Mapping Matters

Your Questions Answered

The layman's perspective on technical theory and practical applications of mapping and GIS

By Qassim A. Abdullah, Ph.D., PLS, CP**

Question: I noticed that according to both ASPRS and NSSDA standards, the vertical accuracy is more stringent than the horizontal accuracy. For example, if I produce orthophoto products from 15 cm (6 in.) digital imagery, the stated ASPRS standard for horizontal accuracy is 30 cm (1 ft), while the expected vertical accuracy is 20 cm (0.67 ft). We always believed that the vertical accuracy of any mapping product is less stringent than the horizontal accuracy. Why is that?

Evgenia Brodyagina, Frederick, Maryland - USA

Dr. Abdullah: I am glad you brought up this important issue concerning existing mapping standards and how they apply differently to imagery acquired by the new digital sensors. I would like to correct your understanding of the ASPRS and National Standard for Spatial Data Accuracy (NSSDA) standards as they relate to the example you've provided. The horizontal and vertical accuracies figures in the example are contradictory not because the ASPRS standard is stated incorrectly but because of the way we associate the image resolution or the Ground Sampling Distance (GSD) with the standard's defined map scale or contour intervals.

When softcopy photogrammetry was introduced in the early 1990s, it was standard practice to scan the film or the dispositive with 21 micron resolution or 1200 dpi (dots per inch). Therefore, for a negative film scale of 1:7,200 (1"=600'), which is designed to support a map scale of 1:1,200 (1"=100') according to 6x enlargement ratio, the resulting Ground Sampling Distance (GSD) after scanning is 15 cm (6 in.). When we transitioned to digital aerial sensors, which essentially replaced film cameras, we maintained the same standards and conventions that we used for film products. As a result, digital imagery flown with 15 cm GSD are routinely used for the production of 1:1,200 (1"=100') scale maps or orthophotos and 2 ft contours. So the confusion actually originated when we adopted the old conventions for the new mapping products from digital cameras.

The ASPRS standard did not specify a certain GSD for a certain map scale, but it did state that for class 1 mapping products, a 1=1,200 scale map should meet a Root Mean Squares Error (RMSE) of 30 cm horizontally. Also, the standard did not specify that imagery with 15 cm GSD had to be used for the production of 2 ft contours. The ASPRS standard states that the class 1 vertical accuracy for elevation data with 2 ft contour intervals must meet an RMSE of 20 cm; however, when we extract accuracy figures for 15 cm imagery, we use the above mentioned association of map scale and GSD to apply the ASPRS accuracy standard for evaluating the new digital sensor data products.

This is clearly a confusing situation that we created ourselves due to the lack of concise mapping standards for the highly accurate products produced from modern digital sensors. Immediate needs forced the mapping community to adapt conventions and measures that were originally designed for film cameras and paper-based products. The well known "enlargement ratio", which had been used in the past to determine how much film or dispositive could be enlarged to produce a final map with minimum or no degradation in quality, is no longer applicable in today's digital world of geospatial data production. An enlargement ratio of 6 was widely accepted and used in the mapping industry when dealing with film-based mapping products; however,

"When we transitioned to digital aerial sensors, which essentially replaced film cameras, we maintained the same standards and conventions that we used for film products. As a result, digital imagery flown with 15 cm GSD are routinely used for the production of 1:1,200 (1"=100') scale maps or orthophotos and 2 ft contours"

some of the modern digital sensors are built with diiferent CCD size (i.e. 6 microns versus the 14 or 21 microns of scanned films) and a variety of lenses, and therefore, the enlargement ratio becomes irrelevant when compared to film scanned at 21 microns. In fact, the application of scale to digital imagery is not valid and only adds to the confusion, particularly since the concepts of paper scale and enlargement ratio are based on film or paper-based maps. Again, the contradicting accuracies represented in our original example are not derived from the ASPRS standard, but result from our misconception that digital imagery with a GSD of 15 cm is only suitable to produce a 1=1,200 (1"=100') scale map with 2 ft. contours.

The ASPRS mapping standard, however, is problematic when applied to data from digital sensors. The ASPRS standard materialized in the 1980s and was approved in the 1990s, before digital sensors were used

continued on page 893

Mapping Matters,, *continued from page 885*

(or even existed) for mapping purposes. When we consider our level of achievement using today's mapping processes, the ASPRS standard is outdated and no longer suitable for further advancement of digital passive and active sensors and to support technologies such as GPS and IMU, especially when the standard is based on mapping scale. Modern standards that are more suitable for digital maps and current and future technologies, such as digital cameras, lidar and IFSAR are needed to replace both the National Map Accuracy Standard (NMAS) and the ASPRS standard. A new set of standards should be developed based on the GSD of the digital data and the resolving power of the imaging sensor, and not on scale since digital scale can vary from one user to another based on the zoom ratio used to evaluate the data.

These same arguments are valid for the more modern standard published by the Federal Geographic Data Committee, which is called the National Standard for Spatial Data Accuracy (NSSDA). The phrase "Accuracy Standard" in the NSSDA title is misleading and should be called "Testing Guidelines". The term "standard test method" is defined by Wikipedia as follows: "to describe a definitive procedure which produces a test result. It may involve making a careful personal observation or conducting a highly technical measurement". This definition does not apply to NSSDA since it does not quantify the testing threshold. To determine the final accuracies, the NSSDA provided a statistical acceptance formula based on 95% confidence level without addressing the threshold (in this case the "RMSE"). Users typically derive an RMSE value in order to use the NSSDA. When users address the NSSDA, we find they are often confused by these guidelines and misrepresent the standard in some way, such as mislabeling requirements (i.e., 2 ft RMSE at 95%). This example statistically makes no sense, since the term RMSE always refers to test results with a confidence level around 68% and not 95%.

In my opinion, the industry desperately needs to reform and consolidate all three standards - NMAS, and ASPRS, and NSSDA - into one single unambiguous national standard that clearly defines procedures and acceptance or rejection thresholds for the different mapping products. This effort requires constructive and focused cooperation between the ASPRS and the FGDC (which represents almost all federal agencies) to draft a standard that's based on today's knowledge, practices, and vision for the future. This effort should focus on developing sets of standards that will remain applicable over time and will not quickly become obsolete as today's innovations and technologies rapidly progress.

In the next issue of this column, I will further discuss my ideas and thoughts on developing this standard, as well as the different conditions and parameters on which it should be based.

to be continued...

Please send your question to Mapping_Matters@asprs.org and indicate whether you want your name to be blocked from publishing.

Answers for all questions that are not published in *PE&RS* can be found on line at www.asprs.org/Mapping Matters.

***Dr. Abdullah is the Chief Scientist at Fugro EarthData, Inc, Frederick, Maryland. He is the 2010 recipient of the ASPRS Photogrammetric (Fairchild) Award.*