



Editorial: The Need for a High-Accuracy, Open-Access Global Digital Elevation Model

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Editorial on the Research Topic

The Need for a High-Accuracy, Open-Access Global Digital Elevation Model

Many different scientific and end-user communities across many disciplines and sectors, as well as many government agencies and international aid and development organizations, agree that there is a pressing need for a high-accuracy, open-access global digital elevation model (DEM). Although some notable efforts and negotiations among important players within the private industry, government agencies and international NGOs are already happening, more needs to be done to realize and speed-up progress in creating a high-accuracy, open-access DEM.

The purpose of this collection of articles is to raise awareness further by describing the problems with current global DEMs and illustrating best practices as well as upcoming opportunities.

In an opening opinion article, Schumann and Bates (2018) lay out the limitations and the requirements for a better global, open-access DEM and present a possible way forward. In a reactive commentary, Winsemius et al. (2019) further argue that for the many applications such a DEM would be game-changing, a DEM itself is not enough and, particularly at the local scale and at the impact-level scale, other properties of the environment besides terrain elevation become important as well. These include details of critical infrastructure such as bridges, culverts and flood defenses. The authors therefore argue that a bottom-up data collection approach at the local community level should complement the global consortium approach suggested by Schumann and Bates (2018) for a better global DEM.

In a thorough assessment study, Tavares da Costa et al. (2019) examine the adequacy of ten different free DEMs for watershed studies. They argue that the intrinsic inaccuracies in free DEMs limit progress and knowledge and they demonstrate that while most DEMs generally represent elevation profiles well enough, they do not adequately represent important topographic and geomorphic features and therefore are inadequate for many applications. This of course has practical implications since non-trivial limitations of any particular global DEM currently available may significantly hinder progress in solving a number of environmental and socio-economic challenges. In a similar study but focusing on coastal areas, Gesch (2018) discusses best practices for elevation-based assessments of sea level rise and coastal exposure risk studies. Using many different low-accuracy global DEMs, but also high-accuracy local DEMs, he demonstrates how accuracy information should be considered in planning and implementation studies. The work shows that current global DEMs are not adequate for high confidence mapping of exposure to fine increments of sea level rise or with shorter planning horizons and thus they should not be used in this way, but they are suitable for general delineation of low elevation coastal zones.

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In view of the fact that the creation of a high-accuracy, open-access global DEM may still take some considerable time, Hawker et al. (2018) and Shastry and Durand (2019) present ways to improve upon existing global DEMs. Hawker et al. (2018) suggest the creation of new DEMs using a geostatistical approach to stochastically simulate floodplain DEMs from several open-access global DEMs based on the spatial error structure. This DEM simulation approach enables an ensemble of plausible DEMs to be created, which can be used for many different applications that are based on probabilistic assessments, such as probabilistic flood risk mapping. In the same context, Shastry and Durand (2019) propose to make use of flood inundation extents from remotely sensed observations to obtain better floodplain topography in data-poor areas, given that such observations indirectly provide information about topography. By combining this information with model predictions via a data assimilation approach, better floodplain topography maps can be generated.

As mentioned by the opening article of Schumann and Bates (2018), there are existing technologies to generate DEMs at the required resolutions and accuracies, over various spatial scales. Backes and Teferle (2020) present a multiscale integration of very high-resolution satellite and drone imagery for creating a high-accuracy DEM over Tristan da Cunha, a remote group of small volcanic islands in the South Atlantic Ocean. Their work demonstrates that combining very high-resolution satellite imagery and low-altitude drone-based imagery can produce inexpensive alternatives to high-quality industry-standard DEMs. This might be particularly relevant for regions, such as small island developing states, where existing satellite data might be insufficient and which may not be prioritized in data acquisition campaigns. Following the same idea of using novel technologies to generate topographic datasets, Faherty et al. (2020) show that with intelligent image classification methods, bare Earth DEMs can be generated for large floodplains using the newest developments in Ka-band synthetic aperture radar (SAR) sensor technology. Specifically, they used NASA GLISTIN-A

airborne mission data with single-pass interferometric SAR (InSAR) processing to derive a terrain model over a large portion of the Red River of the North floodplain (ND, United States), with vertical accuracies comparable to that of state-of-the-art airborne LiDAR but at a much lower cost.

Using the same SAR sensor characteristics onboard the upcoming NASA/CNES surface water ocean topography (SWOT) satellite mission, Langhorst et al. (2019) give valuable insights of how this new sensor technology can improve our global knowledge about important river hydraulic variables, such as water surface elevations, slope breaks and knickpoints in rivers. They present a novel noise reduction method for multitemporal river water surface elevation profiles from simulated surface water ocean topography data on the Po, Sacramento, and Tanana Rivers and obtain average profiles with errors much lower than those of existing DEMs. Findings like this allow of course new advances in riverine research globally that is not possible with the current low accuracy global DEMs.

Despite the exciting approaches described in this Research Topic, DEM data collection remains under-prioritized by satellite agencies and commercial providers given the importance of these data to a range of disciplines and applications. Fundamental progress at the global level for many key environmental problems will only be achieved when a better accuracy and open-access global DEM becomes available.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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REFERENCES

- Backes, D. J., and Teferle, F. N. (2020). Multiscale integration of high-resolution spaceborne and drone-based imagery for a high-accuracy digital elevation model over Tristan da Cunha. *Front. Earth Sci.* 8, 319. doi:10.3389/feart.2020.00319
- Faherty, D., Schumann, G. J.-P., and Moller, D. K. (2020). Bare Earth DEM generation for large floodplains using image classification in high-resolution single-pass InSAR. *Front. Earth Sci.* 8, 27. doi:10.3389/feart.2020.00027
- Gesch, D. B. (2018). Best practices for elevation-based assessments of sea-level rise and coastal flooding exposure. *Front. Earth Sci.* 6, 230. doi:10.3389/feart.2018.00230
- Hawker, L., Bates, P., Neal, J., and Rougier, J. (2018). Perspectives on digital elevation model (DEM) simulation for flood modeling in the absence of a high-accuracy open access global DEM. *Front. Earth Sci.* 6, 233. doi:10.3389/feart.2018.00233
- Langhorst, T., Pavelsky, T. M., Frasson, R. P. M., Wei, R., Domeneghetti, A., Altenau, E. H., et al. (2019). Anticipated improvements to river surface elevation profiles from the surface water and ocean topography mission. *Front. Earth Sci.* 7, 102. doi:10.3389/feart.2019.00102
- Schumann, G. J.-P., and Bates, P. D. (2018). The need for a high-accuracy, open-access global DEM. *Front. Earth Sci.* 6, 225. doi:10.3389/feart.2018.00225
- Shastry, A., and Durand, M. (2019). Utilizing flood inundation observations to obtain floodplain topography in data-scarce regions. *Front. Earth Sci.* 6, 243. doi:10.3389/feart.2018.00243
- Tavares da Costa, R., Mazzoli, P., and Bagli, S. (2019). Limitations posed by free DEMs in watershed studies: the case of river Tanaro in Italy. *Front. Earth Sci.* 7, 141. doi:10.3389/feart.2019.00141
- Winsemius, H. C., Ward, P. J., Gayton, I., ten Veldhuis, M.-C., Meijer, D. H., and Illiffe, M. (2019). Commentary: the need for a high-accuracy, open-access global DEM. *Front. Earth Sci.* 7, 33. doi:10.3389/feart.2019.00033

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