Exploring student ideas about deserts

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Jane examines some common student misconceptions about drylands, their landforms and the processes that create them, then discusses possible reasons for these misunderstandings. This should enable teachers to help students develop a more realistic understanding of drylands.

This article explores student ideas about mid- and low-latitude deserts and semi-arid environments which feature in the Department for Education's subject content of new geography AS and A levels (Figure 1). High-latitude polar deserts are not discussed here: aridity in these areas occurs because cold air cannot hold much moisture, not because potential evapo-transpiration exceeds precipitation, which is the case in other desert areas. Exploring student ideas about desert environments, landforms and processes is best achieved by challenging their initial responses to questions like 'are deserts full of sand?' using images such as those in this article and appropriate data.

Are deserts full of sand?

Some students may believe that deserts are full of sand. Many others may know this to be false, but still find the stereotype difficult to discard (Figure 2). In reality, sand covers on average only 20 % of the surface of deserts; the rest is largely rock or gravel. The percentage also varies from region to region, ranging from nearly 40 % coverage in Australian deserts, to less than 1 % in the deserts of the American south west (Figure 3). The belief that deserts are full of sand may derive from childhood experiences of reading stories such as *The Little Prince* by Antoine de Saint-Exupéry, where a pilot crashes in the Sahara and 'sleeps in the sand'. Sandy deserts also feature in Hergé's *Tintin and the Crab with the Golden Claws* where Tintin, Snowy and Captain Haddock are portrayed wandering amongst sand dunes having crash-landed in the Sahara. In reality, sand seas (ergs) cover only about a quarter of the Sahara, the rest consisting of mountainous areas, e.g. Tibesti and Ahaggar, gravel plains (regs), stone plateaus (hammada), dry valleys (wadis), and occasional salt-flats and dry lakes.

Sand dunes also feature in films such as *The English Patient*, shot partly in Tunisia, and in the *Star Wars* series, which includes scenes in Death Valley's mesquite flat sand dunes. Front covers of textbooks on deserts also often portray sand dunes, undoubtedly because they are more attractive than images of featureless gravel plains. A further reason for the perception that deserts are full of sand may be linked to the growth in desert tourism. Travel companies now offer 'desert safari experiences' which often include opportunities to ride camels, drive over, climb or sand board down dunes and sleep under the stars. In Morocco and Tunisia, for example, tourists can experience the northern edge of some of the Sahara's ergs. Adventurous in nature, these excursions often appeal to families, and consequently some students' perceptions of such deserts may be based on direct experience. Students who have visited deserts in the American south west, which are largely rocky, are likely to have different perceptions (Figure 4).

Figure 2: The dunes of the Namib Desert around Swakopmund, Namibia. **Photo:** Rachel Finnigan.

Landscape systems

Study must include at least one of: either drylands in high-latitude polar regions or mid- and low-latitude deserts or semi-arid environments.

Within these topics students must demonstrate knowledge and understanding of the key areas of content listed below:

- geomorphological processes within landscapes systems and how flows of energy and materials combine to create specific landforms
- how landforms are inter-related and make up characteristic landscapes
- physical processes and patterns at scales from landform to landscape and seconds to millennia
- how landforms and landscapes evolve through past, present and future climate changes
- human activity as one factor causing change within landscape systems.

Figure 1: Drylands in the new geography AS and A level subject content (DfE, 2014).

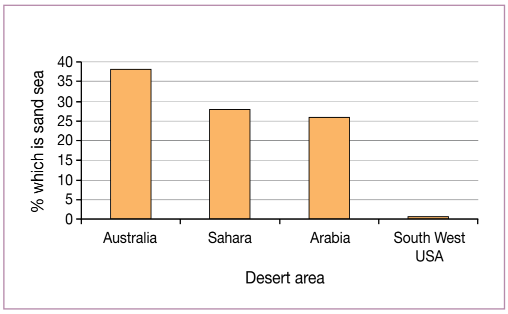

Figure 3: Percentage of the desert area which is sand sea in selected deserts.

Figure 4: Monument Valley, Arizona, USA. **Photo:** Jane Dove.

Is wind the major force shaping desert landforms?

Traditionally deserts have been associated with wind erosion and deposition, and consequently students may be unaware of the significance of water in shaping desert landforms. In high wind energy environments, such as the eastern Sahara, wind is certainly a significant erosional force, but water, especially in deserts such as those in the American south west, is a more important factor in shaping landforms (Figure 4). Similarly, students may believe that pedestal rocks, i.e. isolated pillars of rock with indented profiles, are solely created by wind erosion, whereas, in reality, salt crystal growth is now thought to play a significant role in their formation. The salts crystallize out from saline groundwater, creating a case-hardened cap-rock which is more difficult to erode.

This over-emphasis on the role of wind in shaping desert landforms may well relate to the aforementioned stereotypical image that deserts are full of sand. Images of wind entraining huge quantities of sand to create sandstorms are also visually striking, and therefore memorable. Sandstorms often feature in adventure stories, such as the Tintin books, which the students may recall reading as children. Lack of water in desert areas also encourages the perception that water has no role to play, whereas in fact episodic flash-flooding is highly effective in shaping desert landscapes (Figure 5).

Figure 5: Flash flood in the Gobi Desert. **Photo:** Qfl247(talk) Licensed under GFDL via Wikimedia Commons.

Are deserts hot?

Students' idea of a desert climate is likely to be that experienced in the central Sahara, Arabia and central Australia, which is characterised by high temperatures throughout the year, low humidity, clear skies and strong winds. Students may therefore be unfamiliar with the fact that wide differences in temperature exist between different deserts (Figure 6). These differences arise because of factors such as latitude, altitude, continentality and cool ocean currents. Climatologists often separate deserts into three groups, namely hot (central Sahara) and warm (Kalahari) deserts in tropical and subtropical areas; temperate cool (Mojave) or cold (Gobi) deserts; and coastal cold-water current deserts (Namib, Atacama). The Namib and the Atacama are cooler than might be expected for their tropical latitude because cool ocean currents depress temperatures. Typically, temperatures are 10–20˚C and the annual temperature range is small, making them mild/cool deserts. The Gobi, Great Basin, Taklamakan, Kyzylkum and Karakum deserts, although warm or even hot in some places in summer, are bitterly cold in winter, with temperatures falling as low as –40˚C; consequently they are classified as cold deserts.

The belief that deserts, other than high-latitude polar deserts, are hot probably arises from a failure to realise that deserts are defined by aridity, not temperature. Travel brochures also promote heat as a selling point, especially to northern Europeans, in advertising desert holidays. Students may also be unaware that aridity levels in these environments vary. Deserts are broadly divided into those which are hyper-arid, e.g. the Atacama, and those which are arid, e.g. Thar, while the term semi-arid, or semi-desert, is reserved for areas such as the Kalahari.

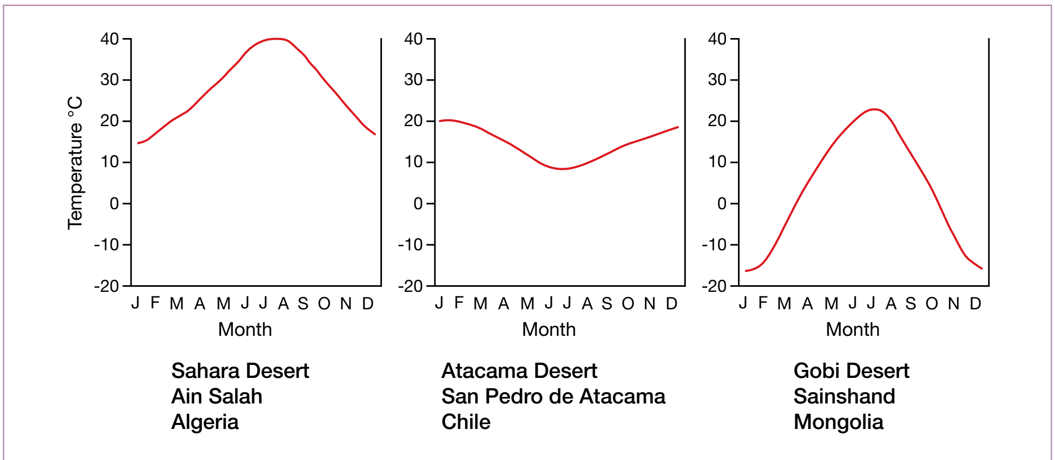

Figure 6: Mean monthly temperatures in three deserts.

Aridity indices vary; an index based simply on annual precipitation defines the boundary for hyper-arid as <25 mm; for arid as 25–250 mm; and for semi-arid as 250–500 mm. Such an index, however, ignores evapo-transpiration which is significant in 'hot' deserts. Most indices, therefore, are now calculated from annual precipitation (P) and potential evapo-transpiration (ET) (Figure 7).

Appreciating that climate varies both between and within deserts is important, because this variation influences the effectiveness of the weathering processes and types of erosion which shape desert landforms. Insolation weathering, for example, is likely to be more effective in deserts which experience a wide range of temperatures, while the presence of moisture in the form of dew, fog and rainfall will increase chemical weathering processes.

Aridity index	
Hyper-arid	A = <0.03
Arid	A = 0.03–0.20
Semi-arid	A = 0.20–0.50

where A = annual precipitation/potential evapo-transpiration

Figure 7: Aridity index.

Other misunderstandings

Students may assume that many weathering and erosional processes and their morphological expressions are unique to 'hot' deserts, whereas for example ventifacts (Figure 8), i.e. wind-polished pebbles with sharp keels, also occur in polar and periglacial environments. They are found here because these areas also have little vegetation cover and experience strong winds.

Students may also be unaware that some landforms seen in the desert today are the result of past, rather than present-day, climates and processes. Silcrete and ferricrete crusts, for example, which cap plateaus and escarpments in Australia, were formed in the Tertiary period, when the climate was warmer and wetter. Large alluvial fans and wadis, clay lunettes and pans and inselbergs were also formed when the climate was wetter. In distinguishing between landforms created by wind and those formed by water, students may fail to appreciate that in some cases both processes may have been involved, as for example in the formation of stone pavements and some deflation hollows.

Finally, students may not realise that humans can modify landforms and geomorphologic processes in deserts. In the Thar, for example, one of the most heavily populated deserts in the world, wood clearing, grazing and cultivation has reactivated semi-stable old dunes and created new ones. Military vehicles in war zones, such as Syria and northern Iraq, risk eroding the desert surface and increasing sand transport. Irrigation and water abstraction lead to changes in the rate of salt weathering. Removal of desert vegetation, as the result of livestock grazing, can increase runoff during episodic flash floods, which in turn can cause greater erosion in desert water courses, i.e. wadis and arroyos.

Figure 8: Ventifact in the Mojave Desert. **Photo:** Wilson44691. Licensed under CC0 via Wikimedia Commons.

Conclusion

Despite the great diversity of landscapes between and within deserts and semi-deserts, the Saharan/Arabian stereotype is likely to be the image students bring to the classroom. Exploring students' ideas is therefore useful to counter stereotypes and raise awareness of how past learning experiences, both formal and informal, shape perceptions. Misconceptions can also act as barriers to learning, preventing the formation of meaningful connections between new and existing knowledge. Time spent exploring ideas, before the topic is taught, would therefore be well rewarded. | **TG**

References

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