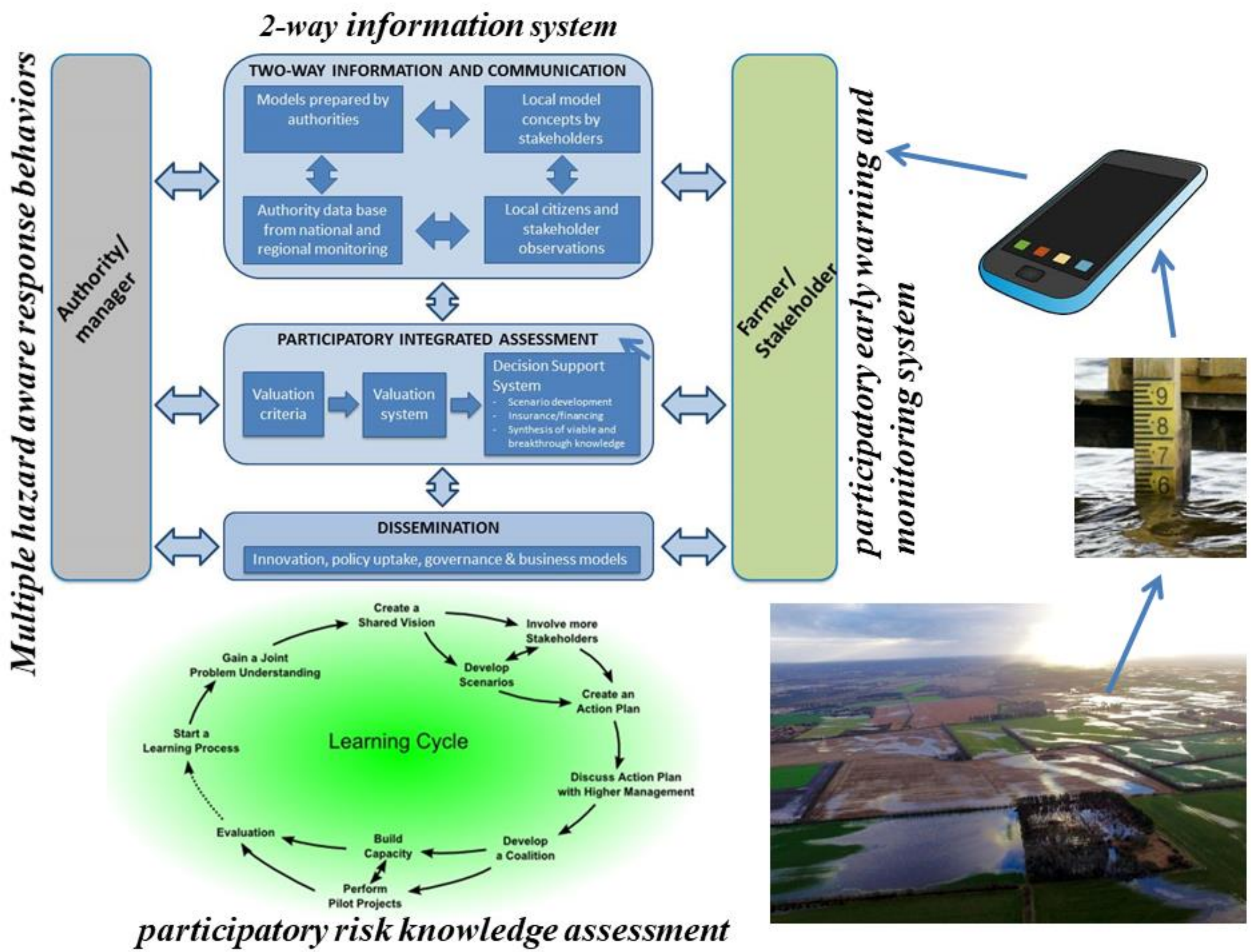




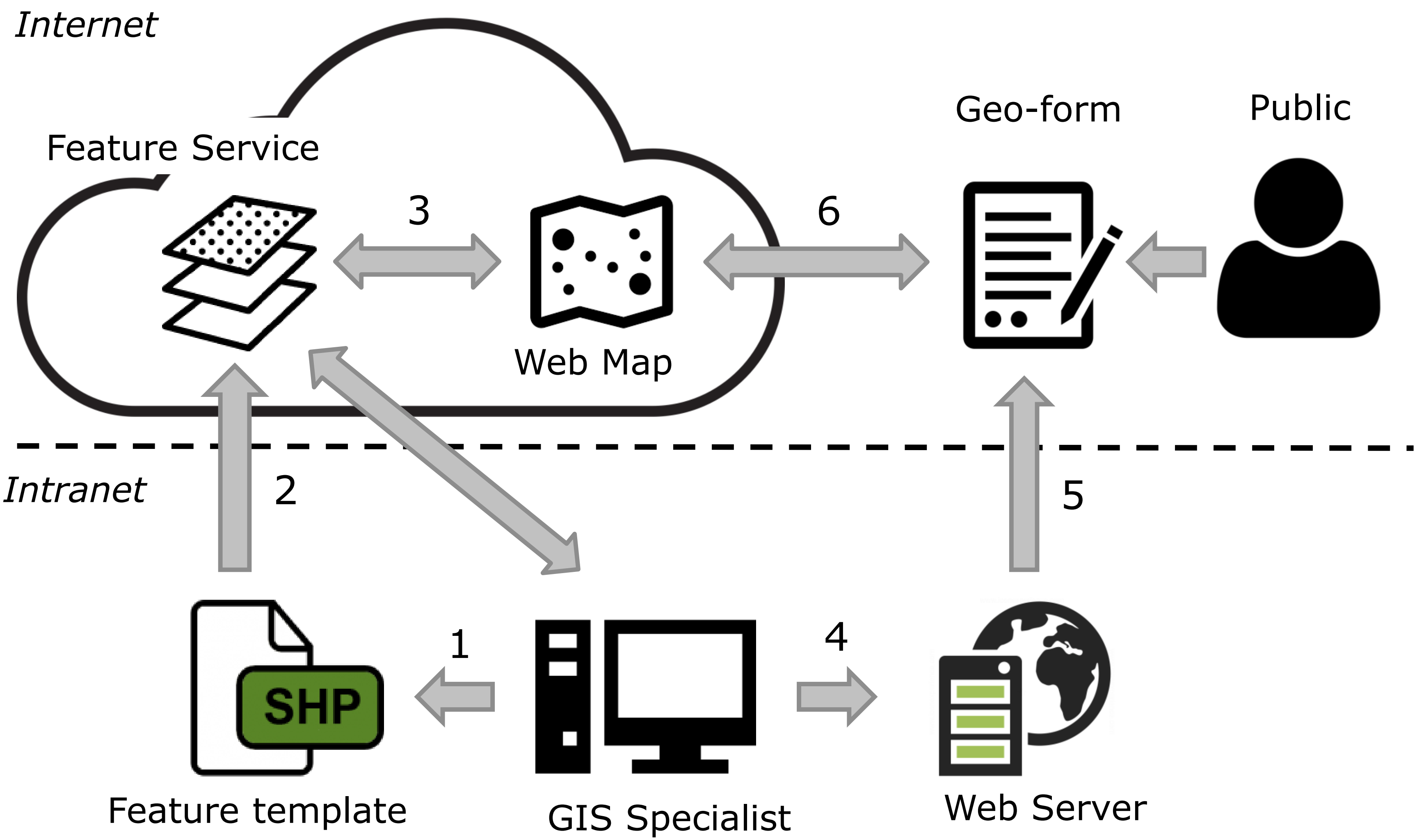
Use of gauging data and visual observations for more accurate discharge estimates

Participatory-based approach to early warnings – NORDRESS

Icelandic Met Office



Components of a geo-form registration page



Design steps to launching a geo-form for crowd-based data collection

Icelandic Met Office

i. Create template shapefile with attributes to collect.
ii. Publish shapefile as a hosted feature service on *ArcGIS Online*.
iii. Create a web-map and add the hosted feature-service on *ArcGIS Online*.
iv. Deploy the geo-form Javascript code on a web-server and make it accessible to Internet.
v. Link web-map to the geo-form via map ID.

For specific requirements and configurable options, see: https://www.arcgis.com/apps/GeoForm/index.html and

https://github.com/Esri/geoform-template-js

Geo-form used during the 2014–2015 eruption at Holuhraun, Iceland

Icelandic Met Office

Used by first-responders and the public in various locations throughout the country to record their assessment of SO_2 concentration.


Veðurstofa Íslands

Skráningarform - Brennisteinsmengun (SO_2)

Vinsamlegast skráðu brennisteinslykt, sem þú hefur fundið í kjölfar eldgoss í Holuhrauni/Bárðarbungu, hér að neðan. **Athugið!** Upplýsingar sem skráðar eru munu birtast á vef Veðurstofunnar (sjá nánar hér). Þátttaka jafngildir samþykki fyrir slíkri birtingu. Athugið að skráningarformið er í þróun og gæti þar af leiðandi innihaldið villur. Vinsamlegast beinið spurningum og/eða ábendingum til *fyrirspurnir@vedur.is*, takk fyrir.

1. Skráið upplýsingar

Fannst brennisteinslykt? (Nauðsynlegt að skrá!)

- Nei
- Já

Veljið já eða nei áður en haldið er lengra.

Dagsetning og tími? (Nauðsynlegt að skrá!)

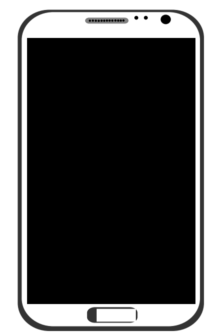
10/11/2017 1:25 PM

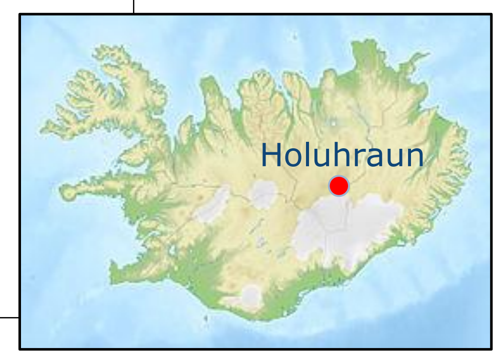
Tilgreinið hvenær brennisteinslykt fannst eða fannst ekki (ef svarið var nei hér að ofan), eins nákvæmlega og mögulegt er (tilgreinið a.m.k. dagsetningu).

Fannstu fyrir einkennum í hálsi?

- Nei
- Já

See: http://www.vedur.is/skraning_brennisteinsmengun/

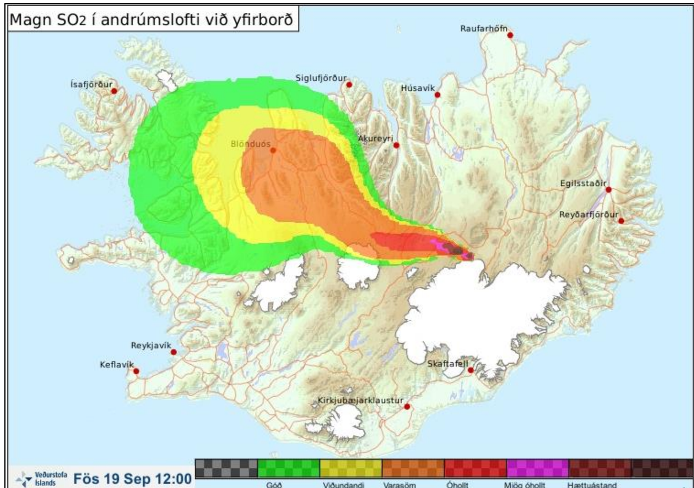


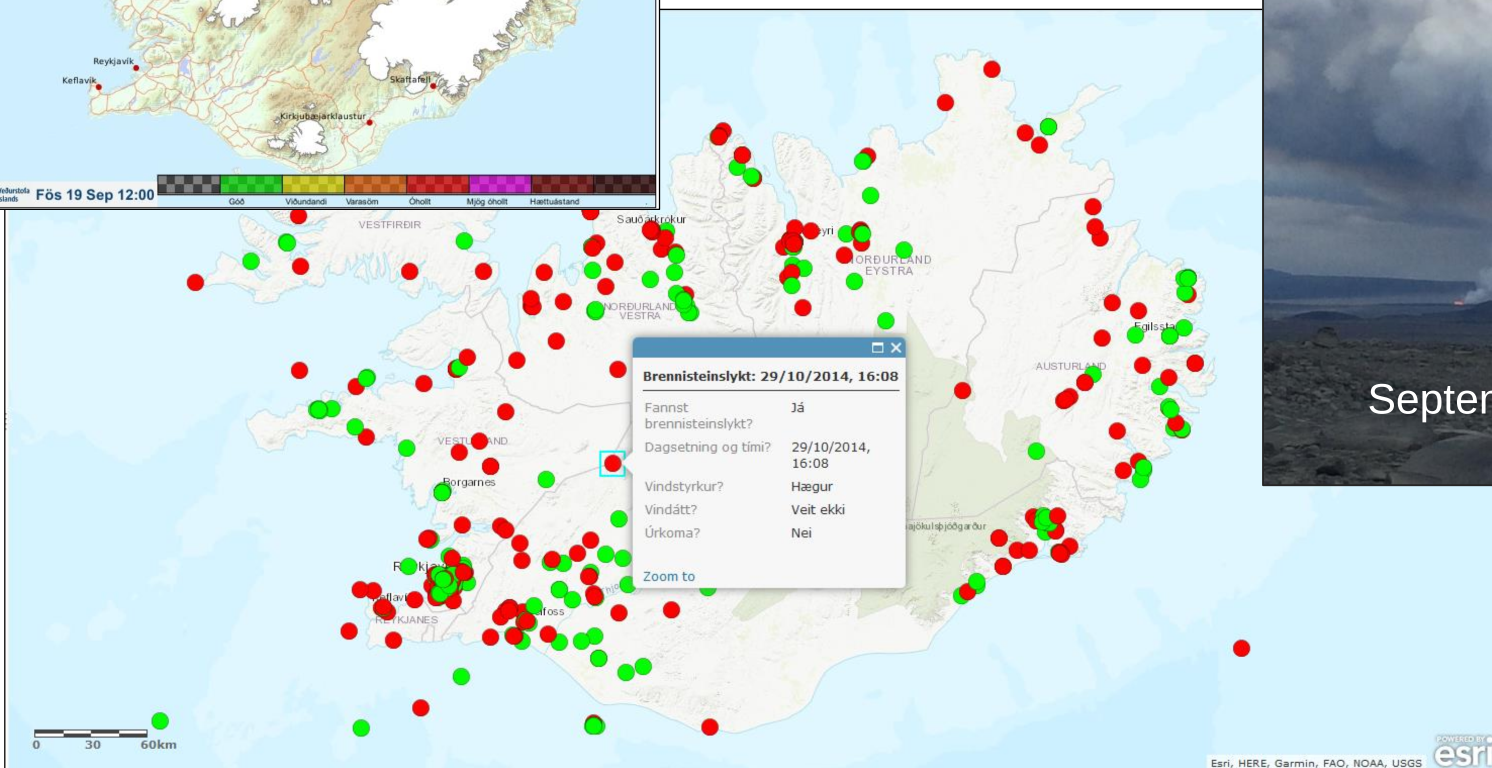


The pages are designed to be used in real-time or retrospectively; this greatly expands the potential of crowd-sourced observations.

Geo-form used during the 2014–2015 eruption at Holuhraun

Icelandic Met Office

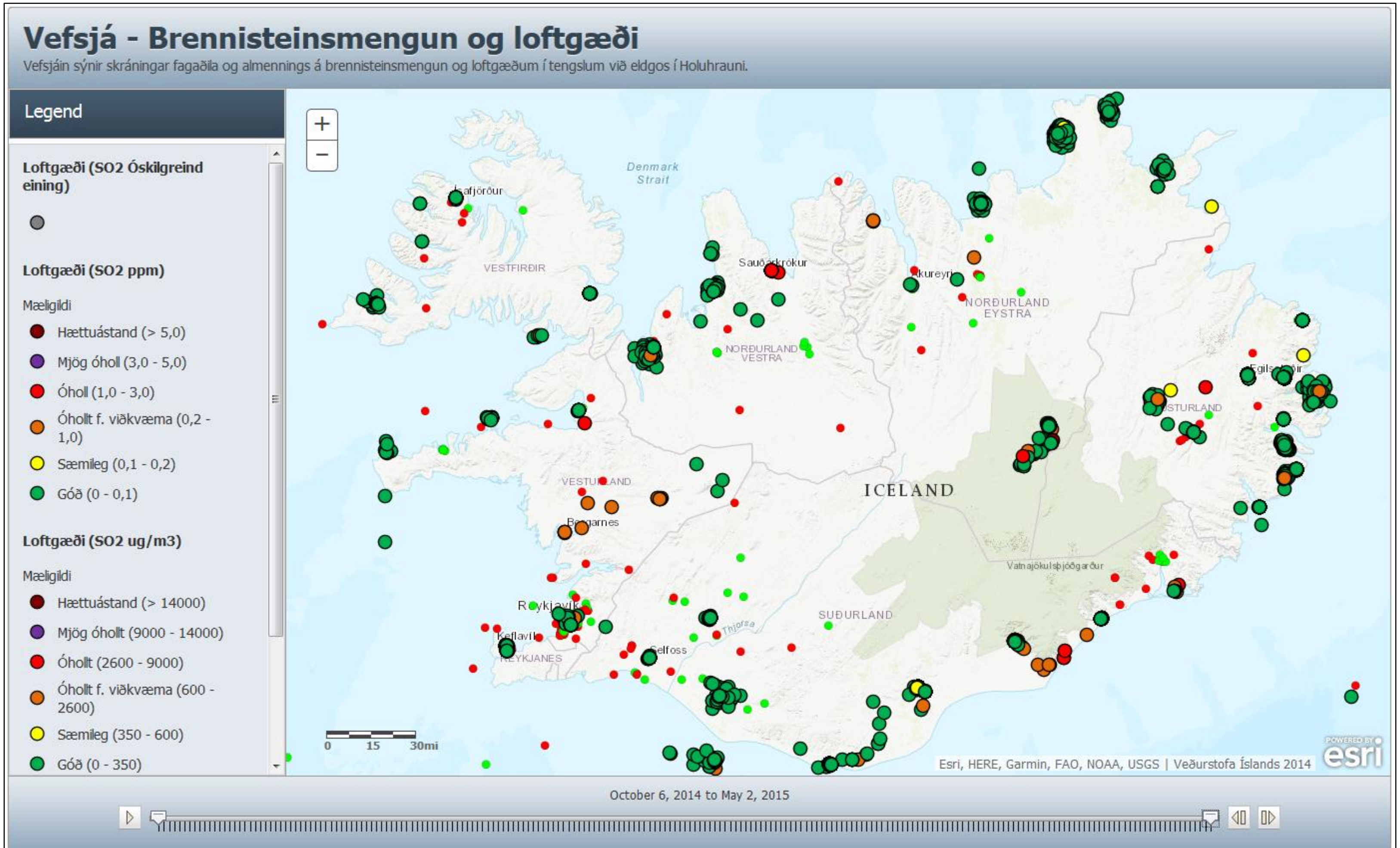




Hundreds of reports received during the eruption

Geo-form data were used to assess impact of SO_2 emissions on air quality

Icelandic Met Office



Web-based interface for viewing measurements over time

Experimental online geo-form at IMO for registering flooding

http://vatnsflod.vedur.is

Icelandic Met Office

Vefkort - Tilkynningar um vatnsflóð

Web Map by eos_vedur

Vefkortið sýnir tilkynningar um vatnsflóð.

Last Updated: Aug 21, 2017 Created: May 12, 2016

(ratings: 0) views: 1612

Web-based map (example below)

vatnsflod_isn93

Feature Layer by eos_vedur

Vefkortaþjónustan sýnir tilkynningar um vatnsflóð.

Last Updated: May 12, 2016 Created: May 12, 2016

(ratings: 0) views: 1574

Feature layer for supporting map-based locations of flooding (see next slide)

Tilkynning um vatnsflóð

Vinsamlegast tilkynnið um hvers konar vatnsflóð sem vart verður við með því að gefa upp upplýsingar sem óskað er eftir hér að neðan. Ljósmyndir eða önnur gögn sem sýna atburðin eru vel þegnar.

Athugið! Veðurstofa Íslands áskilur sér rétt til að birta skráningar á vef stofnunarinnar án takmarkana. Þátttaka jafngildir samþykki fyrir slíkri birtingu. Vinsamlegast beinið spurningum og/eða ábendingum til *fyrirspurnir@vedur.is*, kærar þakkir.

The '*vatnsflod*' feature-service

The interface includes various customisable attributes, as well as a record of received observations

Icelandic Met Office

vatnsflod_isn93

Overview | Data | Visualization

Vefkortaþjónustan sýnir tilkynningar um vatnsflóð.

by eos_vedur

Last Modified: May 12, 2016

Feature Layer

★ Add to Favorites

Open in Map Viewer

Open in Scene Viewer

Open in ArcGIS Desktop

Metadata

Description

Vefkortaþjónustan er útbúin til að safna saman tilkynningum um vatnsflóð. Vefkortaþjónustan er breytanleg og er ætlunin að nýta sérstakt vefform til þess að safna inn í hana áðurnefndum upplýsingum frá almenningi og fagaðilum. Upplýsingarnar verða nýttar af sérfræðingum Veðurstofu Íslands sem liður í náttúruváreftirliti stofnunarinnar.

Layers

Vatnsflóð

Open In ▾ Service URL

Access and Use Constraints

Aðgangur er opinn en notkun og birting utan vefsvæða Veðurstofu Íslands er óheimil án leyfis. Mistnotkun getur varðað við lög.

Details

★★★★★ (0) views: 1,761

Source: Feature Service

Created: May 12, 2016

Data Last Updated: Sep 29, 2017, 4:07:28 PM

Size: 272 KB

Owner

eos_vedur

Tags

vatn, flóð, vatnsflóð, náttúruvá

Credits (Attribution)

Veðurstofa Íslands 2016

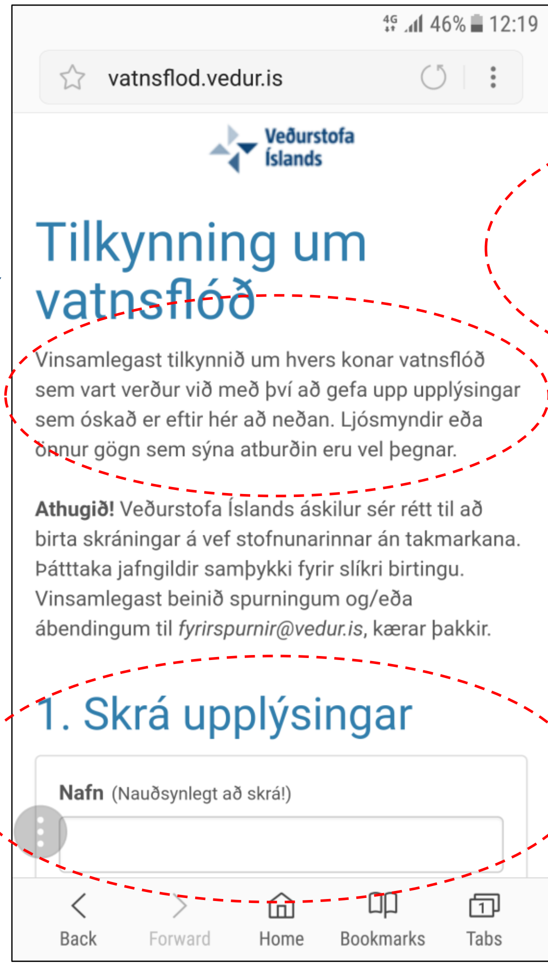
URL: http://vatnsflod.vedur.is

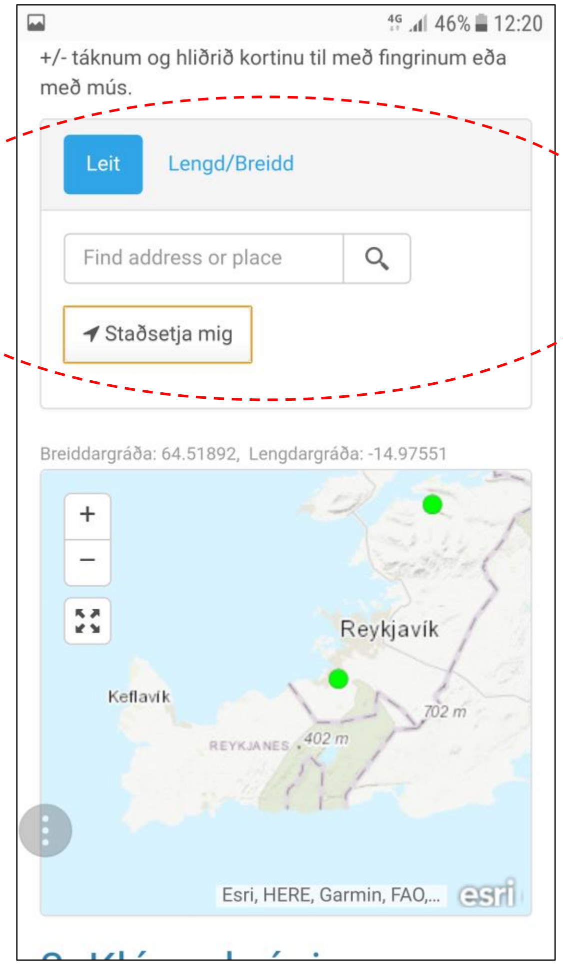
Mobile version of the page allows for easy input of observations and automatic geo-location

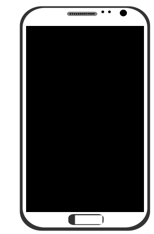
Icelandic Met Office

Introductory text

Observer's name and contact details





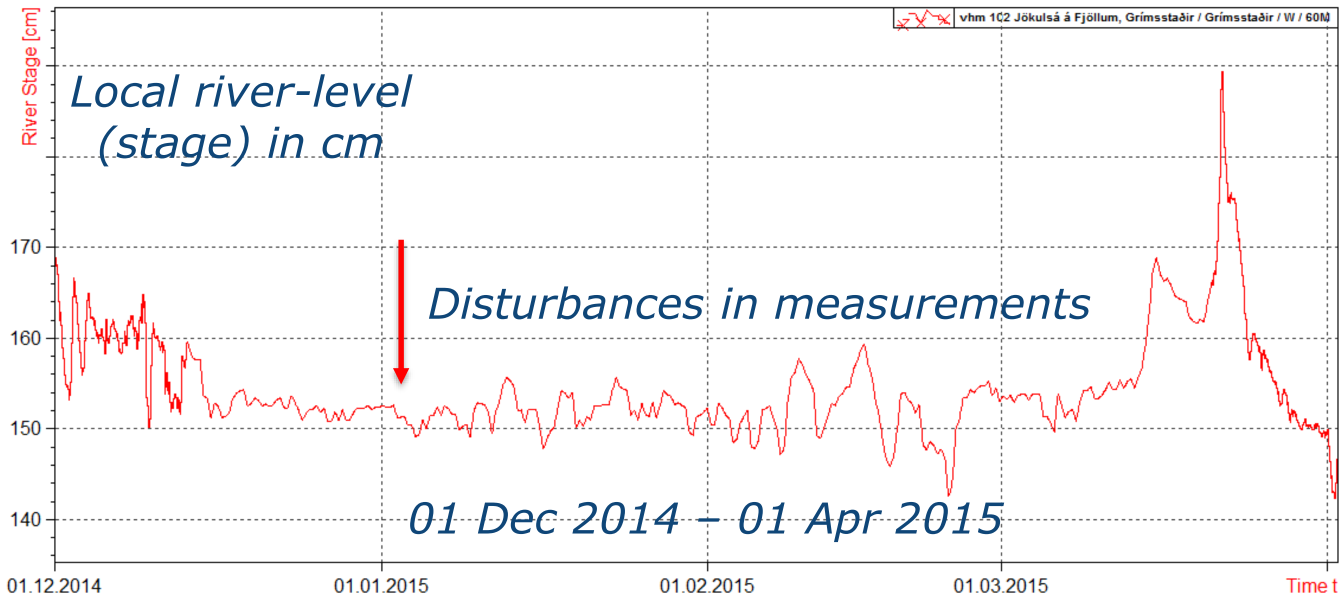


Location options, including automatic location from the telephone's built-in GPS

URL: http://vatnsflod.vedur.is

A simple case-study: Freeze-up ice-jam on Jökulsá á Fjöllum

Icelandic Met Office



Photographer: Njáll Fannar Reynisson, 20 January 2015

On-site observations help to put remote measurements into context

- People can provide valuable on-site observations…

…especially in remote, highland regions where automated measurements are difficult.

Photographer: Bragi Benediktsson, 18 January 2015

Geo-form services have a role in the disaster-risk-recovery cycle

Icelandic Met Office

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;

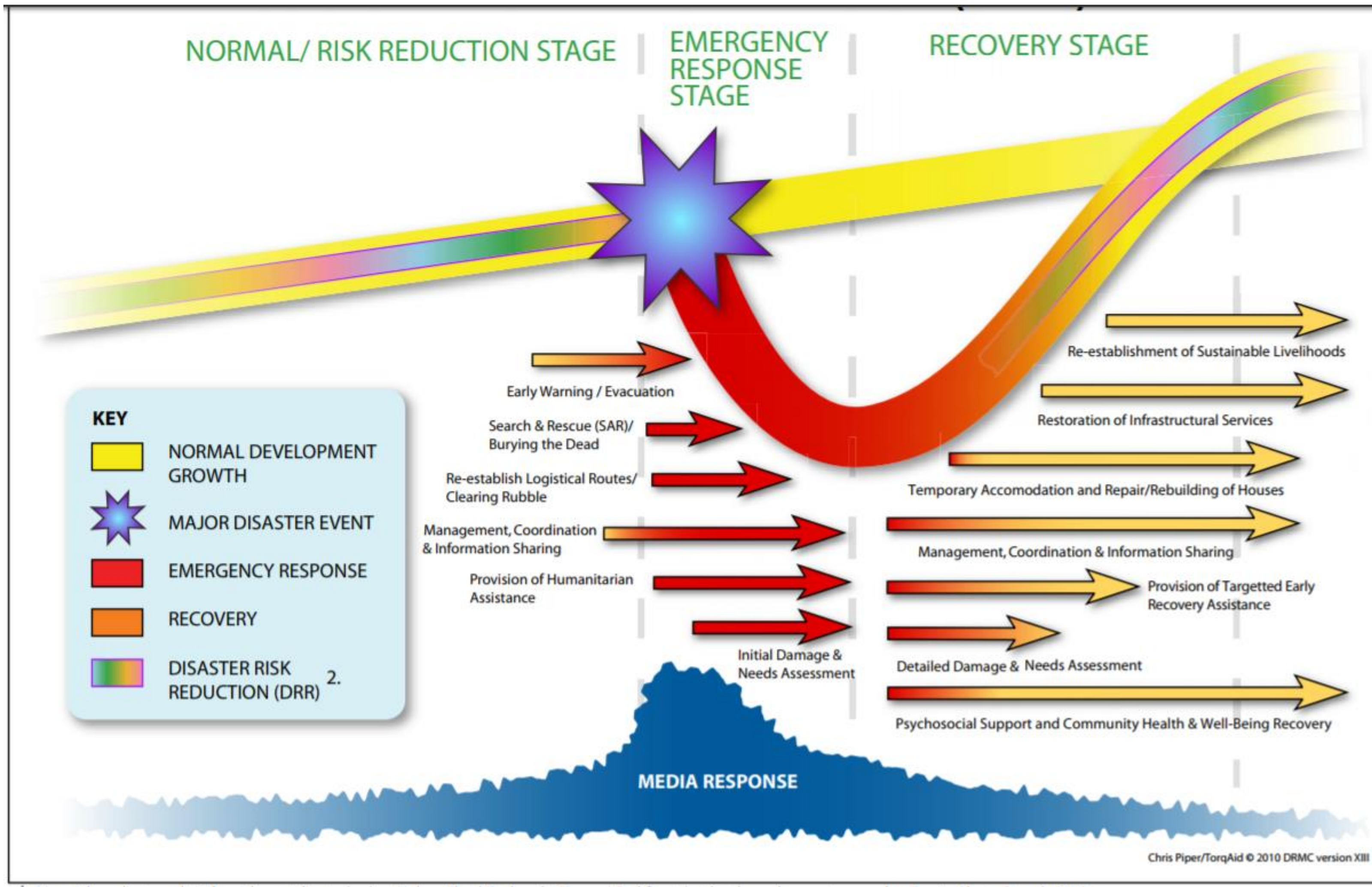
ii. increase the technical capacity to monitor, model and forecast with **higher accuracy**;

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.

On-line GIS services can help communities at risk via awareness and education

Icelandic Met Office



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

Next steps at IMO and within the NORDRESS project

Icelandic Met Office

i. Further improvement of an 'operational dashboard' for viewing incoming observations from the public.

ii. Visual improvements and cross-platform access issues.

iii. Automatic display of preferred language, based on browser locale setting. (*This improvement would allow foreign tourists to use IMO's registration forms.*)

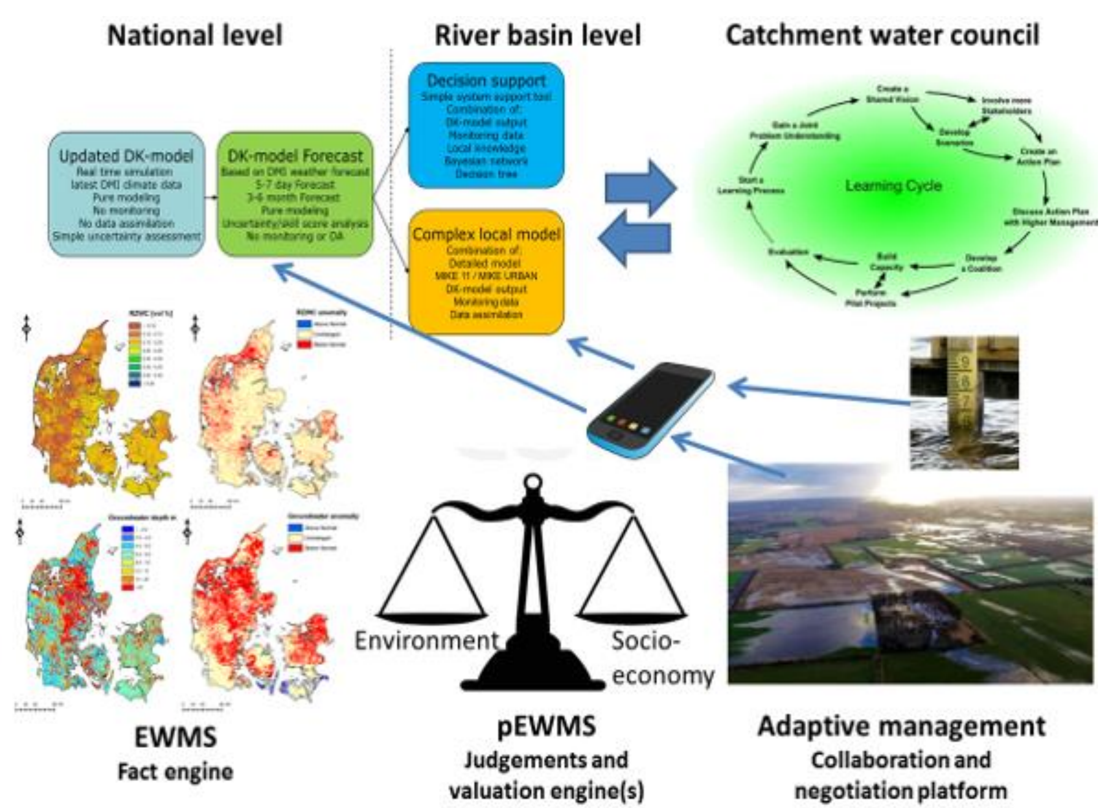
iv. Automatic alerting of newly uploaded photographs via a monitoring script. (*This would make IMO monitoring staff aware of new imagery within minutes of an upload.*)

Forthcoming paper from the NORDRESS project

Hans Jørgen Henriksen *et al.*, submitted. Classic versus participatory early warning and monitoring systems for natural hazards: A Nordic perspective *International Journal of Disaster Risk Reduction*, special issue, 2017.

The paper explores links between risk knowledge, monitoring and warning services, public communication, and response capabilities

GIS-based examples from Denmark, Finland, and Iceland



Conclusions

i. On-line GIS services are clearly a viable and effective way of gathering non-technical information from the public.

ii. Public participation in key stages of the warning process can help to validate forecasts and provide early recognition of potentially harmful changes.

iii. Public reports of unusual or damaging natural events not only provide scientists and first-responders with valuable local information and context, they also help to increase public awareness of natural hazards.