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Visualising geomorphology: improving communication of data and concepts through engagement with the arts

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raise the visibility of geomorphology, both literally and metaphorically.

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Context

Recent years have seen increased collaboration between the arts and sciences, with conferences, exhibitions and residencies devoted to exploring the inspirations and mutual benefits that can arise from activities that bridge the two spheres. Critical commentaries have focused on the tensions between art's roles in illustrating, communicating, and interrogating sciences such as biology, chemistry, physics, climate change and geology (e.g. Kemp, 2000; Ede, 2005; Wilson, 2010; Miller, 2014; Gorman, 2014). But where is geomorphology? The discipline has a rich visual subject matter that has long offered aesthetic inspiration for artists (e.g. painters, photographers, sculptors, poets, film makers, musicians), and there are historical examples where geomorphologists have engaged with the arts to help communicate data and concepts, including by embedding artists in scientific expeditions (Rees, 1973). Presently, however, geomorphology-art collaborations remain limited in number and scope, and so the potential intellectual benefits and opportunities for promoting geomorphology as an active, relevant science remain underexploited.

To address this issue, the British Society for Geomorphology's 'Visualising Geomorphology' Working Group has been established. The Group's remit is to explore the possibilities for engagement with the arts (broadly defined to include diverse visual and non-visual forms of creative expression) to help raise the visibility of the Society and the discipline more generally. To prompt discussion, the following sections address interrelated issues that include historical, contemporary and forward-looking aspects of geomorphology-art relations.

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Geomorphology as artistic inspiration

Earth surface processes and landforms provide a kaleidoscope of perspectives, colours, textures, smells and sounds that can provoke aesthetic inspiration across the visual and non-visual arts. Resulting art works may be displayed (paintings, photographs), projected (films), performed (poetry, music) or installed (sculptures). Land art works, such as by Richard Long or Robert Smithson (Figure 1), are made directly in the landscape by sculpting earth or building structures using natural materials including boulders and organic debris (Tufnell, 2006). Yet despite geomorphological subject matter serving as inspiration, with the resulting art works helping to shape perceptions of landscape, these examples only serve to highlight that the geomorphological community has been slow to seize the opportunities for promoting the discipline. Does a landscape painting, photograph, poem or land art work – valuable though they may be in cultural terms – lead to enhanced awareness of the geomorphological discipline, or to greater appreciation of geomorphologists’ roles in society? In most cases, the answer is likely ‘no’. Many landscape-inspired artists share conceptual concerns with geomorphologists – for instance, in conveying the nature of time and history, process and material flux, and human influence – but their activities commonly remain largely divorced from geomorphological science. Even where artists have a background in geomorphology (e.g. photographer James Balog) and the subject matter is explicitly geomorphological (e.g. rapid changes to glacial landscapes), the discipline is rarely mentioned, or the subject matter is commonly badged with alternative (supra)disciplinary labels (e.g. ‘geology’, ‘geoscience’). Where benefits have accrued to geomorphology from artistic works, these are usually incidental and after-the-fact; for example, some geomorphologists have mined historical paintings, poems or other documents to reconstruct past environments, including flood and tsumani events, glacial and fluvial landscape dynamics, and changing societal perceptions of landscape (e.g. Zumbühl et al., 2008; Goff, 2012; Griffiths and Salisbury, 2013).

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Figure 1 here

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The artistic aspects of geomorphology

Artistic decisions are involved when representing complex three-dimensional landforms on a flat page, particularly when attempting to incorporate a sense of temporal change.

Traditionally, visualisation in geomorphology has revolved around sketches, plan view maps, cross sections, use of block diagrams ('cartoons'), graphs, and photographs. As with all aspects of science imaging (Frankel, 2004), decisions need to be made regarding features to include and ignore, perspective, scale, symbology, colour schemes and/or shading. These decisions are partly scientific and partly artistic, as shown by a particularly rich tradition in cartography and landscape change illustrations (Figures 2A-B), some of which arguably form artworks in themselves, while others have inspired artists (Crozier and Priestley, 2011).

Figure 2 here

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In an increasingly technology-driven, digital world, which visualisation techniques remain most useful for communicating geomorphology? Field sketches – a prominent feature of D. Dixon et al.'s (2013) commentary on the aesthetic aspects of geomorphology – have long fallen out of fashion and nowadays are rarely undertaken as part of research projects, let alone incorporated in publications, but might still have value in outreach (see below). But can the artistic decisions embedded in these traditional geomorphological visualisations be augmented by newer techniques that incorporate automated data capture, digital processing, and graphic design? Cartography and mapping, for instance, have derived major benefits from technological developments (e.g. high-resolution imaging tools such as LiDAR) with

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2 101 some outputs again forming artworks in themselves (Figure 2C). Landform and landscape
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4 102 photography has also benefitted greatly from technological developments (e.g. remotely
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7 103 sensed imagery, time lapse techniques, Structure-from-Motion photogrammetry, digital
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9 104 enhancement). Visualisation of dynamic earth surface processes and microforms is more
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11 105 challenging, but benefits have arisen from technological developments (e.g. high-
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14 106 magnification SEM imaging or high-speed photography), and the resulting images also may
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16 107 have aesthetic appeal (Figure 2D).
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21 109 In other scientific disciplines, the merger of new technologies and visualisation techniques
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23 110 sometimes has gone beyond mere communication, and even helped to alter the direction of
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26 111 scientific research. Cressey (2014) cites historical examples where visual representations of
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28 112 medical data helped changed the way science was conducted. During the early phase of
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31 113 space exploration, a photograph showing our planet rising above the Moon's horizon
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33 114 ('Earthrise') contributed to the growth of environmentalism and the now-familiar scientific
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35 115 conception of the Earth as a system. Today, new technologies are opening up new physical
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38 116 frontiers (e.g. the deep oceans, other planetary landscapes), so could novel visualisations of
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40 117 captured data result in similarly transformative images for geomorphology?
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45 119 **New artistic approaches to communicate geomorphology to non-specialists**
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47 120 Engagement with artistic approaches undoubtedly can help communicate geomorphology
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49 121 among specialist academic audiences, but significant impacts can also be made in outreach
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52 122 contexts. Commenting on his 25-year tracking of a spherical chunk of oak down the Afon
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54 123 Dwyrdd, north Wales, sculptor David Nash noted that this serendipitous piece of art "became
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56 124 a stepping-stone into the drama of physical geography" (Peterson, 2008). Along with land art
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59 125 works that ultimately become part of the topography (Figure 1), such 'experiments' could be
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more widely exploited for geomorphology's benefit, particularly by helping to communicate key concepts such as time, process, and material flux to non-specialist audiences. Could newer, technology-driven artistic approaches also be employed to communicate geomorphology to these audiences? Geomorphological subject matter has yet to feature widely among a recent surge in digital artworks but many possibilities exist, including using: i) video animations to visualise landscape change scenarios (e.g. with sea level rise); ii) laser scanning and 3D printing, or other novel sculptural approaches, to reveal 'invisible' landform details (e.g. abraded river pothole interiors, subterranean insect colony structures); and iii) naturally-derived 'soundworks' to enhance perception of geomorphological processes (e.g. the sonics of bedload transport or aeolian saltation). Multisensorial approaches that enable immersion inside virtual realities (e.g. using The Oculus Rift system) also offer many possibilities for communicating geomorphology (see SeriousGeoGames website).

Practical applications include improved communication of geomorphology at popular natural attractions. Accurate and engaging geomorphological information for landforms and landscapes is commonly non-existent or poorly presented, even in national parks. But the above artistic approaches – perhaps disseminated using podcasts or apps – could help enliven and/or enhance the design and display of geomorphological information traditionally presented on signboards or dioramas, including to people with impairments. For example, greater use of non-visual (auditory or tactile) artistic approaches for illustration of processes and landforms could help to communicate geomorphology to those deprived of visual faculties. Haptic use of 3D printing has great potential here, and the power of the written word in describing landscape change using non-technical language is also important (e.g. Norman Nicholson's poem 'Beck' - Whalley, 2014).

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2 151 Irrespective of social or educational background, the ‘beauty’ or ‘experience’ of landscape is
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4 152 something that appeals to many people (Goudie and Viles, 2010) but could improved
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7 153 geomorphological communication through engagement with the arts further help to heighten
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9 154 landscape appreciation? This is a vexed issue but requires consideration, especially for
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11 155 geoconservation and geoheritage promotion. Case studies show how geomorphology is
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13 156 integral to many aspects of culture (Gregory, 2006) and abundant opportunities exist to
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15 157 interweave geomorphology with art and other knowledge forms in novel, engaging ways to
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17 158 heighten landscape appreciation. Alongside the technology-driven approaches highlighted
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19 159 above, and linked with revitalised debate over the role and value of fieldwork in
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21 160 geomorphological research and education (Legleiter and Marston, 2013; Thornbush et al.,
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23 161 2014), field locations can enable experimentation with alternative means of communicating
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25 162 geomorphology to non-specialists in accessible and affective ways. Field-based participatory
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27 163 art projects that are concerned with collective interactions in the process of creating an art
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29 164 work or event (e.g. a landscape ‘walkover’) offer particular opportunities. As part of these
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31 165 projects, landform sketching or poetic expression might help people to capture the personal
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33 166 essence of their landscape experience, while also providing opportunities to communicate
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35 167 geomorphology.
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45 169 **Possible ways forward?**

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47 170 Other scientific disciplines (e.g. biology, geology) have been proactively and successfully
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49 171 engaging with the arts to help communicate data and concepts, thereby raising their profiles.
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51 172 Geomorphology has been slow off the mark, so we end with some linked challenges: i) can
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53 173 we identify the types of geomorphological data and concepts that are best suited for visual
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55 174 and non-visual artistic expressions?; ii) how can we encourage more geomorphologists
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57 175 working with these types of data and concepts to consider engaging with the arts to
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communicate their research?; and iii) how can geomorphologists best cultivate mutually-beneficial collaborations with individuals from the arts communities?

Currently, some of the most fertile ground for engaging with the arts is provided by debates over future climate change and the putative Anthropocene. These topics are among the most forward looking parts of the geomorphological discipline and novel artistic approaches may be useful – indeed essential – for conveying the risks and uncertainties associated with imagined futures (cf. Sheppard, 2012). Many artists have latched onto the abundant imaginative possibilities offered by the Anthropocene debate, and are using novel combinations of photography, film, sculpture and sound to communicate geomorphologically-relevant topics such as rapid landscape transformation, altered material fluxes, novel ecosystems, and the permanence or otherwise of human impacts (e.g. Davis and Turpin, 2015). We should tap into this creativity to help communicate geomorphology to fellow scientists and the wider public, and then feed into debates about options for landscape conservation, restoration and management in a rapidly changing world. Science is about communicating beautiful ideas (Cressey, 2014), whether through written language or other visual/non-visual forms. The challenge in geomorphology-art collaborations is to use approaches that communicate geomorphological meaning whilst maintaining artistic integrity.

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2 250 **Figure captions**

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7 252 **Figure 1** ‘Spiral Jetty’ by Robert Smithson, constructed 1970 on the northeastern shore of the
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9 253 Great Salt Lake near Rozel Point, Utah, USA. As lake water levels fall and rise, the jetty is
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11 254 alternatively exposed and submerged. Originally consisting of black basalt against ruddy
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13 255 water, the earthwork is now more white against pink owing to salt encrustation. These and
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16 256 other ‘living sculptures’ ultimately become part of the topography, and represent a unique
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18 257 class of anthropogenic landforms.

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23 259 **Figure 2** Examples of geomorphological images that also have aesthetic appeal, with A) to C)
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26 260 focusing on representations of river meanders:

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28 261 A) one of the numerous maps produced by Harold Fisk to show the historical traces of the
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30 262 lower Mississippi River, USA (see associated report by Fisk, 1944);
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33 263 B) one of the many illustrations produced by Charles Cotton, a New Zealand
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35 264 geomorphologist, to show a sequence of landscape development (Cotton, 1922). Cotton’s
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37 265 simple, evocative illustrations provided inspiration for the landscape paintings of New Zealand
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40 266 artists Colin McMahon and Bob Kerr;
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42 267 C) part of a colour-coded LiDAR image revealing the alluvial landforms of the Willamette
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44 268 River valley, Oregon, USA (Dan E. Coe, Oregon Department of Geology and Mineral
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47 269 Industries);
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49 270 D) SEM image of a wind-blown basalt sand grain from Hawaii (R.A. Craddock, unpublished).
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51 271 Extensive pitting on the grain surface is made visible, revealing an otherwise hidden micro
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53
54 272 landscape.



Figure 1

Figure 1 'Spiral Jetty' by Robert Smithson, constructed 1970 on the northeastern shore of the Great Salt Lake near Rozel Point, Utah, USA. As lake water levels fall and rise, the jetty is alternatively exposed and submerged. Originally consisting of black basalt against ruddy water, the earthwork is now more white against pink owing to salt encrustation. These and other 'living sculptures' ultimately become part of the topography, and represent a unique class of anthropogenic landforms.

254x190mm (72 x 72 DPI)

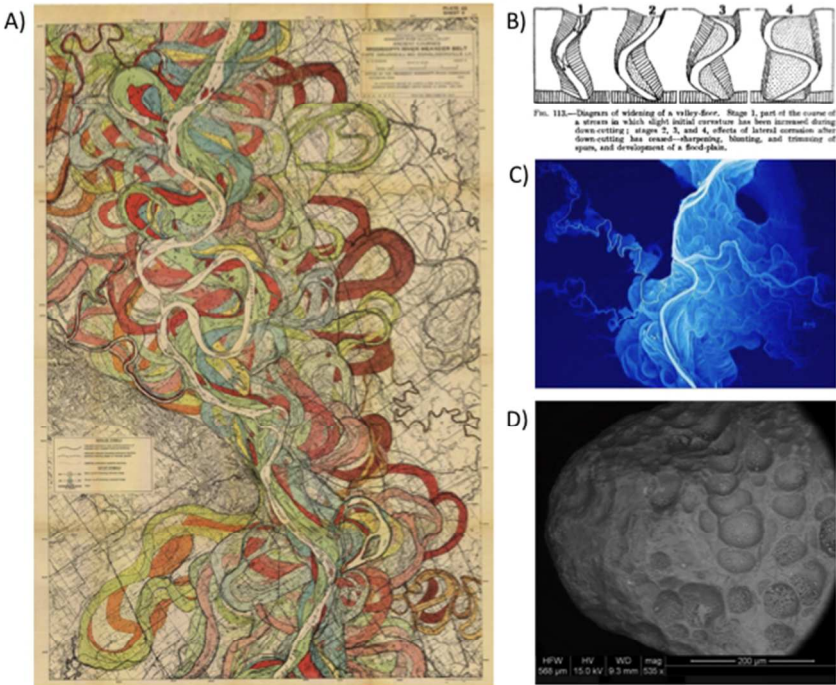


Figure 2

Figure 2 Examples of geomorphological images that also have aesthetic appeal, with A) to C) focusing on representations of river meanders:

- A) one of the numerous maps produced by Harold Fisk to show the historical traces of the lower Mississippi River, USA (see associated report by Fisk, 1944);
- B) one of the many illustrations produced by Charles Cotton, a New Zealand geomorphologist, to show a sequence of landscape development (Cotton, 1922). Cotton's simple, evocative illustrations provided inspiration for the landscape paintings of New Zealand artists Colin McMahon and Bob Kerr;
- C) part of a colour-coded LiDAR image revealing the alluvial landforms of the Willamette River valley, Oregon, USA (Dan E. Coe, Oregon Department of Geology and Mineral Industries);
- D) SEM image of a wind-blown basalt sand grain from Hawaii (R.A. Craddock, unpublished). Extensive pitting on the grain surface is made visible, revealing an otherwise hidden micro landscape.

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