OPEN DATA AND ITS BENEFITS TO SOCIETY: REMEMBERING THE BUCHENWALD CONCENTRATION CAMP

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ABSTRACT: More and more countries, states, and municipalities are making their raw LiDAR archives accessible to the general public. Many are doing so entirely for free with instant online access via download portals and a generous open license that allows data sharing and commercial use. The traditional argument for restricting access to national geospatial data (paid for by taxes) and selling it back to tax payers to "fund future acquisitions" was exposed as flawed by a "freedom of information" request in England. It showed that the total amount of revenue generated for all LiDAR and derivatives sales by England's Environment Agency was a mere 0.03 percent of their operating budget. The reaction was swift. The Environment Agency has since made all DTM and DSM rasters down to 0.25 meter resolution as well as raw point clouds available online for open access with a very permissible license. This policy resulted in incredible re-use of data originally only acquired for flood mapping purposes and the Agency has been propelled into the role of a “champion for open data”.
In our talk we show how a similar open LiDAR policy in the German state of Thuringia has empowered us to focus on the former Buchenwald Nazi Concentration Camp in recent GIS capacity building and LiDAR training exercises. Given the rise of demagogues it is imperative to remind the citizenry of where demagoguery can lead. We create a hill-shaded Digital Terrain Model (DTM) from the bare-earth LiDAR points to finds the remnants of internment barracks and camp buildings that were demolished in 1950 but are still clearly visible ground disturbances under the canopy of the dense forest that has grown there since. Combining these open LiDAR derivatives with old maps allows us to create course materials that not only teach technical skills but are of important societal value.

1. INTRODUCTION

More and more countries, states, and municipalities have been deciding to make their raw LiDAR archives accessible to the general public. Some are doing so entirely for free with instant online access via download portals and generous open licenses that allow data sharing and commercial use. Others still charge a “small administrative fee”, require filling out actual paperwork with real signatures in ink, or postal mailing of hard drives that can easily take half a year to complete. Their data licenses are often much stricter, prohibiting to share raw data or derived products and disallowing commercial use.
The traditional argument to justify the sale of geospatial data paid for with taxes back to the tax payers had been that the proceeds were needed to finance future surveys. In England - whose Environment Agency used to sell raw LiDAR and derivatives - this was publicly exposed as a flawed argument. The "freedom of information" request by Louise Huby on November 21st, 2014 showed that the total amount of revenue generated for all LiDAR and derivatives sales by the Environment Agency was only around £323,000 per year between 2007 and 2014. This figure was dwarfed by the agencies’ annual operational budget of £1,025,000,000 in 2007/08. On average the revenue from LiDAR sales was a mere 0.03 percent of the budget … enough to buy coffee and snack for the office but not in the least enough to refinance anything.
The reaction was swift. In September 2015 the Environment Agency made all their DTM and DSM rasters down to 0.25 meter resolution available online for open access and in March 2016 added the raw point clouds for download in LAZ format [1] with a very permissible license. This open data policy has resulted in an incredible re-use of the LiDAR that was originally only acquired for flood mapping purposes and the Environment Agency has literally been propelled into the role of a “champion for open data”.
Finland, Denmark, Holland, Norway, Slovakia, the USA and others also offer their national LiDAR holdings as open data. However, in Germany the raw LiDAR point clouds and raster derivatives have traditionally been tightly guarded by the 16 state survey departments and is sold for more than just a fee. Financial reasons would usually prohibit residents in Germany from making, for example, an elevation profile for their favorite mountain bike trail for hobby purposes. Or starting a small business that, for example, sells “Gassi-Maps” (the term “Gassi is a German expression meaning “to go for a walk with your dog so he can poop”) for 5 EUR a sheet with elevation-optimized dog walking routes of low incline that pass by suitable potty spots and dog-friendly coffee shops.

2. OPEN DATA IN GERMANY

Frustrated with the situation in Germany and inspired by the change in geospatial data policy in England, we have made similar "Frag den Staat" freedom of information requests with 11 of the 16 German state mapping agencies, asking about how much sales revenue was generated annually from their LiDAR and derivative sales. Bavaria, Hesse, Saxony, and Baden-Württemberg denied the request, we never heard back from Lower Saxony, and Thuringia wanted more fees than we were willing to spend. But our requests were answered by five states and - just like in England - the reported revenues (see Figure 1) were just a tiny fraction of the original LiDAR acquisitions and processing costs. Here are the revenues as a yearly average:

- Rhineland-Palatinate, 58,012 EUR / year (2005 – 2015)
- Saxony-Anhalt, 132,350 EUR / year (2011 – 2015)
- Saarland, 4,448 EUR / year (2008 – 11/2015)
- Schleswig-Holstein, 18,458 EUR / year (2012 – 2014)
- State of Bremen, 597 EUR / year (10/2012 – 09/2015)

a)

Jahr	DGM	DOM	Rohdaten
2012 (ab Oktober)	160,00 EUR	--	--
2013	1334,00 EUR	--	--
2014	439,00 EUR	--	--
2015 (bis 30.09.)	456,00 EUR	--	--

b)

	Gesamtein-nahme pro Jahr	DOM & Derivate	DGM & Derivate	klassifizierte Laserscanda-ten (seit 2014)
2011	47.814,17 €	17.037,00 €	30.777,17 €	
2012	192.955,54 €	23.226,00 €	169.729,54 €	
2013	216.990,14 €	34.061,00 €	182.929,14 €	
2014	97.387,86 €	34.204,00 €	63.133,86 €	50,00 €
2015	106.604,58 €	38.680,00 €	67.463,14 €	461,44 €

d)

Jahr	Einnahmen
2012	1 230,- Euro
2013	40 470,- Euro
2014	13 674,- Euro

c)

Einnahmen	DGM	DOM	Rohdaten	shaded Relief
2008	10.260,00 €	264,00 €	688,00 €	
2009	6.012,00 €		400,00 €	
2010	4.408,00 €		320,00 €	
2011	4.464,00 €		272,00 €	
2012	824,00 €		120,00 €	12,00 €
2013	2.300,00 €			34,00 €
2014	3.760,00 €			177,84 €
2015 (bis 23.11.2015)	1.232,00 €		40,00 €	

e)

Jahr	Einnahmen gesamt	davon Einnahmen DGM	davon Einnahmen Rohda-ten (LPG, LPO)
2015	43.205,10 €	38.456,10 €	4.749,00 €
2014	71.180,88 €	64.176,88 €	7.004,00 €
2013	62.744,56 €	45.176,56 €	17.568,00 €
2012	141.002,00 €	17.377,00 €	123.625,00 €
2011	162.373,50 €	49.534,50 €	112.839,00 €
2010	31.567,80 €	25.705,80 €	5.862,00 €
2009	40.333,98 €	38.429,98 €	1.904,00 €
2008	41.611,00 €	29.451,00 €	12.160,00 €
2007	24.846,80 €	18.846,80 €	6.000,00 €
2006	12.589,34 €	12.589,34 €	./.
2005	6.685,80 €	6.685,80 €	./.

Figure 1: Annual sales revenue from LiDAR and derivative sales reported (a) by the State of Bremen, (b) by Saxony-Anhalt, (c) by Saarland, (d) by Schleswig-Holstein, and (e) by Rhineland-Palatinate

However, it is not all bad news in Germany. In January 2017 the floodgates of geospatial data have at least partially opened. The OpenNRW initiative of the state of North Rhine-Westphalia made all its LiDAR points, DTM and DSM rasters, and several other geospatial data sets available for download with a very permissible open license. A few days later the state of Thuringia implemented a similar open data policy for their geospatial data holdings. And it's not just LiDAR. Presented beautifully via a very functional download portal you can download:

- raster DTM (DGM) and DOM (DSM) and LiDAR points
- aerial images and orthophotos
- topographical maps (as GeoTIFFs or in layers)
- various land cover models
- shapefiles of all cadastral districts
- 3D buildings (LOD1 / LOD2) in CityGML
- building coordinates
- building footprints

And it all comes with a very permissible license called "Datenlizenz Deutschland – Namensnennung – Version 2.0" or "dl-de/by-2-0" that allows data and derivative sharing as well as commercial use. Kudos to OpenNRW and TLVermGeo for creating this treasure cove of free-for-all geospatial data.

3. USING OPEN DATA FOR CAPACITY BUILDING

Since open LiDAR has become available in Germany we have put it to good use. Each year, rapidlasso GmbH holds numerous LiDAR capacity building events and participates in remote sensing summer schools around the globe. With the recent rise of demagogues around the world we decided that to take our students - geospatially

speaking - to a stark reminder of where such demagoguery can lead.

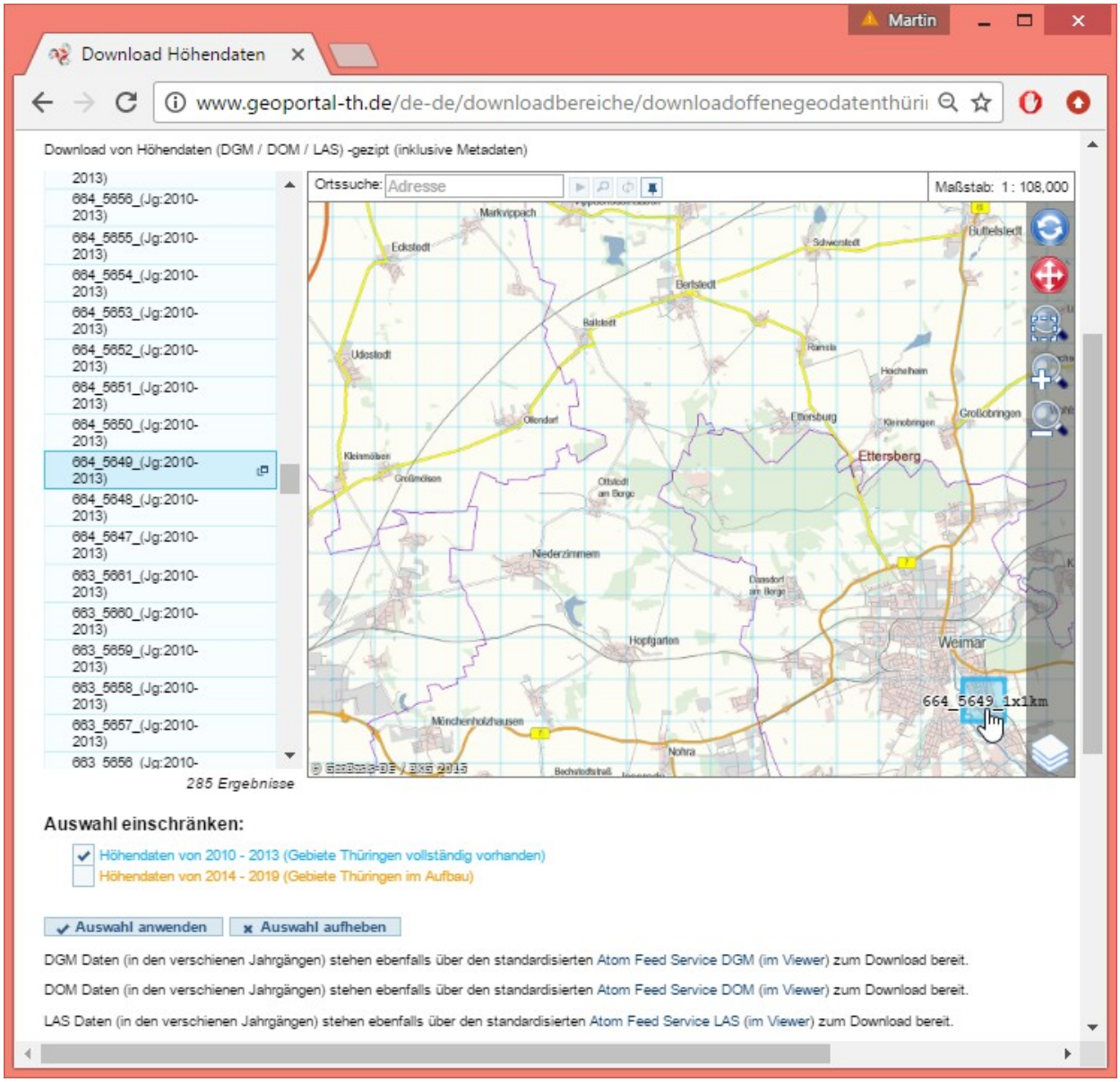

Figure 2: Open Data download portal of the state of Thuringia (created and managed by TLVermGeo).

Using the fabulous download portal of TLVermGeo (see Figure 2) we let the students focus on a forested area to the North West of Weimar, a city famous for Goethe, Schiller, Bauhaus, and National Socialism. We zoomed in on Buchenwald (which is German for “beech forest”) the site of a former concentration camp. It was established in July 1937 and was one of the largest on German soil. Today the remains of Buchenwald serve as a memorial and as a permanent exhibition and museum.

(*) The free and open source LASzip point cloud compressor used for Terabytes of LiDAR by TLVermGeo, England, Finland, Denmark, Holland, Slovakia, USGS, NOAA, OpenTopography and other portals turns bulky LAS files into compact LAZ files without information loss. LASzip was the winner of the 2012 Geospatial World Forum Technology Innovation Award in LiDAR Processing and the runner-up for innovative product Wichmann award at INTERGEO 2012. Today LASzip is the de-facto standard for LiDAR compression and the LAZ format has native support in most software packages.

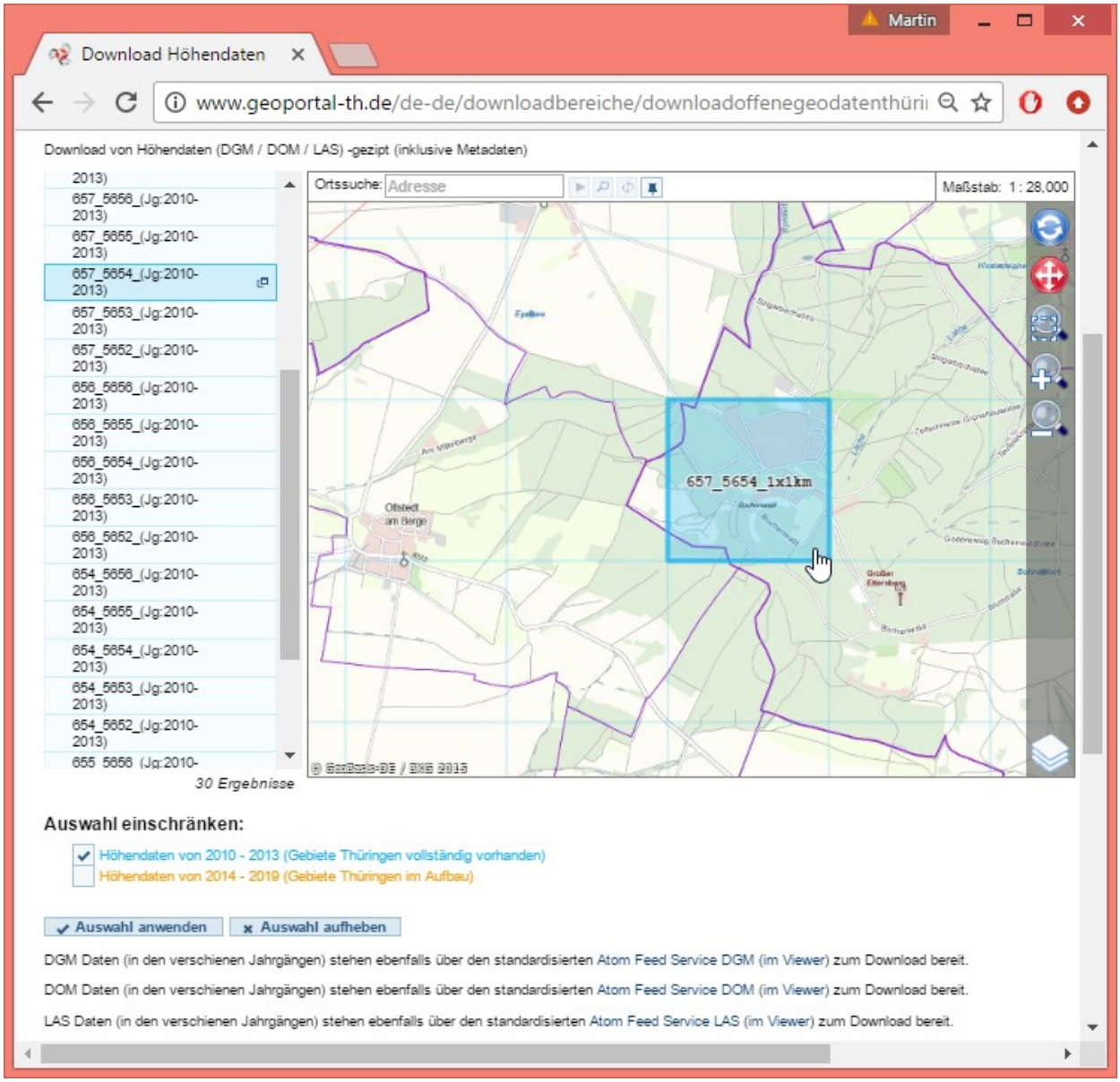

Figure 3: The 15 tiles surrounding the blue one are being downloaded for the capacity building exercises.

For our exercises we download the LiDAR data around the Buchenwald concentration camp: the 15 tiles surrounding the blue one: two on its left, two on its right and one corresponding row of five tiles above and below. Each of the 15 zipped archives contains a *.laz file and *.meta file. The *.laz file contains the LiDAR points compressed with LASzip (*) and the *.meta file contains the textual meta information shown below where “Lage” and “Höhe” refer to “horizontal” and “vertical”.

```
Datei: las_655_5653_1_th_2010-2013.laz
Erfassungsdatum: 2011-03
Erfassungsmethode: Airborne Laserscanning
Lasergebiet: Laser_04_2010
EPSG-Code Lage: 25832
EPSG-Code Höhe: 5783
Quasigeoid: GCG2005
Genauigkeit Lage: 0.12m
```

```
Genauigkeit Höhe: 0.04m
Urheber: (c) GDI-Th, Freistaat Thueringen, TLVermGeo
```

Next we typically run a few quality checks on these 15 tiles by processing them with several modules of our LAStools software like lasinfo, lasoverlap, and lasgrid. Eventually we let the students check the quality of the existing ground classification in the LiDAR by generating a hillshaded Digital Terrain Model (DTM) for visual inspection with las2dem. Problems in the ground classification of LiDAR points are often visible in a hillshaded DTM. In addition to the usual ground points (classification code 2) we also keep the synthetic points TLVermGeo has added to improve the DTM under bridges (16), under buildings (17), and along building edges (18). This is the command line achieving this:

```
las2dem -i las_*2010-2013.laz ^
        -keep_class 2 16 17 18 ^
        -step 1 ^
        -hillshade ^
        -odir quality -odix _shaded_dtm -opng ^
        -epsg 25832 ^
        -cores 4
```

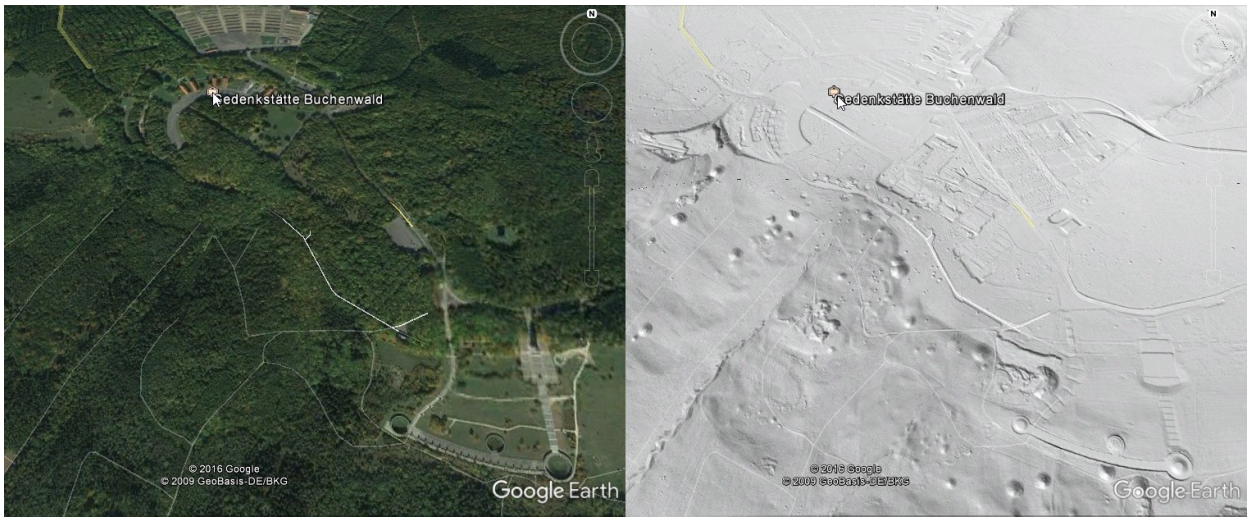

Figure 4: Comparing aerial imagery from Google Earth with the hillshaded DTMs generated from the LiDAR.

We see a number of ground disturbances in the hillshaded DTM (see Figure 4). Some of them are expected because if you read up on the history of the Buchenwald concentration camp you will learn that in 1950 large parts of the camp were demolished. However, the laser does find the remnants of those barracks and buildings as clearly visible ground disturbances under the canopy of the dense forest that has grown there since. And then there are also many many bumps that look like bomb craters. Are those from the fatal American bombing raid on August 24, 1944 that accidentally killed 388 prisoners?

Aerial images show mostly forest. But the old foundations of the destroyed buildings of the former concentration camp are clearly visible in the hillshaded DTM. They perfectly match the building footprints of an overlaid visitor map to the memorial site. However, our initial assumption that those bumps would be bomb craters is wrong. We are not sure if all the bumps are there for the same reason. But we found an old schematic map (see Figure 5) and overlaying it on the area for which we have LiDAR suggests that at least the bigger bumps are not bomb craters. Similar bumps like those seen in the hillshades are labelled as “Erdfälle” which is German for “sink hole”.

Figure 5: Comparing an old schematic map of the area with the hillshaded DTMs generated from the LiDAR. At least the bigger bumps in the hillshaded DTM are not bomb craters. They are labelled as "Erdfälle" (sink holes) in this older map.

The open data release also contains geo-referenced high-resolution aerial images that were taken by US surveillance planes during the final years of the war (see Figure 6). In future capacity building and training events we plan to use some historical images that show the Buchenwald camp in its fully build-up state for more elaborate exercises in data fusion and temporal analysis.

3. CONCLUSION

Using LiDAR of Buchenwald concentration camp paid for by taxes and provided as open data allows us not only to train students in point cloud processing. The historically relevance of our open LiDAR download and processing exercise gives students a glimpse into conflict archaeology, data fusion, and geomorphology and reminds them of the danger of demagogues. This is not all. We can also find a few wind turbines in this area and regularly use them to explain the concepts of flight lines and scan angles.

Acknowledgment: The LiDAR data of TLVermGeo comes with a very permissible license. It is called “Datenlizenz Deutschland – Namensnennung – Version 2.0” or “dl-de/by-2-0” and allows data and derivative sharing as well as commercial use. It only requires us to name the source. For this we merely need to cite “geoportal-th.de (2017)” with the year of the download in brackets. We should specify the Universal Resource Identification (URI) but have not found this yet. We use this URL as a placeholder until we know the correct one. Done. So easy. Thank you, geoportal Thüringen.

Now we are waiting for the other 14 German states whose geospatial data is still locked behind a wall of administrative procedures and expensive fees. Which German state will make their data open next? And which will be the first country in Asia to implement a similar open geospatial data policy as they have been becoming common in Europe and North America?

ADDITIONAL MATERIAL:

[1] http://rapidlasso.com/2017/01/03/first-open-lidar-in-germany/
[2] http://rapidlasso.com/2017/01/09/second-german-state-goes-open-lidar/

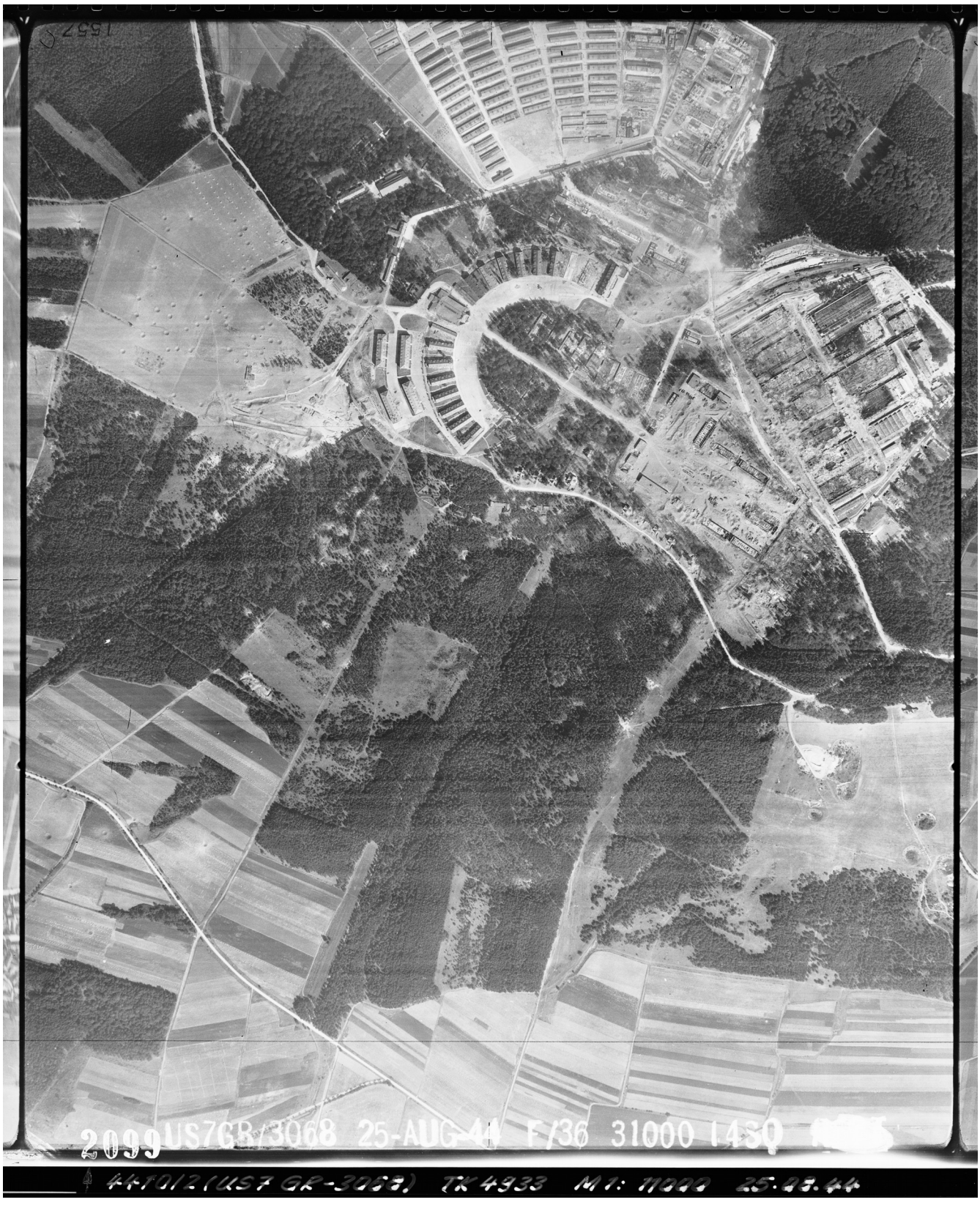

Figure 6: Airborne image of Buchenwald concentration taken by US surveillance planes in Aug ust of 1944