How can the TanDEM-X Digital Elevation Model Support Terrestrial Impact Crater Studies?

M. Gottwald, T. Fritz, H. Breit, B. Schättler: Remote Sensing Technology Institute, DLR-IMF, Oberpfaffenhofen, Germany
A. Harris: Institute of Planetary Research, DLR-PA, Berlin, Germany

TanDEM-X DEM and the Earth in 3D

With the availability of the TanDEM-X DEM, Earth becomes the solar system body providing the most accurate elevation information. This DEM has an independent pixel spacing of 12 m, an absolute horizontal and vertical accuracy of <10 m and relative vertical accuracies reaching at least 2 m in moderate or 4 m in steep terrain [1]. While on bodies such as, e.g. the Moon, Mars or Mercury the corresponding DEMs are dominated by numerous impact craters, the <200 exposed terrestrial structures are embedded into an environment modified by tectonic activities or erosion. Therefore crater studies based on space-borne remote sensing data is often a non-trivial task. The high-quality TanDEM-X elevation information, however, will ensure excellent topographic mapping capabilities for the entire exposed terrestrial surface.

TanDEM-X DEM Status

When the complete final TanDEM-X DEM will be available by mid 2016, it will cover Earth's solid surface with ~20000 square tiles of 110 × 110 km^2 extent (at the equator). They have been derived from ~460000 individual overlapping scenes (Raw DEMs), mostly 30 × 50 km^2 wide. The Raw DEMs are the result of data acquisitions between December 2010 and early 2015 with the two satellites TerraSAR-X and TanDEM-X acting as a single-pass X-band radar interferometer. More than 90% of these Raw DEMs showed good signal-to-noise quality. By mid 2015 the tiles for more than 65% of the Earth's land mass have already been generated. 98.5% are compliant with the specifications and the absolute height accuracy exceeds the requirement by one order of magnitude. The status of the TanDEM-X DEM can be found on the TanDEM-X Science Server under https://tandemx-science.dlr.de/. This site will also inform about when and how to access individual DEM tiles via AO calls.

TanDEM-X DEM and Impact Craters

In the past two years we have studied the terrestrial impact crater record by using available Raw DEMs, the Intermediate DEM as a regional DEM version after the first year's coverage and existing final DEM tiles. For most of the structures the Raw DEMs were sufficient. They already provided the required accuracy [2]. Meanwhile we have mapped ~100 confirmed structures listed in the *Earth Impact Database*. The smallest clearly identified crater is Veevers in Western Australia with a diameter of 80 m. This is compliant with what can be expected from a dataset with 12 m independent pixel spacing. When compared with Vredefort, the largest structure, the TanDEM-X DEM crater scale spans more than three orders of magnitude.

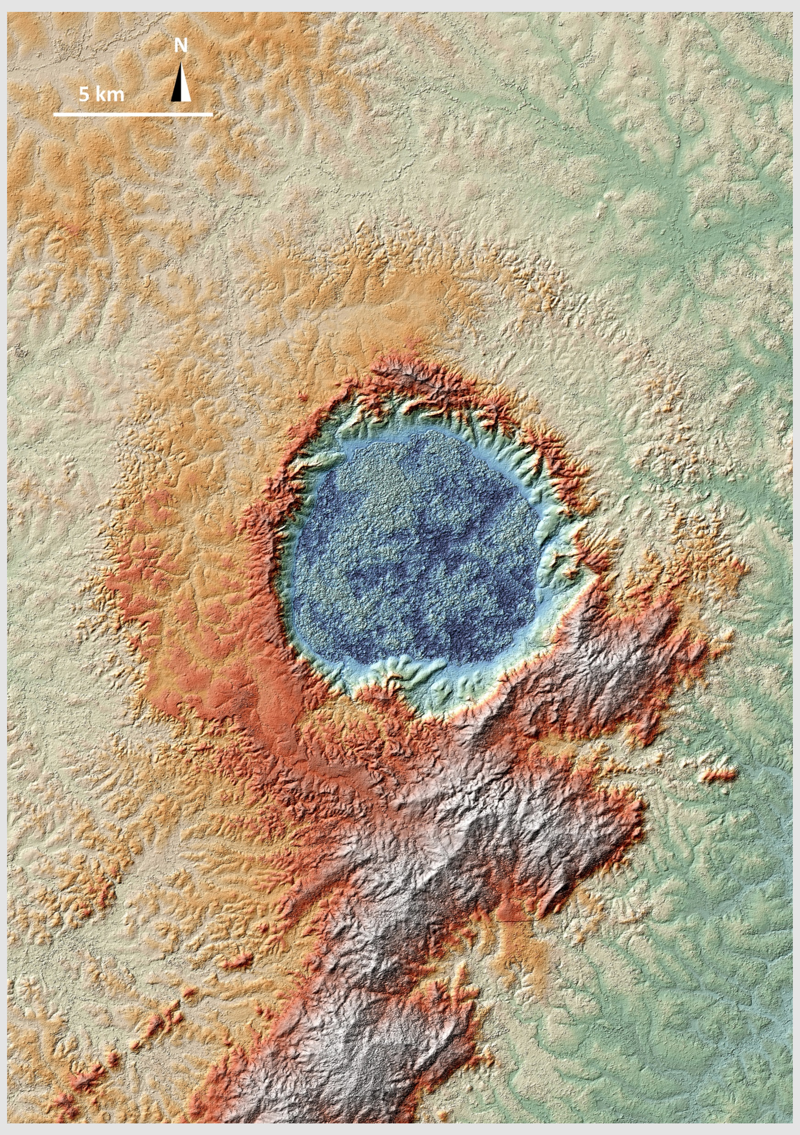
What next?

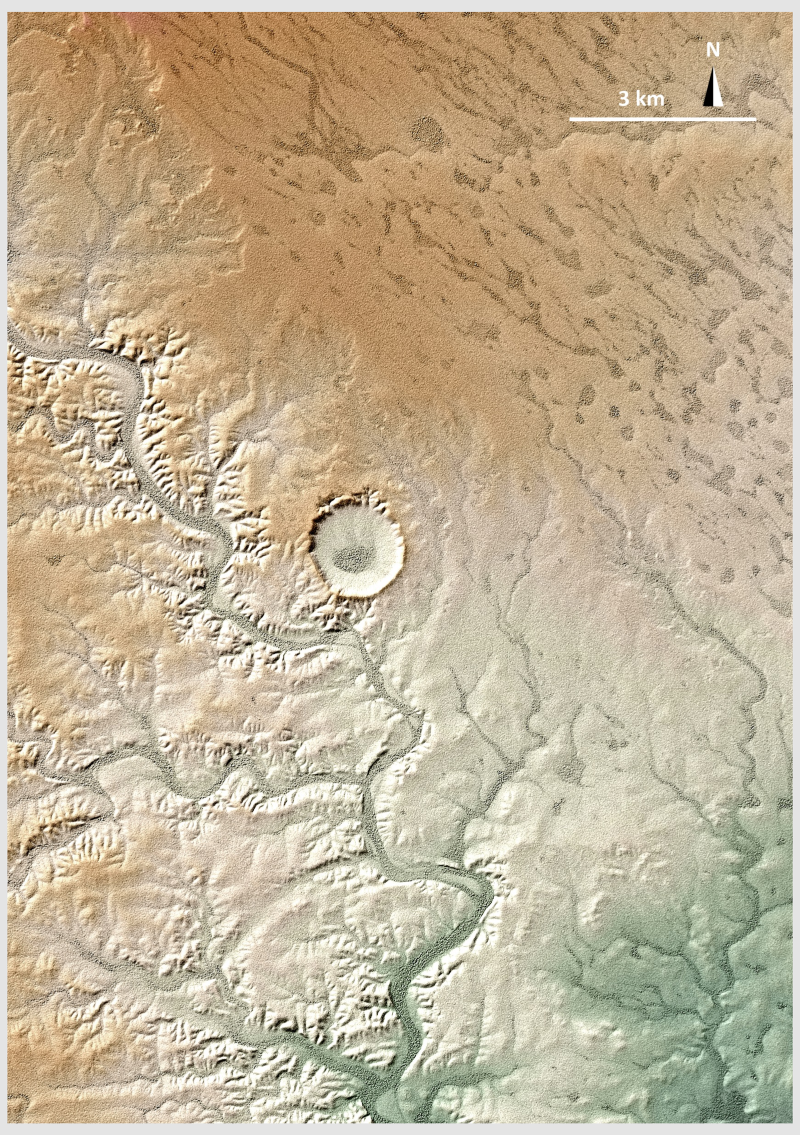
Our work approaches the goal to obtain a homogeneous, consistent mapping of all confirmed terrestrial impact structures. In the framework of this analysis we understand how the detectability of craters in the TanDEM-X DEM depends on various parameters such as their diameter, depth and degree of preservation. In addition, the texture of the surrounding terrain plays an important role. The small craters up to several 100 m in diameter can only be detected in flat arid regions. Vegetation, water bodies or an environment dominated by hills and mountains strongly hamper such findings. It is just this crater size which may populate the sample of still undiscovered impact structures on Earth [3]. Developing search algorithms and applying them to well suited test areas might unveil some of them. We plan to tackle this challenging task in the near future.

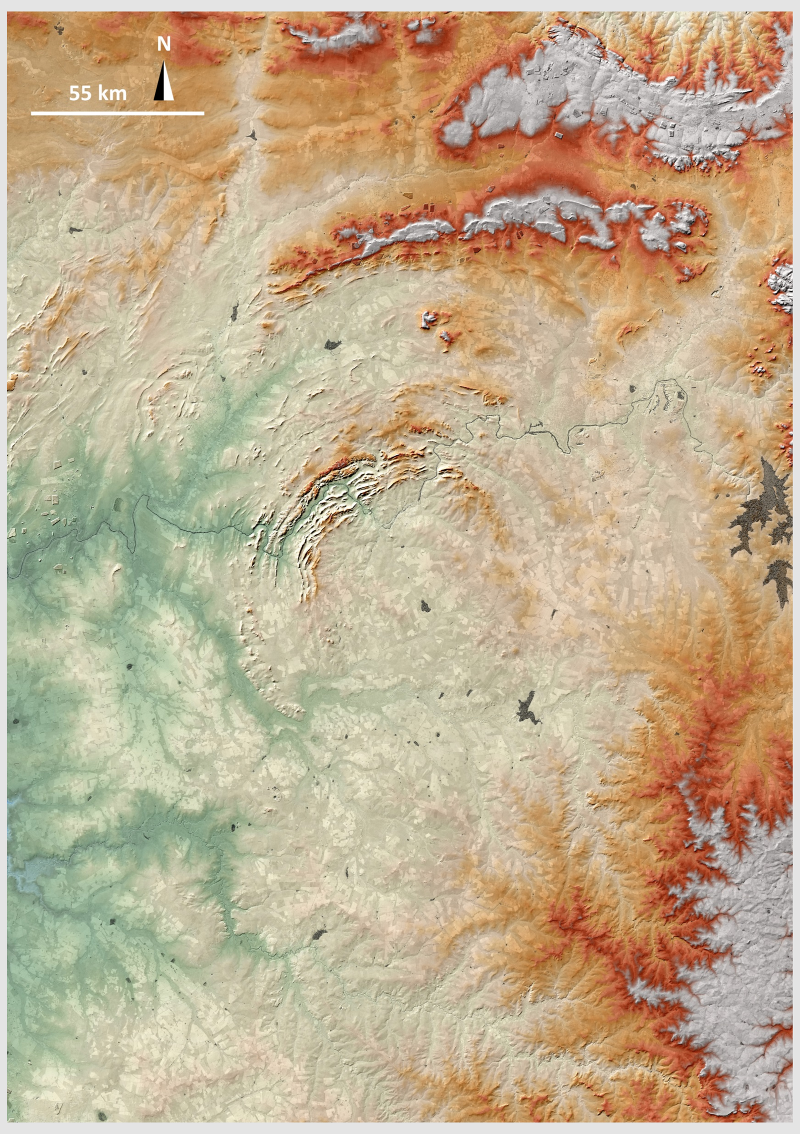
[1]: Krieger et al., TanDEM-X: A radar interferometer with two formation-flying satellites, Acta Astronautica 89, 83-98, 2013.

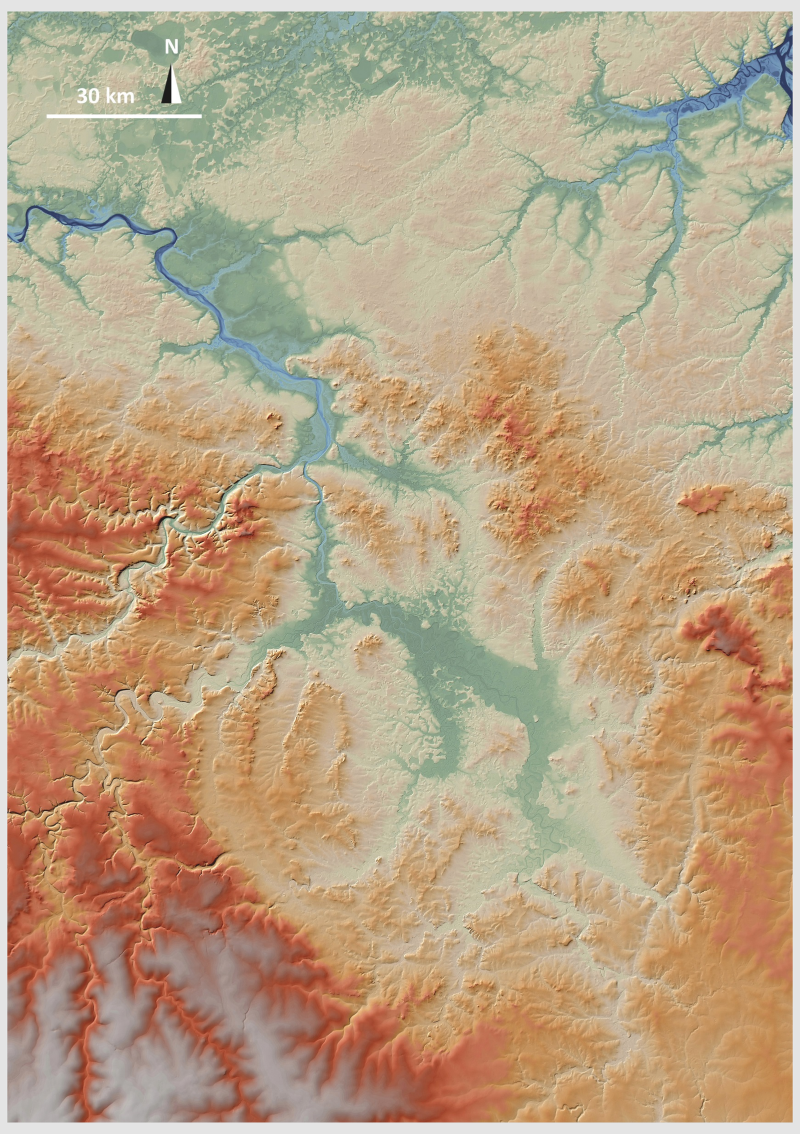
[2]: Gottwald et al., Mapping terrestrial impact craters with the TanDEM-X DEM, in Osinski and Kring, eds., Large Meteorite Impacts and Planetary Evolution V, GSA SP518, 2015, in press.

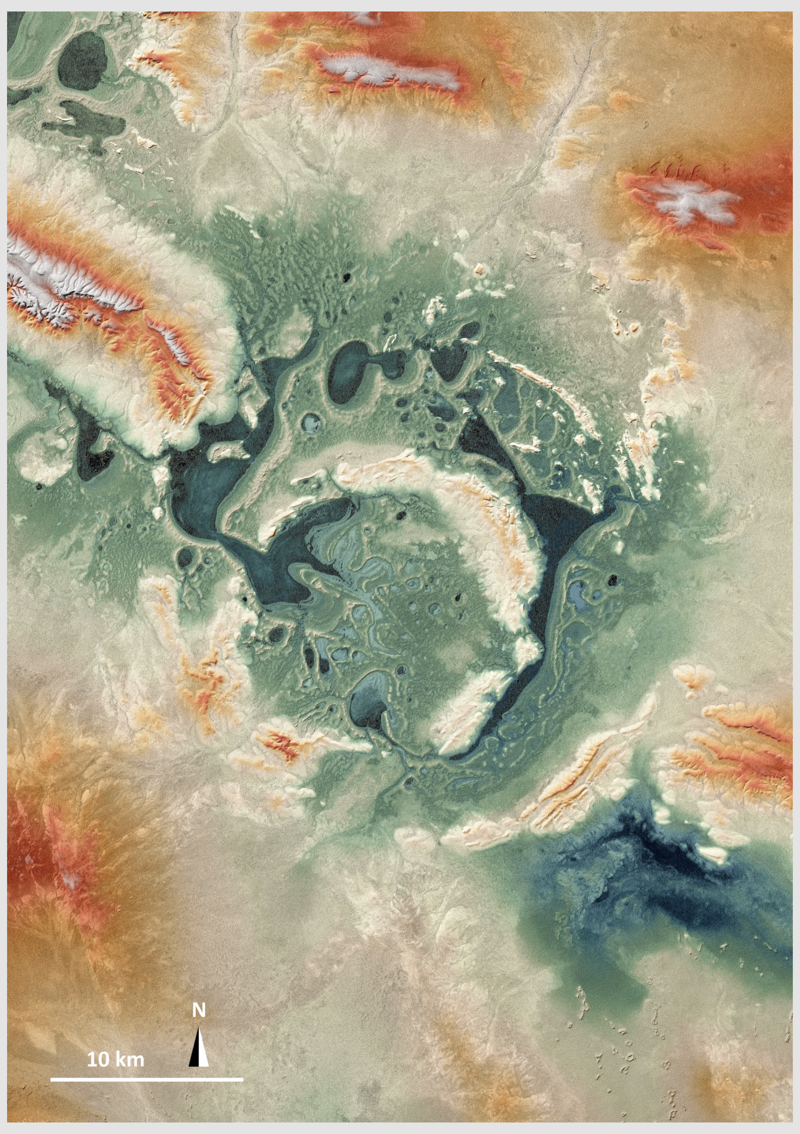
[3]: Hergarten and Kenkmann, The number of impact craters on Earth: Any room for further discoveries?, Earth and Planetary Science Letters, 187-192, 2015.

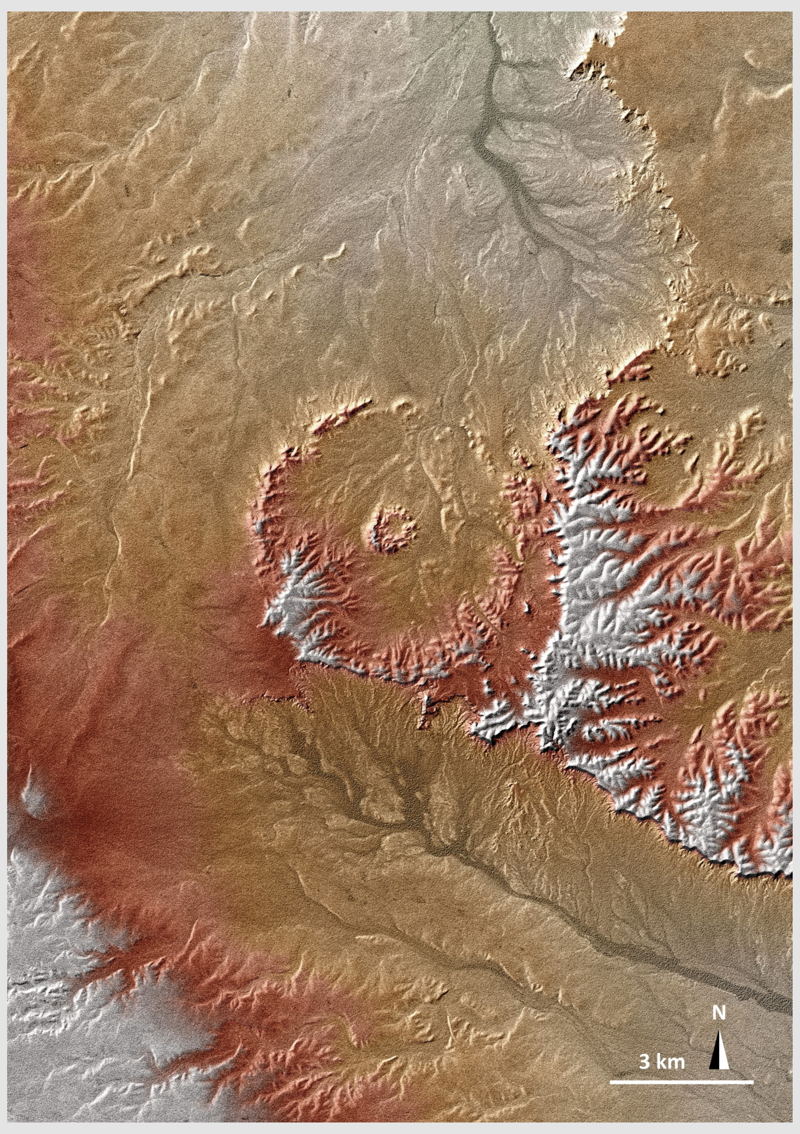












The „portfolio" of terrestrial impact structures as seen in the TanDEM-X DEM (hillshaded DEM or hillshaded DEM with underlying X-band radar image brightness). From top to bottom row, right to left column: Henbury, Amguid, Talemzane, Jebel Waqf as Suwwan, Bosumtwi, Shoemaker, Popigai, Vredefort

The TanDEM-X project is partly funded by the German Federal Ministry for Economics and Technology (Förderkennzeichen 50 EE 1035).

DLR Deutsches Zentrum für Luft- und Raumfahrt