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Review on the processing and application of historical aerial and satellite spy images in geosciences

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Historical aerial photographs captured since the early 1900s and spy satellite photographs from the 1960s onwards have long been used for military, civil, and research purposes in natural sciences. These historical photographs have the unequalled potential for documenting and quantifying past environmental changes caused by anthropogenic and natural factors.

The increasing availability of historical photographs as digitized/scanned images, together with the advances in digital photogrammetry, have heightened the interest in these data in the scientific community for reconstructing long-term surface evolution from local to regional scale.

However, despite the available volume of historical images, their full potential is not yet widely exploited. Currently, there is a lack of knowledge of the types of information that can be derived, their availability over the globe, and their applications in geoscience. There are no standardized photogrammetric workflows to automatically generate 3D (three-dimensional) products, in the form of point clouds and digital elevation models from stereo images (i.e. images capturing the same scenery from at least two positions), as well as 2D products like orthophotos. Furthermore, influences on the quality and the accuracy of the products are not fully understood as they vary according to the image quality (e.g. photograph damage or scanning properties), the availability of calibration information (e.g. focal length or fiducial marks), and data acquisition (e.g. flying height or image overlap).

We reviewed many articles published in peer reviewed journals from 2010 to 2021 that explore the potential of historical images, covering both photogrammetric reconstruction techniques (methodological papers) and the interpretation of 2D and 3D changes in the past (application papers) in different geoscience disciplines such as geomorphology, cryosphere, volcanology, biogeosciences, geology and archaeology. We present an overview of these published studies and a summary of available image archives. In addition, we compare the main methods used to process historical aerial and satellite images, highlighting new approaches. Finally, we provide our advice

on image processing and accuracy assessment.