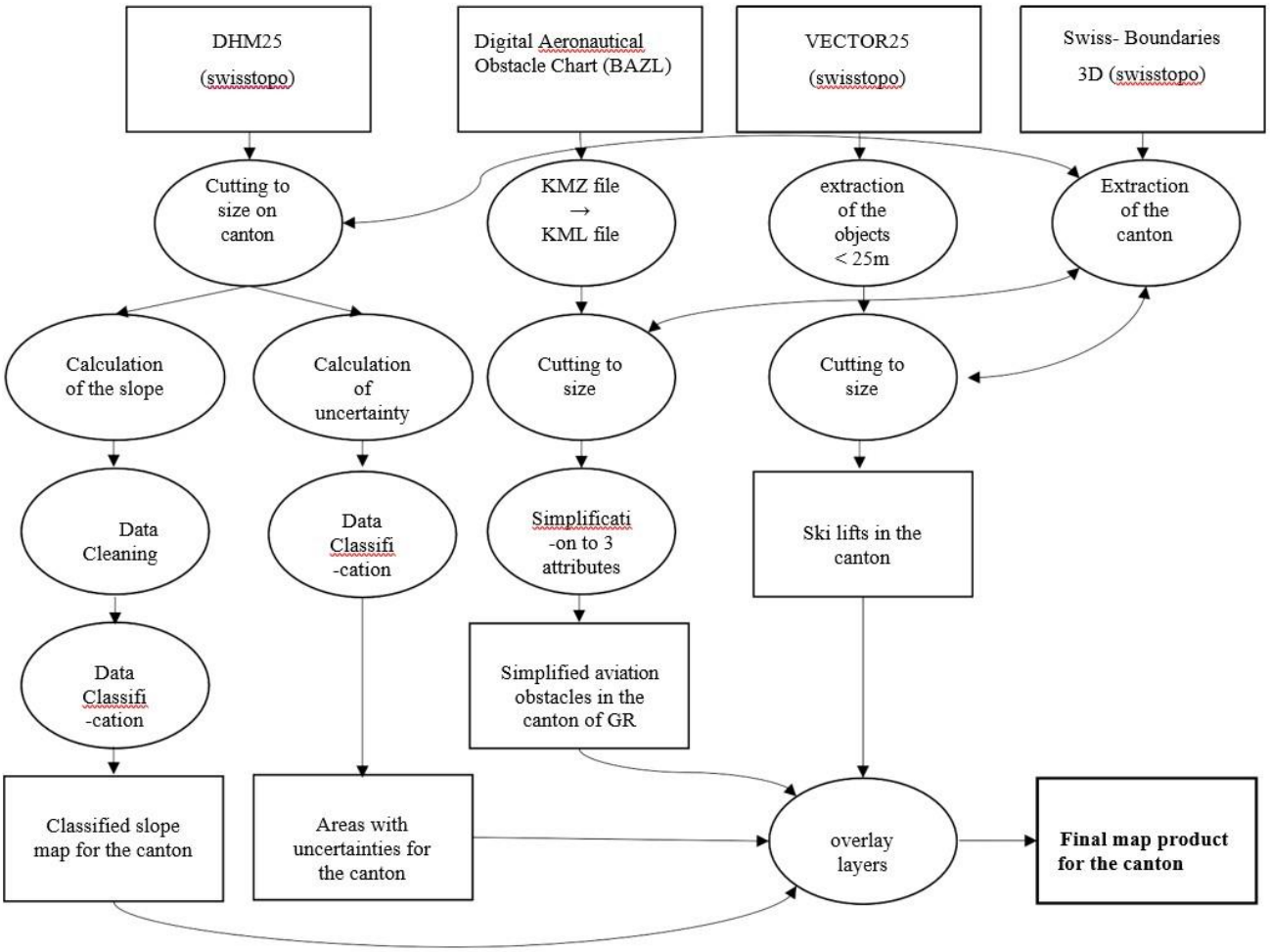
Supplementary Material

1 Production of the maps

The maps are produced on the basis of four spatial data sets in a multi-stage process. The entire process is shown graphically in Figure S1 and is explained step by step below. Most of the operations are performed using ESRI's ArcMap 10.4.1 software, with the exception of uncertainty calculations, which are performed using a code written specifically in Java. The Illustrator CS6 program from Adobe is used for the graphic editing and finishing of the maps.



Supplementary Figure 1. Entire process for producing the maps. Rectangles represent data or map products; ellipses represent working steps.

The four spatial data sets used are the digital elevation model (DHM25) from swisstopo (as of 2000)[1], the digital obstacle map (WeGOM)[2] from the Federal Office of Civil Aviation (FOCA, as of 30 January 2017), VECTOR25 from swisstopo (as of 2008)[3], and SwissBOUNDARIES3D also from swisstopo (as of 2015)[4].

1.1 SwissBoundaries3D

Since the mean deviation of the DHM25 is highest in the Alps (swisstopo 2005), all map sections come from the canton of Graubünden. In order to crop the Swiss data records to the canton Graubünden, the canton border of Graubünden is extracted from the data record Swiss-BOUNDARIES3D and used to crop the data records.

1.2 Digital Height Map (DHM25)

The DHM25 describes the three-dimensional shape of the earth's surface in Switzerland and was derived from the elevation information of the National Map 1:25,000. The DHM25 is available as a basic model and as a matrix model. The basic model is the digitized elevation curves and nodes. The matrix model was derived by interpolation and is an elevation model with a regular grid arrangement of 25m mesh width. The quality level of the DHM25 is defined by levels. At level 1 the mean deviations from the model to control points are between 1.5m in the Mittelland, over 2m in the foothills of the Alps and in Ticino in the Alps up to 3m. In the Alps, however, the actual deviation can be up to 8m (swisstopo 2005).

After being tailored to the canton of Graubünden, the slope inclinations and uncertainties are calculated. The slope inclinations are calculated in degrees using the finite difference method (Horn 1981). Since a clear staircase effect is visible in the resulting slope inclination map and it is therefore not a harmonious map image, the slope inclination map is adjusted after the procedure of Streit (2013). In this procedure, a 3x3 average filter (a low pass filter) is first used to eliminate individual extreme pixels and thus smooth the map image (Burrough et al., 2015). Subsequently, the 25x25m slope inclination grid is downsampled to a grid of 5x5m using the Nearest Neighbour resampling method. A mean value filter is applied to this finer structured grid again, but with a 5x5 neighbourhood, which corresponds to the original dimension of the grid cell. This adjustment reduced or eliminated the visible staircase effect so that the map image is more harmonious, as the before-after comparison in figure S2 illustrates. After the correction, the slope inclination values are divided into six classes: (1) 0.0-10.0°, (2) 10.1-15.0°, (3), 15.1-20.0°, (4) 20.1-35.0°, (5) 35.1-50.0° and (6) >50.1°. In order to simplify the decision somewhat, a divergent color scale is used. The first two classes, which are suitable for helicopter landings, are colored with green tones and the remaining four classes, which are unsuitable for landings, are colored with violet tones. The color scale and the concrete colors were selected with the help of ColorBrewer 2[5].

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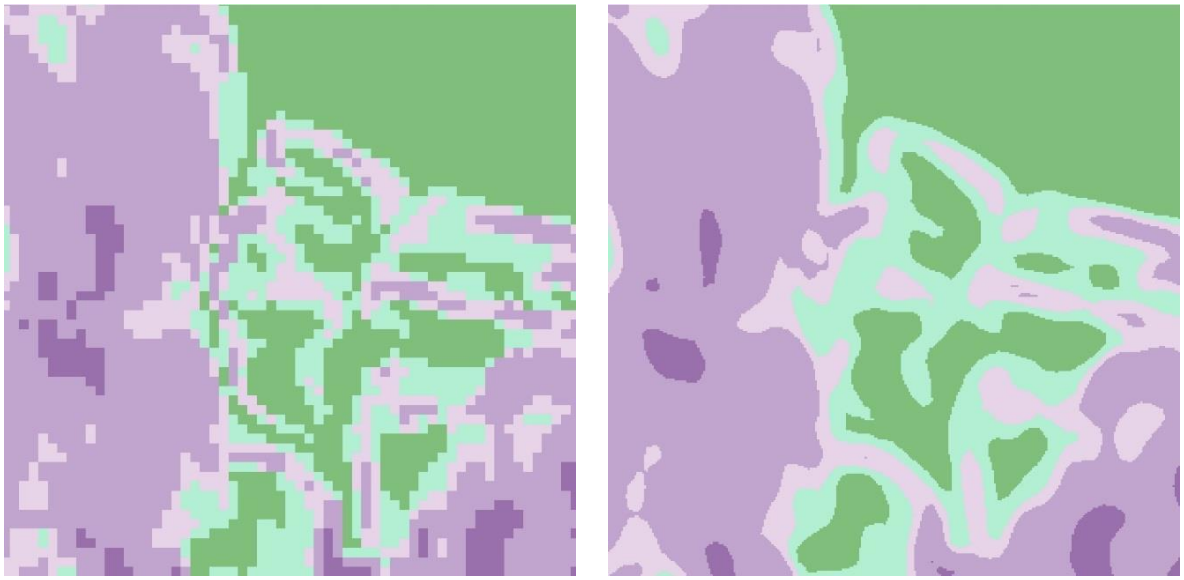
[1] https://shop.swisstopo.admin.ch/en/products/height_models/dhm25

[2] https://www.bazl.admin.ch/wegom

[3] https://shop.swisstopo.admin.ch/en/products/maps/national/vector/smv25

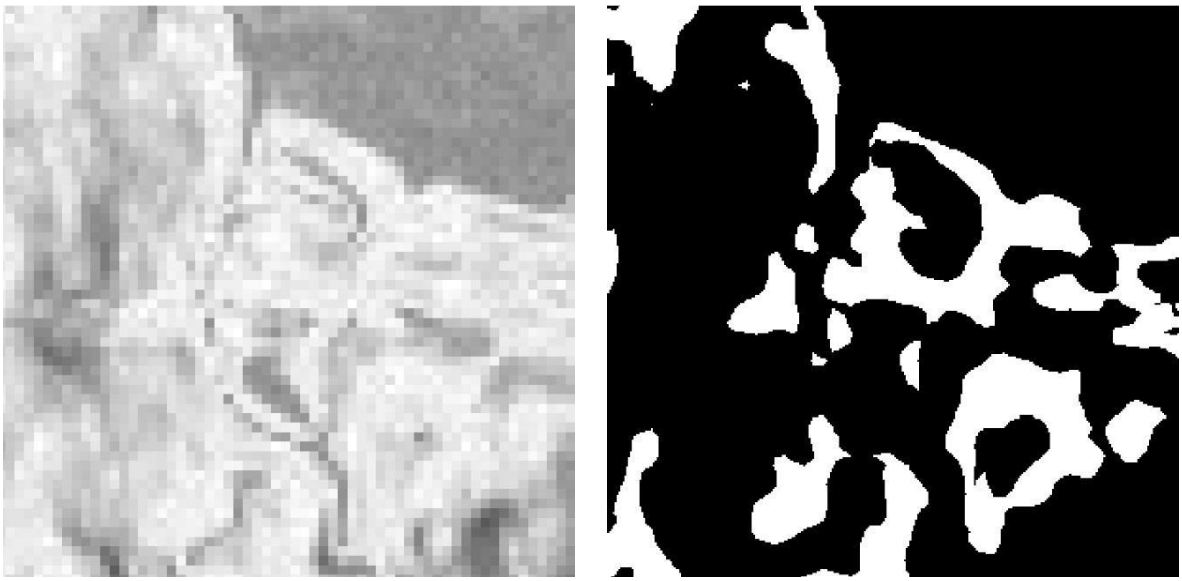
[4] https://shop.swisstopo.admin.ch/en/products/landscape/boundaries3D

[5] http://colorbrewer2.org/#type=divergingcheme=PRGn=3



Supplementary Figure 2. Before and after comparison of the correction of the slope map to reduce the staircase effect. Left: before the cleanup, right: after the cleanup. For a better comparison, the slope inclination is already classified in this figure, but the correction was carried out on the unclassified slope inclination data.

Since swisstopo only communicates the mean deviation of the DHM25, the uncertainties are calculated using Monte Carlo simulations, since only the RMSE has to be known for this method. The calculation of the slope inclination as well as the subsequent Monte Carlo simulation was executed by Java code written by Prof. Dr. Ross Purves. Input parameters for the calculation of the uncertainty using this code are the DHM (in this case the DHM25 tailored to the canton) in ASCII format, the number of simulations and the deviation (uncertainty) of the input DHM in meters. At level 1 the average deviation of the DHM25 for the Alps is 3m. When estimating the accuracy of the DHM25 at level 2, however, it is evident that for the majority of the regions in Canton Graubünden the mean deviation is 4-6m (swisstopo 2005). Therefore, the average value of 5m was used for the input. The value 1000 was selected for the number of iterations. Output is a standard deviation map in addition to the slope map. This shows how large the deviation in degrees from the slope map is, i.e. how large the uncertainties of the slope map are. On the left in Figure S3 a section of this map can be seen (it is the exact same section as in figure S2). Since the absence or presence of uncertainties is only visualized qualitatively in the final map and not quantitatively in terms of the magnitude of the uncertainty, the standard deviation map is reclassified into two classes (see Figure S3, right), whereby all areas with a large deviation of more than 5° are classified as unsafe areas and are finally visualized as such in the final maps. All areas with a minor deviation are considered to have no uncertainties. For the visualization of areas with uncertainties, the uncertainty visualization technique using black dots from Retchless and Brewer (2016) is used based on the findings of the preliminary study (see section 2 in main text).



Supplementary Figure 3. Left: Standard deviation chart as an output of the Monte Carlo simulation. The values range from 0° (black) to 5.65° (white). Right: reclassified standard deviation chart. Black = areas without uncertainty, white = areas with uncertainty.

1.3 Web-GIS Obstacle Map (WeGOM)

The Web-GIS Obstacle Map (WeGOM) can be downloaded from the FOCA website[6] as a KMZ file and integrated directly into aeronautical navigation systems, for example. The WeGOM is updated twice a week and thus always shows all current aviation obstacles. In built-up areas, aeronautical obstacles are analgesics and plantings that are higher than 60m. Outside these zones there are objects that are higher than 25m. The data set consists of seven different point and seven different ligneous aviation obstacles. In order to be able to edit the data set in ArcMap, it must first be converted into a KML file. The first processing step is then cutting to size for the canton of Graubünden. Since it is irrelevant for the decision task what kind of point or linear aviation obstacle it is exactly, the data set is simplified after cutting by combining the seven different point obstacles into a single one, which is called "single / group obstacle" in the map. Six of the seven different linear obstacles are united to form a linear obstacle that is "cableway, cable." The linear obstacle "high voltage overhead line" is then directly added. The final map therefore shows three differently marked aviation obstacles.

1.4 Vector Maps (VECTOR25)

VECTOR25 is based on the National Map 1:25,000 in terms of content and geometry and, as a digital landscape model of Switzerland, contains all natural and artificial landscape objects. The location of the objects is 3-8m. VECTOR25 consists of nine thematic levels. The element relevant for decision-making tasks belongs to the "other traffic" level, which contains data on car ferries, aerial cableways, material railways, passenger ferries and ski lifts (swisstopo, 2007). Since material and aerial cableways are usually higher than 25m, and therefore already present in the WeGOM, the

[6] https://www.bazl.admin.ch/wegom

VECTOR25 only uses the data about the ski lifts. The data set for the ski lifts does not require any modification apart from cutting to canton Graubünden.

2 Assembling of all map elements and completion of the final maps

After the creation of the individual layers, they are combined to a single map by overlay, whereby the slope inclination map together with the uncertainty (if visualized) represents the base map and the remaining elements are superimposed. All sections are shown on a scale of 1:12'000 in a square of 12.55x12.55cm, which in reality corresponds to 1506x1506m or 2.27km2. An example of a final map with all layers and uncertainty visualizations is shown in the main text (Figure 3).

2.1 Selection of the regions for the map sections

A total of nine regions from Canton Graubünden (one for the example task and eight for the decision tasks) were selected to insert the elements for the decision tasks (landing sites and person in emergency) into the map. Selection criteria are the presence of at least one aviation obstacle, a ski lift and various suitable and unsuitable slopes. Table S1 lists all selected regions with the name of the nearest town and the coordinates of the point located in the middle of the map section for each region. The location of the individual regions within Canton Graubünden is also shown in Figure S4. More information on the individual map elements and decision criteria is given in the main text (section 3.1.3).

Supplementary Table 1. List of the villages used for the production of the maps and the corresponding map centers.

Region	Coordinate of the map's telpoint (CH1903/LV03)
Arosa	769997.05 / 184005.01
Bergün	776965.42 / 166812.70
Bivio	770253.60 / 148077.80
Churwalden	760889.68 / 182866.67
Flims	735484.36 / 192789.61
Klosters	786375.32 / 192789.61
San Bernadino	732882.69 / 146416.00
Serneus	785569.47 / 199276.65
Tschiertschen	765261.00 / 187276.09

Supplementary Figure 4. Location of the selected localities for decision-making tasks within the canton of Graubünden.