wissen wohin
savoir où
sapere dove
knowing where

swisstopo

# National mapping agencies in age of digital transformation

## and the changing demands for research and development

Dr. André Streilein

# The task of mapping agencies is …

# … producing nice maps

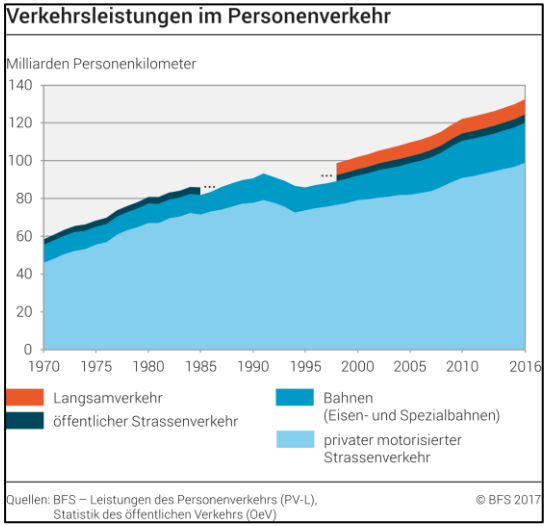
# The task of mapping agencies

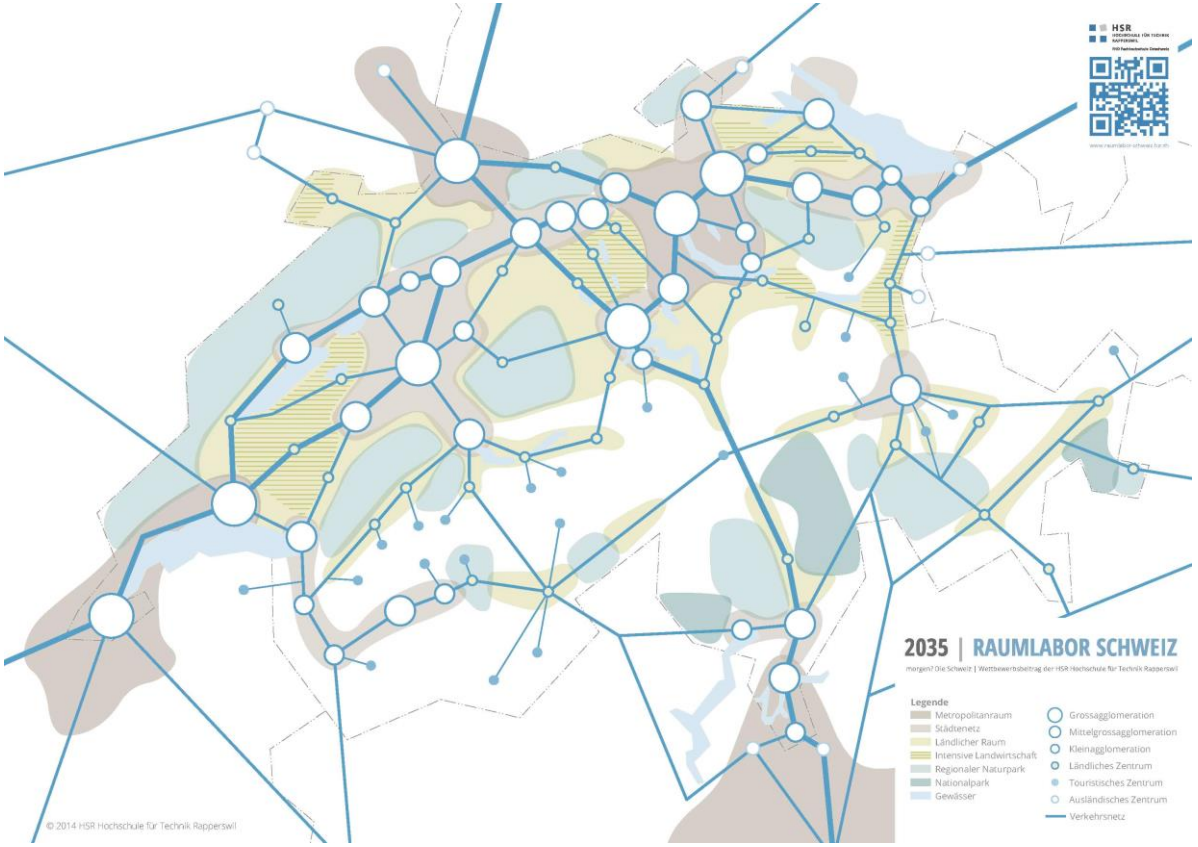
- **Geoinformation** is a vital part of any modern country's **national infrastructure**. It is just as important as traffic and communication networks and is growing in significance as an economic factor.
- **Fundamental information** to make transparent, traceable **decisions** in matters of politics, economics and society.
- Official bodies must provide **reliable geoinformation**,
  - to ensure a properly functioning **democracy** in which citizens can participate in making important political decisions
  - to contribute to the **social development** expected in any modern state.

# United Nations 2030 Agenda

# Development of mobility

- Public and private traffic increases.
- Not do more of the same.
- Steering of traffic flows requires reliable geoinformation



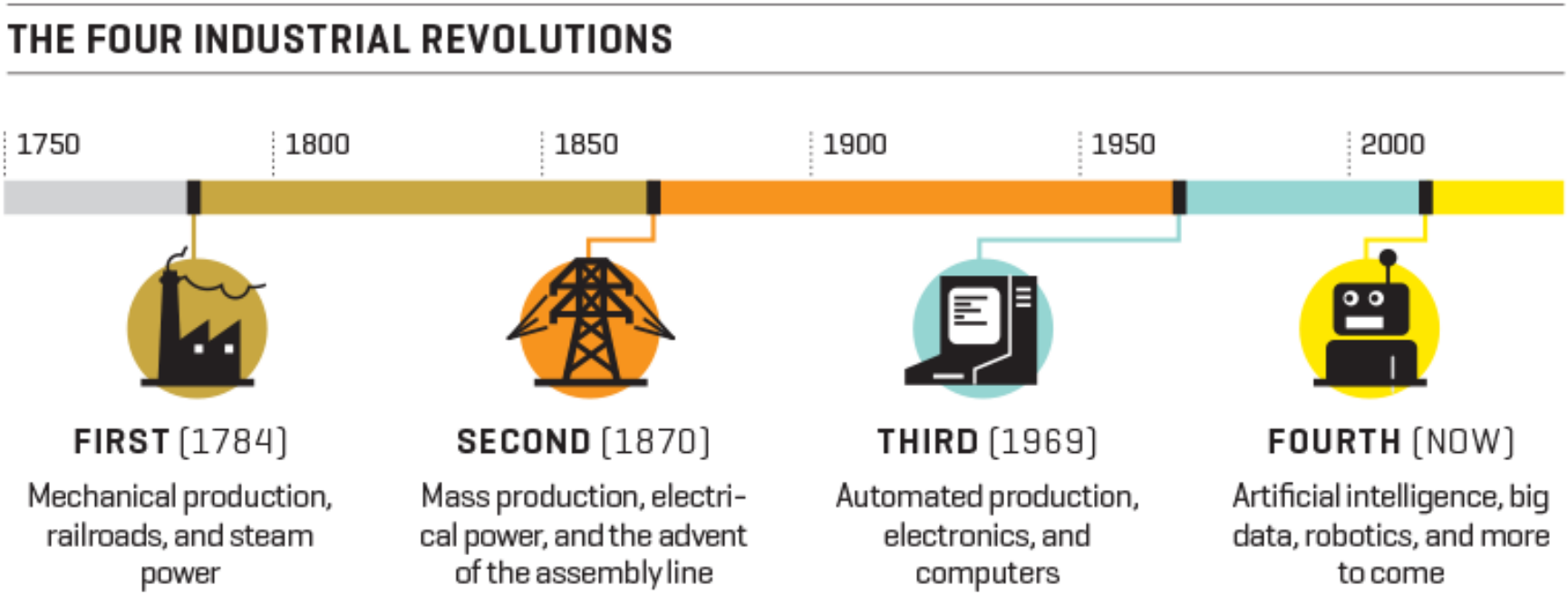

© HSR University Rapperswil

# Agenda

- Tasks of (national) mapping agencies
- Challenges of digital transformation
- Strategic response of a NMA
- Maintaining Trust
- Conclusions

WORLD ECONOMIC FORUM

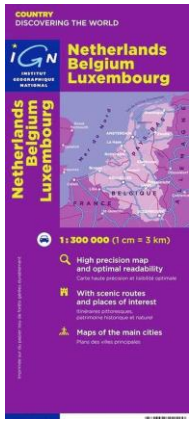
# Location




Allan Murray, Fortune: «CEOs: The Revolution Is Coming"
http://fortune.com/2016/03/08/davos-new-industrial-revolution/

# Digital transformation in telecommunication

# Digital transformation in geoinformation ?



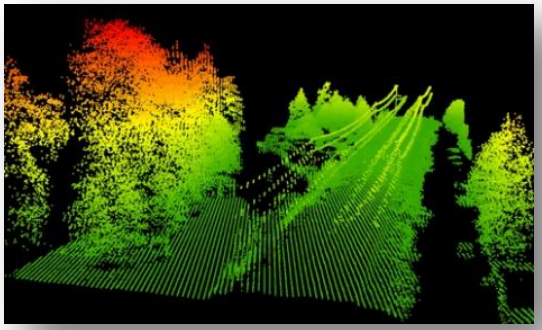
# digital transformation

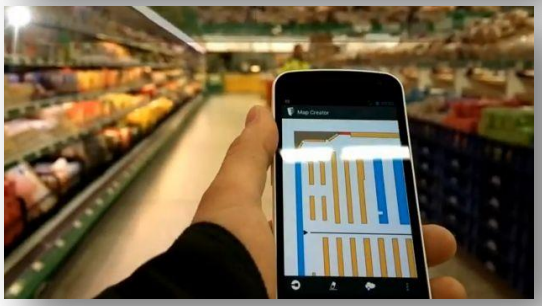
# Collecting and Updating Data in a 20th Century Mapping Agency

- Data collection used to be so easy:
  - Surveyor on the ground, with total station or GPS kit
  - Stereo imagery from a metric camera in an aircraft
  - Office-based image interpreters
  - Manual data capture into a 2D GI database (or “map”)

adapted from David Holland OS GB - ISPRS 2016

# Collecting and Updating Data in a 21st Century Mapping Agency





- Now data is available from many other sources:
  - Surveyor on the ground, with scanners & cameras
  - Multi-overlap aerial imagery
  - Multi-temporal and multi-spectral satellite imagery
  - Oblique imagery
  - Lidar, single photon lidar, Geiger mode
  - Imagery from consumer cameras on UAVs
  - Multi-sensor backpacks and trolleys
  - Multi-sensor mobile mapping systems
  - Geo-coded social media (images and messages)

**Bundesamt für Landestopografie swisstopo**

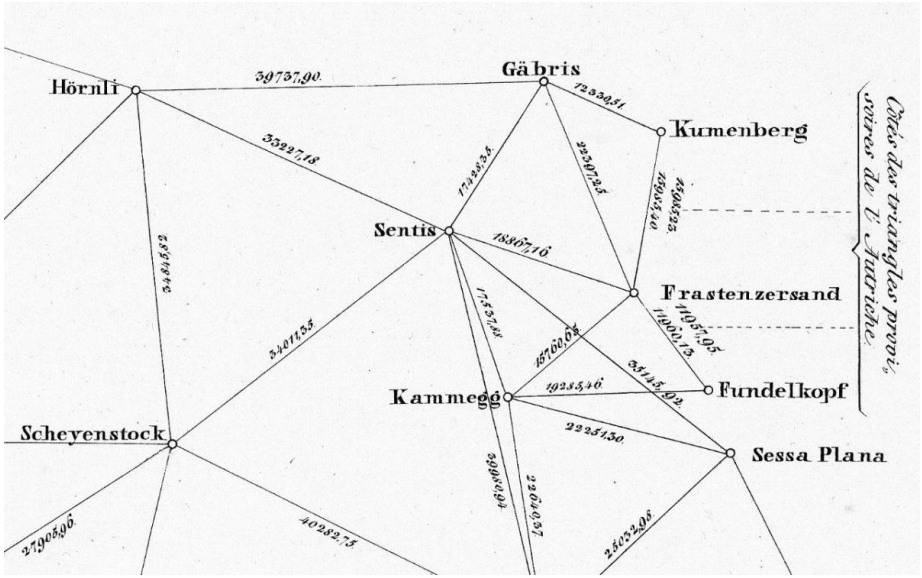
adapted from David Holland OS GB - ISPRS 2016

# And … citizens as a sensor

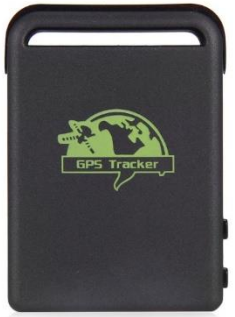
Dufour map 1854 - new name and position added by customer

**Bundesamt für Landestopografie swisstopo**

# Mapping has turned from a task of high specialised experts ….



# … to common property



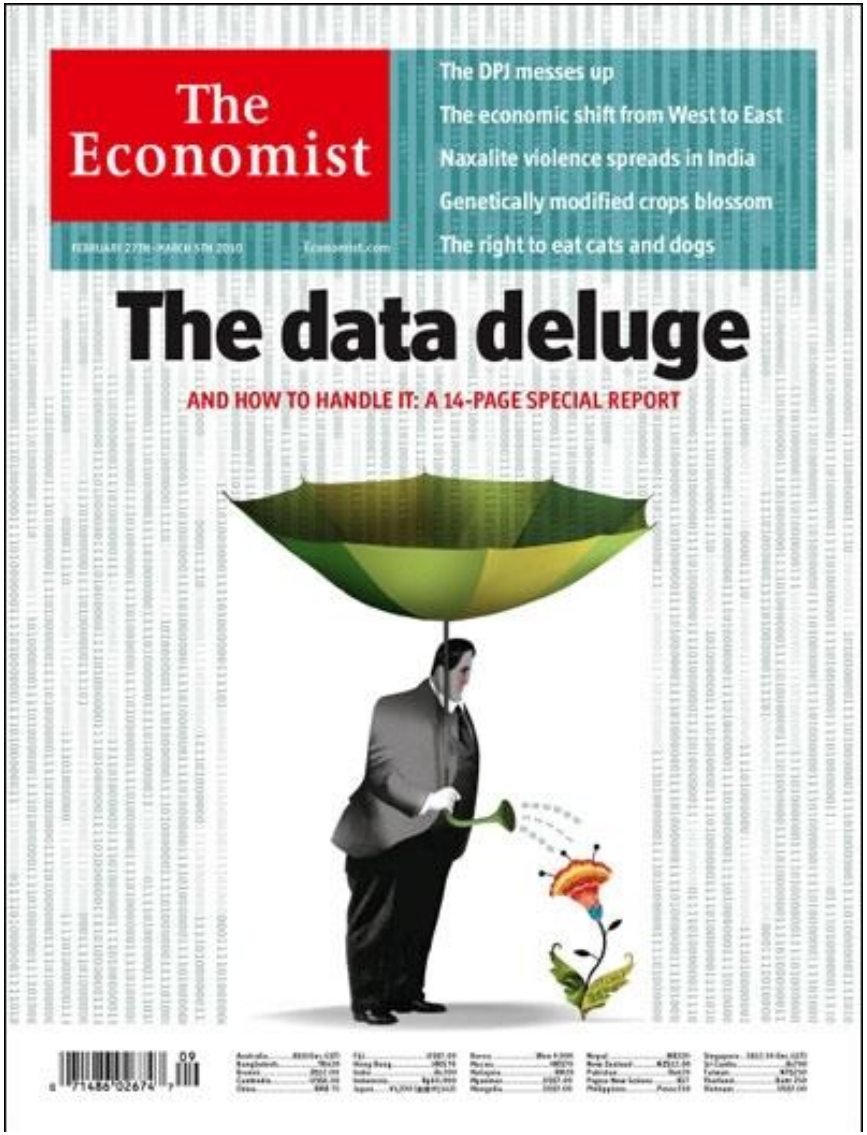
# And we see hypes …

# … the concept of drones is more than 100 years old

Source: Dr Julius Neubronner's Miniature Pigeon Camera, 1908

# New processes

Library collegiate church St. Gallen

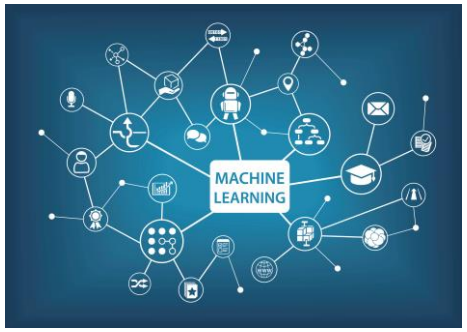


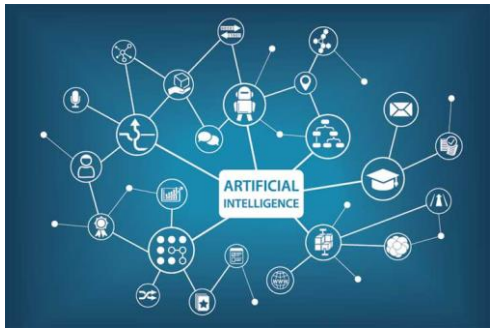
# The age of Big Data

volume
velocity
variety

«Correlation is enough. We can stop looking for models.»

Chris Anderson, Chief editor, Wired magazine, 2008

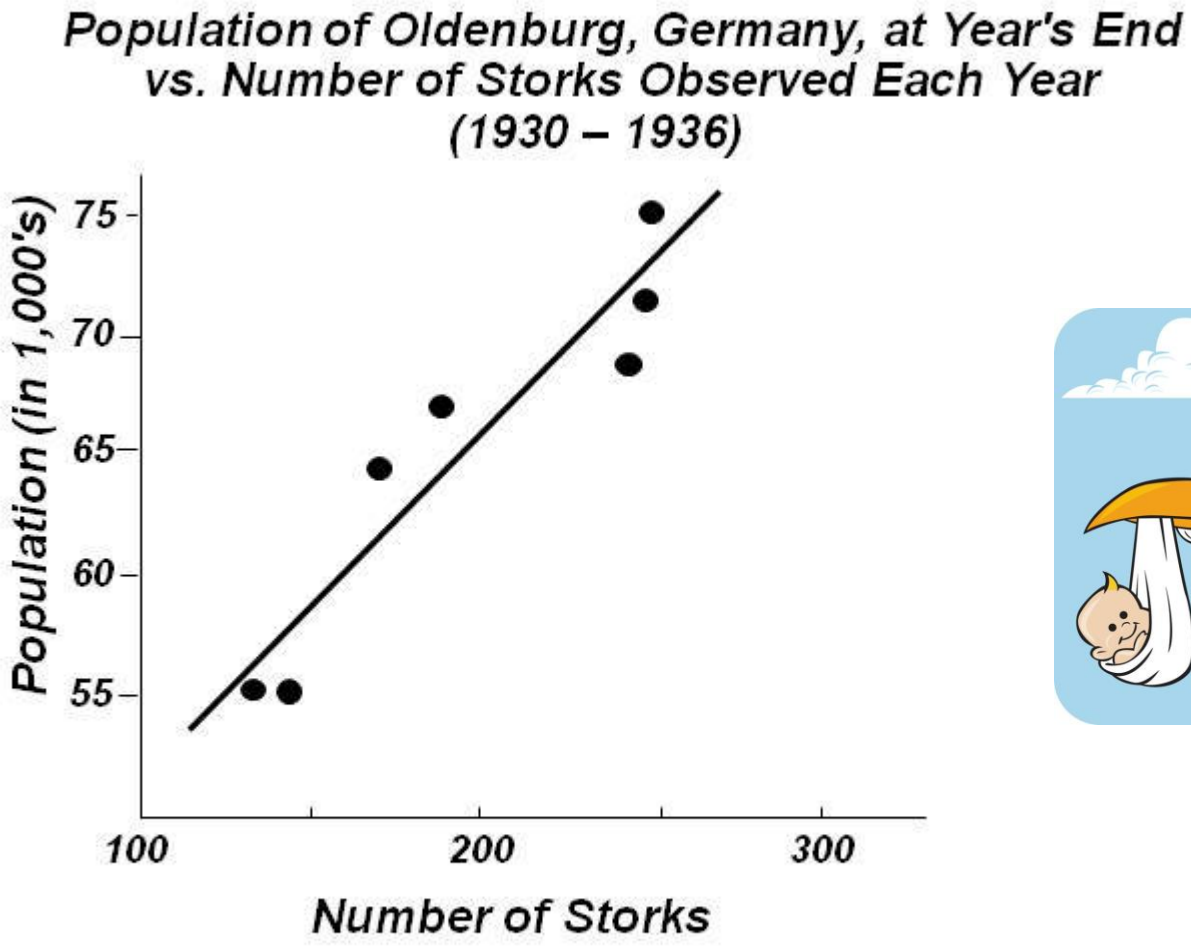


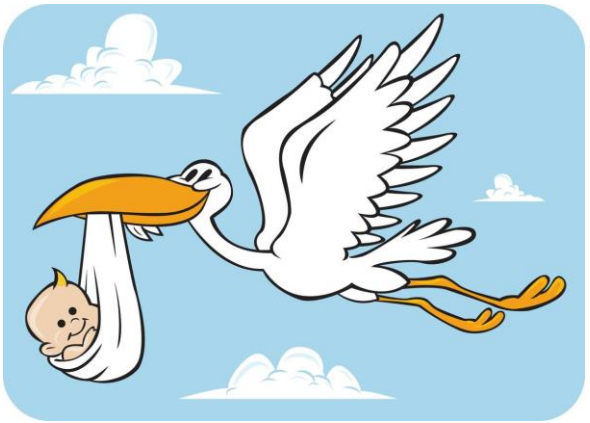



# “A Fool with a Tool is still a Fool”

Grady Booch (*1955) - american software engineer, best known for developing the Unified Modeling Language (UML) with Ivar Jacobson and James Rumbaugh

# Spurious correlation



Source: Statistics for Experimenters,
by Box, Hunter & Hunter

**MORE IPHONES MEANS MORE PEOPLE DIE FROM FALLING DOWN STAIRS**

40M
30
20
10
0
20

Deaths caused by falls down stairs (U.S.)

2,000
1,975

**LET'S CHEER ON THE TEAM, AND WE'LL LOSE WEIGHT**

$25B
20

Per capita consumption of high-fructose corn syrup (U.S.)

75 LBS
65

**TO INCREASE AUTO SALES, MARKET TRIPS TO UNIVERSAL ORLANDO**

8M
7

Visitors to Universal Orlando's "Islands of Adventure"

6M
5
4

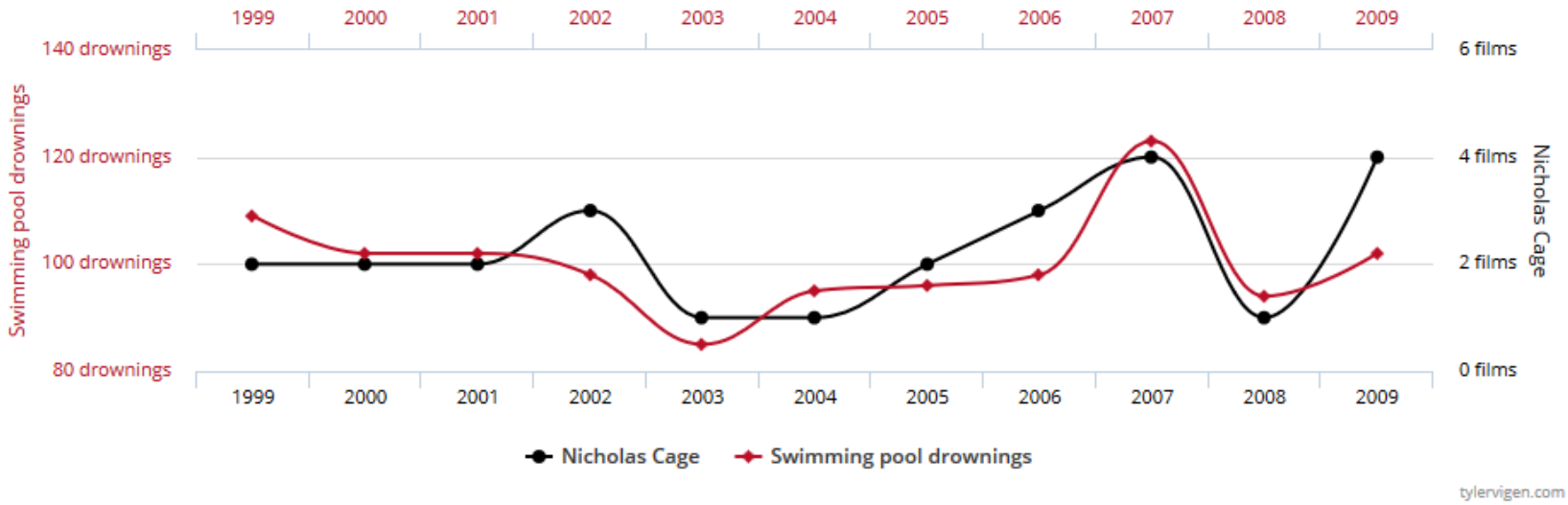
SOUR
FRON
RG

## Number of people who drowned by falling into a pool

correlates wtih

## Films Nicolas Cage appeared in

Correlation: 66.6% (r=0.666004, p>0.05)

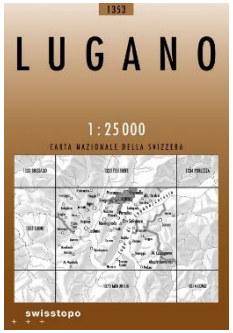


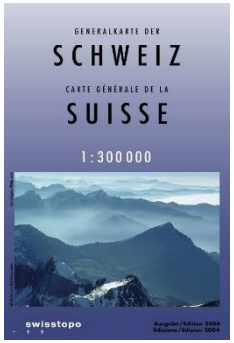

tylervigen.com

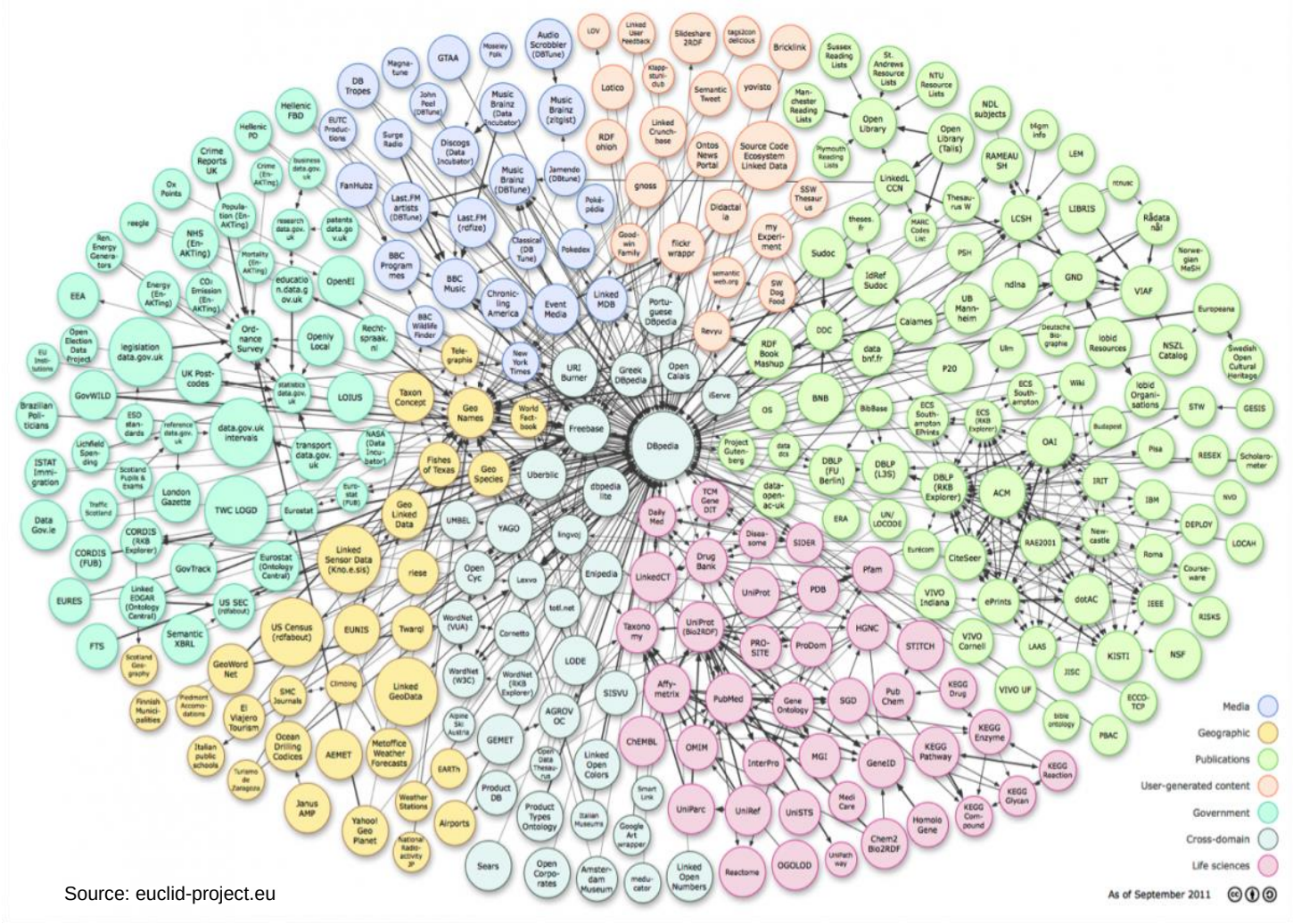
Data sources: Centers for Disease Control & Prevention and Internet Movie Database

# New users

# Information usage - interconnected

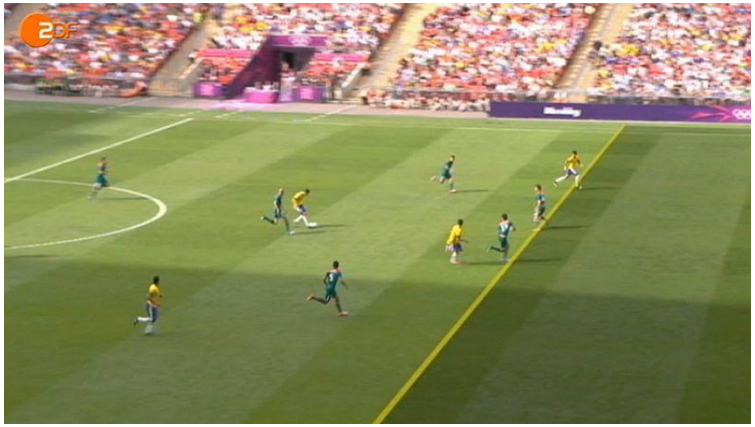


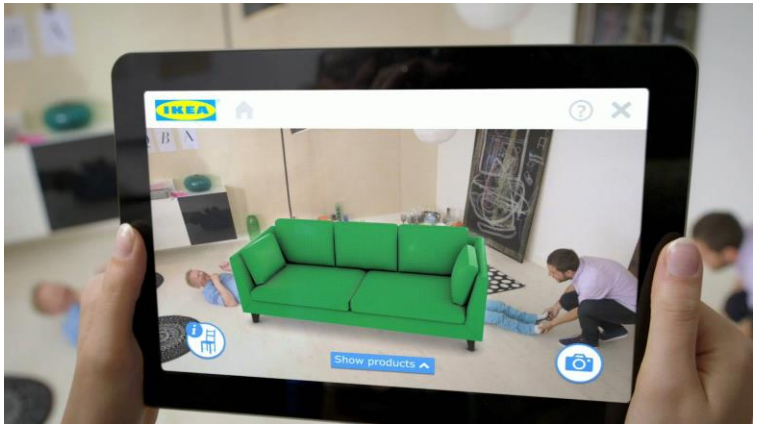



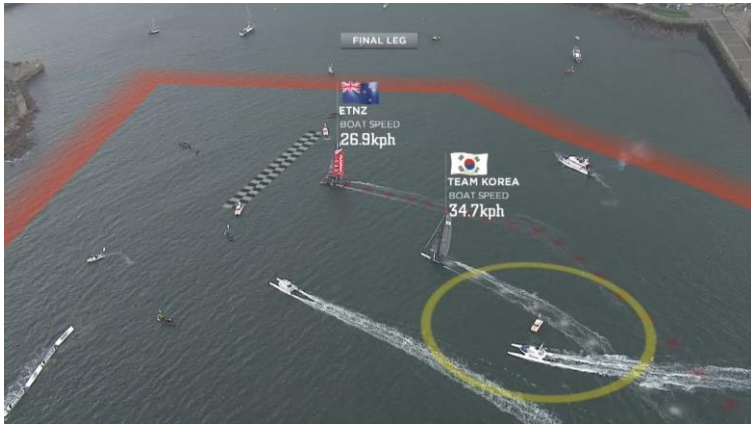




Source: euclid-project.eu

# Information usage - augmented reality

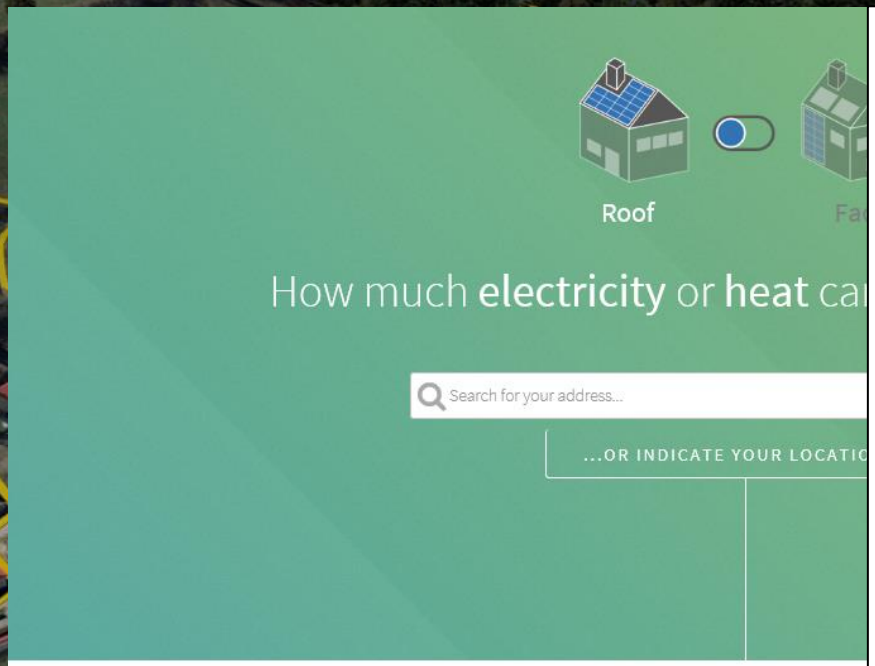


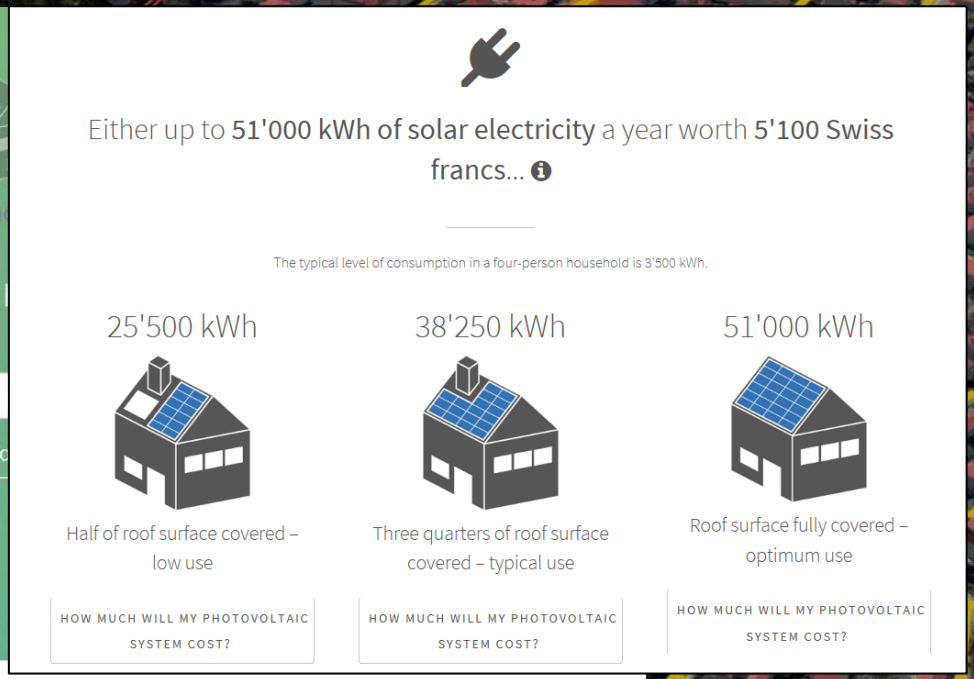


# Information usage - augmented reality

# Information usage
# Swiss Energy Strategy 2050




Seftigenstrasse 264
3084 Wabern

Suitability: Very high

Either Solar electricity worth up to 5'100 Swiss francs...

...or Solar heat for 4 % lower heating costs.

Full screen

www.sonnendach.ch

swissTLM3D

# Challenges for mapping agencies

# Agenda

- Tasks of (national) mapping agencies
- Challenges of digital transformation
- Strategic response of a NMA
- Maintaining Trust
- Conclusions

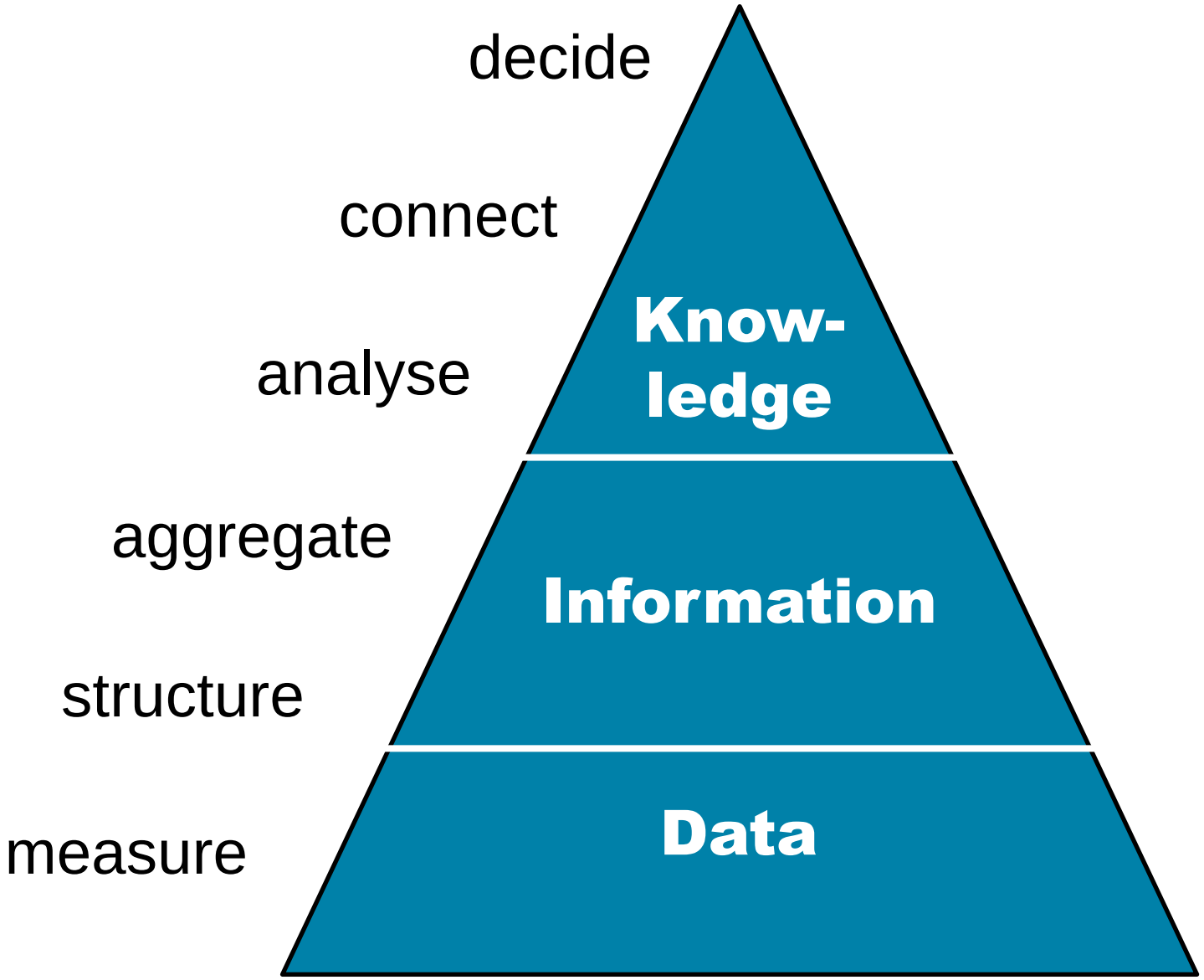
# Geoknowledge - for a changing society

# For a changing society

Inauguration pope
Benedikt XVI, 2005

Inauguration pope
Franziskus I, 2013

# From information to knowledge



# And the good message …

80% of all political, economic and private decisions are based on spatially information.

In everyday life, almost everyone uses geoinformation regularly, often without even realising it.

The quality of decisions depends on good and trustable geographic information

# Maintaining databases
# Incremental update

© City of Bern / Switzerland

# swisstopo - strategic focus 2020

- swisstopo will strengthen its position as the **centre of expertise** for geoinformation and georesources.
- swisstopo will publish comprehensive, **up-to-date** geographical reference data for Switzerland that meets the necessary quality requirements.
- swisstopo will make available its official digital data and products in accordance with the principles of **open government data**.
- swisstopo will improve the **usability** of its data and products.
- swisstopo will work with its partners to **round off** its offer of geographical reference data in Switzerland.

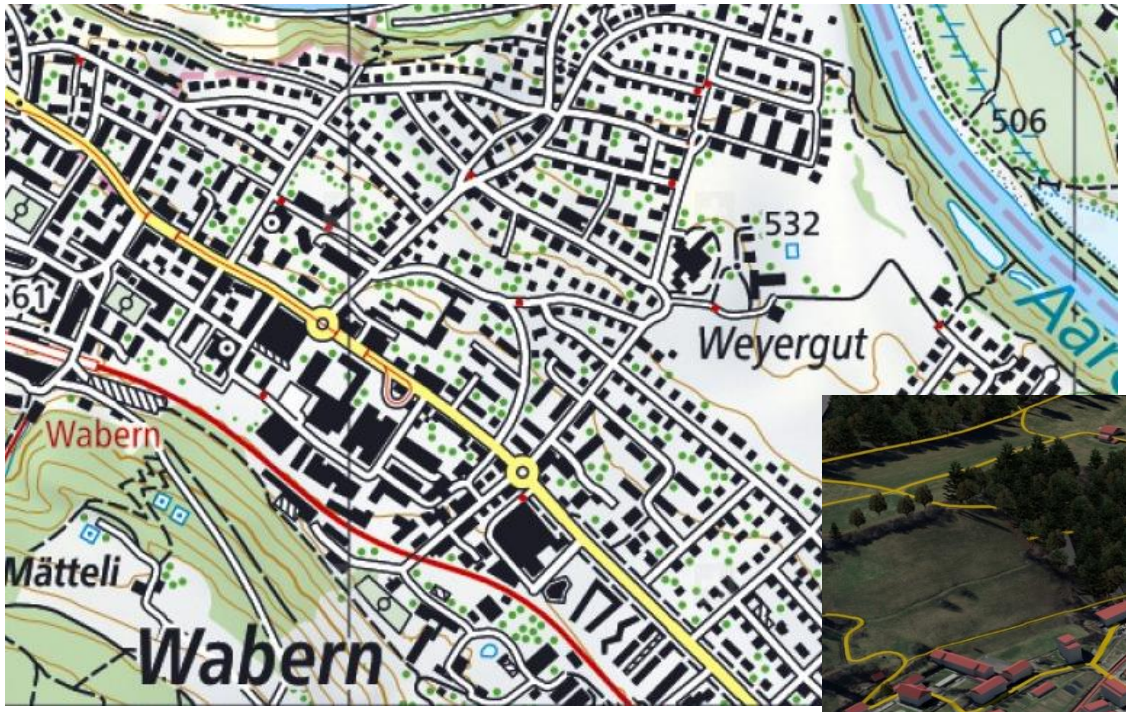
# Strategic focus - usability

**Improved, future-proof usability**

- **Future use/users**
- **Link information (with other sources)**
- **Augmented reality**
- **3D**

- swisstopo
  - …… will gear its products towards future generations and their user behaviour;
  - … will provide data and products that meet international requirements;
  - … will provide basic geodata that can be easily linked to other attribute data (linked data);
  - … will make its data and products compatible with augmented reality applications;
  - … will provide highquality 2D and 3D visualisations for various platforms;
  - … will ensure that changes over time in the real world are documented in the reference data;
  - … will improve the economic relevance of its data and products.

# Move from an analogue to a digital twin of our environment



Bundesamt für Landestopografie swisstopo

# digital twin

Ordnance Survey

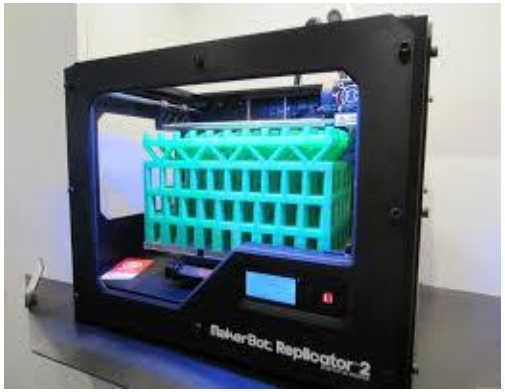
A Digital Twin of the UK would have to be:

- structured – a federated system of systems (managed by a multitude of organisations)
- extensible – to allow for future infrastructure developments that go beyond the road, rail, power, waste, water, and telecomms of today; and,
- deferential – by which we mean impartial and trusted

https://www.ordnancesurvey.co.uk/blog/2017/10/digital-twin-new-smart-city/

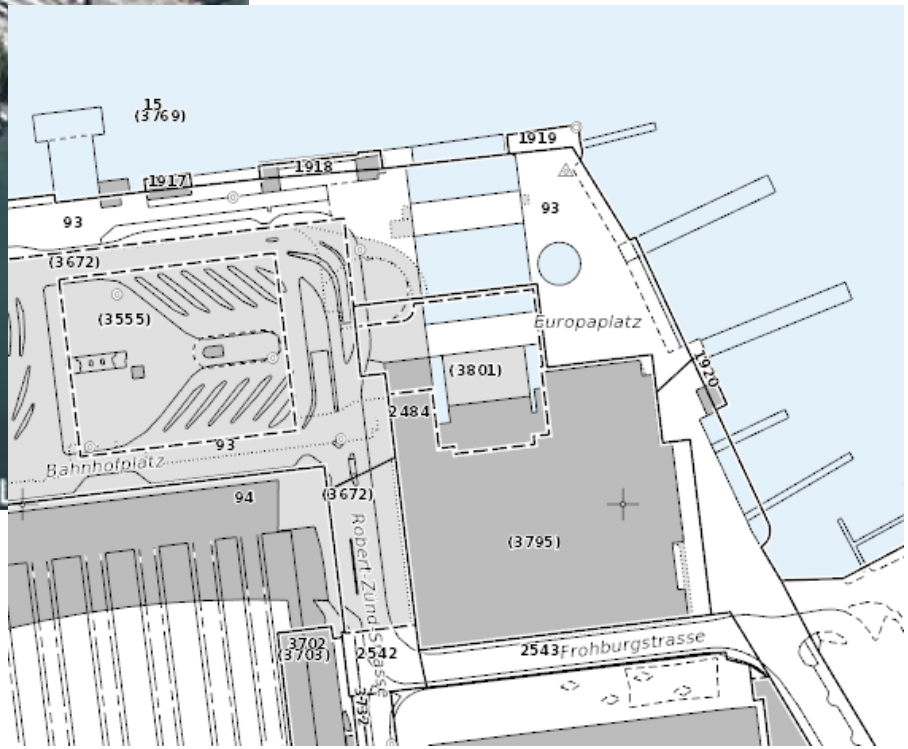
# 3D geoinformation

# 3D is the technology of today



# But reality is made flat …

## … to fit in our 2D traditions




example
Switzerland

Bundesamt für Landestopografie swisstopo

# But reality is made flat …

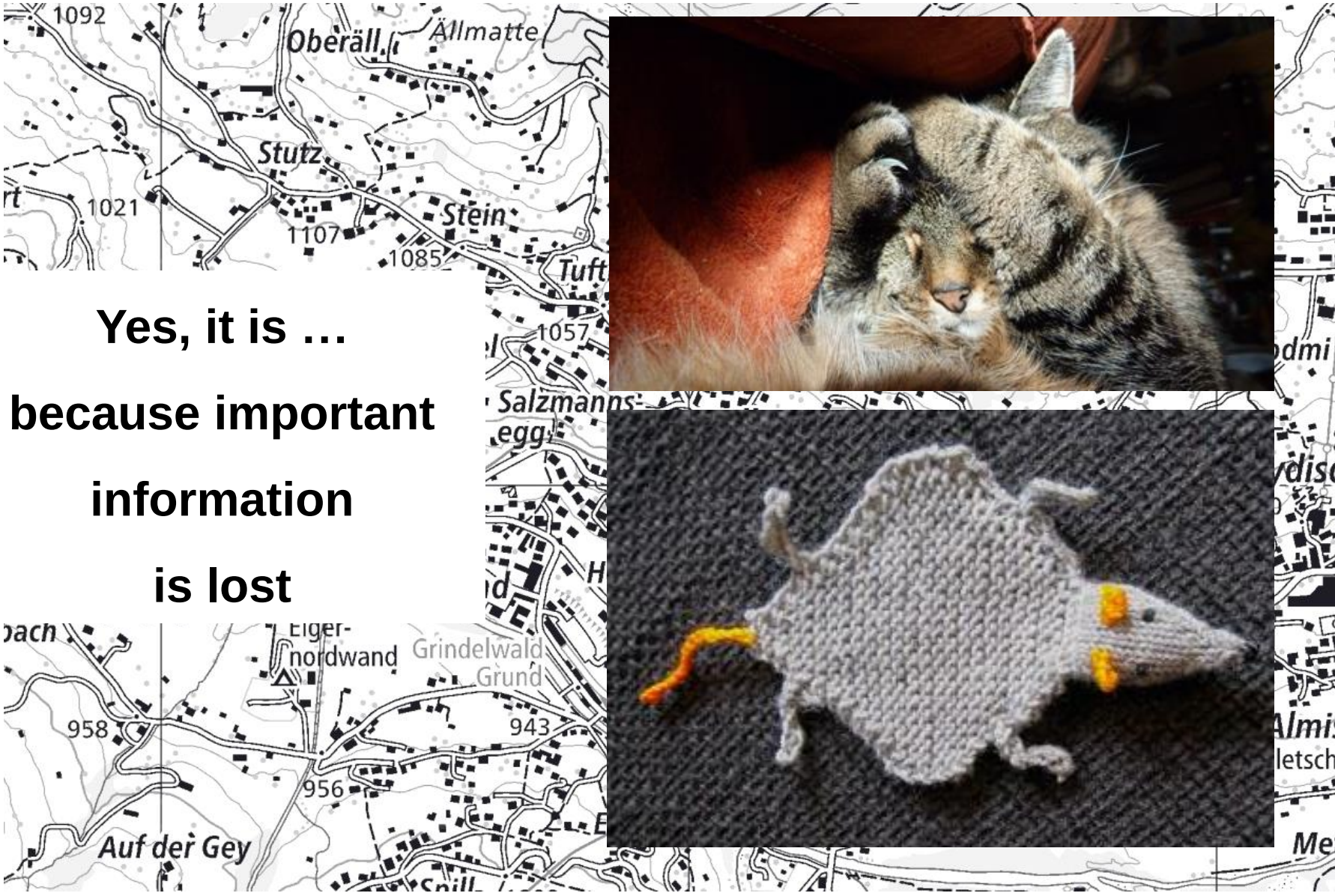
## … to fit in our 2D traditions

Example
France



Paris, Avenue de France

# Is this a problem?




**Yes, it is …**

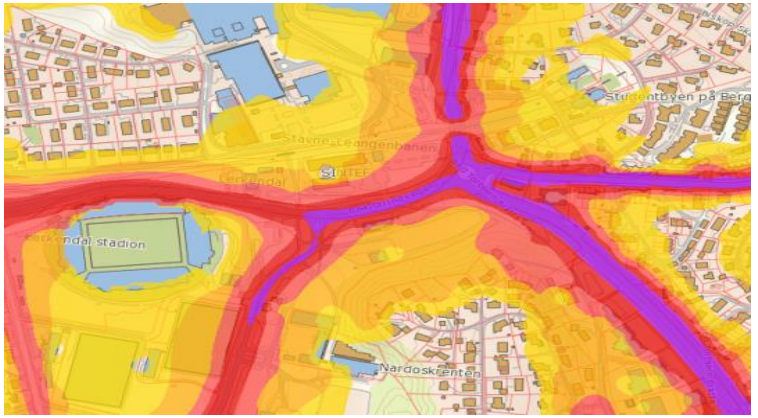
**because important information is lost**

# In 2D important information is lost

# 3D for civic participation

# 3D for sustainable development

Risk preparedness

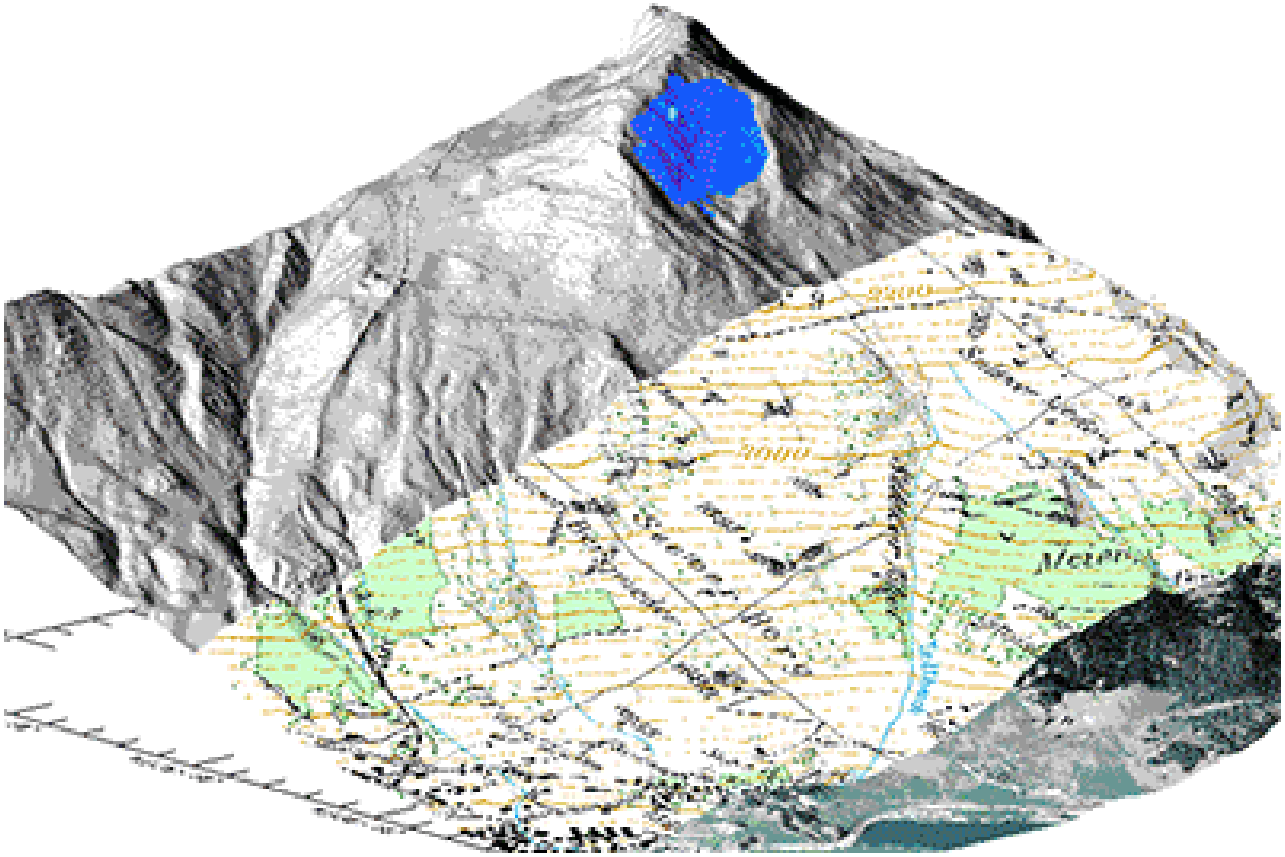


Noise pollution

Property

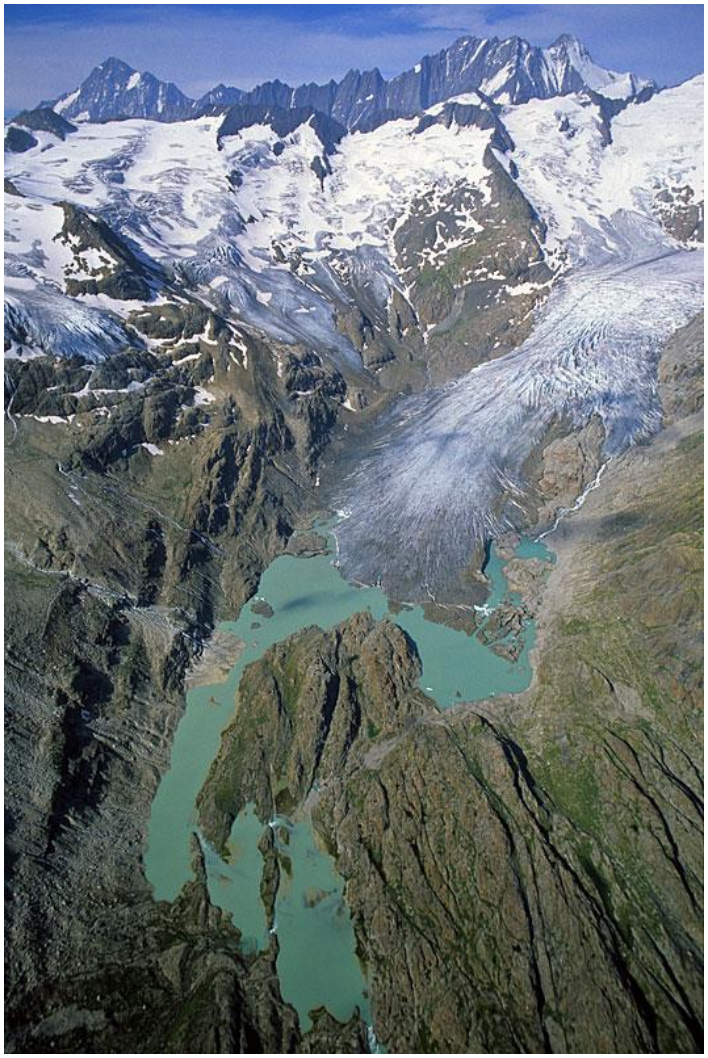
Solar potential

# And … it is necessary to understand dynamic phenomena



© WSL/SLF

# Relevance of 3D geodata – analysis of climate impacts

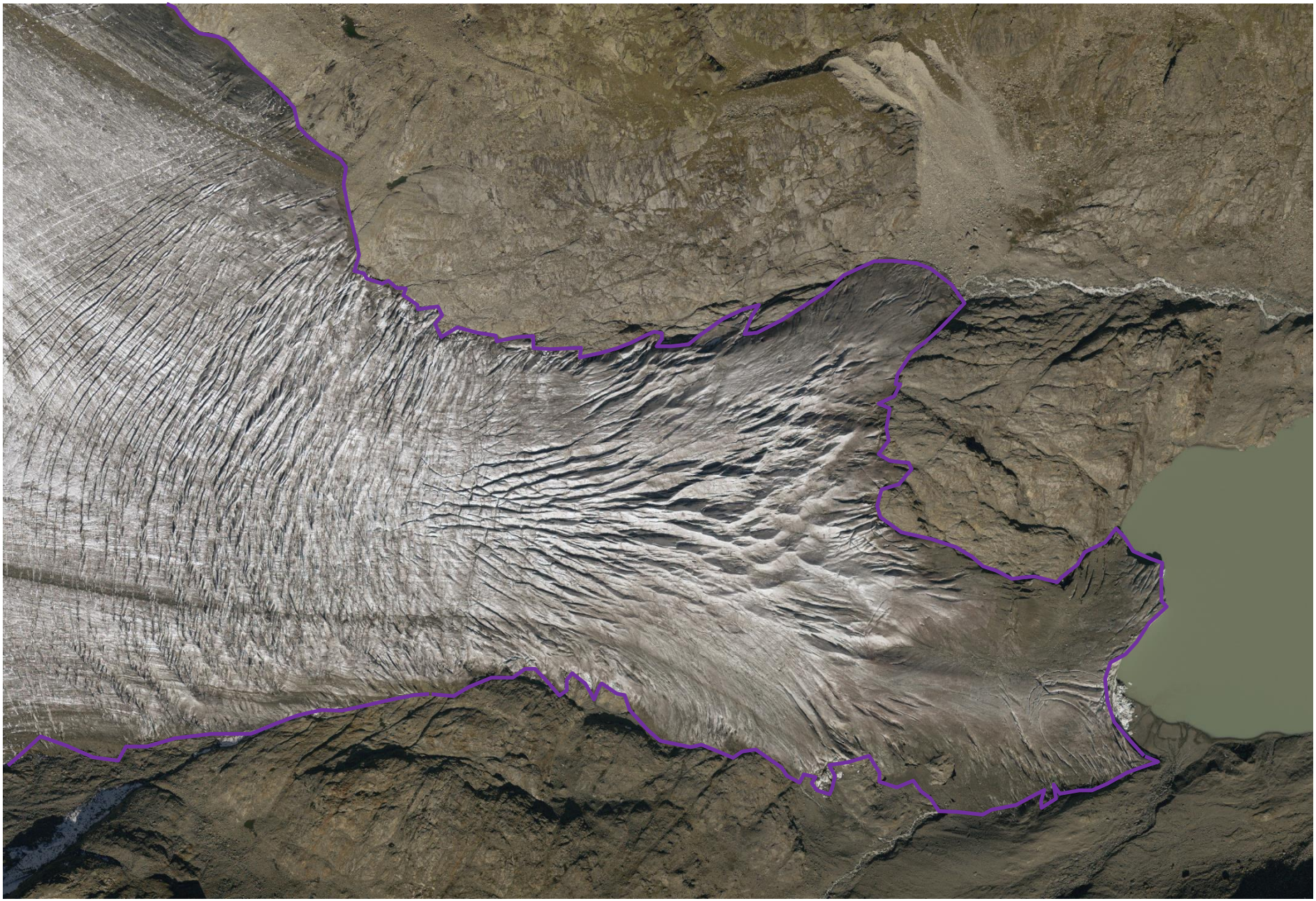


Bundesamt für Landestopografie swisstopo

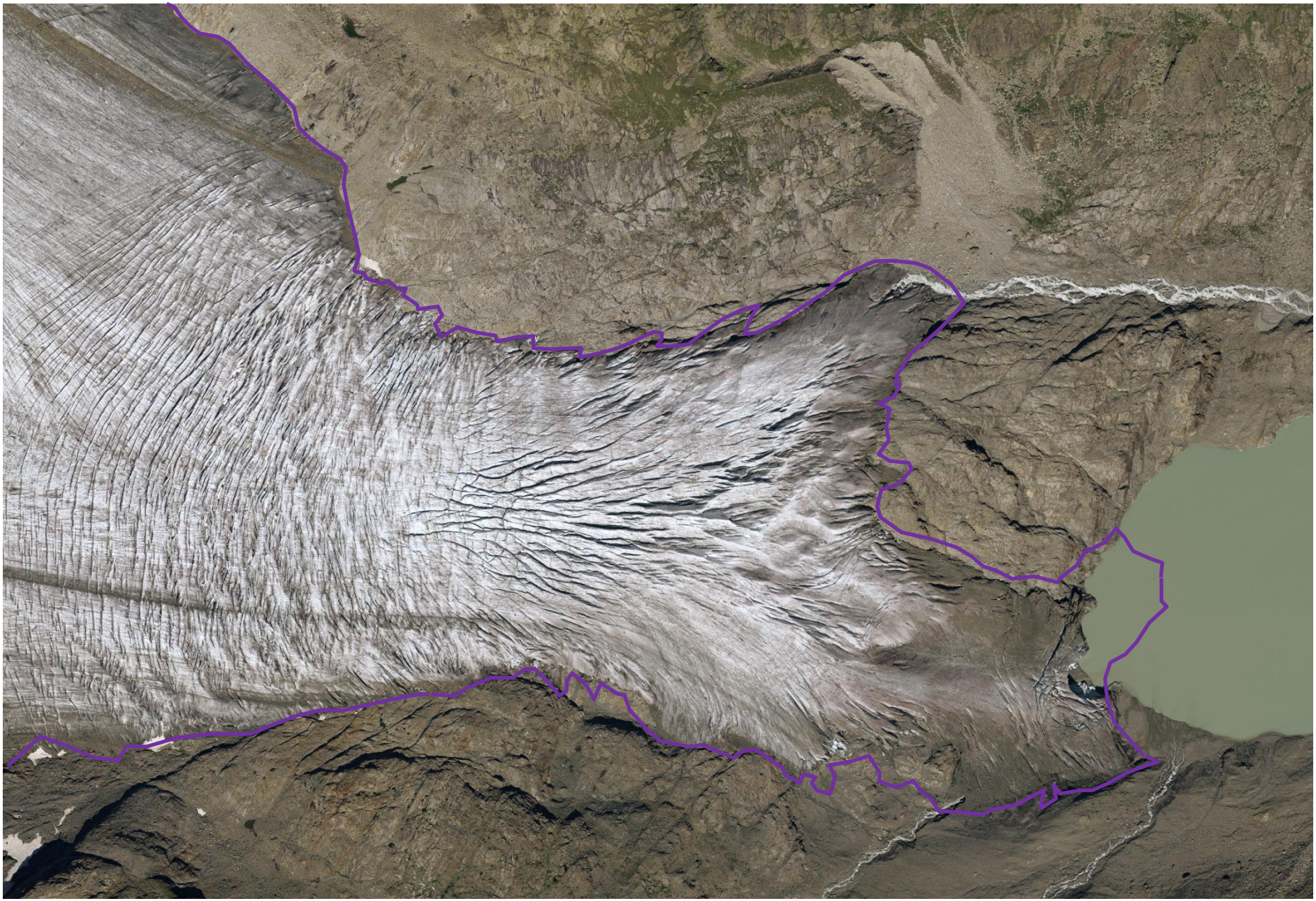
**Example: Gauli glacier, Innertkirchen (BE)**

- length: 6.80 km
- altitude range: 2’140 - 3’600 m
- area: 13.70 $km^2$

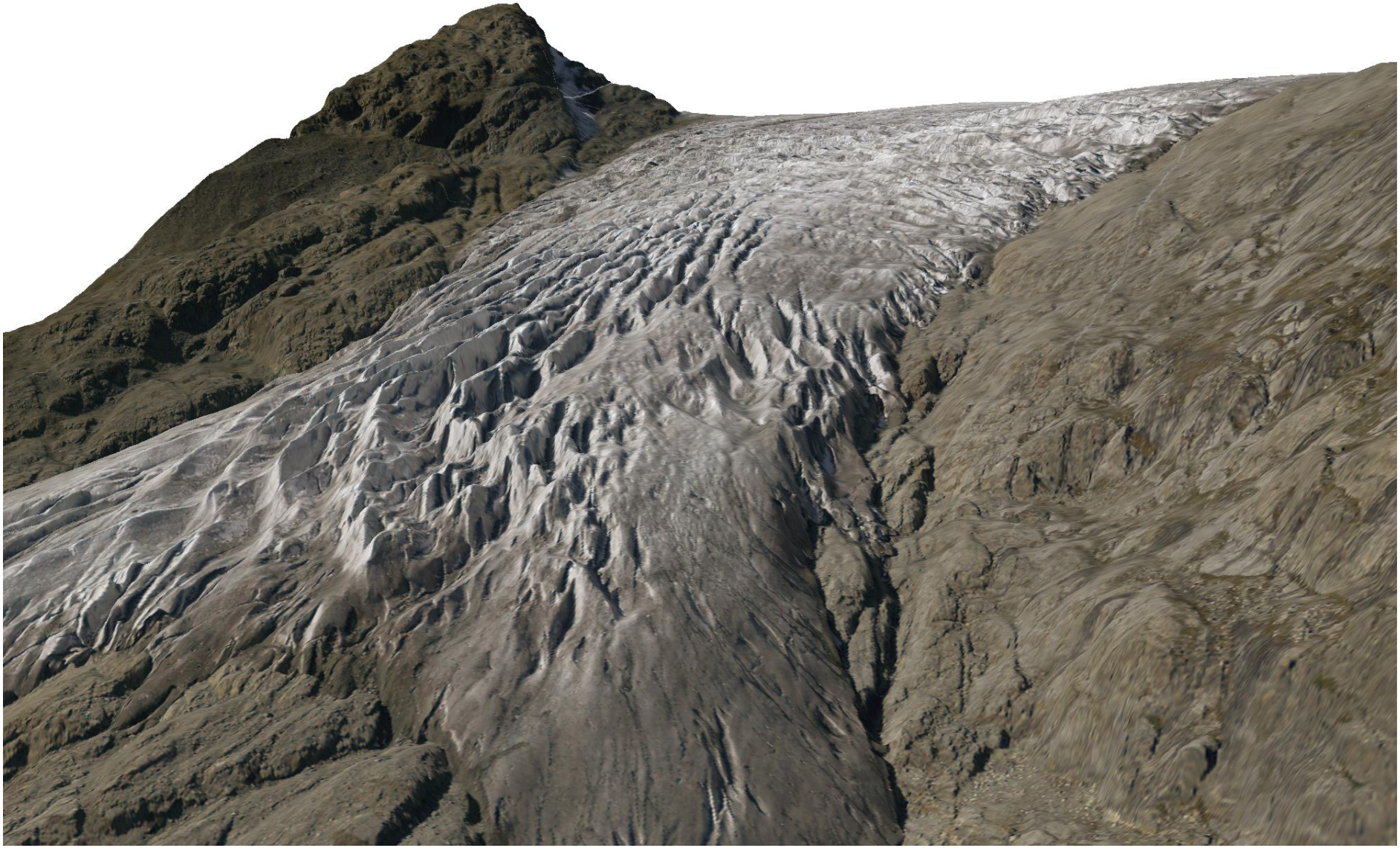
1946: Worldwide first airborne rescue in an alpine environment



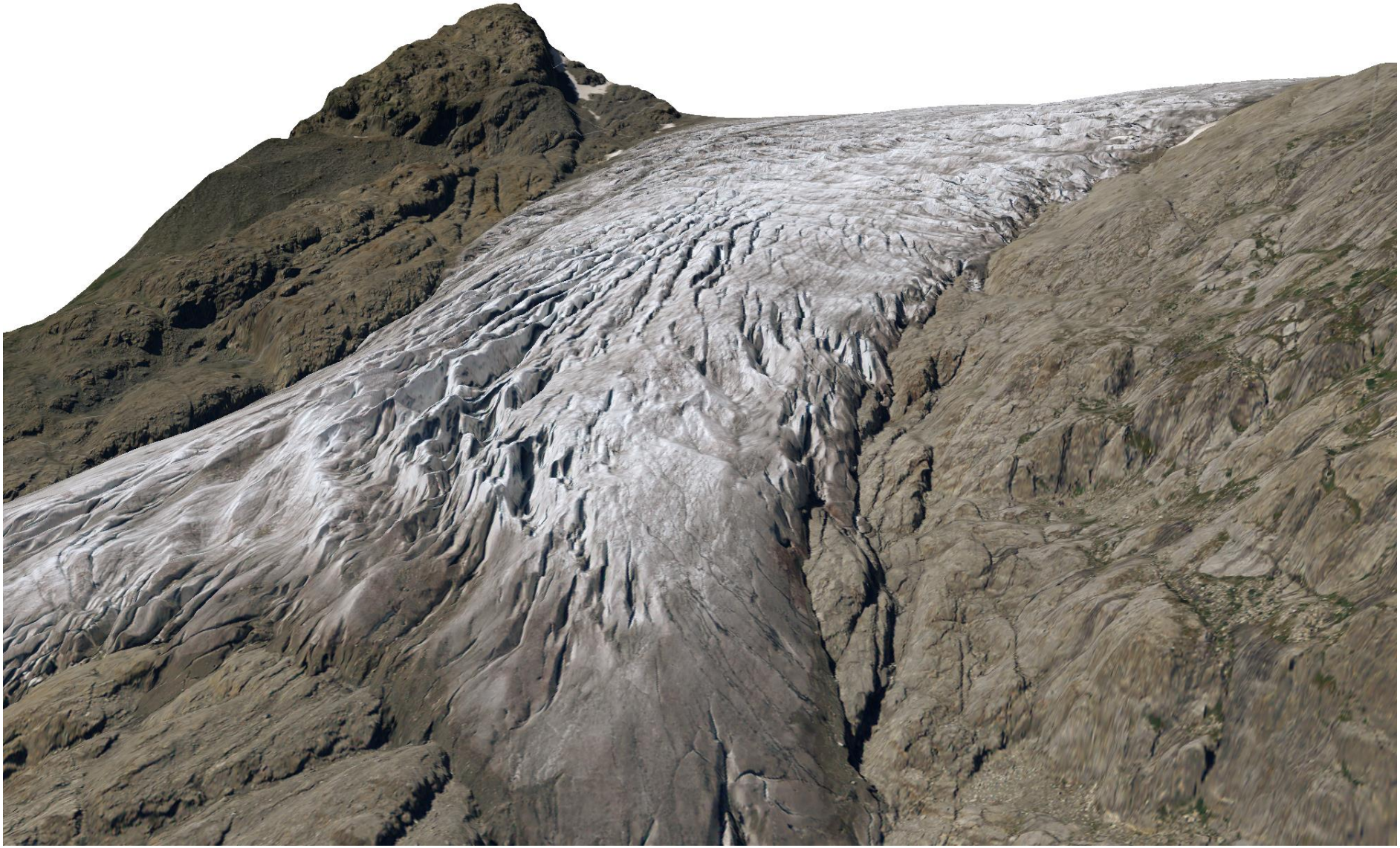
2011



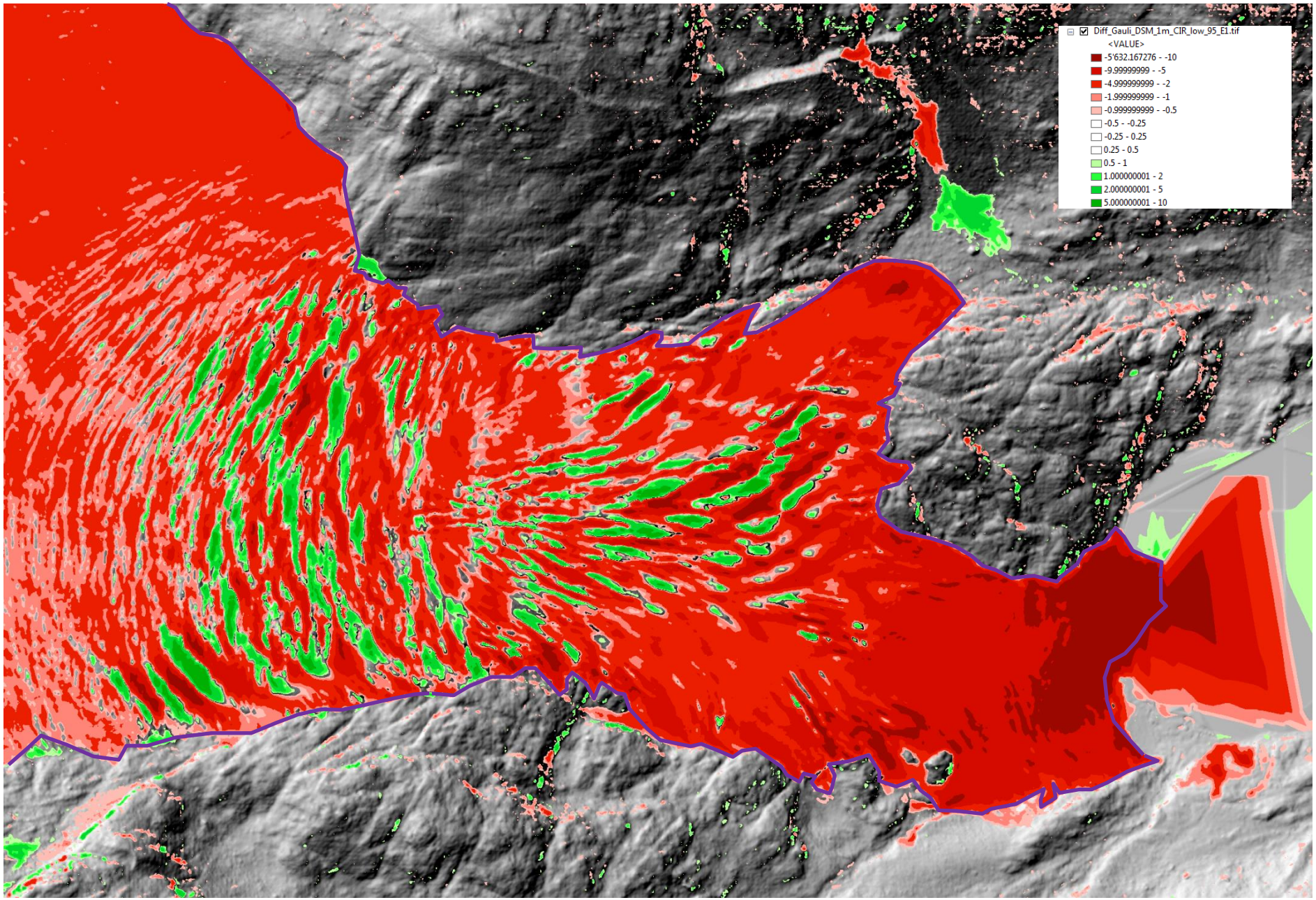
2012



2011



2012

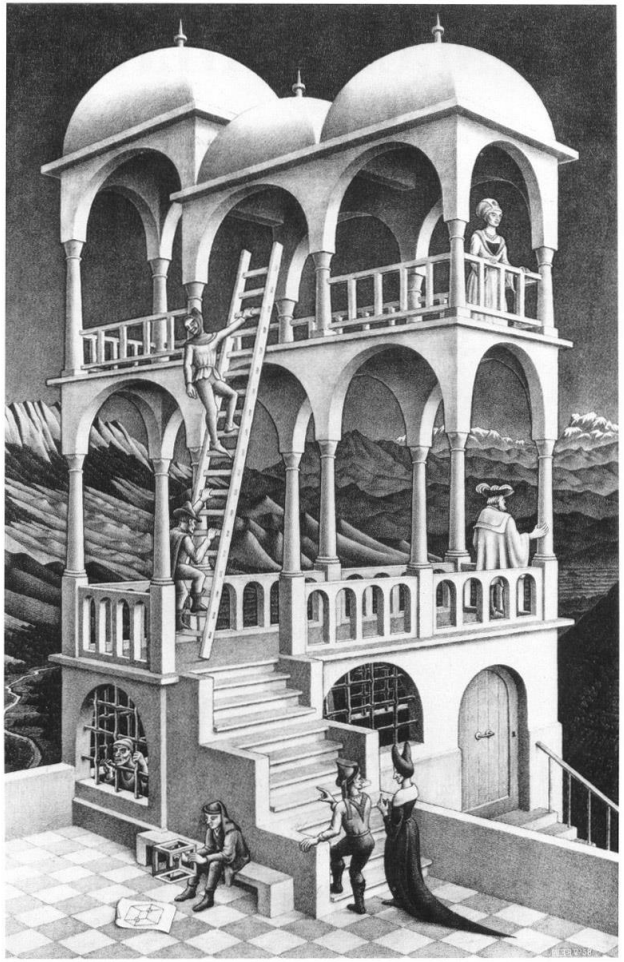



2011 Change detection : 2012 - 2011 2012

# Research issues in 3D

- object reconstruction
- standards and data modelling
- maintenance, storage and update
- dissemination and portrayal
- quality
- integration, fusion and consistency
- users and customers

*400 years of experience in 2D vs. 10 years of experience in 3D*

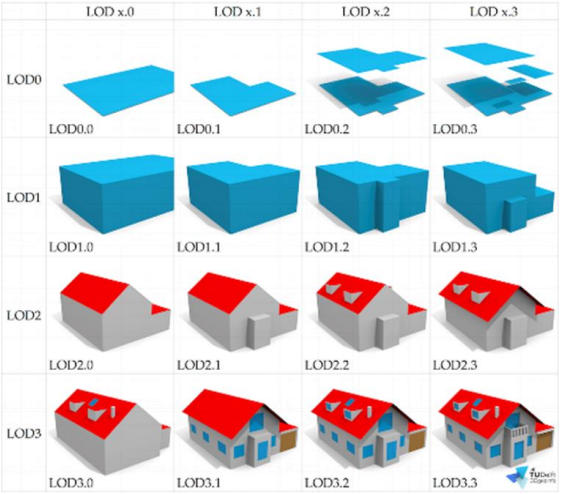


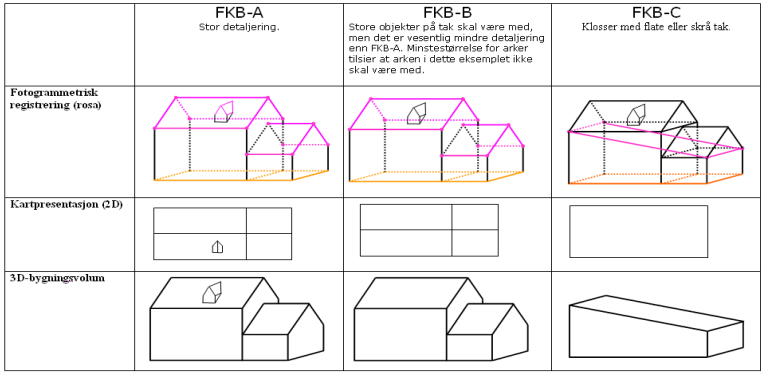
M.C. Escher (1898-1972)

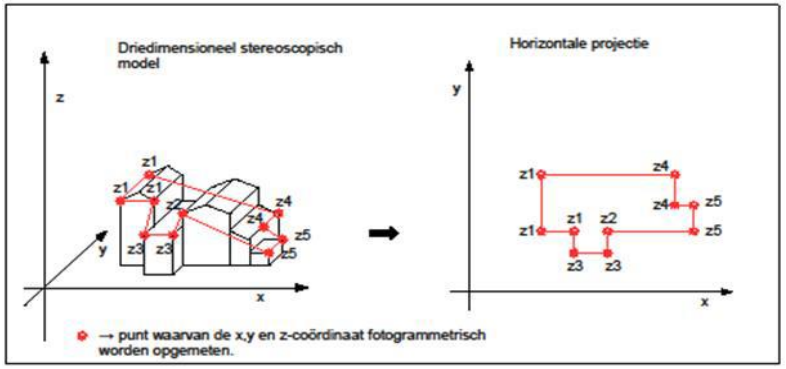
# 3D standards and data modelling

## Level of Detail (and other terminology)

- Widely accepted to define details in 3D models
- But ambiguous



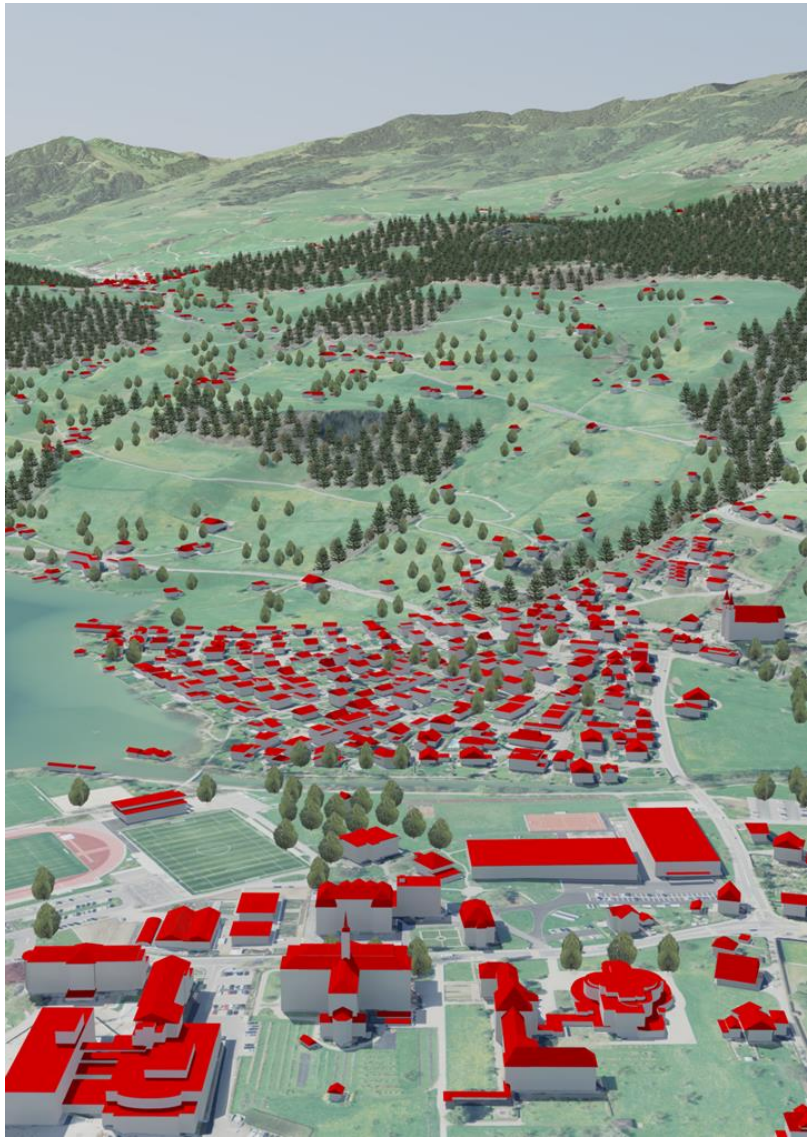




LANTMÄTERIET

NATIONAAL GEOGRAFISCH INSTITUUT
INSTITUT GEOGRAPHIQUE NATIONAL

Bundesamt für Landestopografie swisstopo

# 3D standards and data modelling



Valid 2.5D

- Vertical faces
- How to deal with building footprints (horizontal or following the terrain)
- How to model hypersurfaces
- How to model unequal crossings, bridges
- Consistency 2D and 2.5D

Valid 3D

- Meet ISO requirements?
- Closed?
- Solid or surface?
- Semantic level of detail?

3D data modelling, more issues:

- Common vocabulary for 3D concepts, both for geometry and semantics
- Common vocabulary on scale/LOD
- How to derive 2D from 3D data?
- How to derive LOD(n-1) from LODn

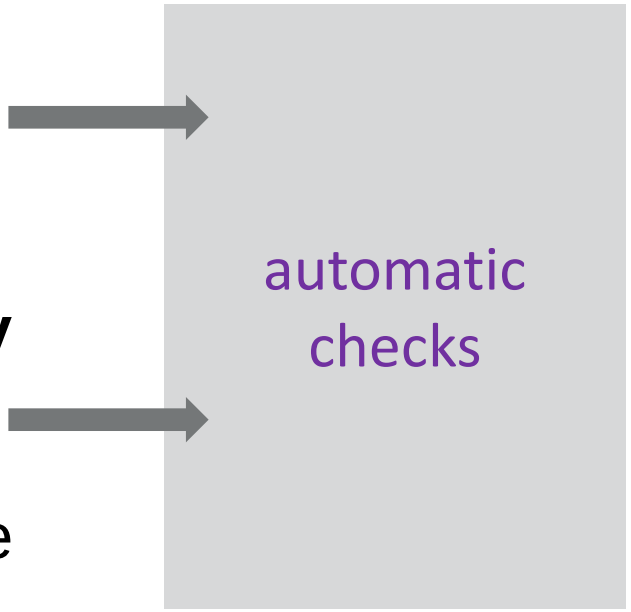
# The A⁴C⁴ quality requirements:
## for landscape models (swissTLM$^{3D}$)

- **Authority** — data source, production
- **Accuracy** — precision
- **Availability** — data access
- **Actuality** — date of data specific survey
- **Completeness** — steered by surveying rules
- **Coverage** — nationwide homogeneity, not hotspots
- **Consistency** — data contradictoriness and coherence
- **Correctness** — comparison model <-> landscape

© T. Kellenberger / ISPRS 2016

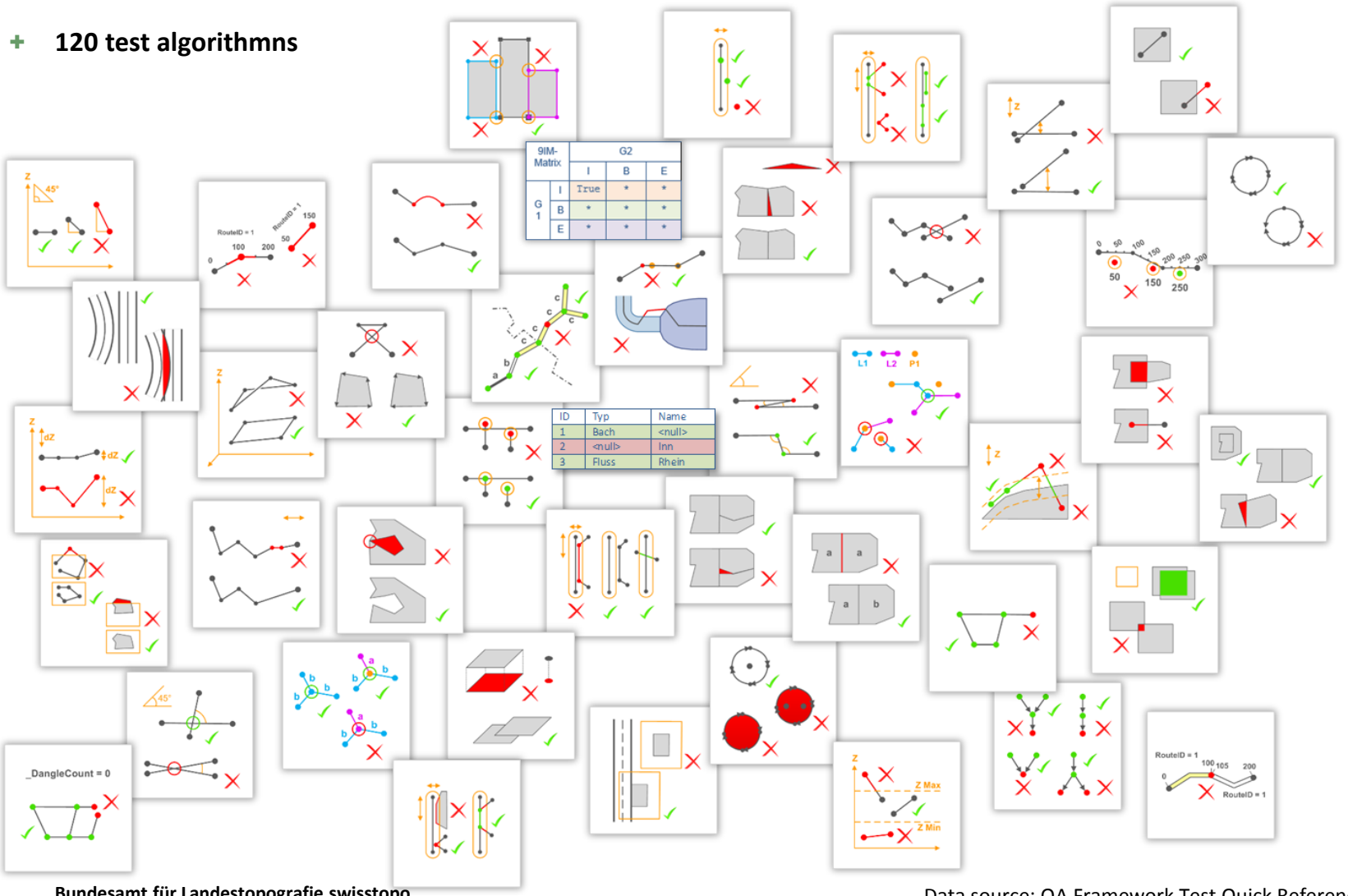
# Quality requirement: consistency

- **Technical consistency**
  demands on data structures and data acquisition tools
- **Logical (content) consistency**
  conformal coherence in the data set (e.g. geometry, attributes, spatial and attributive relations and precision, etc.)



# Technical & logical consistency for 2D data: automatic checks

- **120 test algorithmns**

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Data source: QA Framework Test Quick Reference

# Quality checks in landscape models of mapping agencies

- **For 2D data well developed** ✓
  - Cartography / map driven from history
  - Graphical focus
  - Vertical perspective
  - Established data structures and models
  - Common understanding of 2D objects and representation

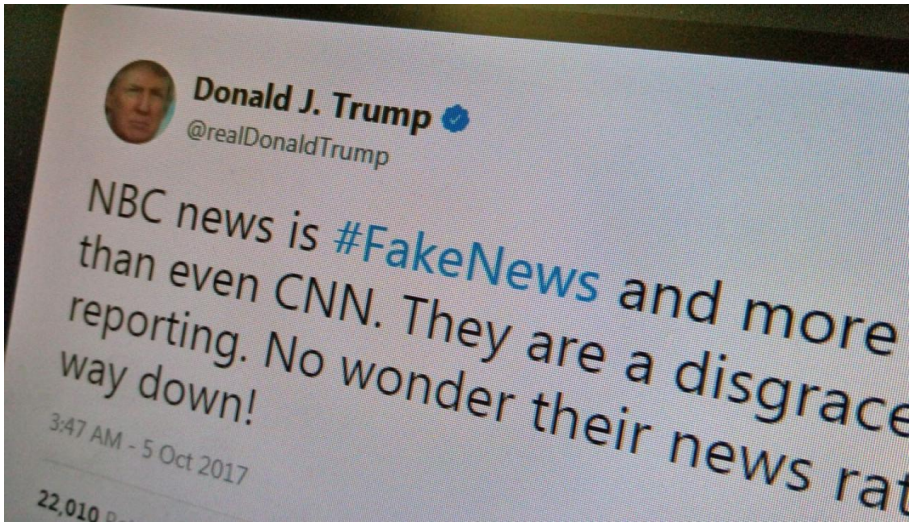
- **For 3D …. let's say we try hard to catch the train** ☝
  - Analysis and visualisation driven (less cartography)
  - 3D modelling focus
  - Free 360° perspective
  - Data structures and models are missing or not generic 3D
  - Slowly evolving understanding of 3D objects
  - Poor common understanding of representation

# Agenda

- Tasks of (national) mapping agencies
- Challenges of digital transformation
- Strategic response of a NMA
- Maintaining Trust
- Conclusions

# The task of mapping agencies

- **Geoinformation** is a vital part of any modern country's **national infrastructure**. It is just as important as traffic and communication networks and is growing in significance as an economic factor.
- **Fundamental information** to make transparent, traceable **decisions** in matters of politics, economics and society.
- Official bodies must provide **reliable geoinformation**,
  - to ensure a properly functioning **democracy** in which citizens can participate in making important political decisions
  - to contribute to the **social development** expected in any modern state.



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# Is it obvious?

FAKE NEWS

REAL

FAKE NEWS

REAL

REAL

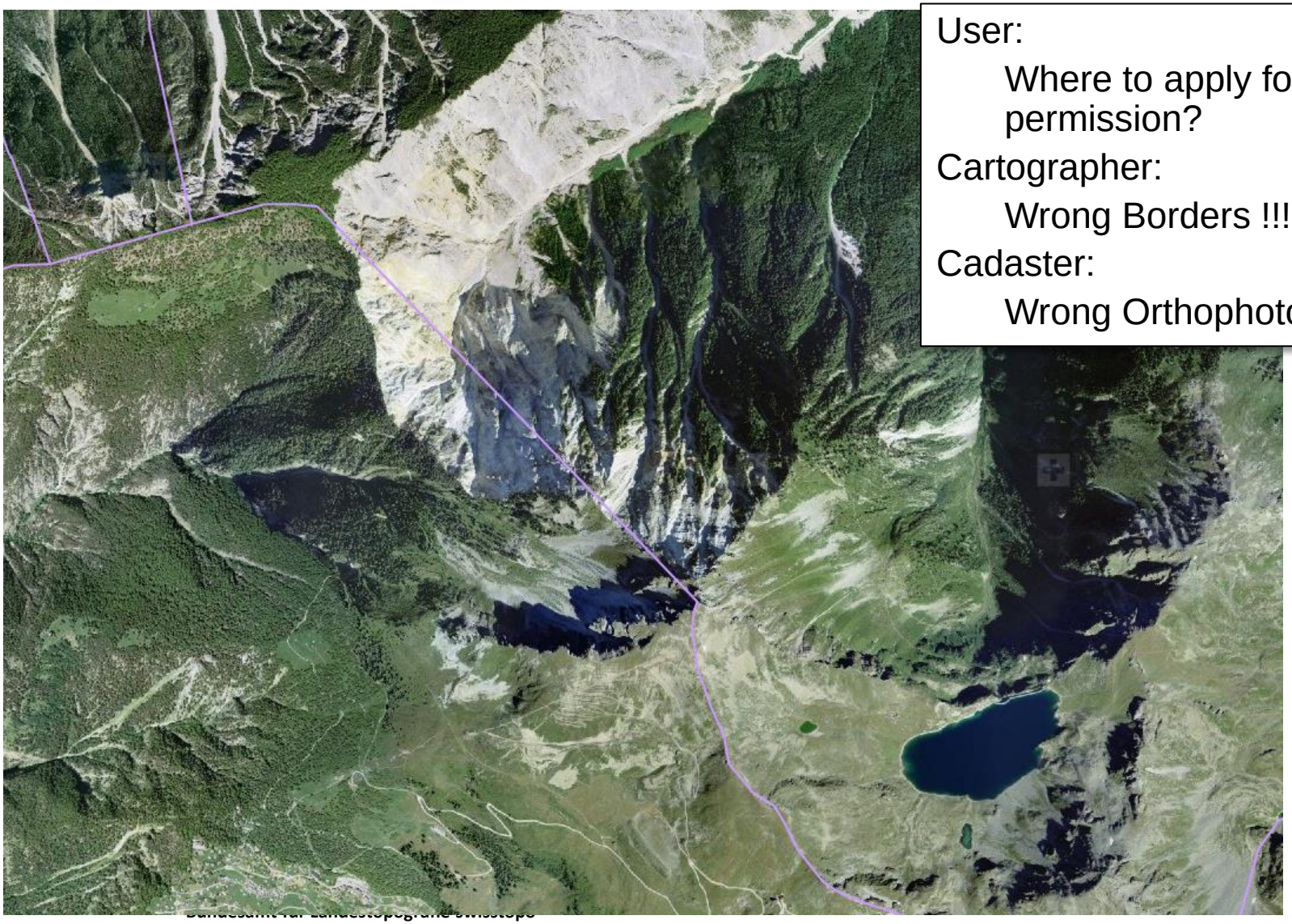
REAL

## How Many Canadians Got It Right?

| 58% | 58% | 53% | 52% | 49% | 43% |
|---|---|---|---|---|---|

"Majority of Canadians can't spot fake news: Ipsos poll" by Andrew Russell
https://globalnews.ca/news/3478926/majority-of-canadians-cant-spot-fake-news-ipsos-poll/

# Is it right? administrative boundaries



User:

Where to apply for a permission?

Cartographer:

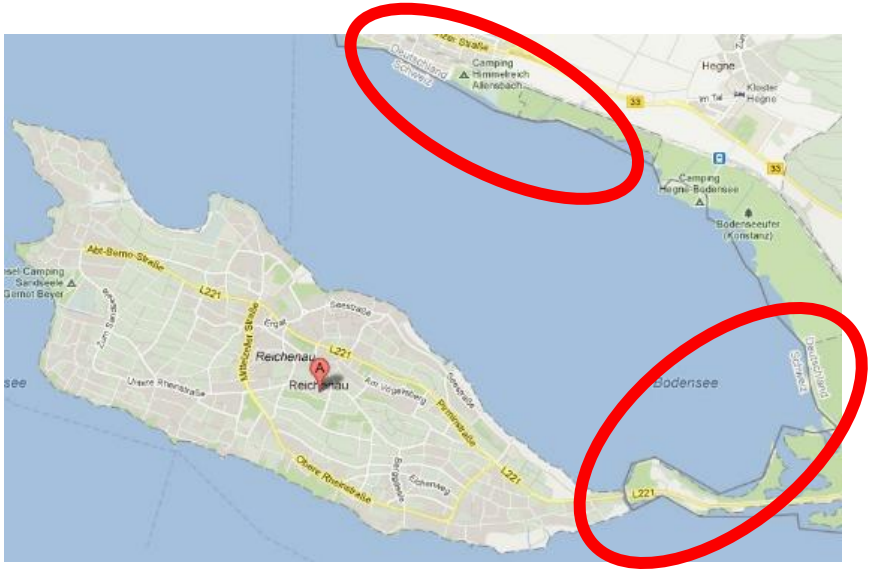
Wrong Borders !!!

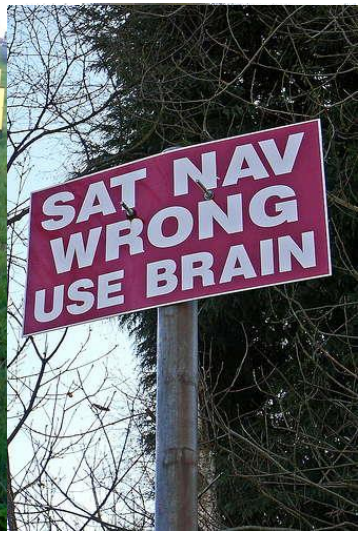
Cadaster:

Wrong Orthophoto !!!

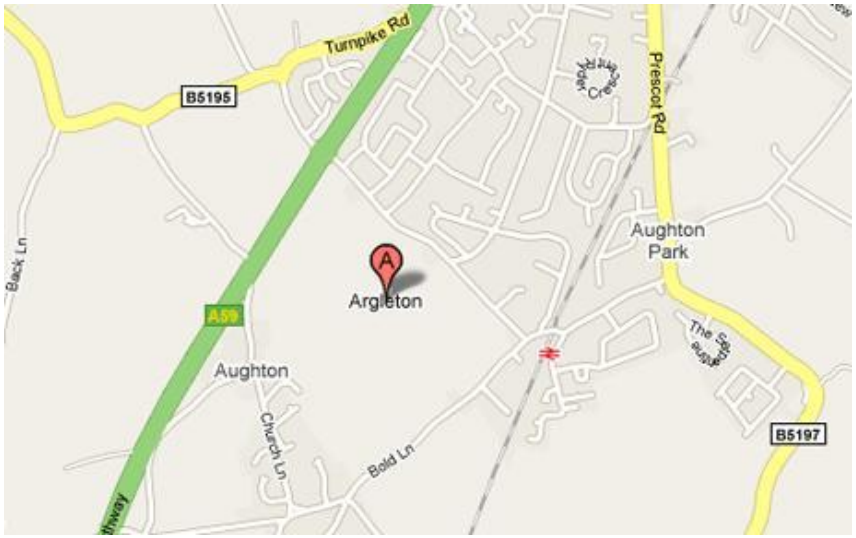
Illgraben between Annivers and Leuk (Switzerland) https://s.geo.admin.ch/7ad1f8f9e9

# So, what is right? what is wrong?

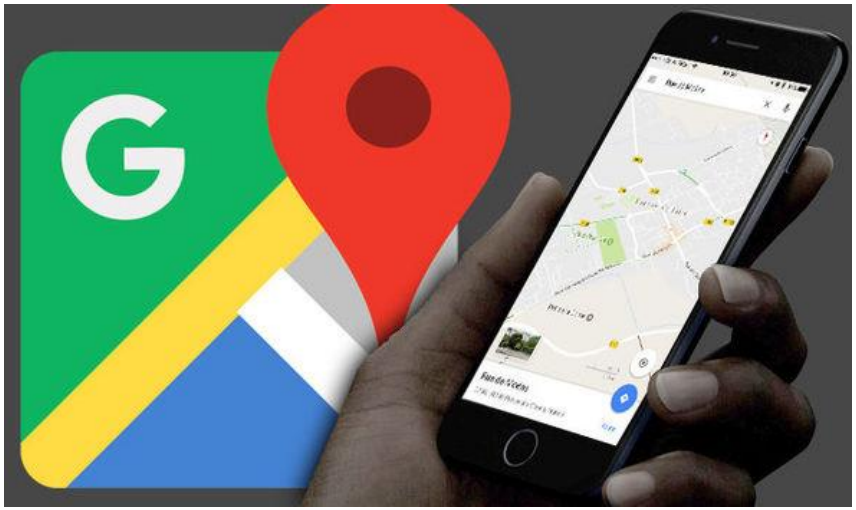




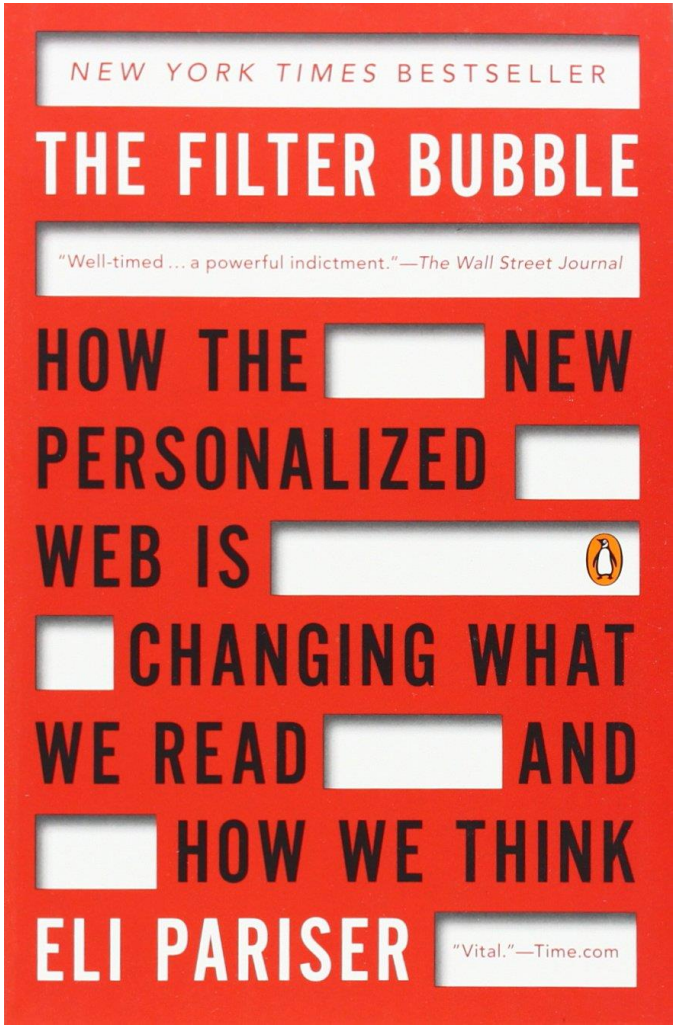
# Trap streets




On maps that are not of streets, other "copyright trap" features (such as nonexistent towns, or mountains with the wrong elevations) may be inserted or altered for the purpose of "trapping" potential copyright violators of the map.

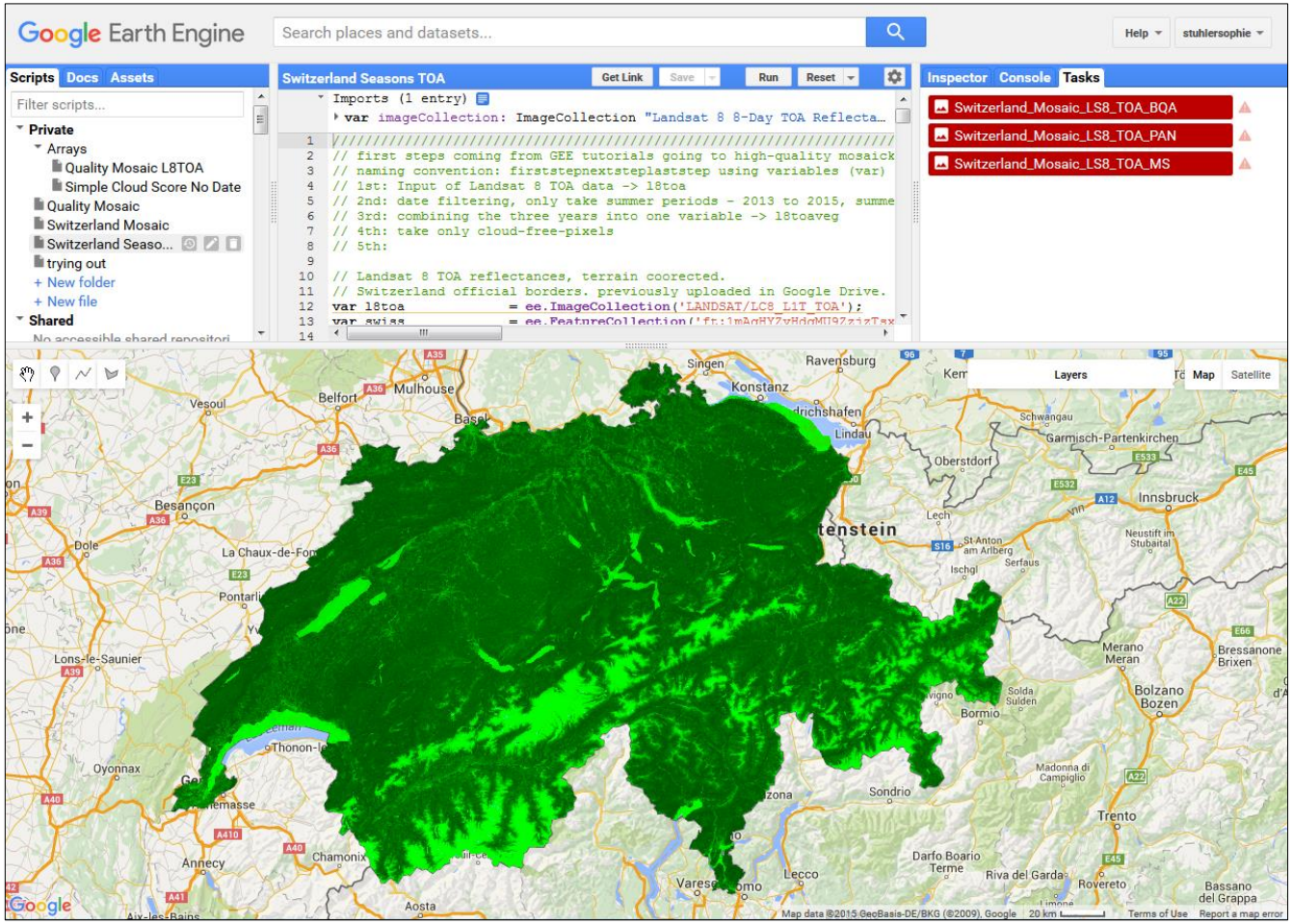


# And do we get, what is there?

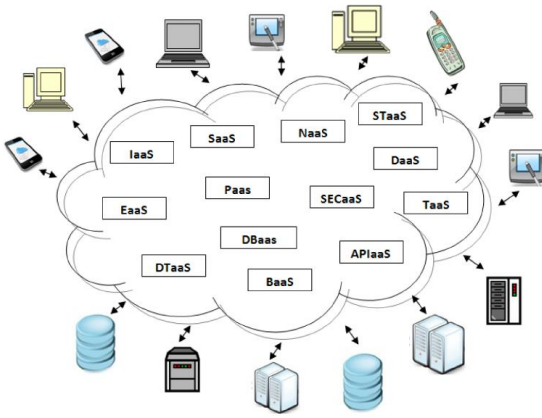


"Instead of a balanced information information diet, you can end up surrounded by information junk food"
Eli Pariser
HUFFPOST TECH 03/07/2011

# Remote sensing cloud computing: Google Earth Engine API




Digital Age proofed




DaaS, SaaS, PaaS

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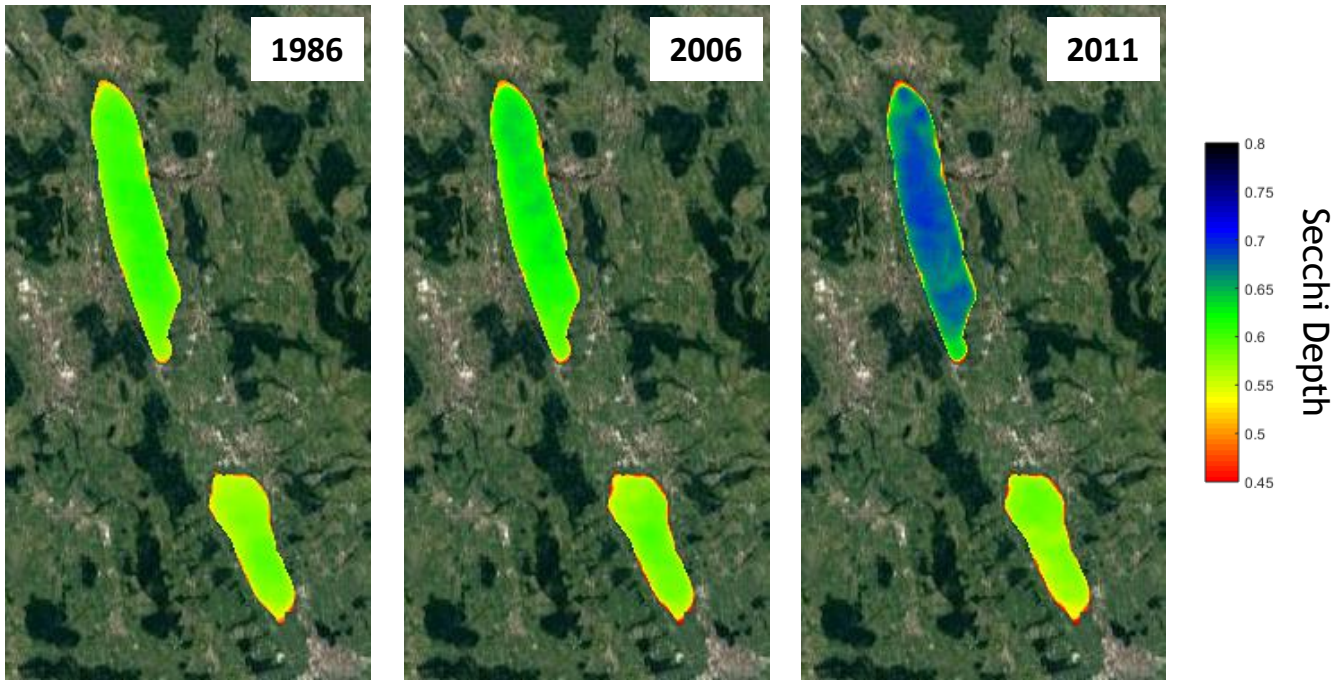
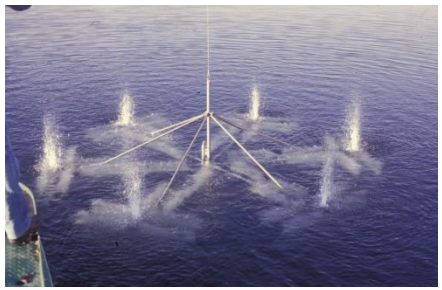
# Example: Hydrology

## Secchi depth - water quality indicator





Kt. Luzern

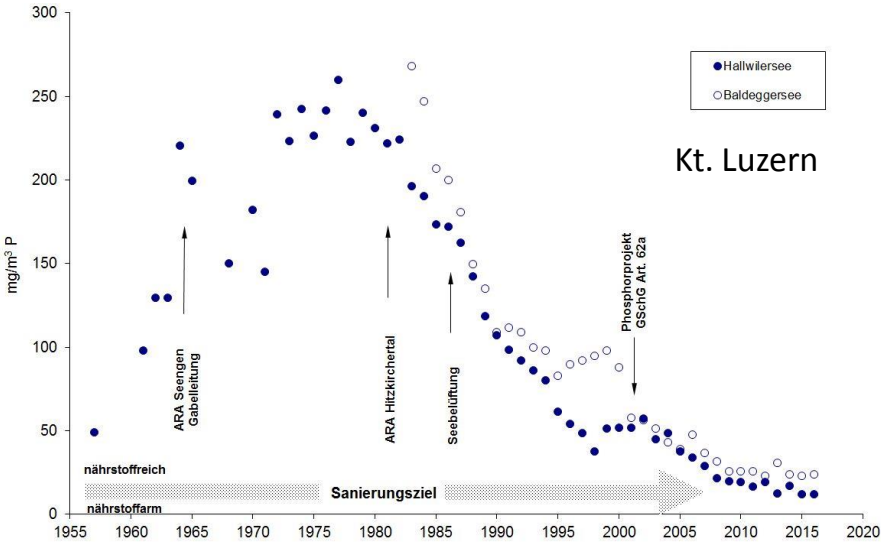
Data: Landsat 5 Surface Reflectance. Summer 1986, 2006, 2011

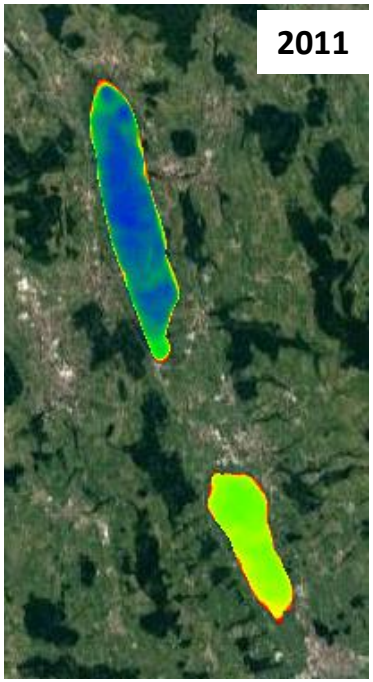


© Philip Jörg / RSL Uni Zürich

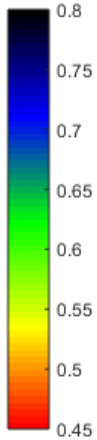
# Example: Hydrology

## Secchi depth - water quality indicator




Secchi Depth



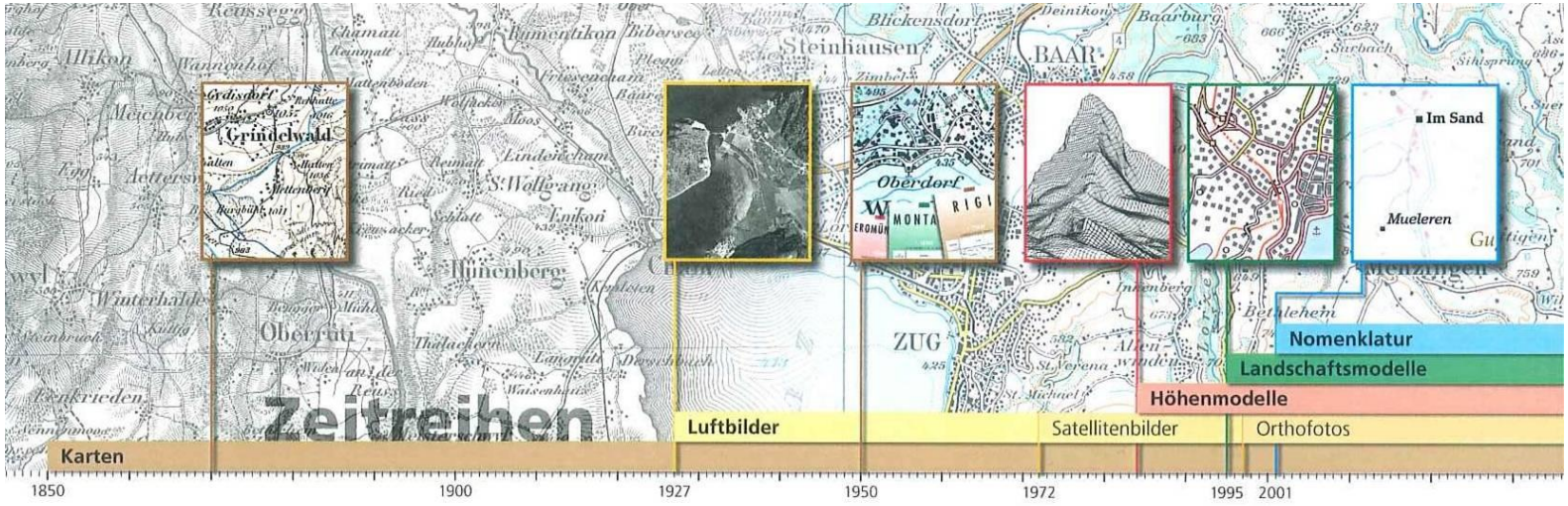

→ Both lakes are artificially ventilated, but only Hallwilersee shows an increased transparency!
→ Remote sensing data should always be verified with independent data!

© Philip Jörg / RSL Uni Zürich

# Conclusions

- **Geoinformation** is a vital part of any modern country's national infrastructure.
- Official bodies must provide reliable and sustainable geoinformation (**authorative data**)
- Creation and maintenance of a **digital twin** (for governmental acts)
- **3D geoinformation** – measure, update, store, standards
- **Incremental update** of databases (-> reliable detection of unchange)
- New users – **new use cases**
- **A lot of research issues -> NMA's seek for close collaboration with you !!**

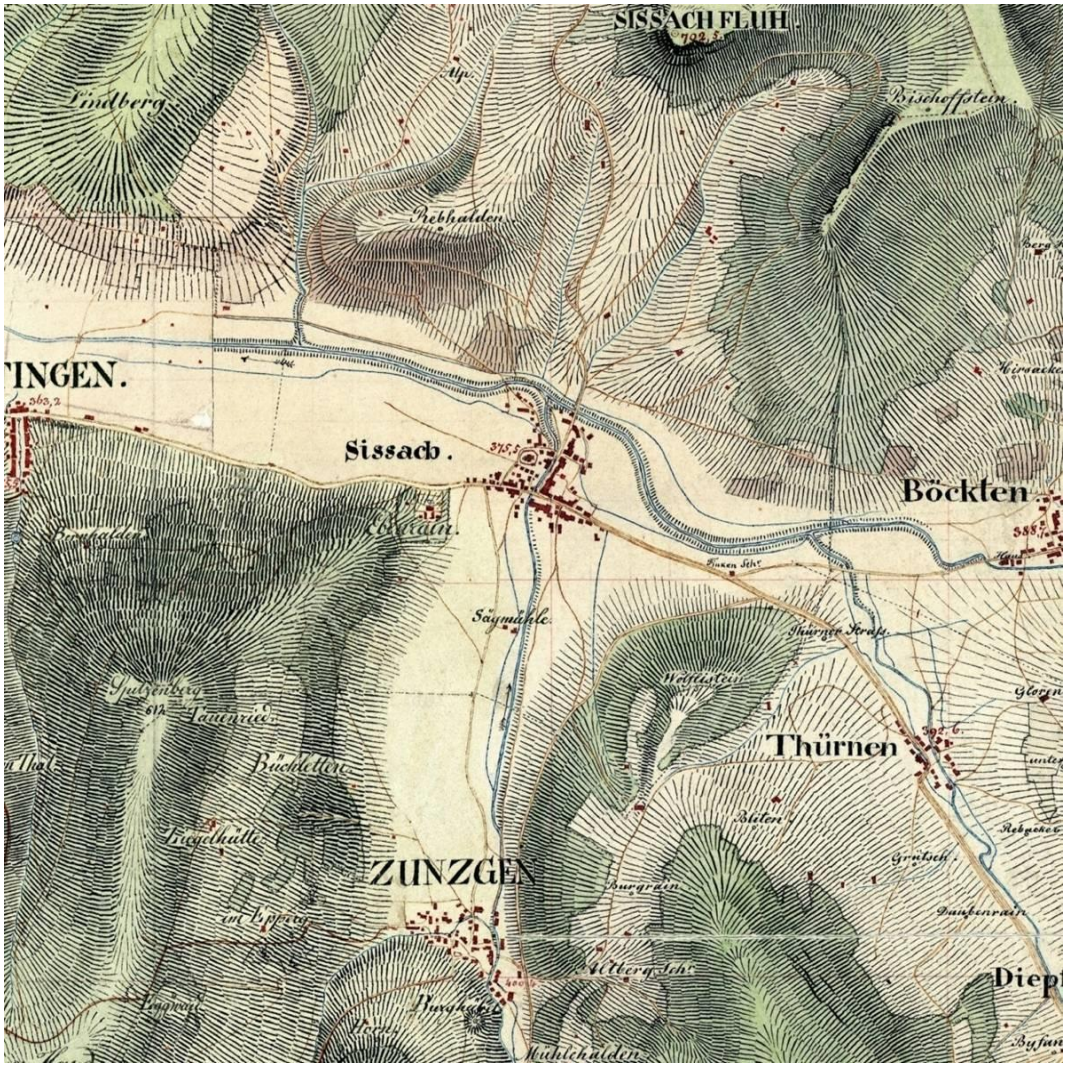
# Documenting the landscape




## Spatial monitoring

- Spatial reference data – spatial development
- Updating and archiving of reference geodata

# Documenting the landscape




1838–1843
Friedrich Baader
1:25,000
Dufour Map
swisstopo map collection

# Documenting the landscape

1875 / 1877
Alfred Cuttat
1:25,000
Siegfried Map
swisstopo map collection

# Documenting the landscape

1877–1880
Siegfried Map
1:25,000
First edition
swisstopo map collection

# Documenting the landscape

1894
Siegfried Map
1:25,000
1st revision
swisstopo map collection

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# Documenting the landscape

1902
Siegfried Map
1:25,000
2nd revision
swisstopo map collection

# Documenting the landscape

1915–1916
Siegfried Map
1:25,000
3rd revision
swisstopo map collection

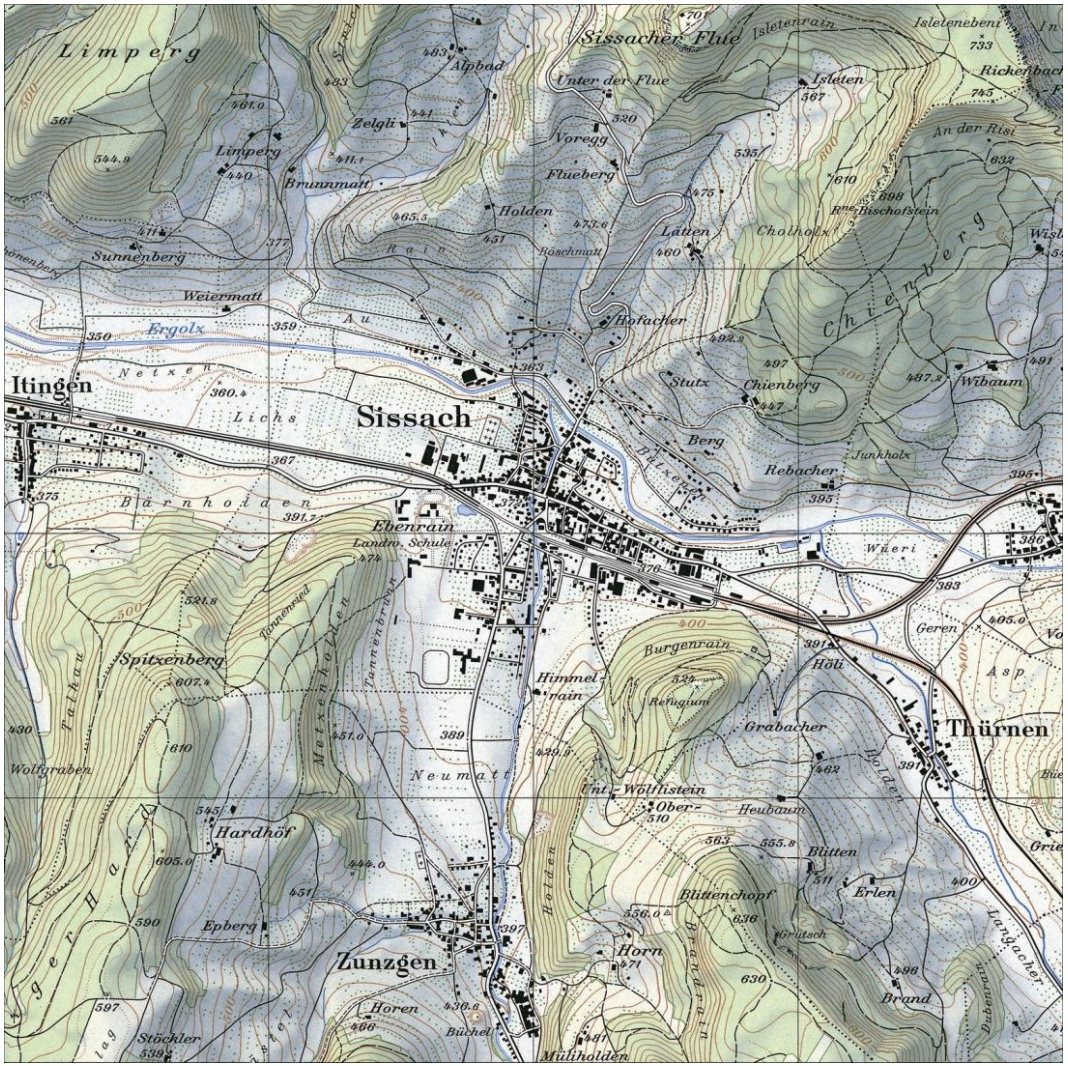
# Documenting the landscape

1931
Siegfried Map
1:25,000
4th revision
swisstopo map collection

# Documenting the landscape

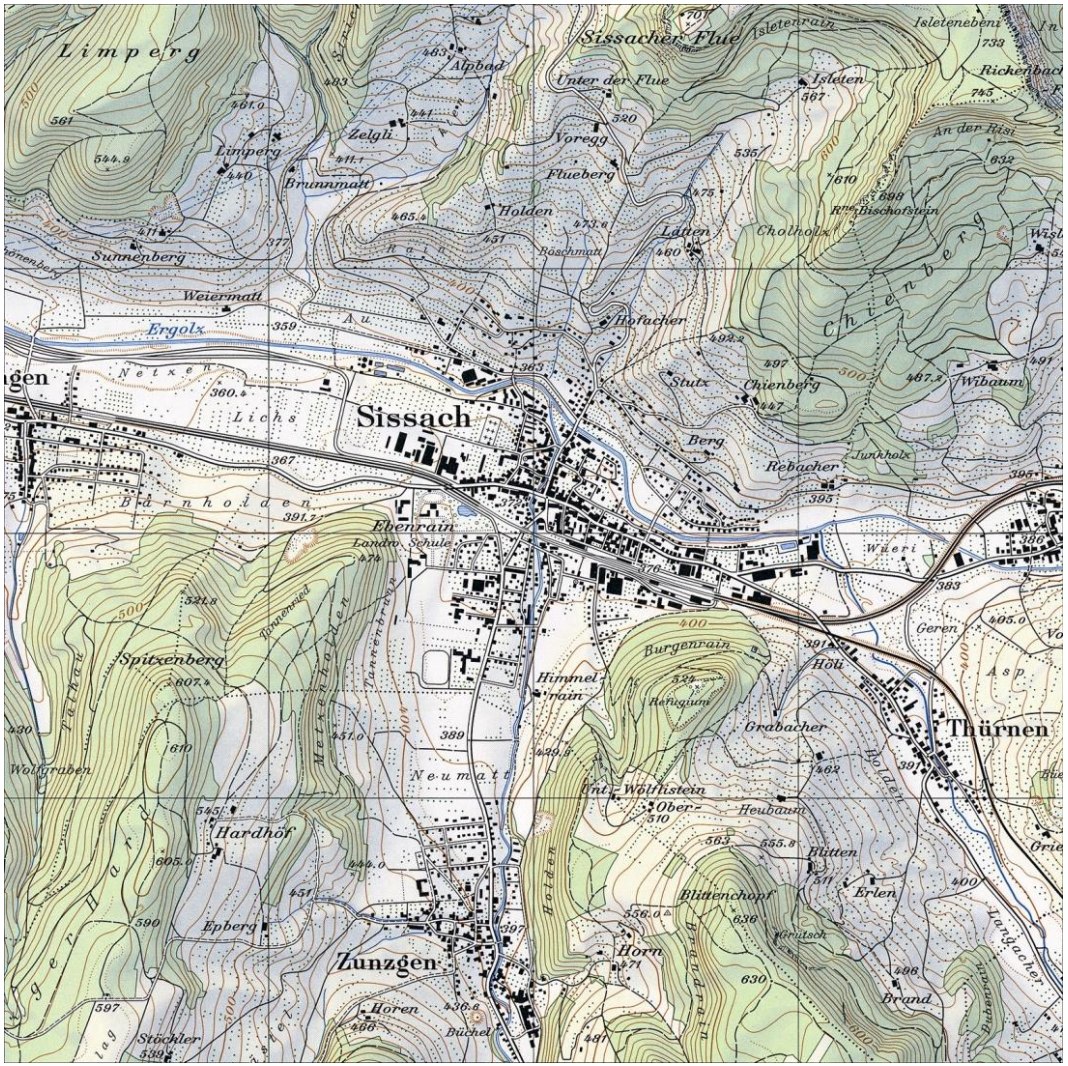
Sissach
Ergolz
Zunzgen
Thürnen
Diepflinge
Sonnenberg
Weihermatt
Grabenäcker
Ebenrain
Bernhalden
Sonnhalde
Flahberg
Halden
Alpbad
Zelgli
Brunnmatt
Lettenacker
Bumperrain
Wolfistein
Hard
Erlenhof
Unterfeld
Obere Reben
Hohle
Reben
Weinbaum
Berg
Stutz
Kirchberg
Bützenen
Ergolz
Wühren
Rebacker
Starchennest
Grabenacker
Langacker
Heubaum Auf der Halde
Brunnmatt
Rebmatt
Horen
Stockler
Ipberg
Hüslerhorn
Wolfistein
Sägematt
Schützenhalden
Netzengraben
Hardacker
Thalhaus
Tannenpfad
Grempenholzle
Holzli
Schützenplatz
Bachgraben
Reigoldswilerstrasse
Sissacher Fluh
Isletten
Vorweg
Letten
Böschmatt
Hühlerstetten
Rain
In der Au
In der Alp
Under der Fluh
Ob.
Mühle
Neue Welt
Kirchhofreben
Wehrenen
Schulmattacker
Schützenmatt
Schützenplatz
Schützenhaus
Schützenmatt
Schützenhaus
Schützenplatz
Schützenmatt
Schützenhaus
Schützenplatz
Schützenmatt
Schützenhaus
Schützenplatz

# Documenting the landscape




1955
Map of Switzerland
1:25,000
First edition
swisstopo map collection

# Documenting the landscape




1965
Map of Switzerland
1:25,000
1st revision
swisstopo map collection

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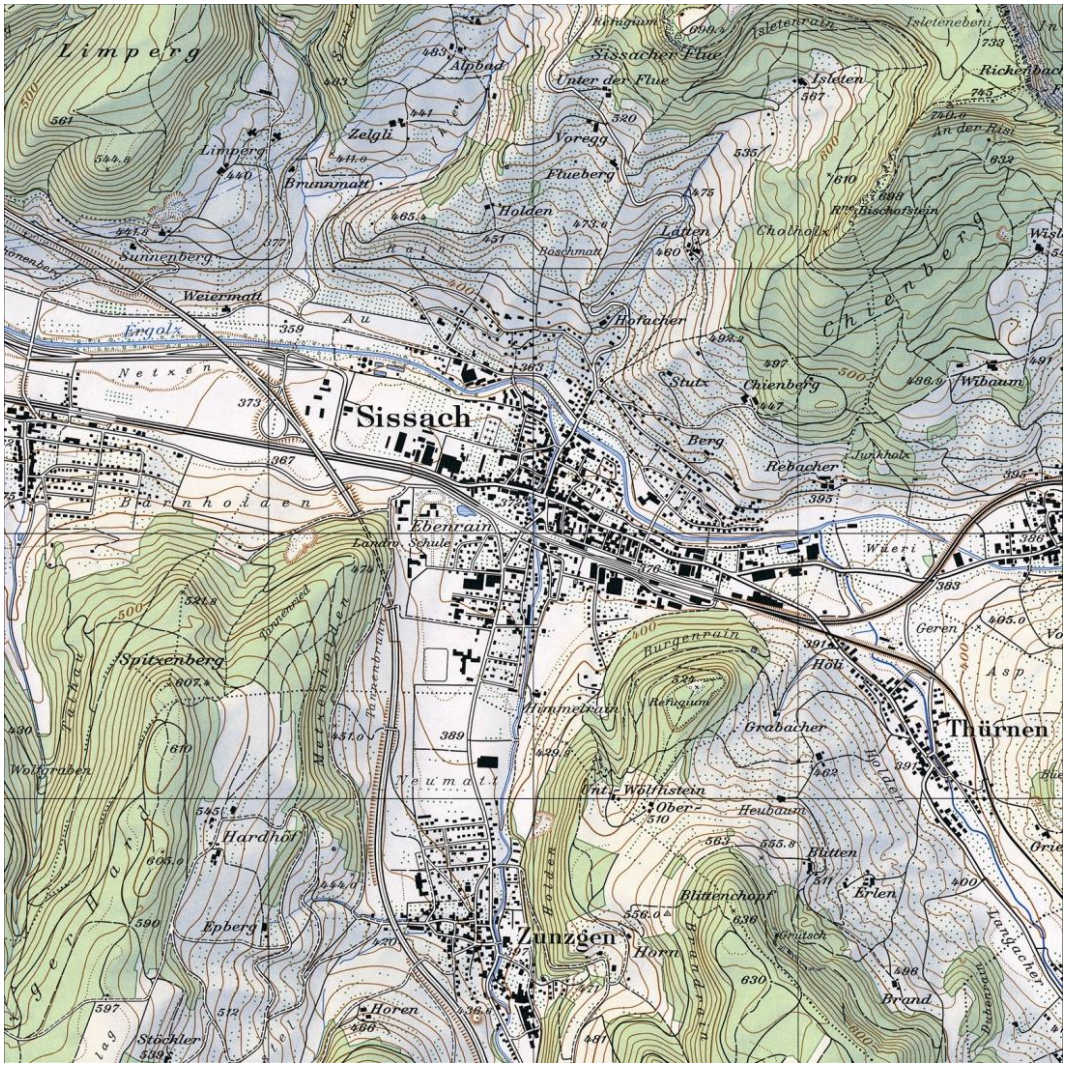
# Documenting the landscape




1970
Map of Switzerland
1:25,000
2nd revision
swisstopo map collection

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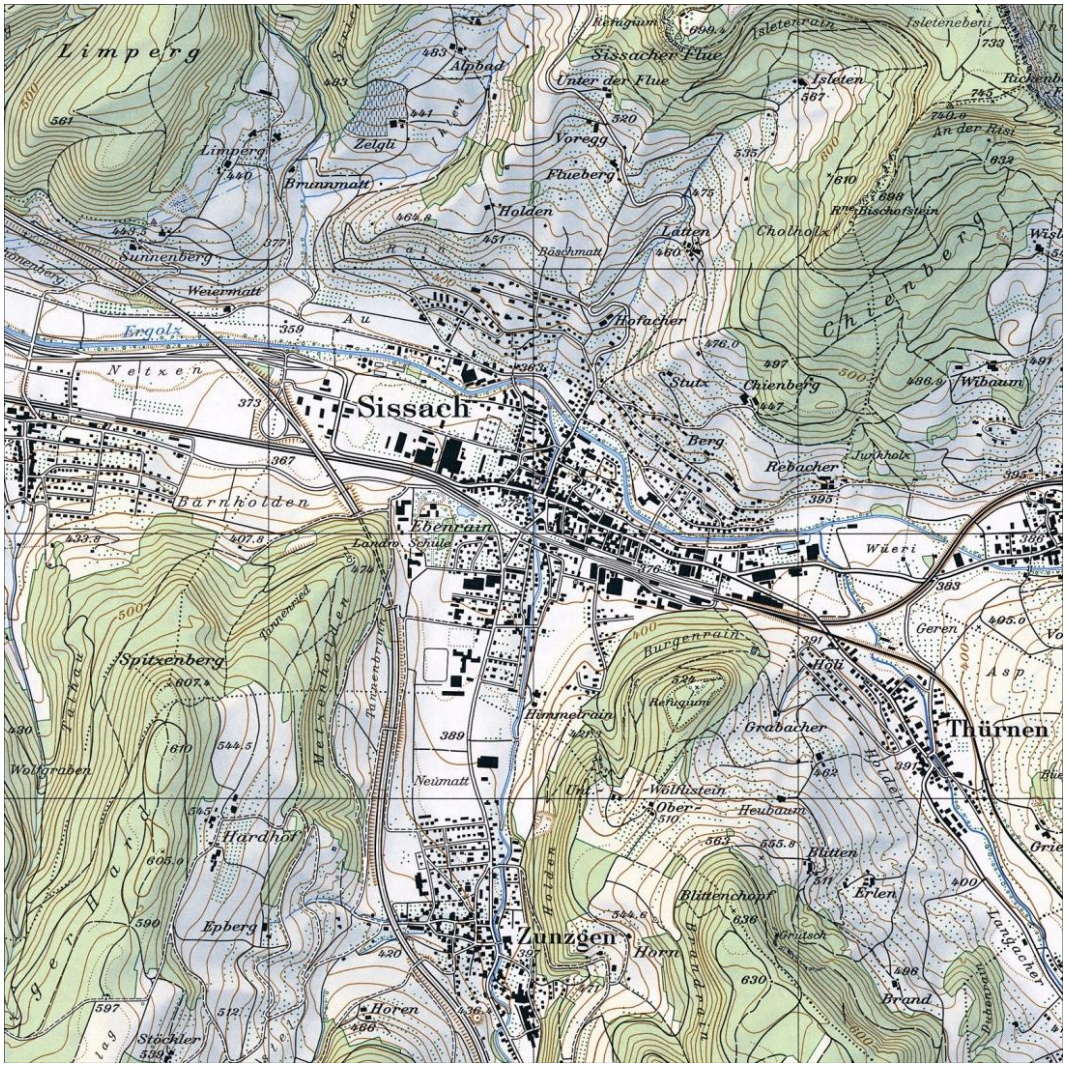


1976
Map of Switzerland
1:25,000
3rd revision
swisstopo map collection

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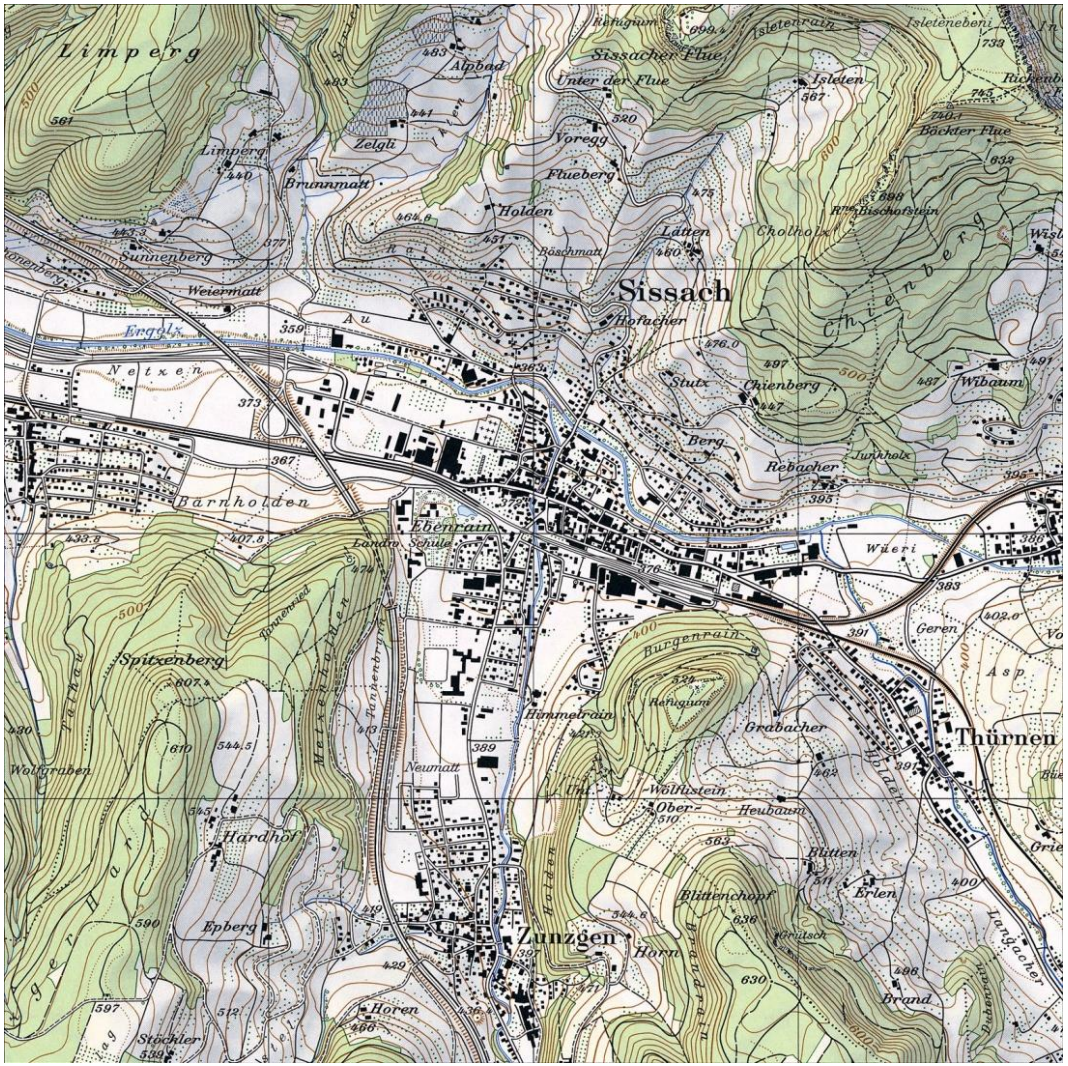
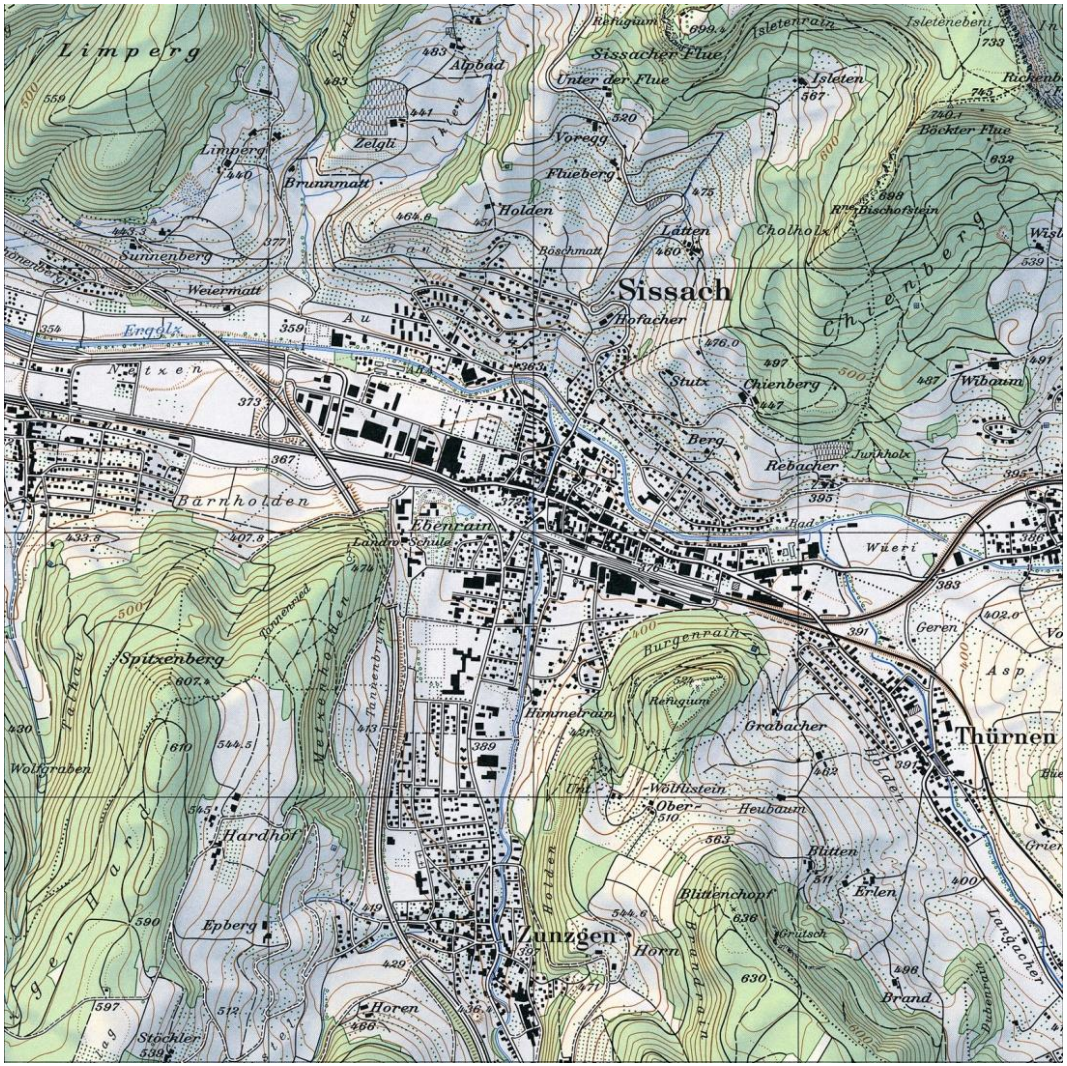
# Documenting the landscape



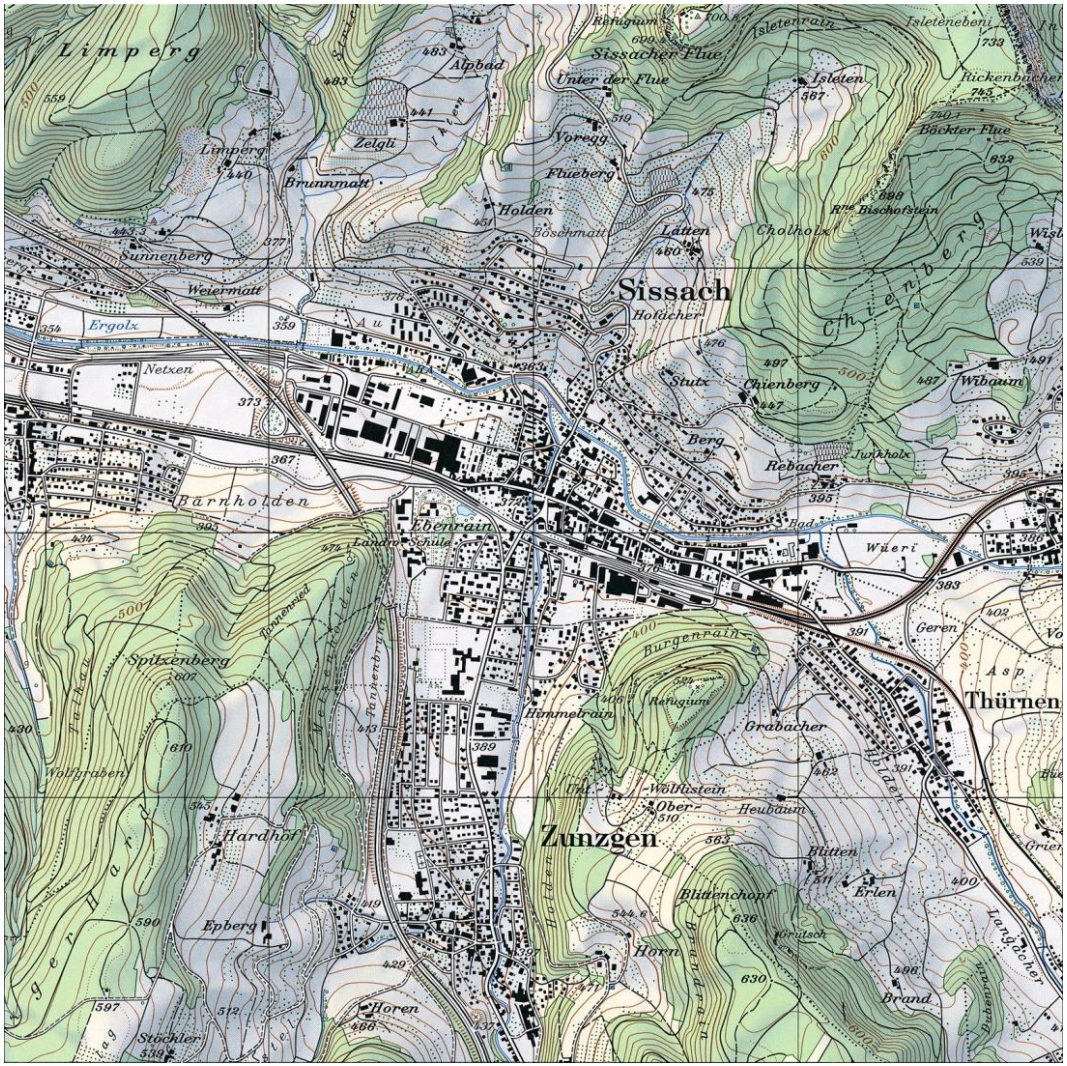

1982
Map of Switzerland
1:25,000
4th revision
swisstopo map collection

# Documenting the landscape




1988
Map of Switzerland
1:25,000
5th revision
swisstopo map collection

# Documenting the landscape




1994
Map of Switzerland
1:25,000
6th revision
swisstopo map collection

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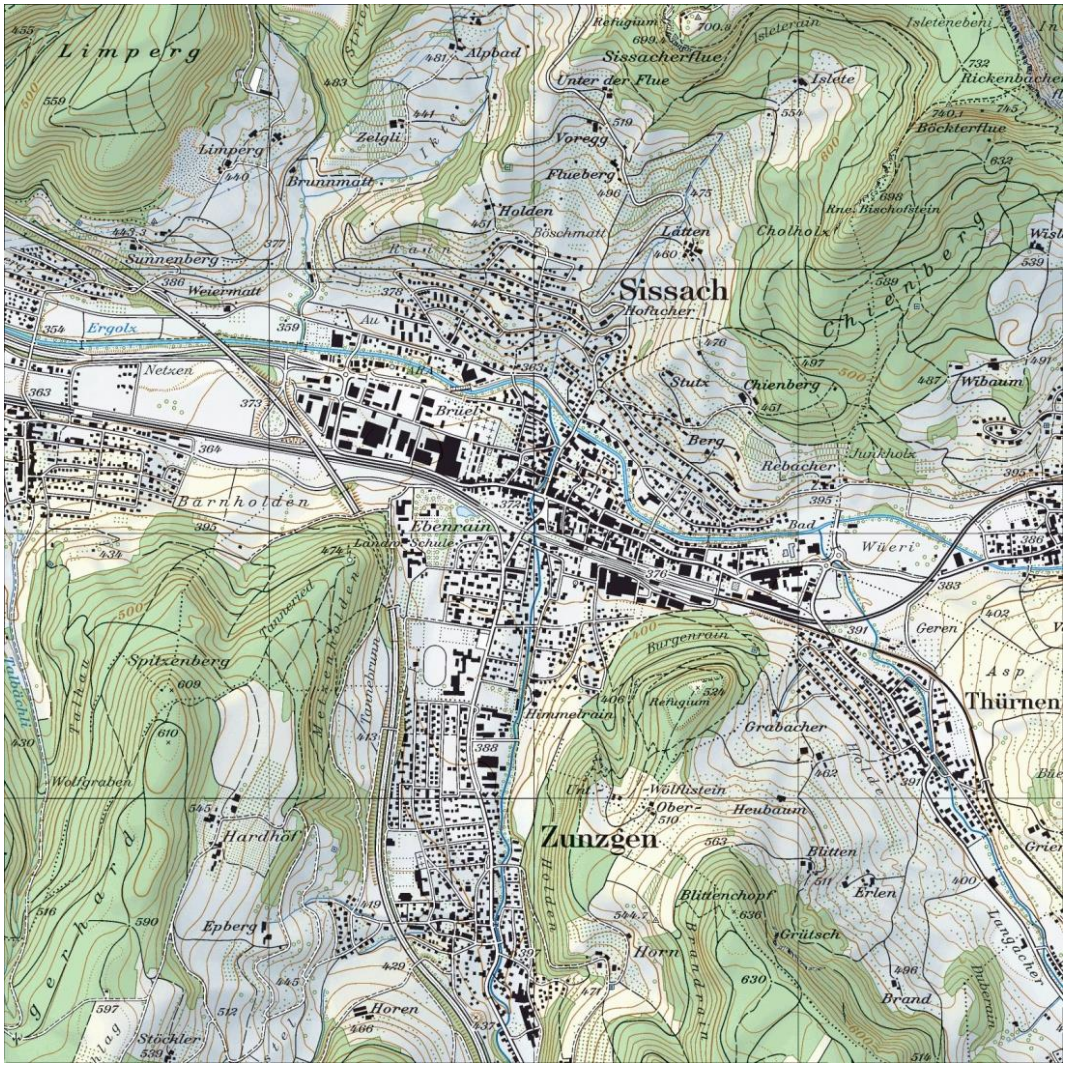
# Documenting the landscape




2000
Map of Switzerland
1:25,000
7th revision
swisstopo map collection

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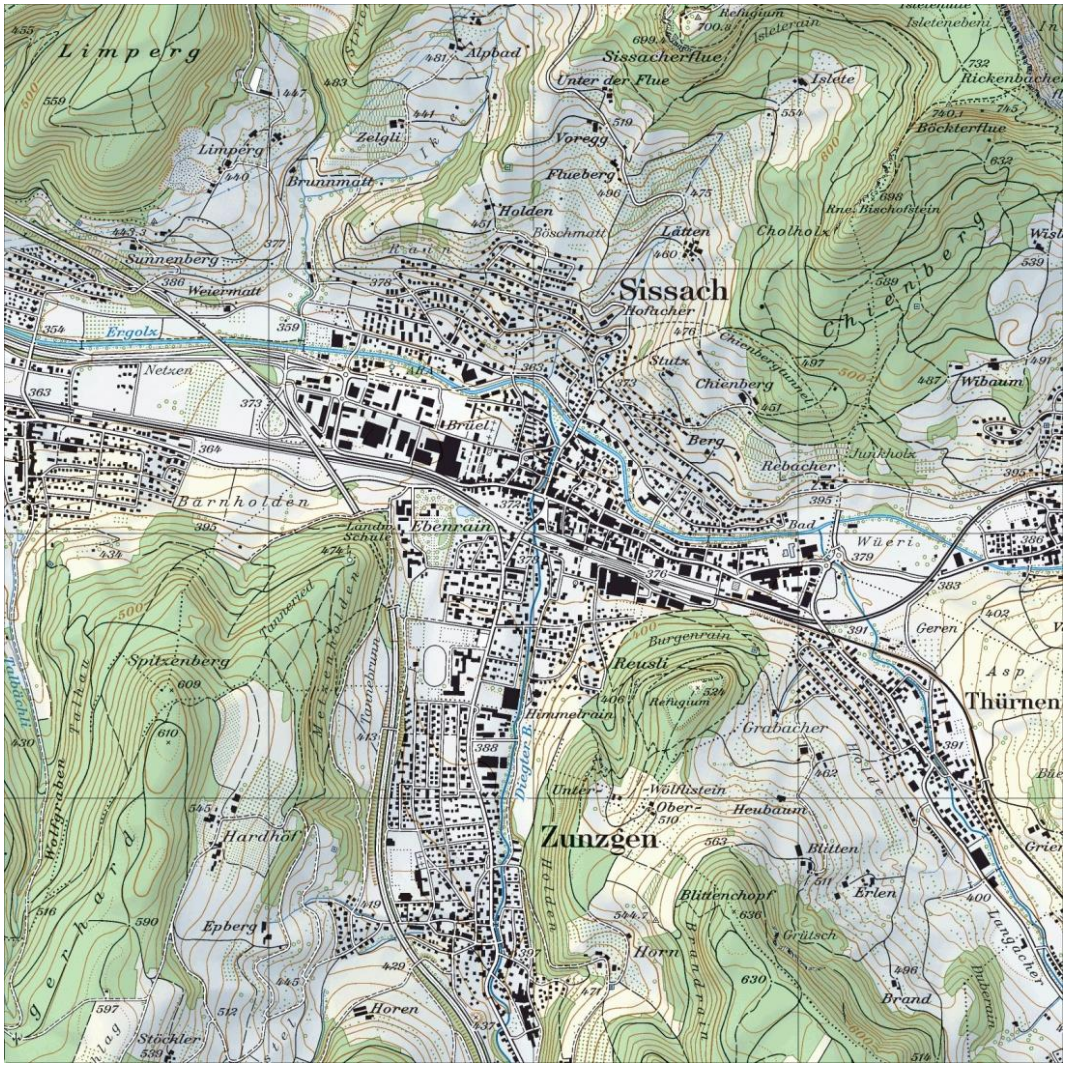
# Documenting the landscape




2006
Map of Switzerland
1:25,000
8th revision
swisstopo map collection

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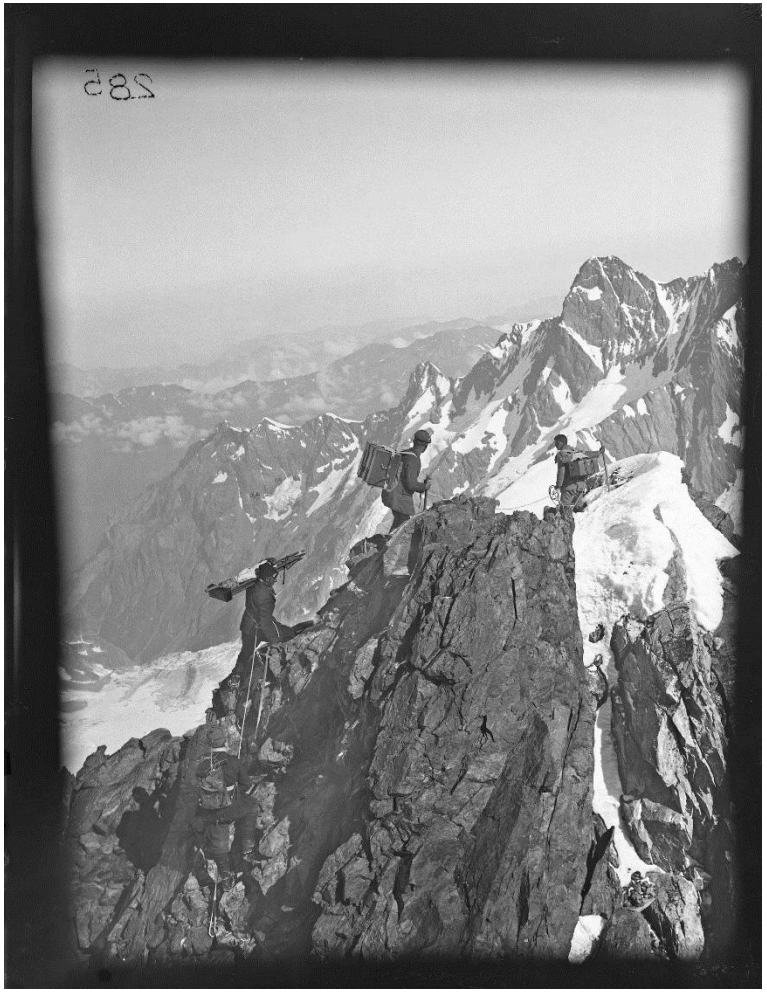
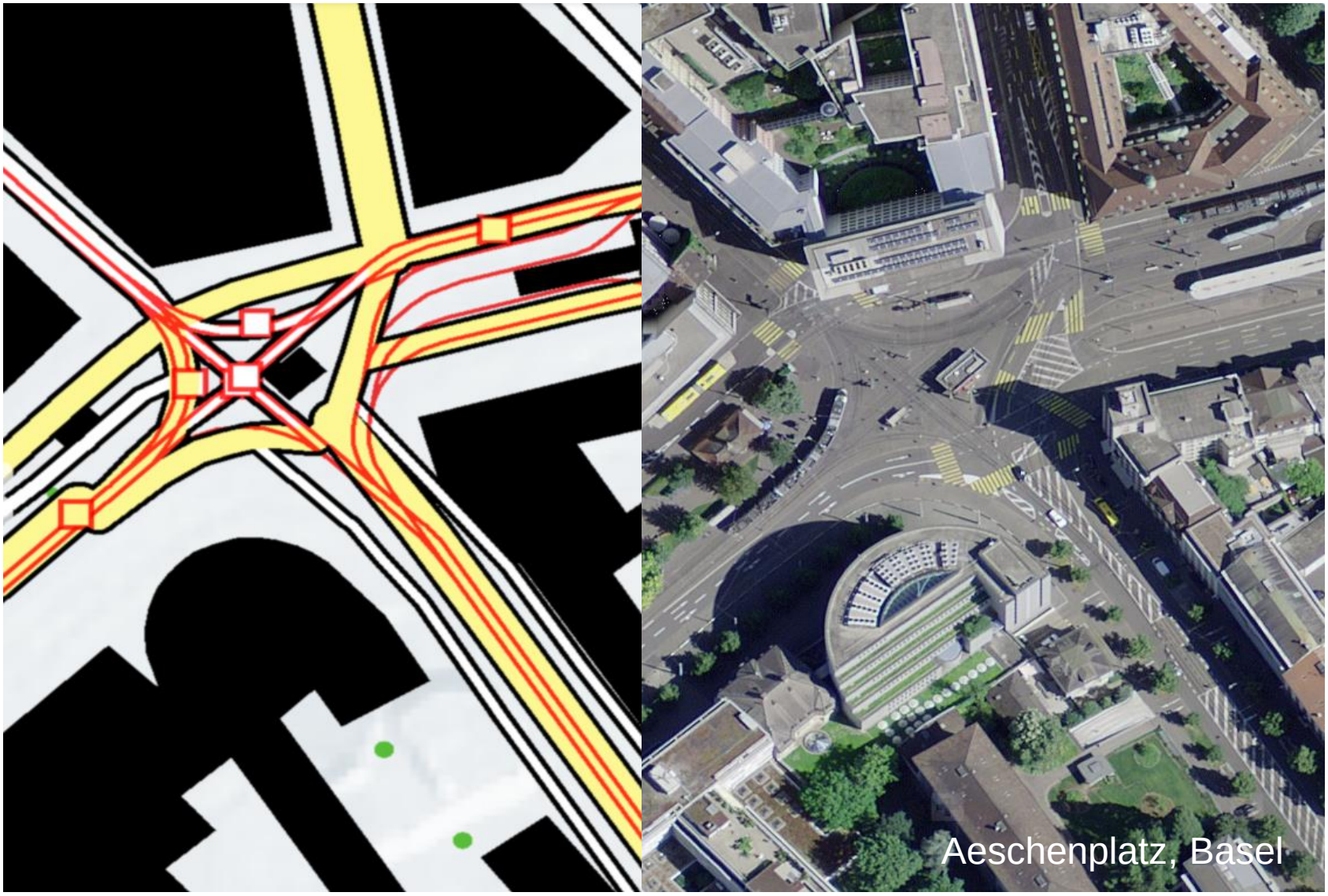
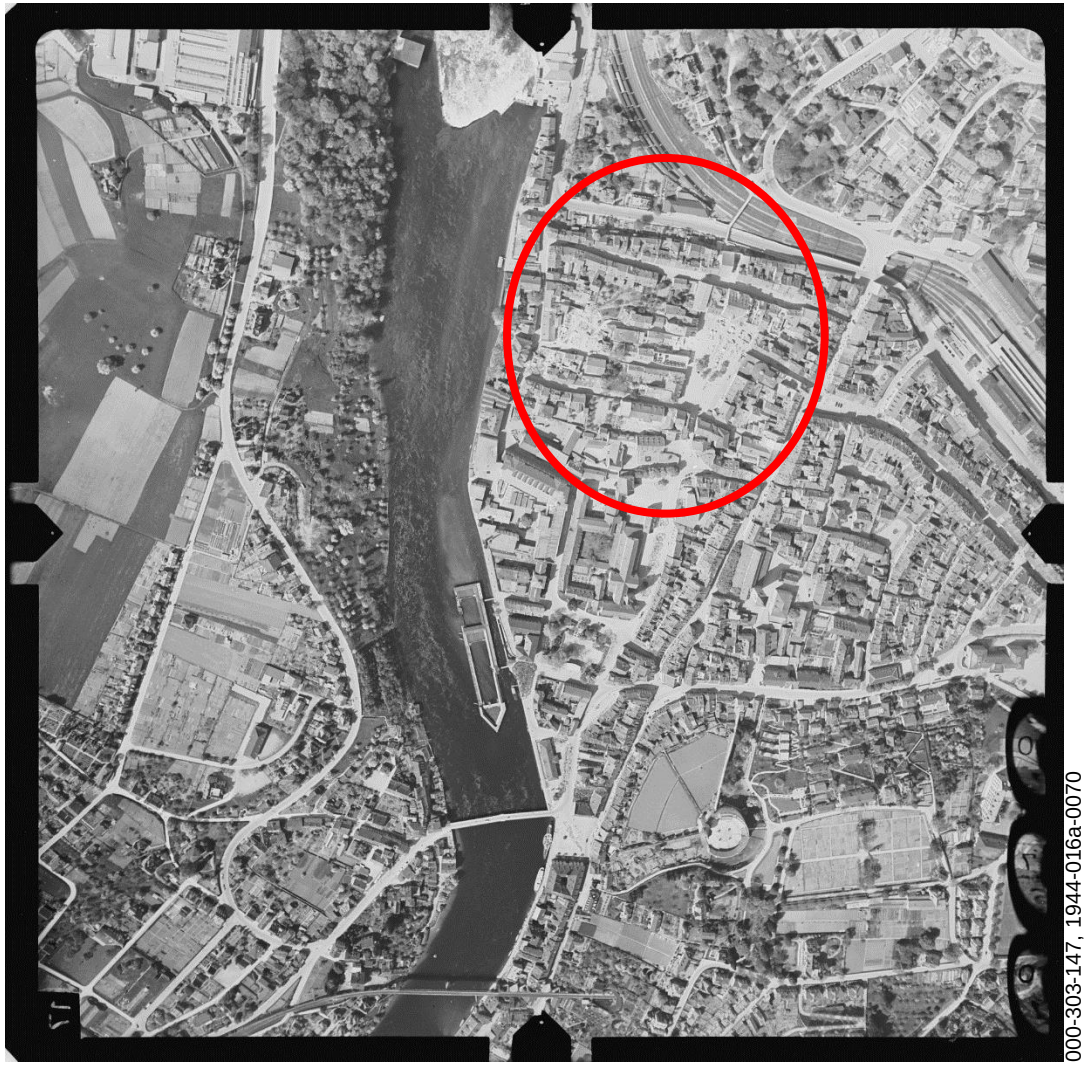
# Long time series of metric imagery



# Images are not limited to an object catalog

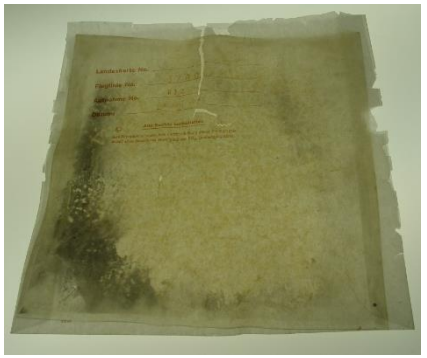


# Schaffhausen, 02.05.1944

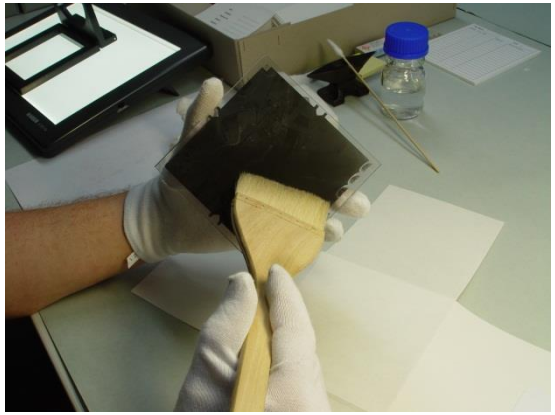


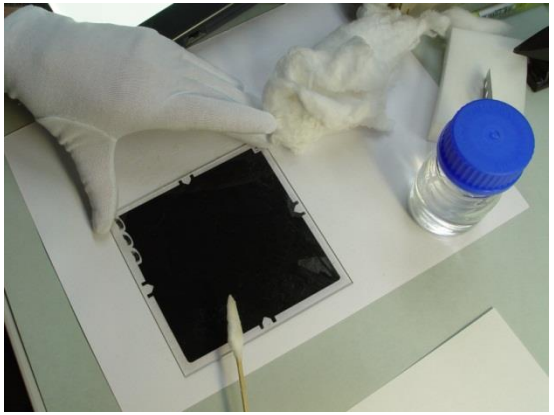

On April 1, American pilots accidentally dropped about 400 fire and blast bombs on the city, causing nearly 50 fires, killing 40, and injuring 270. 66 buildings were completely destroyed or badly damaged, and about 450 people lost their shelter.

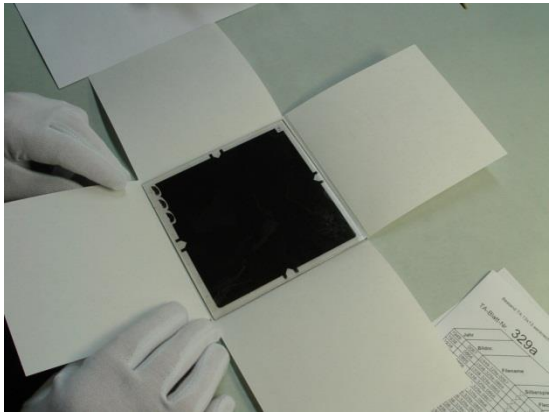
# Analogue Image Archive



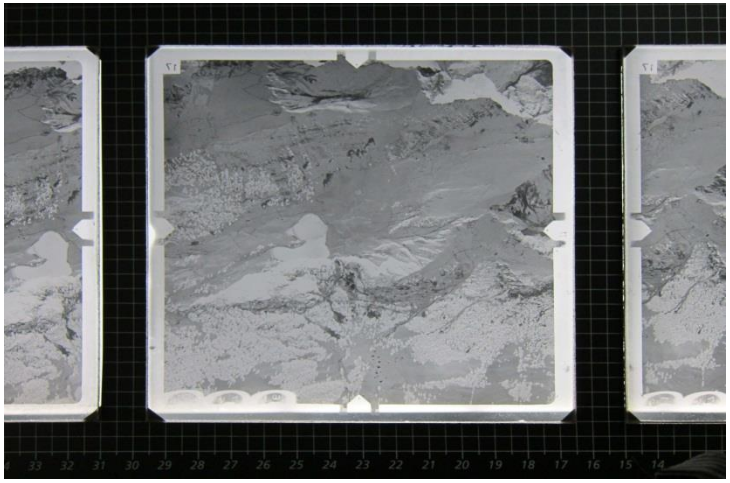
# Conservation



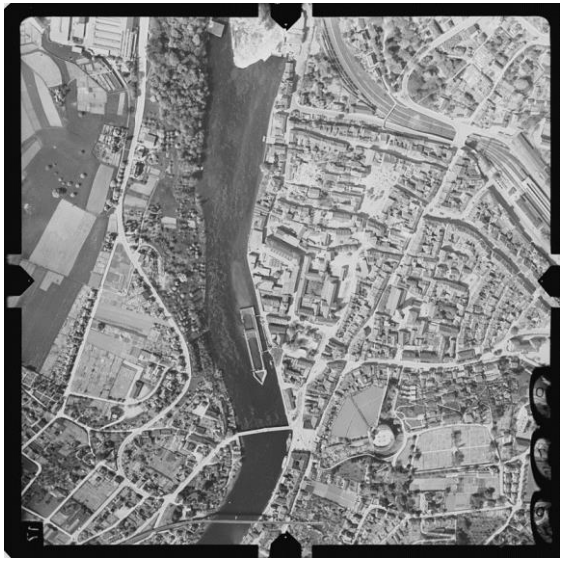




# Digitisation



# EuroSDR investigation



- 19 participating mapping agencies
  - from Spain to Poland (W to E)
  - from Cyprus to Norway (S to N)
- All with existing archive of aerial and terrestrial imagery
- **Total amount > 9.5 Million aerial and terrestrial images**
  - Some mapping agencies have up to 1.5 million
- Digitisation of analogue film and glass plates in progress
  - Overall digitalization progress around 40 %
  - Duration of many projects until 2030
- Need to develop automatic workflow

# Issues in developing workflows to process analogue images

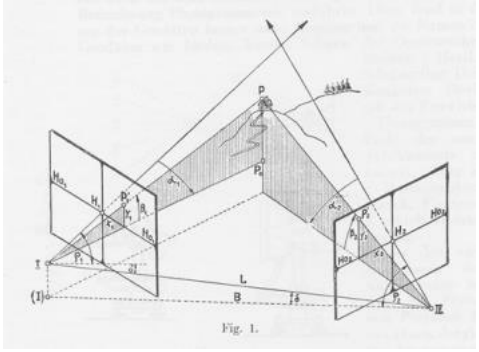
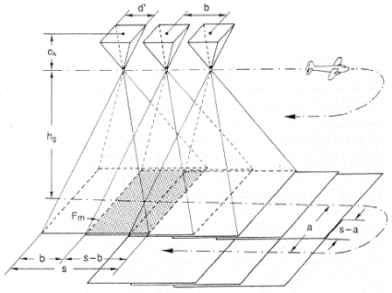


Fig. 1.

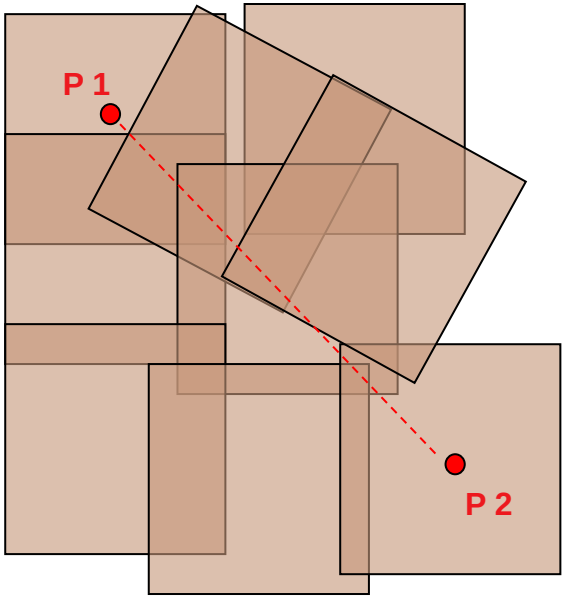
In the process to develop processing workflows, participants have indicated issues they encounter

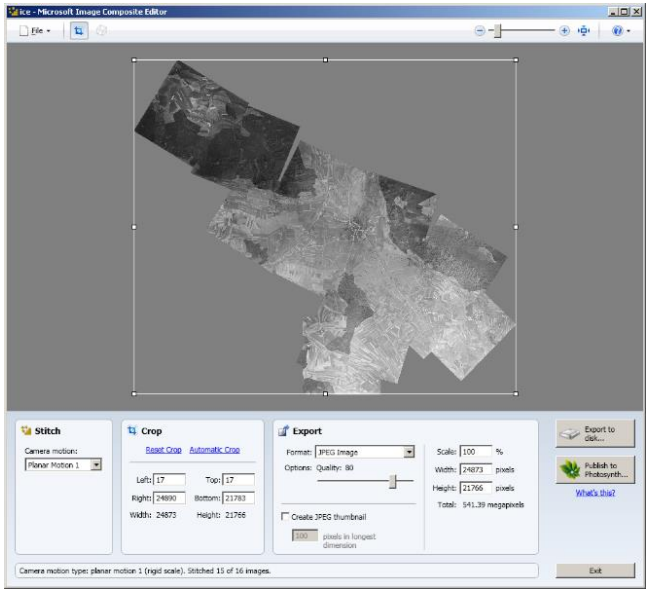
- From the perspective of **metadata** :
  - Missing camera calibration certificates
  - Missing GCP
  - Missing image orientation

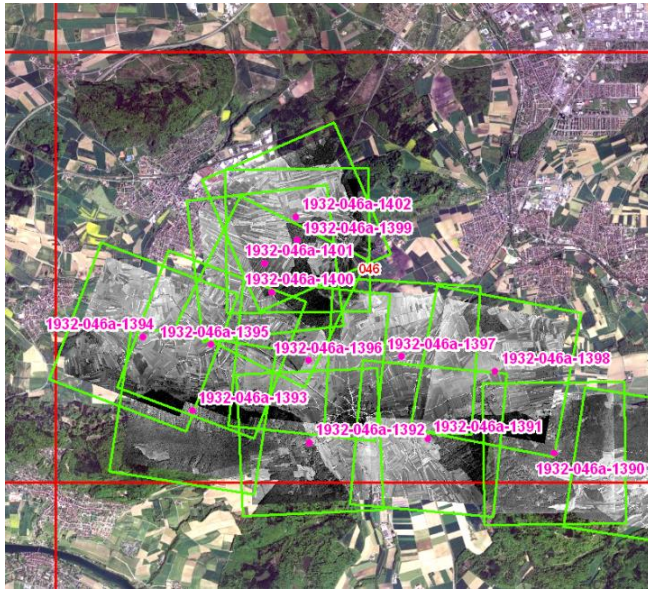


- From the **technical** perspective :
  - Quality of original data
  - Miss effective workflows
    - Orientation
    - Terrain
    - Orthophoto

# Approximate georeferencing stitching of original aerial imagery

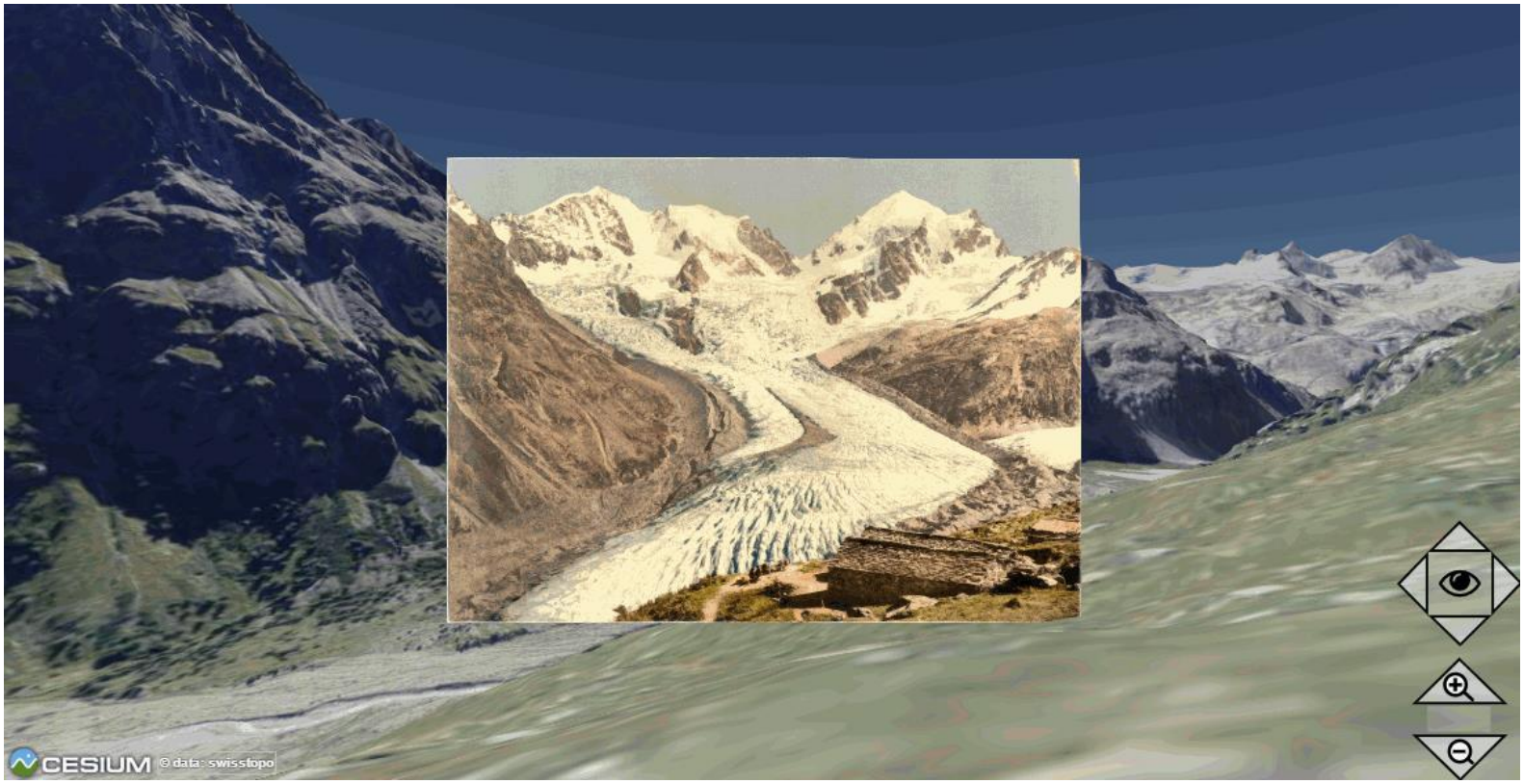



swisstopo development for ArcMap
contains Microsoft Image Composite Editor (ICE) an panoramic image stitcher

# Smapshot for terrestrial or oblique imagery




smapshot.heig-vd.ch

Thank you for your attention!

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