Tracing Recent Water Level Changes in a Saudi Arabian Cave by Mining YouTube Videos

TECHNISCHE UNIVERSITÄT DARMSTADT
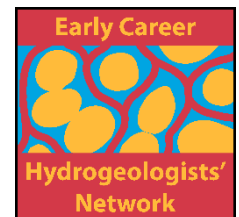
N. Michelsen[1], H. Dirks[2], S. Schulz[3], S. Kempe[1], M. Al-Saud[4], C. Schüth[1]

DORNIER CONSULTING

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

المملكة العربية السعودية
وزارة المياه والكهرباء
MINISTRY OF WATER & ELECTRICITY

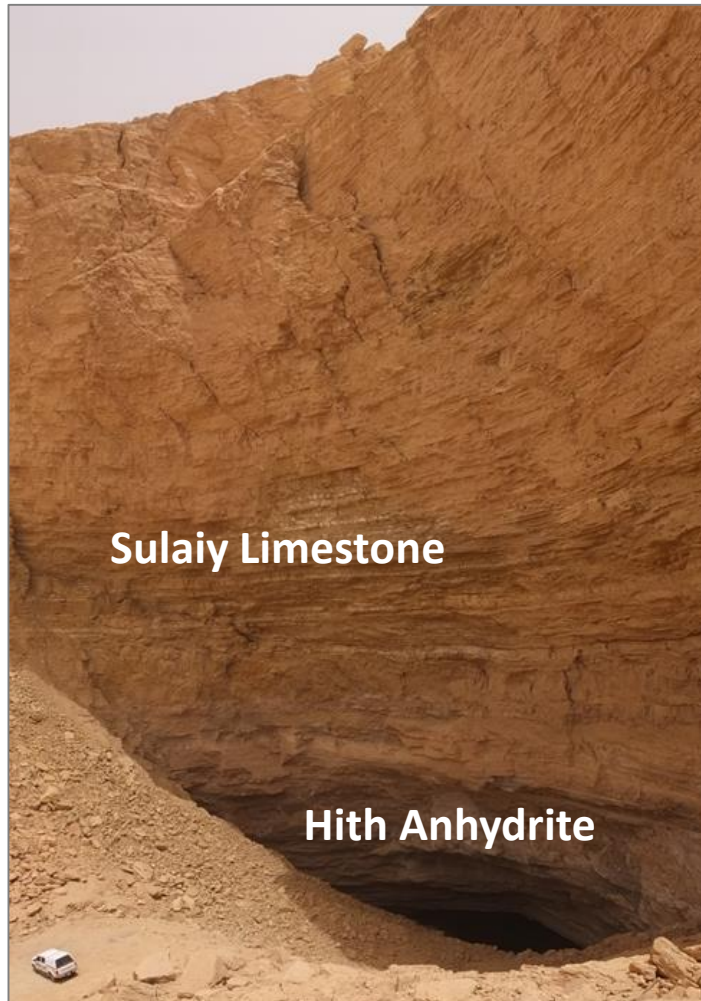[1] Technische Universität Darmstadt, Darmstadt, Germany
[2] Dornier Consulting, Riyadh, Saudi Arabia
[3] UFZ – Helmholtz Centre for Environmental Research, Halle, Germany
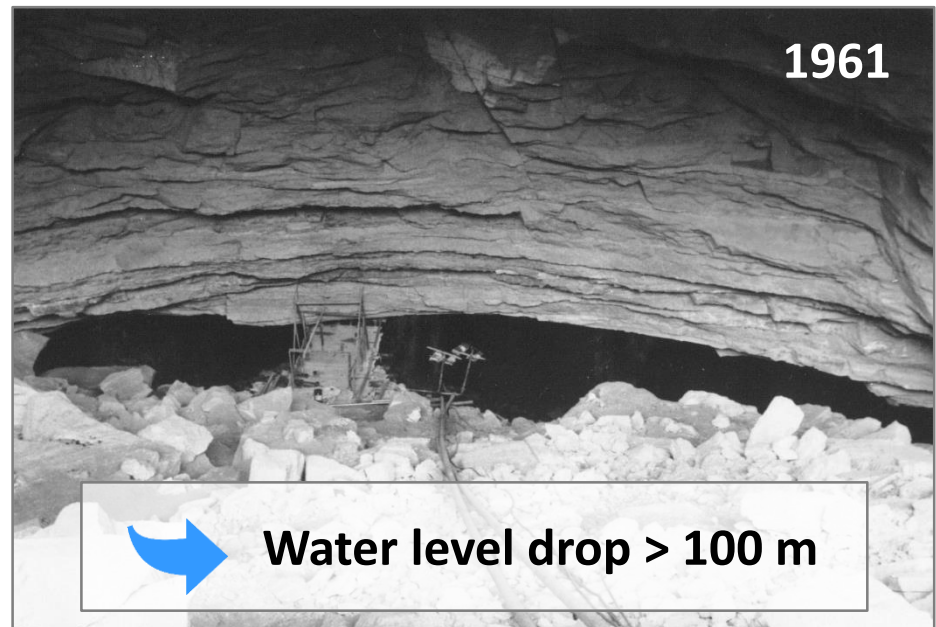[4] Ministry of Water & Electricity, Riyadh, Saudi Arabia

Early Career
Hydrogeologists'
Network

1877

Study Site and Motivation

Sulaiy Limestone

Hith Anhydrite

Riyadh
Dahl Hith

Dahl Hith cave:

- also known as Ain Hith
- Hith Anhydrite is a major seal rock/aquitard
- used for water supply

1961

Water level drop > 100 m

Study Site and Motivation

2008

Climbing down over boulders...

Study Site and Motivation

2008

...over a car wreck...

Study Site and Motivation

2008

...passing by cave graffiti...

Study Site and Motivation

2008

...reaching the water at
> 100 m below the entrance

Study Site and Motivation

2013

Method

Method: The YouTube Approach

Results

Results

Results

Labels on the figure:
- Dahl Hith
- N (north arrow)
- to Riyadh
- Sulaiy Limestone Escarpment
- Riyadh
- Dahl Hith
- to Kharj
- 2 km

Lakes formed from treated sewage effluent (since 2008)
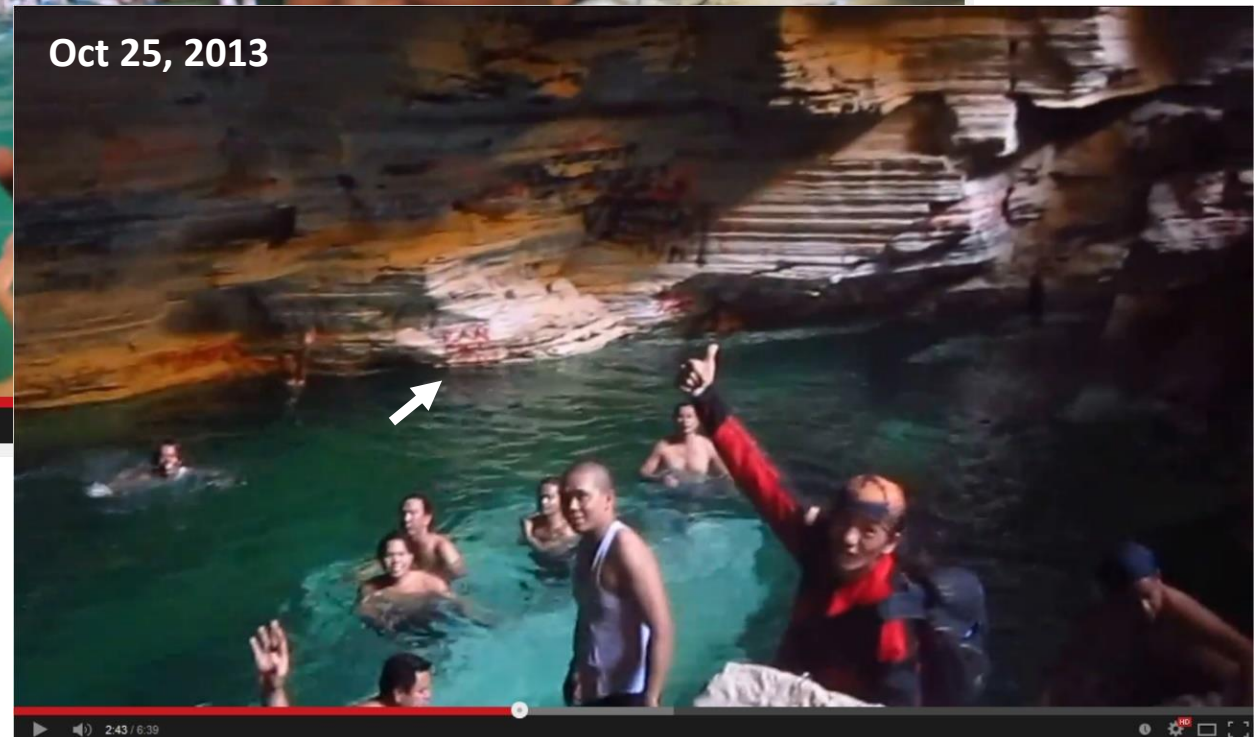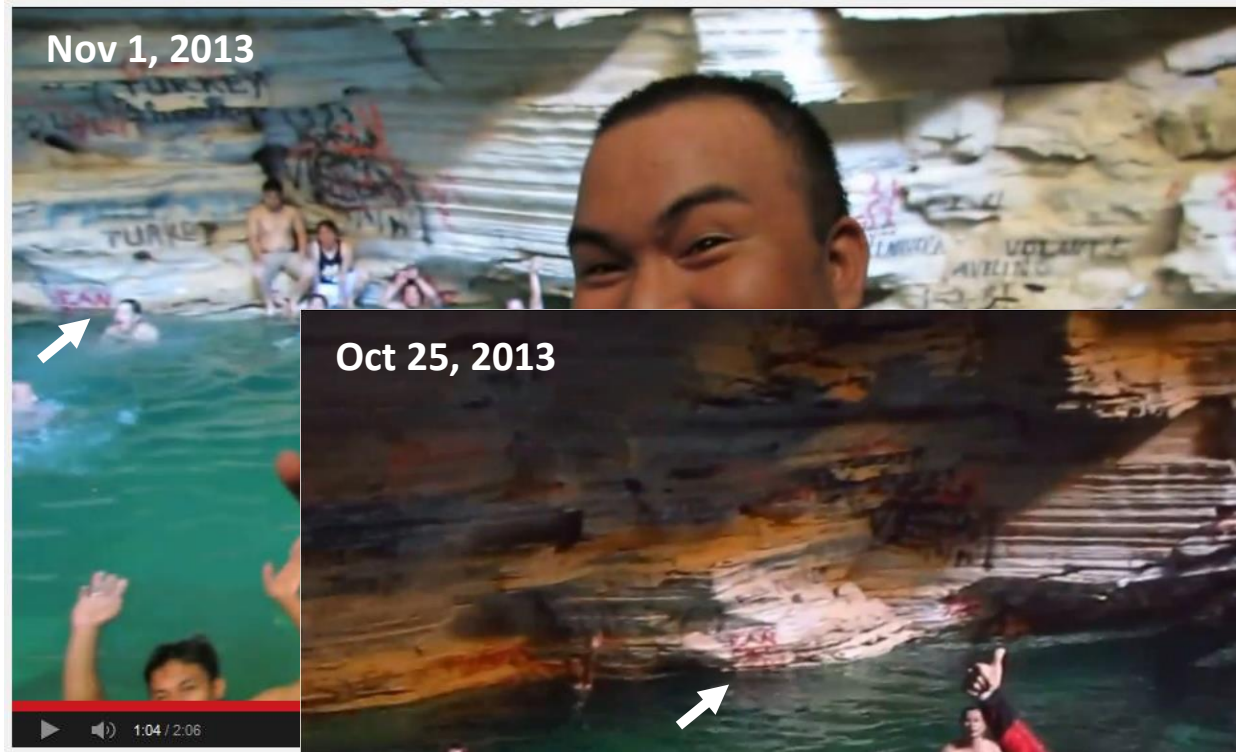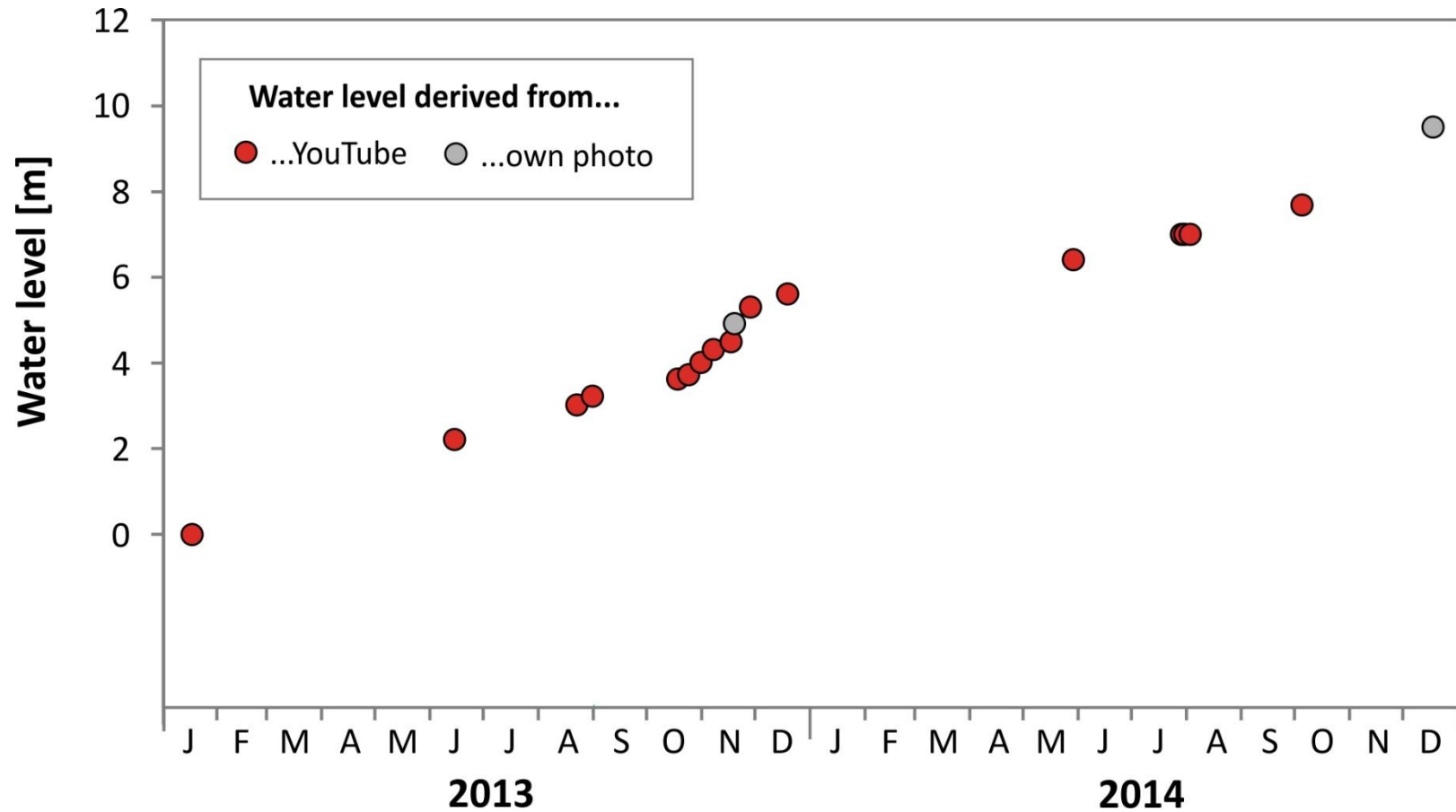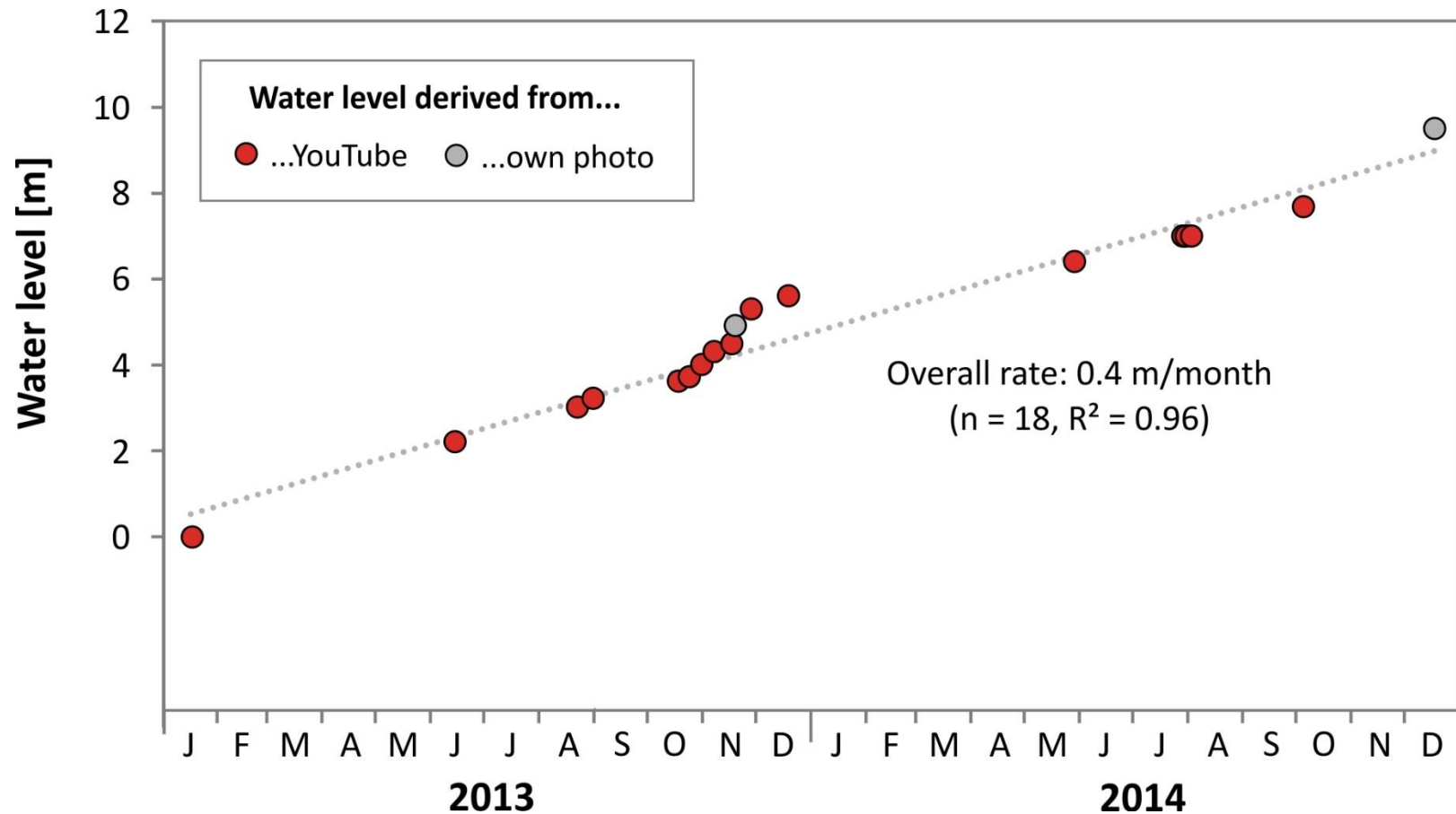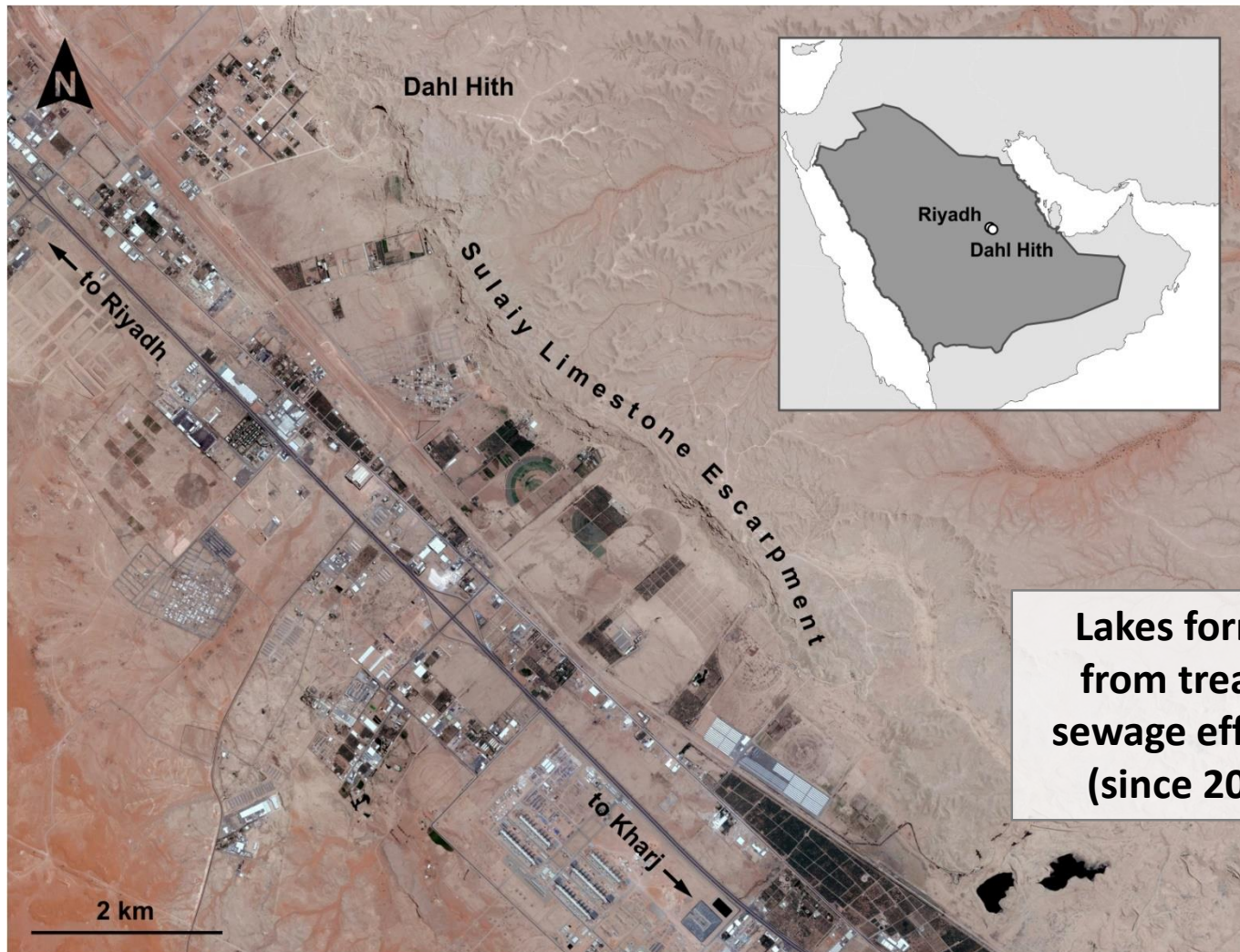
Results

View to SSE

"...nearly hopeless jumble of low hills representing complexly settled rocks" (Steineke et al. 1958)

Results
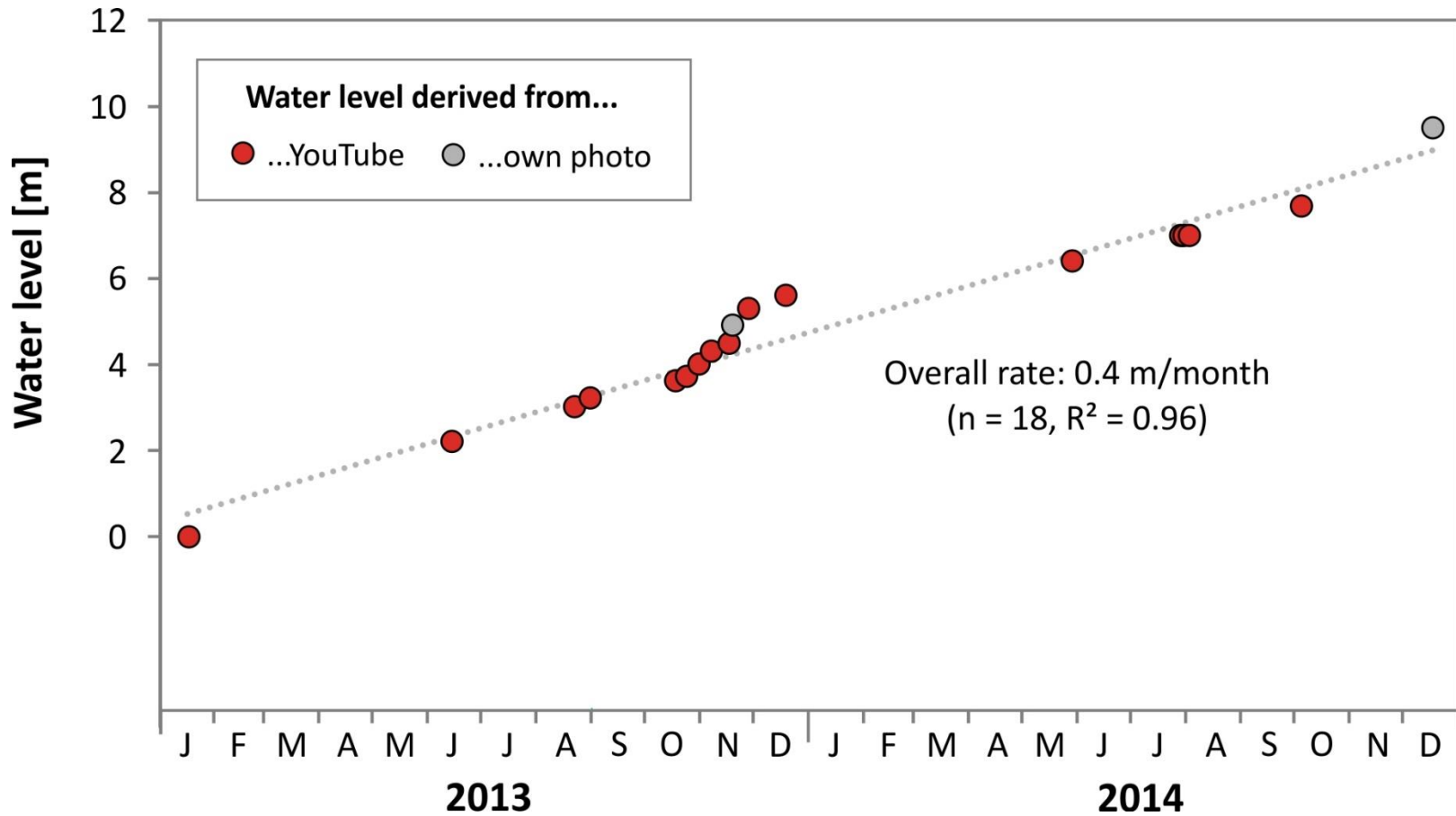
Results
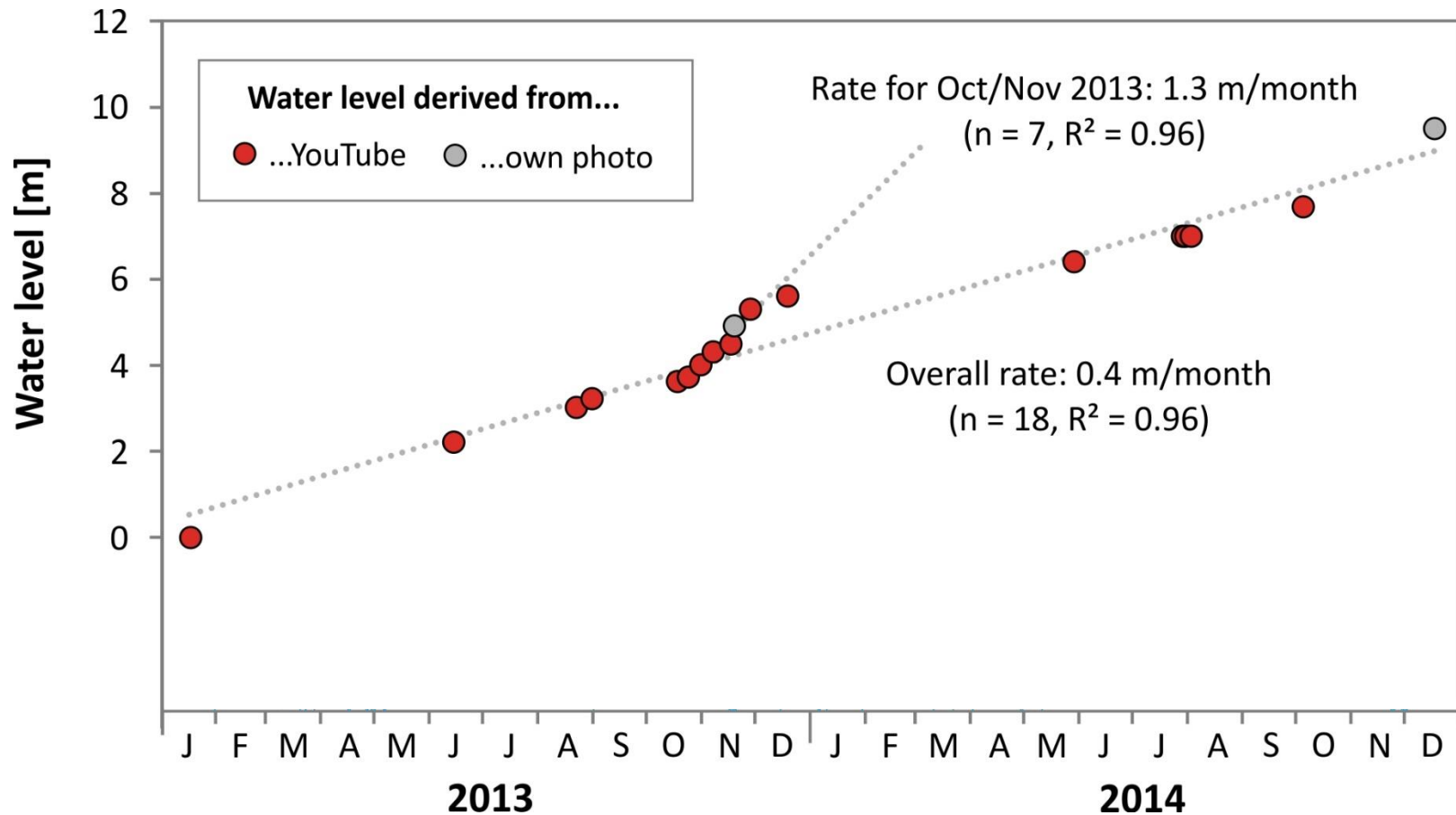
Results

Discussion

- Approach provides ESTIMATES only (complementary data source)

- Quantification of error and error propagation difficult

- *In principle* possible, e.g. by physically measuring previously estimated distances

- …would currently require diving (dangerous, water quality, etc.)

So what?

Approach could be adapted to other settings: Spring discharge, stream stage, etc.

Summary and Conclusions

- Social media mining (citizen science, crowd-sourcing in a broader sense)

- Precedent of using multiple YouTube videos to reconstruct historical water levels over an extended time period
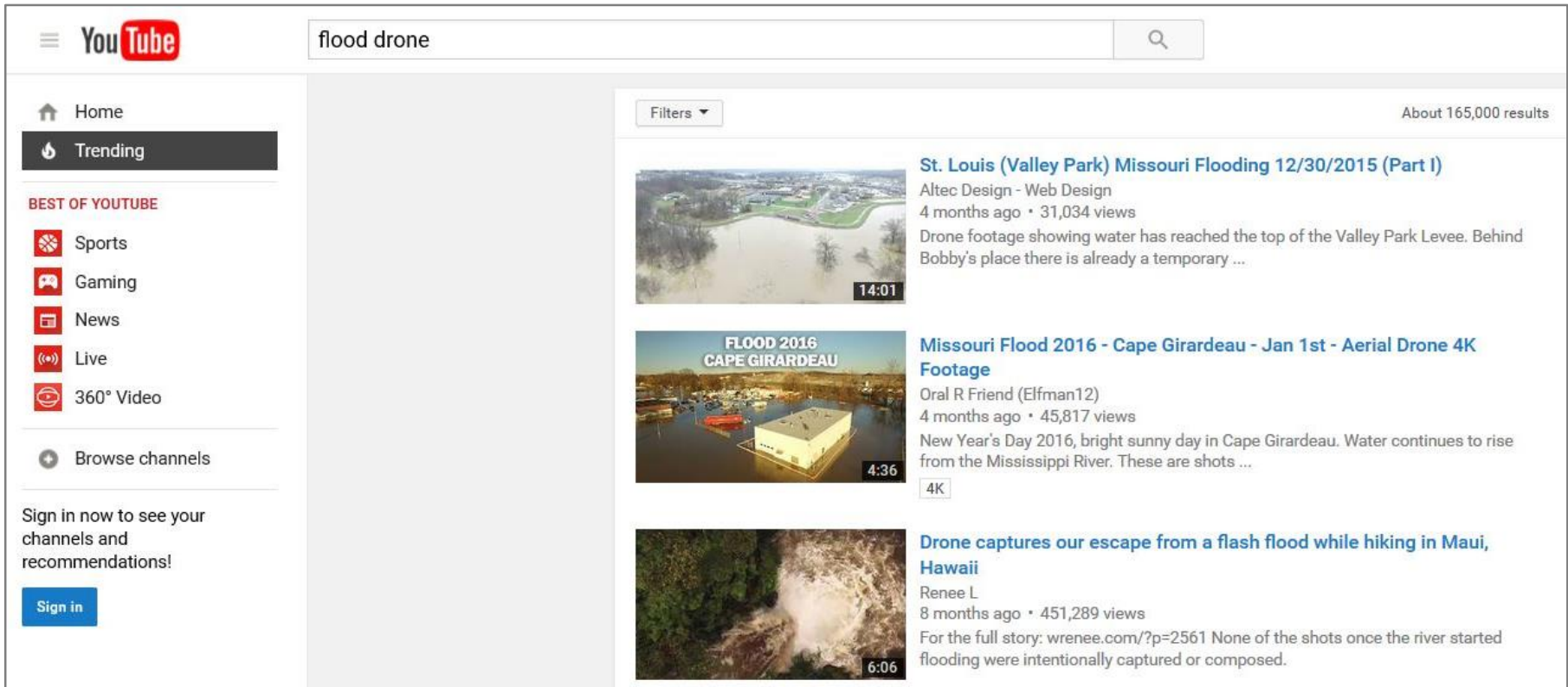
- Approach yields estimates, but probably viable in data-scarce settings

- Method is transferable (spring discharge, stream stage, flood extents, etc.)

- Outreach component

More details:
Michelsen et al. (2016) YouTube as a crowd-generated water level archive
Sci. Tot. Environ., 568, 189-195

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Outreach

http://www.bbc.co.uk/news/science-environment-32324232

More genuine water level data hidden in the graffiti…

Hijri date: ١٣٩٧/٤/٧
Gregorian date: 27 March 1977

Michelsen et al. (2016)

More genuine water level data hidden in the graffiti…

Michelsen et al. (2016)

ID	Date	Link	Screenshot time	Comment	Water level [m]
1	18 Jan. 2013 (U)	www.youtube.com/watch?v=JBlKxGCFOc0	0:12	Reference	0.0
2	15 Jun. 2013 (U)	www.youtube.com/watch?v=t1IKZBy9xQc	0:18, 0:35, 0:39	2.2 m higher than ID 1	2.2
3	23 Aug. 2013 (U)	www.youtube.com/watch?v=fh_mtqMdHjM	3:51, 5:09	0.8 m higher than ID 2	3.0
4	1 Sep. 2013 (U)	www.youtube.com/watch?v=6nze81IilXQ	0:01	0.2 m higher than ID 3	3.2
5	19 Oct. 2013 (V)	www.youtube.com/watch?v=fGwDoLX9FdA	0:11, 0:52	0.1 m lower than ID 6	3.6
6	25 Oct. 2013 (V)	www.youtube.com/watch?v=OqQuVPI1YwI	2:43, 3:41	1.5 m higher than ID 2	3.7
7	1 Nov. 2013 (V)	www.youtube.com/watch?v=hIzpBjYdTD8	0:54, 1:05	0.3 m higher than ID 6	4.0
8	8 Nov. 2013 (U)	www.youtube.com/watch?v=FXyNf_qNskA	0:07	0.3 m higher than ID 7	4.3
9	18 Nov. 2013 (U)	www.youtube.com/watch?v=sQodFaGMILQ	9:36	0.5 m higher than ID 7	4.5
10	20 Nov. 2013 (V)	Own photo	n.a.	0.4 m higher than ID 9	4.9
11	29 Nov. 2013 (U)	www.youtube.com/watch?v=IhqNlrOg0_4	0:03	0.4 m higher than ID 10	5.3
12	20 Dec. 2013 (V)	www.youtube.com/watch?v=HdQ7-cNDyNI	0:37	0.7 m higher than ID 10	5.6
13	30 May 2014 (V)	www.youtube.com/watch?v=JSf1s9CrP1U	0:30, 1:47	1.5 m higher than ID 10	6.4
14	30 Jul. 2014 (U)	www.youtube.com/watch?v=Y69kL-K8Y-k	0:32	0.6 m higher than ID 13	7.0
15	1 Aug. 2014 (U)	www.youtube.com/watch?v=urPHGT340dw	0:14, 2:09	Same as ID 14	7.0
16	4 Aug. 2014 (U)	www.youtube.com/watch?v=mkITdMehbGk	0:05, 0:12	Same as ID 14 and ID 15	7.0
17	6 Oct. 2014 (U)	www.youtube.com/watch?v=rKcNLxLH6xQ	1:16, 1:40	0.7 m higher than ID 16	7.7
18	19 Dec. 2014 (V)	Own photo	n.a.	1.8 m higher than ID 17	9.5

Michelsen et al. (2016)

Method

- Each line represents a Youtube video or own site visit (1-3 screenshots/photographs)

- Multiple reference points

- Reference points were frequently changed due to drowning

Jan 2013

Dec 2014

Gauging extreme floods on YouTube: application of LSPIV to home movies for the post-event determination of stream discharges

Raphaël Le Boursicaud,[1] Lionel Pénard,[1] Alexandre Hauet,[2] Fabien Thollet[1] and Jérôme Le Coz[1*]

[1] *Irstea, UR HHLY, Hydrology–Hydraulics, 5 rue de la Doua CS70077, 69626 cedex, Villeurbanne, France*
[2] *EDF-DTG, 21 avenue de l'Europe BP41, 38040 cedex 09, Grenoble, France*

Survey by CITC & KFUPM (2014) about smartphone/social media use

- 3000 interviews in Saudi Arabia; age range: 12-65 years

- remarkable smartphone penetration: 67% of the respondents owned a smartphone and 72% used a smartphone

- 91% of the respondents used social media

- Use of social media in the preceding six months (multiple choice):
  - YouTube: 70%
  - Facebook: 59%
  - Twitter: 53%
  - Instagram: 41%
  - etc.

www.citc.gov.sa/English/Reportsandstudies/Studies/Pages/default.aspx

Selection of own phtographs

May 2012

Nov 2013

Dec 2014

Study Site

Labels on image: cave entrance, former pump station, Sulaiy Limestone escarpment, abandonned agricultural fields, 200 m, N

Inset map: Riyadh, Dahl Hith

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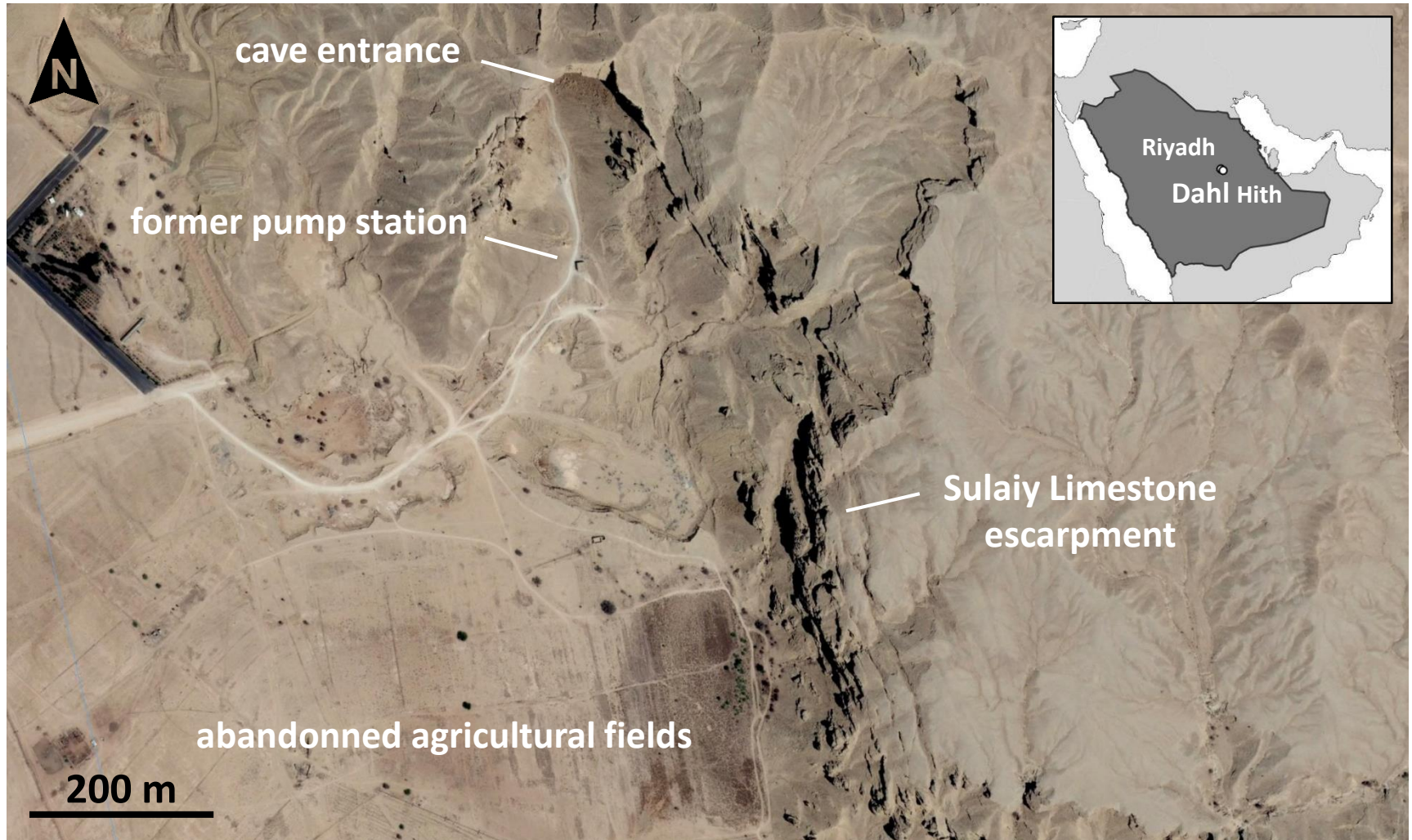
Study Site

Dahl Hith (Ain Hith)

Sulaiy Limestone

Hith Anhydrite

former pump station

Hydrochemistry – Time Series
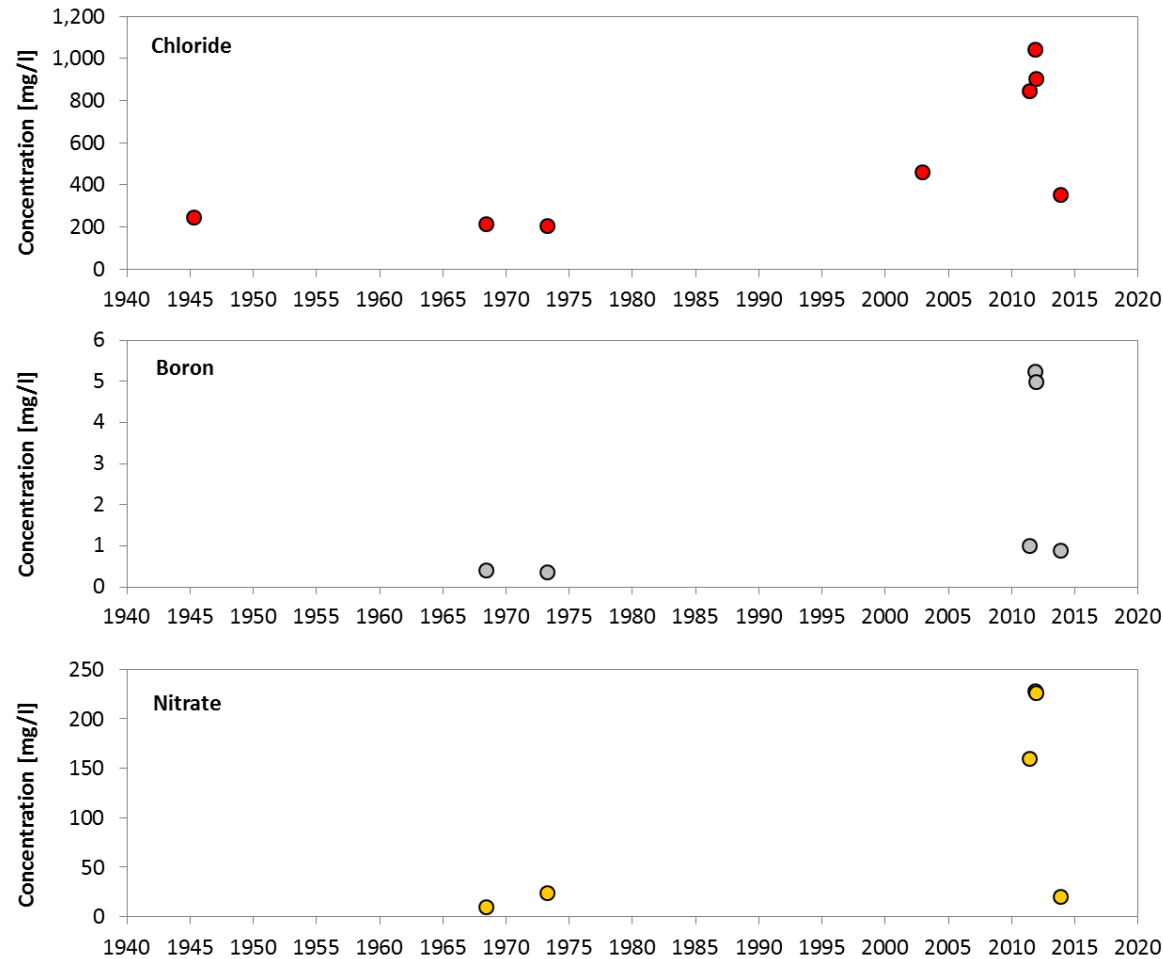
Hydrochemistry – Piper plot

Legend:
- Dahl Hith 1-3 (1945-1973; BROWN 1949, SOGREAH 1968, JOB ET AL. 1978)
- Dahl Hith 4 (2002, GREGORY 2011)
- Dahl Hith 5-8 (2011-2013; SGS 2011, THIS STUDY)
- Waste Water (NW, SE lakes, Riyadh River; THIS STUDY)
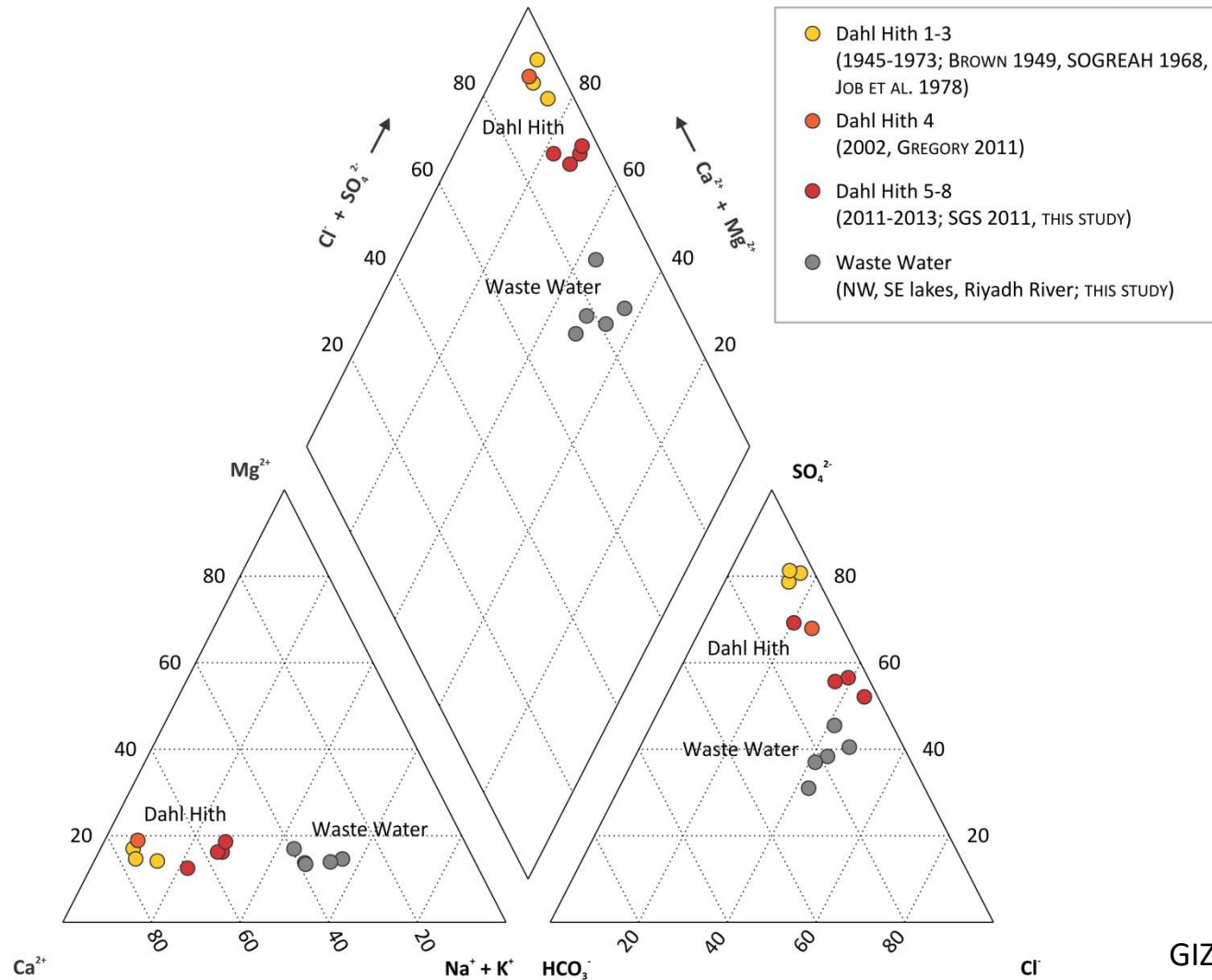
GIZ/DCo (2015)

GOOGLEEARTH (2015)

LANDSATLOOK VIEWER (2015)

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Dec 28, 2006   500 m

May 15, 2011

Aug 17, 2013

June 6, 2014

Feb 22, 2008   Mar 25, 2008

Dec 28, 2010   Mar 2, 2011

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Waste water discharge

Infiltration of waste water

1994

Bjurström (2005)

2002

Killey et al. (2002)