



Unlocking the potential of historical aerial and spy satellite stereo-imaging in geosciences: access, processing, and applications

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Historical imagery captured from aeroplanes since the early 1900s and from spy satellites from the 1960s onwards have long been used in natural sciences for military, civil, and research purposes. These images have the unequalled potential for documenting and quantifying past environmental changes caused by natural and anthropogenic factors. Especially when acquired in stereo mode, these images enable the generation of point clouds and digital elevation models (DEMs), allowing us to quantify surface elevation changes over the past century.

Recent advancements in digital photogrammetry and the increasing availability of historical photographs as digitised/scanned images have heightened the interest in these data for reconstructing long-term surface evolution from local to regional scale. However, despite the large archive of historical images, their full potential is not yet widely exploited. Key challenges include accessibility, lack of metadata, image degradation, limited resolution and accuracy and lack of standardised workflows for generating DEMs and orthophotos.

We reviewed 198 journal articles published between 2001 and 2023 that processed historical aerial and spy satellite imagery. Our review spans methodological advancements in photogrammetric reconstruction and applied research analysing past 2D and 3D environmental changes across geoscience fields, such as geomorphology, cryosphere, volcanology, forestry, etc. We provide a comprehensive overview of these studies, summarise the image archives, applications, and products, and compare the methods used to process historical aerial and spy satellite imagery. Furthermore, we highlight emerging workflows and offer recommendations for image processing and accuracy assessment for future research and applications.